FOREIGN DIRECT INVESTMENT AND EXTERNAL DEBT IMPACTS ASSESSMENT ON ENVIRONMENTAL RESOURCES DEPLETION IN NIGERIA

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Abstract:*The public interest in justness, equity and fairness in the use of environmental resources between the present and future generations have raised concern about the current depletion rate of environmental resources in Nigeria. Several socioeconomic factors are involved. Worrisome however is the inflow of foreign direct investment and external debt escalation in recent years in the economy. Importantly, we asked, do they contribute to the depletion of environmental resources in Nigeria? In that, we modelled the implications of growth in FDI and external debt on four cases of environmental resources depletion (forestry, solid minerals, fisheries, and crude oil resources productions). The estimated results suggested that though the depletion rate of environmental resources like crude oil depends largely, over the long run and short run, on the movement in FDI inflow, critical to the level of depletion of the forest is the short run effect of external debt. Furthermore, the depletion level of fisheries responds positively only to a change in FDI with a lag in the short run. In terms of solid minerals, we found a long run impact*

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of external debt. Therefore, provided the impact of a rise in FDI and external debt on the depletion of environmental resources is subject to the particular resource and time in Nigeria, selective policies based on the FDI and external debt management is appropriately adequate to control the level of depletion of environmental resources in Nigeria for the benefit of the future generation.

Keywords: *External debt, FDI, environmental resources, resources depletion, Nigeria*

JEL Classification: H63, 013, Q22, Q23, Q32

1 Introduction

In the earlier studies, the size of environmental or natural resources had been used extensively to explain the pattern of flows of foreign direct investment (FDI) (Asiedu, 2006; Aleksynska and Havrylchyk, 2013) and how, on the other side, external debt may rise over time for countries heavily endowed with natural resources, often attributed to a resource-curse phenomenon (Boschini, Pettersson & Roine, 2007). Several other studies including Kisswani and Zaitouni (2021), Bao, Chen and Song, (2010), and Demena and Afesorgbor (2020) extended the analyses to portray how the environment suffers degradation such as that of the recurring high incidence of emissions and pollution, climate change, deep erosion and land surface disfigurement with a rise in foreign direct investment inflows or how environmental performance rests on FDI (Udemba & Yalçinaş 2021; Demena & Afesorgbor, 2020). However, much interest in maintaining equity and fairness in the use of environmental resources between the current and future generations and insufficient level of investment in reproducible capital to the current rate of the depletion of environmental resources become a motivation to take seriously a flip of these views, particularly the implication of growth in foreign direct investment alongside external debt accumulation on the depletion level of environmental resources in Nigeria. As observed by Animashaun (2002), the rate of environmental resources depletion nowadays is faster than the future time required replenishing them. Environmental resources depletion is a major problem in many resource-endowed countries, particularly countries with finite natural resources.

Presently in Nigeria, the extensiveness of the level of depletion of environmental resources makes it no longer difficult to think that hardly will it be possible

to preserve life-supporting environmental endowments for the upcoming generations. The level of depletion of natural resources in Nigeria is becoming unsustainable due in part to a surge in the global diffusion of the operations of multinational corporations and international agencies funds flow mostly in terms of foreign direct investment (FDI). Narula and Dunning (2000) pointed to FDI as a powerful avenue for firms to operate directly in resource-endowed countries. No doubt, it is far from fiction that FDI contributes to productivity spillover (Zhao and Zhang, 2010; Demena and Murshed, 2018; Demena and van Bergeijk, 2017), provides technical know-how, long-term finance and managerial expertise and several other beneficial impacts as put forward by Gochero and Boopen (2020), Demena and Afesorgbor (2020) among others. Even so, costs are attached to the environment supplying the resources such as having less of the resources or lacking entirely the stock of the endowments in the nearest future. As argued by the Institute for International Economics, it would be of no use to pretend that foreign direct investment has never been part of the problems relating to the exhaustion of environmental resources such as logging, smelting and copper mining.

