Research Article



# Empirical Test of Pollution Haven Hypothesis in Nigeria Using Autoregressive Distributed Lag (Ardl) Model

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***Abstract***

*This study set out to investigate the reality or otherwise of the pollution haven hypothesis in Nigeria using data from 1970 to 2017 and using the autoregressive distributed lag (ARDL) models both in the short and long run. The study used FDI inflows as measure of economic activity and carbon dioxide emission as a measure of regulatory stringency. The study finds the previous FDI inflows as a significant determinant of current FDI both in the short and long run. This implies that the more FDI an economy attracts, the more potentials it has to further attract more FDI. Population, a measure of demand condition of the host economy is positively and significantly related to FDI inflows both in the short run and in the long run. Trade openness has a positively significant impact on FDI inflows in the long run, meaning that globalization encourages FDI inflows. A year lag of the FDI has a positively significant impact on FDI inflows in the long run. This suggest that pollution haven hypothesis which states that industries with polluting technologies tend to relocate to countries or areas (pollution havens) with lax or less stringent environmental regulations is a reality for Nigeria. The implication of this is that government of Nigeria must weigh the beneficial impact of FDI inflows against the pollution impact of 'dirty' FDI before deciding or setting its environmental policy.*

***Keywords:*** *Pollution haven, environmental stringency, FDI, ARDL, carbon dioxide emission*

## 1. Introduction

Pollution haven hypothesis states that under free trade; relocation of pollution-intensive goods from stringent pollution regulation countries (developed countries) to lax regulation countries (developing countries) takes place. It is strong that this effect overrides other motives for trade in dirty goods (Copeland and Taylor, 2004). This is different from pollution haven effect. Pollution haven effect posits that difference in environmental regulation affects plant location decisions and trade flows. OR stricter environmental regulation decreases net exports of dirty goods.

There is plethora of studies to validate the existence or otherwise of pollution haven hypothesis Worldwide, but few studies have been conducted on Nigeria. According to researchers, studies analyzing the pollution haven hypothesis can be categorized into testing one of the following hypotheses:

i. Differences in the set environmental standards exert significant influence on investment flows.
ii. There is a wide use of pollution – intensive technology in developing countries
iii. Pollution intensive production processes flee the high standard setting countries

Theoretically, there are at least three reasons for differences in environmental standards.

(i) Generally, countries with higher emission discharges are expected to have stricter environmental standards than a country with lower emissions. Developing countries have lower emissions than the developed countries based on their energy consumption per capita (World Bank, 1999) and are expected to have laxer environmental standards.
(ii) Differences in pollution absorptive capacity: There is a wide difference in country's assimilative capacity for pollution than the developed countries (Snape, 1992). The above point however is not supported scientifically as absorptive capacity depends on pollution type, meteorological condition and topography.
(iii) Disparity in intensity of environmental preferences: Environmental quality is assumed to be a luxury good and as such, it is expected to be lower in developing countries.

Apart from the above three points, Birdsall and Wheeler (1993) have observed that there is a higher cost of monitoring and enforcement of pollution standards in developing countries of the World due to inadequate trained personnel, lack of state of the art monitoring equipment, and the high marginal costs of engaging any new governmental activity when the target is curtailing fiscal burdens.

In addition, Oates and Schwab (1988) and Chao and Yu (1997) have proved that some countries (especially developing) are motivated to setting inefficiently low standards so as to raise tax revenue especially when the government's revenue depends more on capital taxation. Lowering standard therefore becomes a way of attracting foreign capital thereby boosting tax revenue. This is also typical of developing countries of the world.

Various studies have been conducted to test the validity of pollution haven hypothesis using panel data. These studies analyzed pollution haven for a number of countries, sectors within the same country, and a group of countries and another. The main problem with these studies is that of heterogeneity. Different countries have different characteristics that may not be captured by their models. There is also the erroneous belief that a country's environmental policy is static and stringency of environmental regulation is constant over time for a country. Even, if environmental laws are constant for a country, its enforcement differs from time to time therefore making the analysis of pollution haven better using a country case study.

To this end therefore, this paper has the broad objective of investigating the validity or otherwise of pollution haven hypothesis in Nigeria using the carbon dioxide emission ($CO_2$) data to capture environmental stringency.

