UMARU MUSA YAR'ADUA UNIVERSITY, KATSINA (UMYUK)
Journal of Economics and Development (UJED)

EFFECTS OF FOREIGN DIRECT INVESTMENT ON ENVIRONMENTAL POLLUTION IN WEST AFRICA

[1] Mansur U. Bata *, [2] Mustapha M., [3] Ojonuwa A. Bernard, [4] Alfa Y., & [5] Anfofum A. Alexander
[1-5] Department of Economics, Faculty of Social Sciences, Nigerian Defence Academy – Nigeria
***Corresponding authors' email**: mansurbata@gmail.com

Journal Info:
ISSN (e): 3026-8028
(p): 3027-0928
Vol: 01
Issue: 02
December 2024

Pages: 103 – 114

Keywords:
Environmental Pollution, Foreign Direct Investment, Pollution Haven Hypothesis, West Africa

JEL Classification Codes:
C33, O44, R13, Q54

ABSTRACT

West African countries face a dual challenge of fostering economic growth while addressing rising environmental pollution. This study examined how foreign direct investment affects environmental pollution in West Africa, using panel data from 16 countries in the region spanning 1996 to 2022. The variables included in the analysis were ecological footprint (as an indicator of environmental pollution), net inflows of foreign direct investment in current US dollars, renewable energy consumption, and urbanization. The data were analyzed using a panel autoregressive distributed lag (ARDL) model. The findings indicate that foreign direct investment leads to increased environmental pollution in both the short-term and long-term. This outcome supports the pollution haven hypothesis in the context of West Africa. Based on these results, it is recommended that policymakers enhance monitoring and enforcement of environmental regulations. It is crucial to strike a balance between promoting foreign direct investment and ensuring environmental sustainability in West Africa.

1.0 Introduction

The increasing human demand for biologically productive land is significantly impacting nature's ability to regenerate ecosystems. According to the Global Footprint Network (GFN, 2023), more than 80% of the world's population lives in countries currently running ecological deficits, where resource consumption exceeds ecosystem replenishment. For instance, China, the United States, India, Japan, and South Korea are among the top five countries with the largest ecological deficits, measured in global hectares (gha).

Environmental pollution refers to the contamination of natural environment by harmful substances, resulting in adverse effects on ecosystems and human health. It is measured by the Ecological Footprint (EF), which quantifies the amount of biologically productive land and water area required to produce the resources consumed and to assimilate the wastes generated by a population or activity (Elum &Momodu, 2017). GFN (2023) distinguishes four EF types: Consumption EF, Production EF, Imports EF, and Exports EF, each assessing different aspects of resource consumption and the impacts of trade activities.

On the other hands, Foreign Direct Investment (FDI) refers to the financial influx usually associated with the transmission of knowledge, technology, and management practices from investors' home countries to host nations (Awan, et al., 2022). Over the past two decades, FDI has become a significant element of global economic integration efforts. On the production side of economies, FDI is known to impact host economies through scale effects, composition effects, and technological advancements (Awan, et al., 2022). The scale effect leads to increased economic activity due to additional investment, which is expected to have implications for pollution, waste, and ecological impacts. The composition effect is seen in changes to the industry mix within host economies, potentially influencing environmental outcomes based on which industries expand or contract. The technological effect involves the transfer of new knowledge and advanced technologies that can potentially boost productivity and improve ecosystem conditions (Huynh et al., 2020).

The existing environmental economics literature, (such as Baloch et al. 2022, Esmaeili, 2023, & Bouzahzah, 2022), associate Foreign Direct Investment (FDI) primarily with air pollution rather than overall ecosystem degradation. Various hypotheses regarding the relationship between FDI and environmental outcomes have been proposed, including the pollution haven hypothesis and FDI halo hypothesis. According to pollution haven hypothesis, FDI tends flow in to countries with less stringent environmental regulations, leading to the relocation of polluting industries from developed to developing nations (Esmaeili, 2023). In contrast, the "FDI halo hypothesis" proposes that multinational corporations from developed countries can transfer advanced knowledge and environmental practices to local firms in less developed economies, thereby facilitating the adoption of improved environmental standards (Adeleye et al., 2023).