Therefore, it is not surprising that environmental resources like solid minerals and forests in Nigeria are fast disappearing following a continuous inflow of FDI. At the micro-level for instance, one can cite several communities in Nigeria endowed with thick forests resources even as of the late 1990s and in some cases up to the mid-2000s. These communities include Ogidi and Ayede in Kogi, Kurmi in Taraba, and Ikare in Ondo State. But today, they have no such resources in abundance owing to a high inflow of FDI in the areas. Many communities in Nigeria had been excessively stripped of their vegetation and other valuable environmental resources. The increased degree of globalization had to a large extent contributed to widening the environmental resource sector's openness to foreign interests or businesses in Nigeria. In addition to the activities of the local firms, the population of the foreign investors in the environmental resources sector such as solid minerals and greenwood is rapidly increasing in the country with a consequence of rising environmental resources depletion in a matter of few years to come at the cost of future generation's benefits.

A similar problem emerges in the case of external debt where more extraction of natural resources must be done to meet a country's debt obligations or more important where more external funds must be sourced to finance productions activities in the environmental resources sector to boost the sector's output.

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Indubitably, external debt contributes to the depletion of environmental resources on the basis that foreign debt financing and repayment require increased natural resources extraction. Environmental resources production is a key means to funding external debt repayment and debt servicing in a country like Nigeria that depends largely on environmental resources to achieve economic fundamentals. So, more debt leads to more resources extraction. The non-reproducible exhaustible environmental resources necessarily exhaust since they cannot regenerate at least in the short run. Nigeria's debt profile in recent time is the worst ever recorded in time past. For example, data from the Debt Management Office suggest that Nigeria's total debt to African Development Bank and World Bank rose astronomically from $7.14 billion to $14.25 billion between the 30th of June, 2015 and the 31st of March, 2021. There are many other agencies or bodies to whom Nigeria owes a huge debt. Thus, Nigeria is currently operating on a mounting level of external debt profile. More than 70% of Nigeria' earnings for debt repayments come from the sales of environmental resources. Hence, a question of the possible impact of rising external debt on the depletion level of endowed environmental resources in Nigeria arises. In that, the primary aim here is on assessing the consequence of a growth in FDI and external debt on the depletion level of environmental resources in Nigeria. This area is of much interest to Nigeria as a result of the unprecedentedly high inflow of FDI witnessed in recent years, especially in the mining and agricultural sectors coupled with an escalating external debt and the need to conserve the available natural resources for the benefit of the future generations.

2 Literature Survey

Understanding the cause of the depletion of environmental resources usually involves synthesizing and analyzing a broad spectrum of differing ideas and opinions or factors believed to aid the level of the depletion. Models ranging from the basic to extended types are normally employed to articulate such ideas as to how frequently the environmental resources are expected to deplete over an assumed period. In Burghes, Lyle and Nichols (2007), a simple optimal model of resources depletion to evaluate the idea that certain factors drag the rate of depletion of environmental resources was suggested. Based on the model, suppose s implies the available stock of environmental resources at time t, and continuously differentiable over t, then, its first derivative with

respect to t measures the rate of its depletion. That is, $ds/dt = \dot{s}$. At the steady-state, $\dot{s} = 0$. Therefore, it follows the condition that $\dot{s} < 0$ if the depletion of natural resources takes place and $\dot{s} > 0$ supposes a regeneration of stock of natural resources, common in the case of water or forestation.

Burghes, Lyle and Nichols (2007), Dasgupta and Heal (1974), Lee and Zepeda (2001), have shown that $\dot{s}$ is determined mostly by factors relating to production inputs such as improved technology and the time at which an alternative technology is made available. It is not enough that the depletion of the environmental resources is a matter of the level of technological advancement but it is also dependent on the quantity of capital and its availability (Poelhekke & van der Ploeg, 2013). In this paper, capital comes in two folds: domestic capital and foreign investment capital inflows. Complemented by the domestic capital, the level of depletion of environmental resources in many of the resource-endowed countries is much related to foreign capital in the form of foreign direct investment[4] facilitated by the transnational companies or foreign multinational corporations that bring the foreign capital into the resource-endowed economies.