## 2. Literature /Theoretical Underpinning

There are various studies on pollution haven hypothesis, some using FDI, inflows as dependent variable while others used net exports. In the same vein, there is no consensus on the measurement of environmental stringency. Some researchers have used the following: permit fees,

emissions limits, environmental taxes or fees, regulatory delays, measurement of pollution, public awareness of environmental problems, environmental agencies' budgets, and international environmental agreements joined by the country among other measures. This study therefore reviews some of the earlier studies so as to learn one thing or the other from the previous studies.

Aliyu (2005) analyzes the impact of dirty FDI on host economies using the annual data on CO2 total emission, and total emission on particulate matters, increasing temperature and total energy use. The study used disaggregated data and panel data finds environmental policy as positively correlated with FDI outflow in II OECD countries. However, FDI inflow insignificantly explains pollution level and energy use in 14 OECD countries.

Riti and Kamah (2015) explores the impact of trade liberalization and FDI inflows on economic growth in Nigeria and; the implication of globalization on environment (carbon dioxide emission) using the method of cointegration and error correction method on data from 1981 to 2013. They find FDI inflows and trade openness as aiding economic growth in Nigeria. They also find FDI inflows as worsening the environment in Nigeria in the long run. They recommend the initiation of sound environmental policy to ameliorate the effect of environmental degradation effects of globalization.

Danladi and Akomolafe (2013) examine the causality between FDI and economic growth population and economic growth and; FDI and economic growth for Nigeria between 1977 and 2010. They utilized data for GDP, FDI and pollution. They find that there is no causality between FDI and GDP growth rate. They also find no causality between carbon dioxide emission ( a measure of pollution) and foreign direct investment indicating the non-applicability of pollution haven hypothesis in Nigeria.

Ayadi (2014) analyzes the contributions of trade liberalization and foreign direct investment inflows on growth in Nigeria and also analyzes the impacts of integration on the Nigerian environment utilizing ordinary least squares (OLS), co-integration and error correction mechanism based on data from 1970 to 2012. He finds trade openness and FDI inflows as having less than substantial implications on economic growth in Nigeria. The study finds capital formation as significantly aiding growth in the long run. The study proposes possible reason for this to; lack of enabling environment in the form of infrastructural deficiency. Other finding is that economic growth and foreign direct investment into Nigeria significantly fuelled pollution while trade is beneficial both in the short and long run. The study recommends infrastructural provision, initiation and enforcement of sound environmental policy among others to make integration to make meaningful impact in developing countries generally.

Temurshoev (2006) examines the effect of free trade on the environment by analyzing which of the 2 theories of Pollution haven hypothesis and factor endowment hypothesis prevails in the trade between US and China using the input-output method. He looks at how much some pollutants (NOx, CO2 and SO2) will increase in US and China if exports and imports in the 2 countries increase by the same amount. He finds that pollution haven hypothesis is unfounded (by data). In other words, US (developed country) is not a winner in terms of emission and China ( a developing country) is not pollution haven for US polluting goods rather, China is a winner and US a loser.

Ayadi (2005) explores the possible channels in which trade liberalization could affect the environment. In the analysis, he conducted a research on the impact of trade intensity (openness on pollution (using Co2 data) and resource depletion (using deforestation figure) in Nigeria using the vector autoregressive model (VAR). His result indicates that the scale effect of trade intensity is positively related to pollution, the composition effect of trade is real in the short and medium term while the technique impact is beneficial. The conclusion on resource utilization indicates that scale and technique impacts are detrimental while it is beneficial via the composition effect. Overall, trade intensity is detrimental to pollution and resource utilization.

Leslie (2016) evaluates empirically the pollution for 30 OECD countries to 70 countries (30 OECD and non-OECD) for the year 2012. His model follows the proximity-concentration trade-off gravity model which explains the choice made by enterprises in engaging in exports or FDI as a tradeoff occasioned by differences in costs and revenue choices associated with each option. Rather than use net export or FDI, this study utilize the ratio of exports to foreign direct investment flows among countries pairs as the dependent variable to capture the ways an enterprise can serve

a foreign market. This ratio not only captures a more complete assessment of locational decisions of enterprise as against observing only one of two of these variables. The explanatory variables of the model are, vectors of cost, vector of the ratio of environmental standards between country's pairs, vector of additional, fixed cost-influential variables, vectors of export and import fixed effects. Specifically, the study estimated a log-linear model in which environmental ratio, distance, tarrif, border, colony and inverse mills ratio.