This study focuses on analyzing the relationship between foreign direct investment (FDI) and environmental pollution, measured by ecological footprints, in West Africa from 1996 to 2022. The region's abundant natural resources and developing industries make it an ideal area to examine how FDI impacts environmental conditions. Given West Africa's economic dependence on FDI and the ongoing challenge of balancing economic growth with environmental sustainability, these countries were chosen for their relevance to the study. The research also investigates the Pollution Haven Hypothesis (PHH), which suggests that multinational corporations may relocate production to countries with less stringent environmental regulations. The primary objective of this study is to determine whether FDI inflows have contributed to an increase in environmental pollution across West Africa. The rest of the paper is structured as follows: the "Review of empirical studies" section reviews the literature; the "Methodology" section outlines the data and model estimation techniques; the "Results and Discussions" section interprets and discusses the results, while the "Conclusion and Policy Recommendations" section concludes with policy recommendations.

2.0 Literature Review

Numerous researchers examined the relationship between FDI and Environmental pollution. For instance, Esmaeili (2023) employs Panel Quantile Regression to analyze the impact of foreign direct investment (FDI), economic complexity, and renewable energy use on CO_2 emissions in N-11 countries from 1995 to 2019. The study introduces the interaction between economic complexity and FDI as a novel factor, finding that economic complexity enhances the Environmental Kuznets Curve in early industrialization stages. Foreign direct investment is shown to worsen environmental quality, supporting the Pollution Haven Hypothesis. However, the interaction between economic complexity and FDI mitigates CO_2 emissions. Additionally, increased renewable energy use correlates with lower CO_2 emissions. Apergis et al. (2023) investigated the influence of FDI inflows on carbon emissions in BRICS countries from 1993 to 2012, finding that FDI origin from specific OECD countries impacts carbon emissions differently.

Bouzahzah (2022) explores how foreign direct investment (FDI) affects CO2 emissions in 40 African countries, focusing on the role of institutional quality in validating the Pollution Haven Hypothesis (PHH). Using Panel ARDL and three estimators (Pooled Mean Group, Mean Group, and Dynamic Fixed Effect), the study finds a nuanced relationship between FDI and pollution. Generally, the PHH is not confirmed; however, the impact varies significantly based on institutional quality across African nations. Countries with high corruption levels show reduced CO2 emissions with increased FDI, whereas those with poor institutional quality experience higher emissions. Similarly, Musah et al. (2022) analyzed the impact of FDI inflows on carbon dioxide emissions in selected G-20 countries from 1992 to 2018. Utilizing advanced econometric methods suited for heterogeneous panel data, their research across different income groups (high-, upper-middle-, and lower-middle-income countries) suggests that higher FDI inflows correlate with increased carbon dioxide emissions, supporting the Pollution Haven Hypothesis across diverse income levels. Additionally, increased energy consumption is identified as a contributing factor to long-term CO2 emission increases at both aggregated and disaggregated levels.

Singhania and Saini (2021) find a significant positive impact of FDI on environmental degradation in developed and developing countries with high carbon emissions, supporting the PHH. Halliru et al. (2020) confirm the PHH for CO2 emissions and identify a U-shaped relationship for ecological footprint in ECOWAS countries, indicating increasing environmental degradation with higher FDI and energy consumption. Guzel and Okumus (2020) analyze ASEAN-5 countries and validate the PHH, linking increased FDI to heightened environmental degradation exacerbated by energy consumption. Destek and Okumus (2019) explore newly industrialized countries, noting a U-shaped relationship between FDI and ecological footprint, alongside impacts from economic growth and energy consumption on environmental degradation.

Upon reviewing existing empirical studies, a significant gap was identified concerning the use of comprehensive environmental pollution indicators. Many studies investigating the relationship between FDI and environmental pollution, and validating Pollution Haven or Halo hypotheses, primarily rely on CO2 emissions as a proxy for environmental pollution. However, this measure has inherent limitations. It is crucial to adopt a more holistic indicator such as the ecological footprint, which provides a comprehensive overview of the overall environmental impact. Therefore, this study aims to address this gap by examining how foreign direct investment (FDI) affects the ecological footprint in West Africa.