A similar model, a knowledge-capital model of environmental resources and FDI by Carr, Markusen and Maskus (2001) suggests transcendence of a relationship between environmental resources and foreign direct investment. Evidenced by the location-based approach to the foreign direct investment model, the decision to move capital from one location to another depends on the characterization of the designated location which includes the magnitude of environment resources endowment and government policy. It is a case that foreign direct investment flows largely to countries with abundant natural resources (Popovici & Calin, 2014). The adverse impact is not limited to rapid biodiversity losses and environmental quality degradation but being a negative shock to the environmental resource stock which can never be regained, especially in the case of non-reproducible exhaustible environmental resources. Yet a relevant source of depletion of environmental resources here is external debt. Tietenberg and Lewis (2009) suggest external debt as a powerful contributor to a rapid depletion of environmental resources. Todaro and Smith (2012) stressed that overwhelming debt has a rising negative impact on the level of endowed environmental resources as the burden of the debt increases.

[4] Portfolio investment is another form of foreign capital. Usually, it is more liquid and volatile compared to FDI. Its contribution to the depletion of environmental resources is largely indirect.

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This relation is dubbed the "debt-resource hypothesis" in the literature. According to this hypothesis, many low-income countries owned large debt stocks. Therefore, most of these countries in an attempt to pay the debt in addition to the accumulated interest are motivated to overexploit their natural resources endowment to raise the needed funds. More so, repayment of the external debt lowers the nation's capacity to enhance its foreign exchange earnings. Even though a less-substantial amount of foreign earnings is still accumulated, in the regime of a high real rate of interest, such little accumulated foreign exchange earnings have to be utilized in servicing these debts therefore, most of the time, the affected countries end up overexploiting their natural resources in order to meet other national needs. While the argument that foreign direct investment and external debt are the cause of resources depletion is still raging, another point to note is the "rich-resources argument".

In the rich-resources argument, environmental resources loss or the depletion of the natural resources endowment in the undeveloped settings are due mainly to the high propensity to consume (MPC) of the developed settings. Supposing a high MPC for the advanced countries, then, the argument implies that there will be a rise in the demand for natural resources in the less-developed countries. An increase in the demand reduces the available stock of the resources so the resources get depleted faster in response to a rise in demand. This, however, is negated by the Conservationists' view that exhaustion of natural resources is due to population growth. Putting it differently, the Conservationists argued that an increase in the population reduces the environmental resources especially those that are finite because the people depend more on the resources as a means of sustenance.

Empirically, past evidence on the role of FDI on the depletion of environmental resources is absent. What appears relevant were on issues such as the FDI and environmental quality (Sabir, Qayyum, & Majeed 2020; Abdouli, Kamoun & Hamdi, 2018; Baek, 2016; Hao & Liu, 2015; Gökmenoğlu & Taspinar, 2016; Acheampong, Adams & Boateng, 2019), and abundance of environmental resources as a stimulant of FDI inflow (Poelhekke & van der Ploeg, 2012; Bokpin, Mensah & Asamoah, 2015; Asiedu, 2006; Aleksynska & Havrylchyk, 2013). Apart from FDI, there is little previous empirical evidence on external debt as a determinant of environmental resources depletion and it is mostly concentrated on a particular aspect of environmental resources depletion – deforestation with a contradictory result. For example, Culas (2006) investigated the hypothesis that large external debt causes high deforestation

in developing countries. The empirical evidence from the study showed that deforestation and foreign debt are positively linked. Conversely, the study conducted by Shafik (1994) failed to provide supportive evidence that debt per capita was statistically significant in the determination of the annual rate of deforestation. The study of Kant and Redantz (1997) in Latin America provided no empirical evidence that high indebtedness leads to deforestation. Also, Neumayer (2005) empirically tested the debt-resource hypothesis between 1979 and 1999 among countries with high debt profiles. The study selected 23 types of natural resources (mineral resources and cash crops) and controlling for land endowment, regressed external debt on each of the selected natural resources. The study failed to establish empirically that countries with huge debt service burdens or high indebtedness have higher mineral resources and subsoil fossil fuel depletion or cash crops production than the others.