Xing and Kolstad (1997) analyze the determinants of FDI from the United States for some sectors of the economy. Basically, their sample is relatively small, but they find the coefficient of environmental strictness significantly negative for some industries (chemical) and some are significant (for electronic industry) implying that lax in environmental regulations do provide incentive for polluting industries to increase their FDI flows to those sectors.

Dean et.al, (2004) estimates the strength of pollution haven hypothesis for 2886 joint venture manufacturing projects for the period 1993 to 1996 by examining the locational choice of equity joint ventures (EJV) projects in China using the methods of Logit and nested multinational logit models. They find EJVs from all sources are channeled into provinces with abundant skilled workers, high level of foreign investment, concentrations of foreign firms, and important incentives. They find environmental stringency as an unimportant factor affecting locational choice.

Kellogg (2006) uses new and highly focused test of pollution haven hypothesis by examining the connection between international factor trade in coal and the concentration of SO2 in urban air for industries classified by SIC codes for 1982, 1987 and 1992 and by NAICS code for 1997. He finds small but statistically significant evidence that countries have higher net factor exports of coal. However, he cautioned on the use of this result as a guide to policy formulation.

Lundh (2017) Studies the effect of differences in environmental regulatory stringency on FDI inflows between European OECD and the recipient BRIICS countries using data between 2003 and 2012. The study utilizes the fixed effect model in this panel study and finds a weak support for pollution haven for a time lag of one year. Based on the above, the discourse of pollution haven hypothesis is far from being concluded and this study makes its contribution by analyzing the pollution haven hypothesis for Nigeria using FDI inflows as the dependent variable and using the carbon dioxide emission as a measure of economic stringency.

The main theory of trade that explains the link between international trade and investment is Heckscher-Ohlin-Vanek (HOV) model. This model asserts that each country would export goods that use intensively the factors of production which is relatively abundant in each country. Cole and Elliot (2002) and; Mani and Wheeler (1999) observe that polluting industries are mainly capital intensive. From evidences, developed as opposed to developing countries are mainly capital intensive and are therefore the major specialists in polluting industries. By implication, HOV model is just the direct opposite of pollution haven hypothesis.

The pollution haven hypothesis is the hypothesis that shows that industries with polluting technologies tend to relocate to countries or areas {pollution havens} with lax or less stringent environmental regulations. The reason for this is clear; environmental regulations or protections come with some costs as it increases major inputs' costs of goods with pollution intensive technology thereby reducing the relative comparative advantage in those goods.

The HOV theory asserts that countries will be inclined to export goods that utilize their abundant factors intensively. In other words, in terms of factor content in consumption, trade and production, the theory assumes that there is free or costless trade; there similarity in goods production by all countries; all countries have access to same technology and factor prices are equal. Therefore, countries consume all factors content of goods in equal proportion and various countries are endowed with different factor ratios, the difference between the heterogeneity in endowment ratios and uniformity of consumption ratios is the factor content of trade.

Environmental regulations imposes extra costs on firms that are subject to stricter environmental regulations than firms that are subjected to stricter environmental regulations than firms that faces lax in environmental regulation or non-existence environmental regulations. Given that two countries are identical in term of endowments and other conditions except for strictness in environmental regulations, economic theory posit that country with lax in environmental policy would offer a cost advantage to dirty producers or industries.

By implication, countries with strict environmental regulations would therefore specialize in cleaner production and import the output of dirty industries. This is also in conformity with the standard international trade theory which states that countries will have a comparative advantage in goods manufactured with factors that are in abundance relatively. In this situation therefore, the environment as an allowable dumping ground for pollution and environmental degradation would serve as scarce factor or abundance factor.

Porter and Van der Linde (1995) also have advanced a theoretical postulate that strict environmental regulations may enhance international competitiveness in the long-run while strict environmental regulation encourage firms to be innovative thereby lowering costs over and above those of their competitors ultimately.