3.0 Methodology

3.1 Data and Sources

The study utilizes panel data spanning from 1996 to 2022 across sixteen West African countries. The dependent variable is environmental pollution, measured by ecological footprint (EFP) in global hectares (gha). Independent variables include net inflows of Foreign Direct Investment (FDI) in current US dollars, renewable energy consumption (REC) as a percentage of total final energy consumption, and urbanization (URB) measured by urban population as a percentage of total population. Guided by the pollution haven hypothesis, which suggests that increased FDI leads to higher environmental pollution, the study anticipates a positive coefficient for FDI. Conversely, renewable energy consumption (REC) is expected to have a negative effect, while urbanization (URB) is expected to have a positive effect on environmental pollution.

Table 1 provides variable codes, descriptions, expected signs of coefficients, and data sources for clarity and reference.

Table 1. Variables Description and Data Sources

Codes	Description	Signs	Sources
EFP	Ecological Footprint (global hectares-GHA) per person		Global Footprints Network (2023)
FDI	Foreign direct investment, net inflows (current US$)	+	World Bank (2023a)
REC	Renewable energy consumption (% of total final energy consumption)	-	World Bank (2023a)
URB	Urban population (% of total population)	+	World Bank (2023a)

Source: Researcher's compilations (2024)

3.2 Model Specification

Following Adeleye et al. (2023), the study starts with specifying a baseline model with environmental pollution measured by ecological footprint (EFP) expressed as a function of control variables which are renewable energy (REC) and urbanization (URB):

$$EFP = f\left(REN, URB\right) \quad (1)$$

To achieve the objective of this study of investigating the impact of foreign direct investment on environmental pollution and whether the pollution haven hypothesis is valid in West Africa, this study adopted Adeleye et al. (2023) model. Thus, the functional form of the model for this study is given as:

$$EFP = f\left(REN, URB, FDI\right) \quad (2)$$

The econometrics representation of model (2) is given as:

$$EFP_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 REC_{it} + \beta_3 URB_{it} + \varepsilon_{it} \quad (3)$$

Where: EFP is Ecological footprint of country i at time t; FDI is Foreign direct investment, with β_1 representing its effect on EFP. A positive β_1 suggests that higher FDI leads to a larger ecological footprint, supporting the Pollution Haven Hypothesis; REC is Renewable energy consumption, with β_2 indicating its effect on EFP; a negative $\beta_{(2)}$ suggests that increased renewable energy consumption reduces the ecological footprint. URB is Urbanization level, with β_3 showing its impact on EFP; a positive β_3 implies that urbanization increases the ecological footprint; β_0 and ε_{it} are intercept and error terms respectively. However, to correct for possible heteroskedasticity, equation (3) is re-expressed in logarithmic form and is given as:

$$\ln EFP_{it} = \beta_0 + \beta_1 \ln FDI_i t + \beta_2 REC_i t + \beta_3 URB_i t + \varepsilon_{it} \quad (4)$$

where: ln = logarithm to base 10. Only EFP and FDI are converted into logarithmic form, whereas renewable energy consumption (REC) and urbanization (URB) remain in their original form because they are expressed as percentages.

3.3 Model Estimation Techniques

The empirical analysis begins with summarizing statistics and conducting correlation analysis, followed by assessing cross-sectional dependence among the countries to determine appropriate methodologies. The risk of cross-sectional dependence is heightened due to the geographical proximity of the units and the potential for shared characteristics. If cross-sectional dependence (CSD) exists in the data, it can lead to biased estimates and unreliable inferences (Pesaran, 2004). To mitigate this issue, the study employs Pesaran's (2004) test for cross-sectional dependency (CD), applicable to both small and large panels. The null hypothesis of no CSD, which is tested against alternative hypotheses and can be rejected at the 1%, 5%, and 10% significance levels, is stated as:

$$CD = \sqrt{\frac{2T}{N}(N-n)}\left(\sum_{i=1}^{N-1}\sum_{k=i+1}^{N}\hat{\rho}_{i,k}\right) \quad (5)$$