3 Data, Empirical Model and Method

The data used for the study are time series data, collected from different sources over the period between 1980 and 2019. Whilst data on solid minerals were gathered from the British Geological Survey, OPEC Annual Statistical Bulletin of various issues is the source of data on crude oil production. Furthermore, data on foreign direct investment, external debt, trade openness, government consumption, and population density were obtained from the World Bank database. Lastly, the fisheries production and deforestation data were sourced from the FAOSTAT.

To build a model of a causal relationship between natural resources depletion and its underlying determinants, diverse factors are involved. Sadly, the literature lacks consensus as to the definite variables or factors to be included in such a model. Tietenberg and Lewis (2009) cited external debt as an important variable to be considered in dealing with issues relating to natural resources depletion. In addition to foreign debt, Neumayer (2005) outlined factors such as discoveries of natural resources, labour and capital, cost of transporting the extracted resources to a foreign market, the state of technology, the capacity of the local market, subsidies and taxation, resources ownership type, real exchange rate, population density, trade openness and the productivity of the land as better determinants of the depletion of the natural resources. Often neglected but important are the issues of securities of lives and the activities of the illegal miners.

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However, although the difficulty of measurement and insufficient dataset are likely to be encountered in adopting some of these variables, where these problems are surmounted. Introducing a wide range of variables could complicate the see-through effect of the model. As such, FDI and external debt, by the study's objective, are the supposed primary variables controlling the rate of depletion of the natural resources in Nigeria, complemented by the government consumption capacity, trade openness, population density, and a dummy variable. The trade openness variable is important since Nigeria depends more on income from exported resources, and the rate of resources exportation, in turn, depends on the extent to which the economy is open to external trade. Also, the Nigerian population is increasing at an unprecedented rate; consequently, much pressure is expected on the available natural resources. The dummy variable takes into account the policy effect of the Structural Adjustment Programme which provided a tenable opportunity to expand the exploitation and trade of the natural resources. As a result, the model to be estimated is as in equation (1).

$$\boldsymbol{NRD}_t = \beta_0 + \beta_1 FDI_t + \beta_2 EXTD_t + \beta_3 TRN_t + \beta_4 GP_t + \beta_5 PD_t + \beta_6 DUM_t + e_t \quad (1)$$

In equation (1), the *NRD* is a vector corresponding to the different categorizations of the depletion of natural resources. Four variants of environmental resources depletion are identified here: deforestation (DEF), fisheries resources production (FSP), crude oil (COP) and solid minerals (SOLM) productions. These classifications covered both the renewable and non-renewable natural resources depletion in Nigeria. The sorts of solid minerals considered are those with the up-to-date dataset, peculiar (to a good extent) to all the geo-political zones in Nigeria and are of high demand by the miners. These are: Feldspar, Columbite, Sub-Bituminous, Tin, Kaolin, Lead and Iron Ore measured in metric tonnes. The forests and fisheries productions are also measured in tonnes while the crude oil is based on 1000 barrels per day. The FDI, EXTD, TRN, GP, POPD, DUM and e are the foreign direct investment, external debt, trade openness, population density, dummy variable and the stochastic term respectively. The External debt is measured by the total external debt stock as a fraction of GDP at the time "*t*". The $\beta_0 \ldots . \beta_6$ are the parameters of the model. Theoretically, as to the key variables of interest, a positive sign is expected from FDI and external debt.

To estimate equation (1), the Autoregressive Distributed Lag (ARDL) method is applied to each of the four identified cases of the depletion of the

environmental resources. The ARDL method is a superior estimating technique where the underlying variables are a mixture of diverse orders particularly order zero and one, denoted as I(0) and I(1). The general form of the ARDL of equation (1) is

$$\Delta(\boldsymbol{NRD}_t) = \omega_0 + \sum_{ħ=1}^{p} \omega_1 \Delta NRD_{(t-ħ)} + \sum_{ħ=0}^{p} \omega_2 \Delta X_{(t-ħ)} + \theta_1 NRD_{(t-1)} + \theta_2 X_{(t-1)} + e_t \quad (2)$$