Empirical validation of this theory has produced so many controversies especially by the measurability of environmental stringency. Some also argued about the simultaneity in the determination of environmental stringency and pollution. Generally, econometric studies on pollution haven hypothesis are based on the estimation of the form (Levinson, 2003):

$$Y_i = \beta_i R_i + \alpha_i X_i + \mu_i$$

Where Y is the economic activity, R denotes the regulatory stringency, X' are the vectors of other determinants of Y while μ is the effort term. In the above model therefore, if there is evidence of pollution haven, $\partial Y / \partial R$ should be significantly negative$(\hat{\beta} < 0)$. Finding a good measure of R (regulatory stringency) has been difficult. Researchers have used the following: permit fees, emissions limits, environmental taxes or fees, regulatory delays, measurement of pollution, public awareness of environmental problems, environmental agencies' budgets, and international environmental agreements joined by the country among other measures.

In the choice of Y itself, there is serious controversy. Some authors used net experts, others used employment, while some used new manufacturing industries and some used foreign direct investment. There are also studies which used sub-national data and some also disaggregated date to sectors or industry to see the differential effect of pollution haven.

## 3. Methodology

The general model adapted for this study is that of Levinson (2003).

$$Y_i = \beta_i R_i + \alpha_i X_i + \mu_i$$

Where Y is the economic activity, R denotes the regulatory stringency, X' are the vectors of other determinants of Y while μ is the effort term. In the above model therefore, if there is evidence of pollution haven, $\partial Y / \partial R$ should be significantly negative$(\hat{\beta} < 0)$.

Specifically, this study utilized the model:

FDI = f(POP, OPENN, CAB, INF, NRE, ELE)

Specifically, the robust econometric model of the study is; ARDL (4,3,0,1,0,0,0):

$$FDI_t = \alpha_0 + \alpha_1 FDI_{t-1} + \alpha_2 FDI_{t-2} + \alpha_3 FDI_{t-3} + \alpha_4 FDI_{t-4} + \delta_1 POP_t + \delta_2 POP_{t-1} + \delta_3 POP_{t-2} +$$
$$+ \delta_4 POP_{t-3} + \gamma_1 OPENN_t + \lambda_1 CAB_t + \lambda_2 CAB_{t-1} + \Omega_1 INF_t + \pi_1 NRES_t + \theta_1 ELE_t + \mu_t$$

Where:

FDI is the inward foreign direct investment in US $. TRAD is the total merchandize trade in US $. ELE is the measure of infrastructure (electricity generation KWh per capita). GDP is the measure of gross domestic product. INF is the inflation rate. POP is the population – a measure of market size, OPENN is trade openness (trade to GDP ratio). NRES is the natural resources rent as a percentage of GDP and POL is the dummy variable capturing political stability (with value 1 for democratization and zero otherwise). The study analyzed the data using the method of autoregressive distributed lag (ARDL) based on its dynamism. Economic activity (FDI) and regulatory stringency (carbon dioxide emission) may be jointly determined, dynamic estimation is appropriate to establish the relationship between these variables.

Data used in this analysis were obtained from World Bank data. Merchandize trade was obtained by adding merchandize import and export. Trade openness was also obtained by adding all imports and exports as ratios of GDP. Data for electricity generation for 1970, and 2015 to 2017

were obtained from autoregressive process. Carbon dioxide emission (a measure of environmental strictness) was obtained from the World Bank data up to 2014. 2015 to 2017 were generated through the autoregressive process. Openness, natural resources and inflation for 2017 were generated from the averages of the last 7 observations.

## 4. Results and Discussion

Table one below shows the results of the stationarity tests of the variables used in the models. The analysis utilizes the Augumented Dickey-Fuller t-statistics and their corresponding probabilities as well as their order of integration.

**Table 1:** Unit root results of the variables of the model

| Variable | ADF T-stats value at levels (probability) | ADF T-stats value at first difference (probability) | Order of integration |
|---|---|---|---|
| TRAD | -1.479673(0.5351) | -8.704541(0.0000) | I(1) |
| CAB | -2.04176(0.2686) | -7.119992(0.0000) | I(1) |
| NRES | -2.092635(0.2485) | -7.476253(0.0000) | I(1) |
| INF | -3.37238(0.0171) | - | I(0) |
| FDI | -1.479673(0.5351) | -8.704541(0.0000) | I(1) |
| ELE | -1.546814(0.5014) | -9.173355(0.0000) | I(1) |
| POL | -1.745400(0.4024) | -6.681845(0.0000) | I(1) |
| OPENN | -2.636099(0.0931) | -9.021012(0.0000) | I(1) |
| GDP | -0.140827(0.9386) | -5.529373(0.0000) | I(1) |