If cross-sectional dependence is detected, the data undergoes second-generation unit root tests to prevent spurious outcomes. Specifically, the study utilizes the cross-sectional augmented Im, Pesaran, and Shin (CIPS) test developed by Pesaran (2007). This test builds upon the unit root test originally proposed by Im et al. (2003). The CIPS test is formulated as:

$$CIPS(N,T) = \hat{T} = N^{-1}\sum_{i=1}^{N} t_i(N,T) \quad (6)$$

where N and T are the numbers of cross-sections and years, respectively. The left-hand side of Eq. (6) is the unit root test for heterogeneous panels, while on the right-hand side, the term ti is the ordinary least squares (OLS) t-ratios employed in cross-sectional averaged augmented Dickey-Fuller (ADF) regression. As a preliminary check, this study also employed the Cross-Sectional Augmented Dickey-Fuller (CADF) panel unit test introduced by Pesaran (2007). Thereafter we assessed whether a long-run relationship exists among the variables using the second-generation panel cointegration tests proposed by Westerlund (2007). This technique is suitable in the presence of CSD in the data, and the null hypothesis of no cointegration can be rejected at the 1%, 5%, or 10% significance levels.

Finally, this study used the panel autoregressive distributed lag (ARDL) model to estimate the parameters of the model. This estimation technique not only addresses cross-sectional dependence but also accommodates different lag lengths for different variables, captures both short-term and long-term relationships, and provides robust estimates even with small sample sizes (Pesaran et al., 2001). The panel autoregressive distributed lag (ARDL) model is given as:

$$\begin{aligned}\Delta \ln EFP_{it} &= \alpha_0 + \alpha_1 \ln EFP_{it} + \alpha_2 \ln FDI_{it} \\ &+ \alpha_3 \ln REC_{it} + \alpha_4 URB_{it} + \sum_{j=0}^{p}\beta_1 \Delta EFP_{t-i} \\ &+ \sum_{j=0}^{q}\beta_2 \Delta \ln FDI_{t-i} + \sum_{j=0}^{r}\beta_3 REC_{t-i} \\ &+ \sum_{j=0}^{s}\beta_4 \Delta URB_{t-i} + \mu_t\end{aligned} \quad (7)$$

Where i and j denote the lags (i = 1, 2⋯ p; j = 0, 1, 2, ⋯,s and t represents time); $\ln EFP_t$ is the dependent variable, FDI, REC, and URB are the explanatory variables; α_0 is the intercept, α_1 to α_4 represent the long-run coefficients of the explanatory variables, β_1 is the short-run coefficient of the lagged dependent variable; β_2 to β_4 represent the short-run coefficients of the lagged explanatory variables. Lastly, μ_t shows the error-term. The error correction forms of model (7) is specified as follows:

$$\begin{aligned}\Delta \ln EFP_{it} &= \alpha_0 + \sum_{j=0}^{p}\beta_1 \Delta \ln EFP_{t-i} \\ &+ \sum_{j=0}^{q}\beta_2 \Delta \ln FDI_{t-i} + \sum_{j=0}^{r}\beta_3 REC_{t-i} \\ &+ \sum_{j=0}^{s}\beta_4 \Delta URB_{t-i} + ECT_{t-1} + \mu_t\end{aligned} \quad (8)$$

ECT_{t-1} represents the lagged value of the error correction term from the cointegration equation. It captures the long-term equilibrium relationship between the variables. The coefficient of ECT indicates the speed at which deviations from the long-term equilibrium are corrected in each period.

4.0 Results and Discussion

4.1 Results of Pre estimations Tests

The summary of descriptive statistics (using untransformed values) is presented in Table 2. The results revealed that the average ecological footprint (EFP) in West Africa is 1.305 GHA, with a standard deviation of

0.382, indicating moderate variability. Foreign direct investment (FDI) averages $536 million, with a wide range from -$884 million to $8,840 million and a standard deviation of $1.180 million. Renewable energy consumption (REC) averages 67.718%, ranging from 20.780% to 94.960%, with a standard deviation of 20.269%, while urbanization (URB) averages 41.193%, varying between 15.407% and 67.545%, with an 11.403% standard deviation.

Table 2: Descriptive Statistics

Variable	EFP	FDI	REC	URB
Mean	1.305	536	67.718	41.193
Minimum	0.778	-884	20.780	15.407
Maximum	2.794	884	94.960	67.545
Std. Dev.	0.382	118	20.629	11.403
Observations	432	432	432	432

Source: Authors' computations (2024).