The lag order is selected by the Akaike info criterion. Through the equation (2), the long run and short run estimates are obtained provided the variables are co-integrated. The parsimonious long run model is illustrated in the equation (3)

$$\boldsymbol{NRD}_t = \alpha_0 + \alpha_1 \boldsymbol{X}_t + e_t \quad (3)$$

The short run parsimonious model is

$$\Delta(\boldsymbol{NRD}_t) = \lambda_0 + \sum_{ħ=1}^{i} \lambda_1 \Delta(\boldsymbol{NRD}_{(t-ħ)}) + \sum_{ħ=0}^{j} \lambda_2 \Delta(\boldsymbol{X}_{(t-ħ)}) + \beta ECM_{(t-1)} + e_t \quad (4)$$

Where NRD is as earlier defined and X is an index of all the explanatory variables in the equation (1). For a test of co-integration, the ARDL Bound co-integration method is employed with critical values from Narayan (2004). Where the co-integration test is inconclusive, knowledge of the order of integration is vital for taking decisions (Narayan, 2004). Hence, the study relies on the Augmented Dickey-Fuller (ADF) unit root tool to determine the order of integration of the underlying series.

4 Empirical Results

The long run and short run coefficients of the estimated models are in Tables 1 to 4 with the effect of population growth, openness to foreign trade, size of government consumption, and policy reform controlled. The results of a fitted ARDL optimal selection model are reported in column 2 of each of the tables. Columns 3 and 4 are for the long run and short run estimates respectively obtained using the ARDL technique. Additionally, the DOLS estimates in the fifth column are intended for further evidence of the long run estimates obtained through the ARDL method.

Table 1 presents the estimated results on fisheries resources. The results suggest no evidence of a significant relationship between foreign direct

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investment and the quantity of fish harvested in the long run. However, a positive and statistically significant relationship exists between the quantity of fish harvested and FDI with a lag in the short run. The estimated result further suggested a statistically significant but negative effect of external debt on the number of fisheries extracted in the long run. The import-substitution effect, whereby preference is placed on imported aquatic products than the locally produced products resulting in a shift in the composition of the expenditure of the government which is usually financed through external borrowing, may cause the inverse relationship between fish production and external debt. Also, increased external borrowings signify more income to the government, and therefore, a reduction of pressure on fishing as a means of income generation. The obtained speed of adjustment from the short run to the long run is about 46 per cent a year as shown in Table 1.

Table 1: Environmental Resource Depletion (Fisheries Extraction)

	ARDL APPROACH			DOLS MODEL
	Auxiliary Regression	Long Run	Short Run	(Long Run)
FSP(-1)	0.5386 (0.00)			
FDI	-0.0160 (0.21)	-0.1108 (0.10)	-0.0160 (0.11)	-0.0600 (0.03)*
FDI(-1)	0.0048 (0.69)		0.0399 (0.00)*	
FDI(-2)	-0.0399 (0.04)			
EXTD	-0.0045 (0.00)	0.0027 (0.41)	-0.0045 (0.00)*	-0.0005 (0.69)
EXTD(-1)	0.0031 (0.06)		-0.0026 (0.11)	
EXTD(-2)	0.0026 (0.11)			
TRN	0.0012 (0.42)	0.0026 (0.40)	0.0012 (0.42)	0.0047 (0.01)*
GP	0.0028 (0.84)	0.0746 (0.06)**	0.0028 (0.84)	0.0310 (0.04)*
GP(-1)	0.0317 (0.00)			

PD	0.0043 (0.02)	0.0094 (0.00)*	0.0043 (0.02)*	0.0101 (0.00)*
PR	-0.0137 (0.79)	-0.0297 (0.79)	-0.0137 (0.79)	0.0154 (0.80)
C	5.3242 (0.01)	11.538 (0.00)		
ECM(-1)			-0.461 (0.00)*	
R^2	0.991		0.989	
σ	0.059		0.066	
F-Stat.	237.2 (0.00)			
$F_{(Autocorr.)}$	0.885 (0.36)			
$F_{(Hetero.)}$	0.287 (0.99)			

NB: σ means the standard error of the regression; $F_{(Autocorr.)}$ represents the Breusch-Godfrey autocorrelation LM test F-statistic; $F_{(Hetero.)}$ stands for the Breusch-Pagan-Godfrey test F-statistic for Heteroskedasticity; **F-Stat.** is the Regression F-statistic.