The result in table 1 shows that trade, carbon dioxide emission, natural resource endowment, foreign direct investments (inflows), electricity generation (a measure of infrastructural availability), political stability, trade openness and the gross domestic products are all non-stationary at level but are however stationary at first difference. Their respective probability values at levels are greater than 0.05 percent. The probability of t-stat. at first difference is as low as zero indicating that variables are integrated of order one. Inflation on the other hand, is stationary at level as the probability of its t-statistic is about 2 percent.

**Table 2:** Result of Bounds test of cointegration

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | **3.457270** | 10% | 1.99 | 2.94 |
| K | 6 | **5%** | **2.27** | **3.28** |
| | | 2.5% | 2.55 | 3.61 |
| | | 1% | 2.88 | 3.99 |

Since all the variables of this study are not integrated of order one, a most appropriate method of testing for cointegration when all variables are not integrated of the same order is the Bound test. The F-statistic of Bound test is 3.457270. The lower and upper bounds critical value at 5 percent significance level are 2.27 and 3.28 respectively. The F-statistic value of 3.457270 is greater than the upper critical value of 3.28 indicating that we cannot accept the null hypothesis of no levels relationship. We therefore conclude that there is cointegration. Meaning that although almost all the variables of the model are non-stationary, linear combination of these variables in a model will produce stationary process.

**Table 3:** Correlation results of the variables of the model

| | FDI | TRAD | CAB | NRES | ELE | GDP | OPENN | POL |
|---|---|---|---|---|---|---|---|---|
| FDI | 1.000000 | 0.892133 | 0.642645 | -0.210458 | 0.798233 | 0.731038 | 0.179915 | 0.572531 |
| TRAD | 0.892133 | 1.000000 | 0.724513 | -0.308651 | 0.813969 | 0.909531 | 0.012578 | 0.660808 |
| CAB | 0.642645 | 0.724513 | 1.000000 | -0.213086 | 0.714223 | 0.639941 | 0.070538 | 0.782631 |
| NRES | -0.210458 | -0.308651 | -0.213086 | 1.000000 | -0.035309 | -0.458664 | 0.526571 | -0.244533 |
| ELE | 0.798233 | 0.813969 | 0.714223 | -0.035309 | 1.000000 | 0.775195 | 0.152466 | 0.591208 |
| GDP | 0.731038 | 0.909531 | 0.639941 | -0.458664 | 0.775195 | 1.000000 | -0.222685 | 0.582640 |
| OPENN | 0.179915 | 0.012578 | 0.070538 | 0.526571 | 0.152466 | -0.222685 | 1.000000 | 0.157551 |
| POL | 0.572531 | 0.660808 | 0.782631 | -0.244533 | 0.591208 | 0.582640 | 0.157551 | 1.000000 |

Table 3 shows the correlation matrix of all variables of the model. From the results, foreign direct investment inflow is positively related to total trade, carbon-dioxide emission, electricity generation, gross domestic product, trade openness and political stability. FDI is inversely related to natural resources although the correlation coefficient is very low.

Foreign direct investment inflow is highly and positively correlated with total trade, carbon-dioxide emission and electricity generation, while it is moderately correlated with political stability. Based on the result, one might be tempted to conclude that foreign direct investment inflows are encouraged by the lax in environmental regulations. However, it is still difficult to conclude until we have a more rigorous model with appropriate analytical technique hence the use of Auto Regressive Distributed Lag (ARDL) model.

**Table 4:** Results of the Auto Regressive Distributed Lag (ARDL) Model

Dependent Variable: FDI
Method: ARDL
Sample (adjusted): 1974 2017
Included observations: 44 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): POP OPENN CAB INF NRES ELE
Number of models evalulated: 62500
Selected Model: ARDL(4, 3, 0, 1, 0, 0, 0)