In this study, pairwise correlation and variance inflation factor (VIF) were employed to detect the presence of multicollinearity among the independent variables under investigation and the results are presented in Tables 3. From the pairwise correlation reported on the lowest panel of Table 2, all the variables with the exception of foreign direct investment (FDI) indicate significant negative association with the dependent variable (EFP). In addition, none of the regressors exhibit a perfect linear relationship, as evidenced by correlation statistics below 0.70 for all variables. Consequently, there is no indication of multicollinearity among the regressors.

Table 3: Results of Pairwise Correlation and Variance Inflation Factor (VIF)

Variable	lnEFP	lnFDI	REC	URB
lnEFP	1.000			
lnFDI	0.877 (0.000)	1.000		
REC	-0.449 (0.000)	0.493 (0.000)	1.000	
URB	-0.725 (0.000)	0.639 (0.000)	0.192 (0.000)	1.000
Variance Inflation Factor:		2.748	1.426	1.305

P-values in parentheses ( ) and ln: natural logarithm.

Similarly, the estimation of the variance inflation factor (VIF) for each independent variable, as shown in Table 3, aims to assess the presence of multicollinearity. The results affirm the absence of multicollinearity, as all VIF values for the independent variables are below 5.

The Pesaran (2004) CD test result presented in Table 4 reject the null hypothesis of no cross-sectional dependence at the 1% significance level, suggesting that any shock in one country may be transmitted to other West African countries. The presence of cross-sectional dependence highlights the interconnectedness or shared influences among these nations, indicating that economic shocks or changes in one country could have spillover effects on neighboring countries within West Africa.

To examine the stationarity of the variables, the Pesaran (2003) CADF and Pesaran (2007) CIPS second-generation unit root test that presumes "cross-sectional dependency" are deployed. The outcomes from both tests indicate that all the variables with the exception of lnFDI are stationary after taking the first difference. The Westerlund (2007) cointegration results indicate a long-run relationship among the variables exist in the model.

Table 4: Results of Cross-sectional Dependence, Slope Homogeneity, Unit Root, and Cointegration Tests

	Pesaran (2004) CD	Pesaran (2003) CADF		Pesaran (2007) CIPS	
Variables	CD-test	Level	1st Diff	Level	1st Diff
lnEFP	3.643***	-1.181	-4.655***	-1.914	-5.870***
lnFDI	31.364***	-4.760***	N/A	-3.612***	N/A
REC	23.239***	-1.777	-2.617***	-1.993	-4.834***
URB	55.172***	-1.771	-3.008***	-1.978	-3.133***

Test	Pesaran & Yamagata (2008)			
	Delta(Δ)	P-Value	Adj.(Δ)	P-Value
	10.642	0.000	12.686	0.000
Test	Westerlund (2007) Cointegration Test			
Variance ratio:	-1.970**	P-value = 0.024		

Note: ***p < 0.01, **p < 0.05, *p < 0.10, ln: natural logarithm, CD: cross-sectional dependence, CD and panel unit root tests performed using the Stata17.

To examine slope homogeneity, the Pesaran and Yamagata (2008) test is utilized. The results indicate that the slopes are heterogeneous, suggesting that the regression coefficients differ across West African countries. This means the impact of the independent variables on the dependent variable varies across entities or time periods. The null hypothesis in this test assumes that the slope coefficients are homogeneous (Pesaran and Yamagata, 2008).

4.2 Results of Long-run and Short-run Estimations

The results of estimated long-run coefficients of the model are reported in Table 5.

Table 5. Results of Estimated Long-run Coefficients (Dependent variable is EFP)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
lnFDI	0.108	0.018	6.020	0.000
REC	-0.545	0.139	-3.921	0.002
URB	-0.291	0.038	-7.658	0.000

Source: Authors' computations (2024)

The results of estimated long-run coefficients in table 5 revealed that foreign direct investment (FDI) has positive and statistically significant relationship with ecological footprint (EFP) in the long-run. This implies that the inflows of FDI lead to an increase in environmental pollution in West Africa. Specifically, a 1% increase in FDI contributes positively to environmental pollution by 0.108% in the long-run. This finding validated the pollution haven hypothesis in West Africa. Moreover, the positive increasing effect may be due to the relocation of polluting firms from high-income countries with quality regulation to low-income West African countries with less stringent environmental regulation (Guzel and Okumus 2020). The environmental pressure of FDI is unsurprising because the West African countries in this study are non-high-income countries with increased pollution. This result support the finding of Esmaeili (2023). Contrarily, Halliru et al. (2020) found evidence of positive relationship between FDI and environmental pollution in West Africa.