Source: Calculated by the Authors

In Table 2, the estimated result of the second case of resources depletion (deforestation) is summarized. Contrary to the theoretical expectation, the result indicates no significant positive effect of foreign direct investment on deforestation. A raison d'être is the regenerative capacity of forestry. The impact of external debt is positive and significant but only in the short term perspective. In the long run, there is no statistical evidence that an increase in external debt contributes to deforestation in Nigeria. The model speed of convergence is slow, roughly 17 per cent per annum.

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Table 2: Environmental Resource Depletion (Deforestation)

	ARDL APPROACH			DOLS MODEL
	Optimum Model Selection	Long Run	Short Run	(Long Run)
DEF(-1)	0.8340 (0.00)			
FDI	-0.0015 (0.17)	-0.0089 (0.32)	-0.0015 (0.18)	-0.00426 (0.31)
EXTD	0.0002 (0.01)	0.0010 (0.18)	0.0002 (0.01)*	0.00028 (0.49)
TRN	8.80E-05 (0.58)	0.0005 (0.51)	0.0001 (0.58)	0.0008 (0.06)**
GP	-0.0007 (0.38)	0.0174 (0.06)**	0.0007 (0.38)	0.0076 (0.12)
GP(-1)	0.0022 (0.01)			
PD	0.0070 (0.00)	0.0153 (0.00)*	0.0070 (0.00)*	0.0113 (0.03)*
PD(-1)	-0.0959 (0.02)		-0.0914 (0.02)*	
PD(-2)	0.0914 (0.02)			
PR	-0.0030 (0.31)	-0.0183 (0.37)	-0.0030 (0.31)	0.0046 (0.62)
C	2.788 (0.05)	16.795 (0.00)		16.772 (0.00)
ECM(-1)			-0.1660 (0.04)*	
R^2	0.997			0.999
σ	0.006			0.005
F-Stat.	990.5 (0.00)			
$F_{(Hetero.)}$	0.355 (0.96)			
$F_{(Autocorr.)}$	1.681 (0.21)			

NB: σ means the standard error of the regression; $F_{(Autocorr.)}$ represents the Breusch-Godfrey autocorrelation LM test F-statistic; $F_{(Hetero.)}$ stands for the Breusch-Pagan-Godfrey F-statistic test for Heteroskedasticity; F-Stat. is the Regression F-statistic as a measure of the overall model fitness.

Source: Calculated by the Authors

Table 3 presents the estimated results on the third case of natural resources depletion (solid minerals). In columns 3 and 4, the effect of FDI on solid minerals extraction is negative and significant. It suggests that the depletion level of solid minerals does not increase as FDI grows. As expected, the long run and short impacts of external debt on solid minerals resources are positive and statistically different from zero. It thus suggests that solid minerals deplete with a rise in external debt. The error correction coefficient of the model suggests roughly 56 per cent of the short run disequilibrium is corrected per annum.

Table 3: Environmental Resource Depletion (Solid Minerals Resources)

	ARDL APPROACH			DOLS MODEL
	Optimum Model Selection	Long Run	Short Run	(Long Run)
SOLM(-1)	0.0630 (0.76)			
FDI	-0.4682 (0.00)	-0.7037 (0.00)*	-0.4682 (0.00)*	-1.1150 (0.02)*
FDI(-1)	-0.191 (0.15)			
EXTD	0.0054 (0.61)	0.0147 (0.08)**	0.0054 (0.61)	0.0321 (0.06)**
EXTD(-1)	0.0150 (0.20)		0.0173 (0.18)	
EXD(-2)	-0.0173 (0.18)		-0.0106 (0.28)	
EXTD(-3)	0.0106 (0.28)			
TRN	0.0170 (0.24)	-0.0220 (0.34)	0.0170 (0.24)	0.0077 (0.82)
TRN(-1)	-0.023 (0.11)		-0.0081 (0.53)	
TRN(-2)	0.0081 (0.53)		0.0224 (0.02)*	
TRN(-3)	-0.022 (0.02)			
PD	-0.2170 (0.23)	-0.3942 (0.00)*	-0.2170 (0.23)	-0.0003 (0. 01) *
PD(-1)	11.066 (0.00)		11.2181 (0.00)*	