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| FDI(-1)*** | 0.296197 | 0.148843 | 1.989996 | 0.0561 |
| FDI(-2)** | 0.352231 | 0.158129 | 2.227492 | 0.0338 |
| FDI(-3) | 0.207668 | 0.173222 | 1.198855 | 0.2403 |
| FDI(-4)** | -0.331112 | 0.164075 | -2.018050 | 0.0529 |
| POP** | 36864.96 | 15832.29 | 2.328467 | 0.0271 |
| POP(-1)** | -98605.25 | 43030.37 | -2.291527 | 0.0294 |
| POP(-2)** | 93495.10 | 41934.40 | 2.229556 | 0.0337 |
| POP(-3)** | -31922.00 | 14794.56 | -2.157684 | 0.0394 |
| OPENN** | 32094660 | 13312605 | 2.410847 | 0.0225 |
| CAB | -22239.26 | 14277.63 | -1.557630 | 0.1302 |
| CAB(-1)** | 37256.59 | 16207.83 | 2.298679 | 0.0289 |
| INF | 3280907. | 9818210. | 0.334166 | 0.7407 |
| NRES*** | 31286109 | 17986420 | 1.739429 | 0.0926 |
| ELE | 5290789. | 13999702 | 0.377922 | 0.7082 |
| C* | -5.41E+09 | 1.38E+09 | -3.927548 | 0.0005 |

| | | | |
|---|---|---|---|
| R-squared | 0.928375 | Mean dependent var | 2.32E+09 |
| Adjusted R-squared | 0.893798 | S.D. dependent var | 2.56E+09 |
| S.E. of regression | 8.36E+08 | Akaike info criterion | 44.19038 |
| Sum squared resid | 2.03E+19 | Schwarz criterion | 44.79862 |
| Log likelihood | -957.1883 | Hannan-Quinn criter. | 44.41594 |
| F-statistic | 26.84906 | Durbin-Watson stat | 2.204359 |
| Prob(F-statistic) | 0.000000 | | |

*Means significant @ 1%; ** means significant @ 5%; *** means significant @ 10%.

Table 4 shows the results of the auto regressive distributed lag (ARDL) (4, 3,0,1,0,0,0) after the package has analyzed 62,500 models and have selected (ARDL) (4, 3,0,1,0,0,0) based on Akaike information criterion (AIC). The coefficient of determination is very high, about 93 percent in variability has been captured by the model. The adjusted coefficient of determination is also very high (about 89 percent) and close to the coefficient of determination indicating that all the included variables and their lags are very important in determining FDI inflows. The F-statistic also corroborates the joint contributions of the independent variables in explaining the dependent variable. The Durbin-Watson figure of 2.204359 does not give any indication whether or not autocorrelation is present in our model because the ARDL has some autoregressive variables $FDI_{t-1}$, $FDI_{t-2}$ and $FDI_{t-3}$. Durbin-h statistic cannot also be obtained under this situation. This study therefore conducted Breusch-Godfrey Langrange Multiplier test on errors up to a lag of 2 and the summary result is depicted on table 5.

**Table 5:** Result of Breusch-Godfrey serial correlation

Breusch-Godfrey Serial Correlation LM Test:

| | | | |
|---|---|---|---|
| F-statistic | 1.415932 | Prob. F(2,27) | 0.2602 |
| Obs*R-squared | 4.176810 | Prob. Chi-Square(2) | 0.1239 |

The Langrange Multiplier produces an F-Statistic of 1.415932 and at the degrees of freedom of (2,27), the corresponding probability is 0.2602 which is greater than the acceptable 0.05 percent, we therefore rule out the presence of serial correlation at least up to order two. The result of test on the observation's R-squared are support the F-test.

Since the result of our model is good enough, we can now present our dynamic results. Foreign direct investment inflow is positively influenced by its own lag up to order 3. The first lag and the second lag respectively has 6 and percent probability while the third lag has an insignificant positive impact. The fourth lag contrary to expectation has negative and significant relationship with FDI inflow. This suggests that the more recent stock of inward FDI in a country has a significant impact on the current FDI inflows. Inward FDI is also affected by population which is a good proxy for demand condition of the host or recipient economy. Current population exerts positively significant impact on inward FDI. The impact of population on FDI inflows alternate in signs when we consider their lagged values. The reason for changing sign is not clear.