However, the results show that renewable energy consumption (REC) has a negative impact on EFP. The coefficient is -0.545 in the long-run means, an increase of renewable energy consumption (REC) by 1% will leads to reduction of environmental pollution by 0.545% in the long-run. This suggests that an increase in renewable energy consumption contributes to a decrease in environmental pollution in West Africa. Similarly, urbanization (URB) exhibits a negative impact on EFP. The coefficient is -0.291 in the long-run, indicate that higher urbanization is associated with a reduction in environmental pollution in West Africa.

Table 6. Results of Estimated Short-run Coefficients (Dependent variable is EFP)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Intercept	0.357	0.083	4.300	0.000
ΔlnEFP	0.364	0.040	9.100	0.000
ΔlnFDI	0.033	0.012	2.730	0.015
ΔREC	-0.068	0.047	-1.450	0.391
ΔURB	0.357	0.083	4.302	0.000
ECT (-1)	-0.727	0.159	-4.549	0.000

Note: Akaike Information Criterion (AIC) was used to select optimum lags of (1, 1, 1, 1, 1).
Source: Authors' computations (2024)

Table 6 presents the estimated short-run coefficients for the ecological footprint (EFP) model, estimated using the panel autoregressive distributed lag (ARDL) approach. The results show that the lagged change in ecological footprint (ΔlnEFP) has a positive coefficient of 0.364, and also highly significant (p-value 0.000). This indicates that a 1% increase in past values of EFP results in a 0.364% increase in the current environmental pollution measured by EFP. For foreign direct investment (ΔlnFDI), the coefficient is 0.033 and significant at the 5% level (p-value 0.015). This suggests that a 1% increase in FDI leads to a 0.033% increase in EFP, indicating that FDI contributes to environmental pollution in the short run.

The change in renewable energy consumption (ΔREC) has a coefficient of -0.068, which is not statistically significant (p-value 0.391). Although the coefficient suggests a negative relationship, indicating that increased renewable energy consumption could reduce EFP, this effect is not significant in the short run. Urbanization (ΔURB) shows a coefficient of 0.357, and highly significant (p-value 0.000). This indicates that a 1% increase in urbanization leads to a 0.357% increase in EFP, highlighting the significant impact of urbanization on environmental pollution.

The error correction term (ECT (-1)) has a coefficient of -0.727 and also highly significant (p-value 0.000). This negative and significant ECT confirms the presence of a long-run equilibrium relationship among the variables, with about 72.7% of the disequilibrium from the previous period being corrected in the current period. In terms of model performance, the R-squared value of 0.8505 indicates that approximately 85.05% of the variation in EFP is explained by the model, demonstrating a good fit. The F-statistic of 17.071, significant at the 1% level (p-value 0.000), suggests that the explanatory variables jointly have a significant effect on EFP.

5.0 Conclusion and Recommendation

The relationship between environmental pollution and macroeconomic variables especially economic growth and foreign direct investment has fueled recent debates. As such, this study contributes to the discourse by engaging an annual panel data of 16 West African countries covering 1996–2022. To achieve the study's objectives, panel autoregressive distributed lag (ARDL) estimation technique is applied. The main findings reveal that foreign direct investment increases environmental pollution both in the short-run and in the long-run. This result confirms the validity of the pollution haven hypothesis in West Africa.