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PD(-2)	-11.218 (0.00)			
GP	0.0980 (0.38)	-0.1750 (0.11)	0.0980 (0.38)	0.4434 (0. 97)
GP(-1)	-0.0829 (0.45)		-0.1088 (0.31)	
GP(-2)	0.1088 (0.31)		0.2879 (0.03)*	
GP(-3)	-0.2879 (0.03)			
PR	-0.1680 (0.69)		-0.1680 (0.69)	0.0033 (0.99)
C	16.271 (0.00)	17.365 (0.00)		8.8280 (0.00)
ECM(-1)			-0.937 (0.00)*	
R^2	0.881		0.728	
σ	0.383		0.638	
F-Stat.	5.922 (0.00)			
$F_{(Hetero.)}$	0.790 (0.69)			
$F_{(Autocorr.)}$	2.601 (0.11)			

NB: σ means the standard error of the regression; $F_{(Autocorr.)}$ represents the Breusch-Godfrey autocorrelation LM test F-statistic; $F_{(Hetero.)}$ stands for the Breusch-Pagan-Godfrey test F-statistic for Heteroskedasticity; F-Stat. is the Regression F-statistic.

Source: Calculated by the Authors

As shown in Table 4, in the case of crude oil production, after controlling for population growth, government consumption, trade openness and the policy reform of 1986, foreign direct investment inflow has a significant positive relationship with crude oil productions in the long run and short run. Thus, an increase in the rate of crude oil depletion ceteris paribus is associated with an additional inflow of foreign direct investment in Nigeria. Nevertheless, the result could not establish a significant impact of external debt on crude oil extraction. The implication is that crude oil depletion in Nigeria is better explained by factors other than a rising level of external debt or overwhelming external debt burden in Nigeria. The same relational circumstance is true of external debt in the short run (column 4) as in the long run (column 3). The

error correction mechanism for the model shows up to 77 per cent of the short run error is corrected, annually, in the long run.

Table 4: Environmental Resource Depletion (Crude Oil Production)

	ARDL APPROACH			DOLS MODEL
	Optimum Model Selection	Long Run	Short Run	(Long Run)
COP (-1)	0.2231 (0.01)			
FDI	0.0189 (0.09)	0.0244 (0.09)**	0.0189 (0.09)**	0.0705 (0.03)*
EXTD	-0.0005 (0.54)	-0.0006 (0.53)	-0.0005 (0.54)	-0.0007 (0.74)
TRN	0.0029 (0.07)	0.0037 (0.07)**	0.0029 (0.07)**	0.0063 (0.02)*
PD	-0.0152 (0.00)	-0.0196 (0.00)*	-0.0152 (0.00)*	0.0105 (0.20)
GP	0.0294 (0.03)	0.0082 (0.50)	0.0294 (0.03)*	0.0127 (0.61)
GP(-1)	-0.0230 (0.01)			
PR	-0.1165 (0.01)	-0.1499 (0.01)*	-0.11648 (0.00)*	-0.1614 (0.02)*
C	6.6969 (0.00)	8.6204 (0.00)		7.1178 (0.00)
ECM(-1)			-0.777 (0.00)*	
R^2	0.888		0.868	
σ	0.064			0.080
F-Stat	25.66 (0.00)			
$F_{(Autocorr)}$	0.665 (0.52)			
$F_{(Hetero)}$	0.472 (0.88)			

NB: σ means the standard error of the regression; $F_{(Autocorr.)}$ represents the Breusch-Godfrey autocorrelation LM test F-statistic; $F_{(Hetero.)}$ stands for the Breusch-Pagan-Godfrey test F-statistic for Heteroskedasticity; **F-Stat**. is the Regression F-statistic.