Trade openness is positively and significantly related to inward FDI. This implies that the more open an economy is the more the likelihood of it generating high investment inflows. This result is in tandem with the theory that globalization brings about free flow of trade and investments between countries of the World. Inflation a measure of macroeconomic stability has no significant influence on foreign direct investment inflows. In the same vein, electricity generation (a measure of availability of infrastructure) has a positive insignificant relationship with FDI. Natural resource endowment has a positive relationship with FDI. The coefficient of natural resource endowment is barely significant at 10 percent level of significance.

The main variable of interest is the measure of environmental stringency (carbon dioxide emission). This variable has a negative and insignificant relationship with FDI. However, a year lag of this variable has a positive and significant relationship with inward FDI. The implication of this finding is that inward FDI flows is not affected by the present level of strictness maybe due to a lag in data collection and availability. We can therefore conclude that pollution haven is true in the long run for Nigeria.

**Table 6:** ARDL Error Correction Regression results (Short Run Model)

ARDL Error Correction Regression
Dependent Variable: D(FDI)
Selected Model: ARDL(4, 3, 0, 1, 0, 0, 0)
Sample: 1970 2017
Included observations: 44

ECM Regression
Case 2: Restricted Constant and No Trend

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(FDI(-1))** | -0.228788 | 0.113875 | -2.009116 | 0.0539 |
| D(FDI(-2)) | 0.123444 | 0.118164 | 1.044685 | 0.3048 |
| D(FDI(-3))* | 0.331112 | 0.117568 | 2.816342 | 0.0086 |
| D(POP)* | 36864.96 | 7687.840 | 4.795230 | 0.0000 |
| D(POP(-1))* | -61573.10 | 14006.78 | -4.395950 | 0.0001 |
| D(POP(-2))* | 31922.00 | 7391.507 | 4.318740 | 0.0002 |
| D(CAB)*** | -22239.26 | 11305.16 | -1.967178 | 0.0588 |
| CointEq(-1)* | -0.475016 | 0.081067 | -5.859545 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.601470 | Mean dependent var | 71005305 |
| Adjusted R-squared | 0.523978 | S.D. dependent var | 1.09E+09 |
| S.E. of regression | 7.50E+08 | Akaike info criterion | 43.87219 |
| Sum squared resid | 2.03E+19 | Schwarz criterion | 44.19659 |
| Log likelihood | -957.1883 | Hannan-Quinn criter. | 43.99250 |
| Durbin-Watson stat | 2.204359 | | |

*Means significant @ 1%; ** means significant @ 5%; *** means significant @ 10%.

The result of ARDL error correction model displayed on table 6 has a high coefficient of determination. A coefficient of determination of about 60 percent represents a good fit for a short-run model. A year lag of the error term $\mu_{t-1}$ (CointeEq(-1)) has a significant and negative coefficient of – 0.475016. This suggests that FDI is out of equilibrium in the short run, FDI adjusts to the independent variables with a lag; about 0.48 share of the discrepancy between long-term and short term FDI is corrected within a year.

The lag of first and third difference of FDI significantly determines FDI inflows while the second and the third lag have positive relationship, only the third has a significant relationship. The short run impact of FDI and its lag is not so clear. The short run of demand condition on FDI inflow is significant and positive even though it alternated in sign in the second and third lag. The short run impact of stringency variable is negative in the short run and insignificant at 5 percent significance level.

## 5. Conclusion and Implication

This study set out to investigate the reality or otherwise of the reality of pollution haven hypothesis in Nigeria using data from 1970 to 2017. The study used FDI inflows as measure of economic activity and carbon dioxide emission as a measure of regulatory stringency. The study finds the previous FDI inflows as a significant determinant of current FDI both in the short and long run. This implies that the more FDI an economy attracts, the more potentials it has to further attract more FDI.

Population, a measure of demand condition of the host economy is positively and significantly related to FDI inflows both in the short run and in the long run indicating that the more populated a country is; the more potential it has to further attract more FDI. Trade openness has a positively significant impact on FDI inflows in the long run, meaning that globalization encourages FDI inflows. The more open an economy is, the more it receives FDI.

A year lag of the FDI has a positively significant impact on FDI flows in the long run. This suggest that pollution haven hypothesis that shows that industries with polluting technologies tend to relocate to countries or areas (pollution havens) with lax or less stringent environmental regulations is a reality for Nigeria. The implication of this is that government of Nigeria must weigh the beneficial impact of FDI inflows against the pollution impact of 'dirty' FDI before deciding or setting its environmental policy.

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