Based on these findings, it is recommended that policymakers should strengthen monitoring and enforcement of environmental regulations and strike a balance between foreign direct investment and environmental sustainability in West Africa. Secondly, recognizing the adverse impact of substantial foreign direct investment on environmental quality, policymakers should implement a comprehensive set of measures to mitigate these negative effects. Strategies may include the establishment of stringent environmental standards and regulations that foreign investors must adhere to, ensuring that their operations align with sustainable practices. Additionally, promoting transparency and accountability in the FDI approval process can help scrutinize the environmental implications of proposed investments. Policymakers should actively engage with foreign investors to encourage the adoption of eco-friendly technologies and practices, fostering a responsible and environmentally conscious approach to foreign direct investment. This multifaceted approach aims to harness the benefits of FDI for economic growth while safeguarding the environment and promoting sustainability.

References

Adeleye, B. N., Akam, D., Inuwa, N., James, H. T., & Basila, D. (2023). Does Globalization and Energy Usage Influence Carbon Emissions in South Asia? An empirical revisit of the debate. Environmental Science and Pollution Research, 30(13), 36190-36207.

Adu, D. T., & Denkyirah, E. K. (2019). Economic growth and environmental pollution in West Africa: Testing the Environmental Kuznets Curve Hypothesis. Kasetsart Journal of Social Sciences, 40(2), 281-288.

Ahmed, Z., Zhang, B., & Cary, M. (2021). Linking economic globalization, economic growth, financial development, and ecological footprint: Evidence from symmetric and asymmetric ARDL. Ecological Indicators, 5(3), 121-137.

Al-Mulali, U., Ozturk, I., &Solarin, S. A. (2016). Investigating the environmental Kuznets curve hypothesis in seven regions: The role of renewable energy. Ecological indicators, 67, 267-282.

Apergis, N., & Ozturk, I. (2015). Testing environmental Kuznets curve hypothesis in Asian countries. Ecological indicators, 52, 16-22.

Apergis, N., Pinar, M., &Unlu, E. (2023). How do foreign direct investment flows affect carbon emissions in BRICS countries? Revisiting the pollution haven hypothesis using bilateral FDI flows from OECD to BRICS countries. Environmental Science and Pollution Research, 30(6), 14680-14692.

Apergis, N., Pinar, M., &Unlu, E. (2023). How do foreign direct investment flows affect carbon emissions in BRICS countries? Revisiting the pollution haven hypothesis using bilateral FDI flows from OECD to BRICS countries. Environmental Science and Pollution Research, 30(6), 14680-14692.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The review of economic studies, 58(2), 277-297.

Atasoy, B. S. (2017). Testing the environmental Kuznets curve hypothesis across the US: Evidence from panel mean group estimators. Renewable and Sustainable Energy Reviews, 77, 731-747.

Awan, A., Abbasi, K. R., Rej, S., Bandyopadhyay, A., &Lv, K. (2022). The impact of renewable energy, internet use and foreign direct investment on carbon dioxide emissions: A method of moments quantile analysis. Renewable Energy, 189, 454-466.

Baloch, A., Shah, S. Z., Rasheed, S., & Rasheed, B. (2022). The impact of shadow economy on environmental degradation: empirical evidence from Pakistan. GeoJournal, 87(3), 1887-1912.

Bouzahzah, M. (2022). Pollution haven hypothesis in Africa: does the quality of institutions matter?. International Journal of Energy Economics and Policy.

Churchill, S. A., Inekwe, J., Ivanovski, K., & Smyth, R. (2018). The environmental Kuznets curve in the OECD: 1870–2014. Energy economics, 75, 389-399.

Destek, M. A., &Okumus, I. (2019). Does pollution haven hypothesis hold in newly industrialized countries? Evidence from ecological footprint. Environmental Science and Pollution Research, 26, 23689-23695.

Elum, Z. A., & Momodu, A. S. (2017). Climate change mitigation and renewable energy for sustainable development in Nigeria: A discourse approach. Renewable and Sustainable Energy Reviews, 76, 72-80.

Esmaeili, P., Lorente, D. B., & Anwar, A. (2023). Revisiting the Environmental Kuz netz curve and Pollution Haven Hypothesis in N-11 Economies: Fresh Evidence from Panel Quantile Regression. Environmental Research, 228, 115844.

Fang, Z., Gao, X., & Sun, C. (2020). Do financial development, urbanization and trade affect environmental quality? Evidence from China. Journal of Cleaner Production, 259.

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. The quarterly journal of economics, 110(2), 353-377.