Source: Calculated by the Authors

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5 Summary and Conclusion

The primary interest of this paper is in determining the potential consequence of foreign direct investment inflows and external debt accumulation on the level of depletion of environmental resources in Nigeria. The paper covered four key variants of environmental resources endowments in Nigeria: fisheries, forestry, crude oil and solid minerals, and control the effect of population growth, openness to foreign trade, size of government consumption, and policy reform. In the case of fisheries, the paper found no empirical evidence that an increase in external debt leads to a higher rate of depletion of fisheries but foreign direct investment positively contribute to the depletion of fisheries with a lag in the short run. In terms of forest resources, foreign direct investment played no role in deforestation both in the long run and short run. The impact of external debt on deforestation is positive but limited to the short run.

Consequently, a rise in external debt reduces forest resources in the short run in Nigeria. For solid minerals, no evidence that an increase in the FDI inflow results in the depletion of solid minerals over time but external debt on the other hand accounted for solid minerals depletion in Nigeria in the long run. In terms of crude oil, though an increase in external debt does not increase crude oil production in the short run and long run, the result provides enormous evidence that an increase in foreign direct investment pushes up crude oil production in Nigeria. This implies that FDI drives the depletion of crude oil resources in Nigeria.

Policy Relevance of Findings and Conclusion

Controlling of FDI inflows and external debt accumulation to manage the available stock of natural resources should be considered based on the individual environmental resources. Illustratively, though it will be fruitful to regulate FDI to control the rate of depletion of crude oil or embracing external debt cutback policy to mitigate solid minerals exhaustion, it will be meaningless to rely on external debt reduction policy to conservation crude oil for future use. Hence, each of the environmental resources must be duly assessed to determine if FDI, external debt or both should be controlled to lessen its rate of depletion. This is essential since a good fraction of government earnings in Nigeria depends at least in part on the volume of FDI inflow in the economy and how much the government is able to borrow externally. In conclusion, though external debt and FDI are vitally essential factors driving the level of

environmental resources depletion, it is not without a caveat that their effects varied across the different natural resources evaluated and are therefore to be approached under such circumstance.

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Appendix

Table A1: Unit Root Test

Series	Intercept		Intercept, Trend		Order
	Level	1st Diff	Level	1st Diff	
FSP	-0.114 (0.94)	-8.160 (0.00)	-2.872 (0.18)	-8.118 (0.00)	I(1)
FDI	-4.188 (0.00)	-8.200 (-2.94)	-4.050 (0.02)	-8.159 (0.00)	I(0)
EXTD	-1.149 (0.69)	-5.764 (0.00)	-1.902 (0.63)	-5.932 (0.00)	I(1)
SOLM	-3.697 (0.01)	-5.522 (0.00)	-4.210 (0.00)	-5.413 (0.00)	I(0)
DEF	-3.530 (0.01)	-9.367 (0.00)	-0.488 (0.98)	-11.146 (0.00)	I(1)
COP	-2.041 (0.27)	-6.847 (0.00)	-2.278 (0.44)	-6.837 (0.00)	I(1)
PD	-1.375 (0.58)	-2.557 (0.11)	-4.017 (0.02)	-0.802 (0.00)	I(0)
TRN	-2.713 (0.08)	-7.938 (0.00)	-3.282 (-0.08)	-3.118 (0.12)	I(0)
GP	-1.119 (0.70)	-5.775 (0.00)	-2.844 (0.19)	-5.695 (0.00)	I(1)

Note: Values in the bracket are the p-values
Source: Authors' compilation

Table A2: ARDL Bound Co-integration Test

Computed Wald/F-statistic values	1	$F_{(DEF)}$: 8.26	2	$F_{(SOLM)}$[5]: 5.27	3	$F_{(FSP)}$: 29.44	4	$F_{(COP)}$: 7.30
Critical values	Restricted intercept and no trend				Restricted intercept and trend			
	Lower Bound		Upper Bound		Lower Bound		Upper Bound	
1%	3.62		5.18		3.89		3.89	
5%	2.64		3.88		2.82		4.24	
10%	2.22		3.34		2.36		3.62	

Note: 1= Deforestation model, 2 = Solid Mineral, 3 = Fisheries and 4 = Crude oil Production model
Source: critical values from Narayan (2004)

[5] Estimated with a restricted intercept and trend assumptions