Guzel, A. E., &Okumus, İ. (2020). Revisiting the pollution haven hypothesis in ASEAN-5 countries: new insights from panel data analysis. Environmental Science and Pollution Research, 27, 18157-18167.

Halliru, A. M., Loganathan, N., Hassan, A. A. G., Mardani, A., & Kamyab, H. (2020). Re-examining the environmental Kuznets curve hypothesis in the Economic Community of West African States: A panel quantile regression approach. Journal of Cleaner Production, 276, 124247.

Halliru, A. M., Loganathan, N., Sethi, N., & Hassan, A. A. G. (2020). FDI inflows, energy consumption and sustainable economic growth for ECOWAS countries: The pollution haven hypothesis approach. International Journal of Green Economics, 14(4), 327-348.

Huynh, C. M., Nguyen, V. H. T., Nguyen, H. B., & Nguyen, P. C. (2020). One-way effect or multiple-way causality: foreign direct investment, institutional quality and shadow economy?. International Economics and Economic Policy, 17, 219-239.

Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. Econometrics 115(1):53–74.

IPCC (2019) Sources of CO2. In: Gale J, Bradshaw J, Chen Z, Garg A, Gomez D, Rogner H-H, Simbeck D, Williams R, Toth F, van Vuuren D, El Gizouli I, Hake JF (eds) IPCC Special Report on Carbon Dioxide Capture and Storage. IPCC, pp 75–105.

Jeetoo, J., & Chinyanga, E. R. (2023). A spatial econometric analysis of the environment Kuznets curve and pollution haven hypothesis in Sub-Saharan Africa. Environmental Science and Pollution Research, 30(20), 58169-58188.

Köksal, C., Işik, M., &Katircioğlu, S. (2020). The role of shadow economies in ecological footprint quality: empirical evidence from Turkey. Environmental Science and Pollution Research, 27, 13457-13466.

López-Menéndez, A. J., Pérez, R., & Moreno, B. (2014). Environmental costs and renewable energy: Re-visiting the Environmental Kuznets Curve. Journal of environmental management, 145, 368-373.

Maddala GS, Wu S (1999) A comparative study of unit root tests with panel data and a new simple test. Oxford Bull Econ Stat 61:631– 652

Musah, M., Mensah, I. A., Alfred, M., Mahmood, H., Murshed, M., Omari-Sasu, A. Y., ... &Coffie, C. P. K. (2022). Reinvestigating the pollution haven hypothesis: the nexus between foreign direct investments and environmental quality in G-20 countries. Environmental Science and Pollution Research, 1-18.

National Geographic (2019) Carbon dioxide levels are at a record high. Here's what you need to know. Retrieved from https://www.nationalgeographic.com/environment/global-warming/green house-gases/

Onifade, S. T. (2022). Retrospecting on resource abundance in leading oil-producin g African countries: how valid is the environmental Kuznets curve (EKC) hypothesis in a sectoral composition framework? Environmental Science and Pollution Research, 29(35), 52761-52774.

Pesaran MH (2004) General diagnostic tests for cross section dependence in panels. University of Cambridge, Faculty of Economics, Cambridge Working Papers in Economics No. 0435.

Shao, Q., Wang, X., Zhou, Q., & Balogh, L. (2019). Pollution haven hypothesis revisited: a comparison of the BRICS and MINT countries based on VECM approach. Journal of Cleaner Production, 227, 724-738.

Singhania, M., & Saini, N. (2021). Demystifying pollution haven hypothesis: Role of FDI. Journal of Business Research, 123, 516-528.

Tachega, M. A., Yao, X., Liu, Y., Ahmed, D., Ackaah, W., Gabir, M., & Gyimah, J. (2021). Income heterogeneity and the environmental Kuznets curve turning points: Evidence from Africa. Sustainability, 13(10), 5634.

Weimin, Z., Sibt-e-Ali, M., Tariq, M., Dagar, V., & Khan, M. K. (2022). Globalization toward environmental sustainability and electricity consumption to environmental degradation: does EKC inverted U-shaped hypothesis exist between squared economic growth and CO2 emissions in top globalized economies. Environmental Science and Pollution Research, 29(40), 59974-59984.

Westerlund J (2007) Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics 69(6):709–748.