Testing the "Pollution Havens Hypothesis (PHH)" in Nigeria from 1970-2013

Baghebo, Michael PhD

Department of Economics, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.
P.O.Box 1147 Yenagoa, Bayelsa State, Nigeria
Email: mikephd3c@gmail.com

Apere, Thankgod O.

Department of Economics, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria

Doi:10.5901/mjss.2014.v5n23p598

Abstract

Economic integration is a way of increasing World output of oil and gas production based on the economies of scale property and exchange of technology, ideas and information. Two major channels through which integration contributes to growth in the literature have been identified as trade and foreign direct investment. Recently, various integration proposals have been advanced for Africa, but the efficacy of integration on growth in Africa is far from being established. Again, since economic growth is not totally divorced from environmental conditions, we explored the contributions of trade liberalization and foreign direct investment inflows on growth in Nigeria and the implications of integration on the Nigerian environment by using the Autoregressive Distributed Lag (ARDL) approach. Annual time series data is employed for the period spanning 1970-2013. The results which emanated from the findings depict that there was none existence of a long run relationship between FDI and growth on the one hand while there exists a long run causal link between CO₂ per capita (a measure of environmental quality) and FDI inflows on the other hand. Also, we found that economic growth and foreign direct investment into Nigeria significantly fuelled pollution while trade is beneficial both in the short and long run. We recommend provision of infrastructure, initiation and enforcement of sound environmental policy among others to enable integration to make meaningful impact in developing countries generally. The policy lessons from these findings are that any policy that will aim at attracting foreign direct investment inflow should be one that will encourage and promote the adoption of cleaner production technologies.

Keywords: Pollution Haven Hypothesis, Foreign Direct Investment, Nigeria.

1. Introduction

The economic significance of the Nigerian Petroleum Industry is no longer doubt. It is now a vast operation covering on-shore and off-shore oilfields. As it is with many blessings of modern civilization, there are benefits and adverse externalities from the exploration and production of oil and gas. Thus, the appellation of "black gold" ascribed to oil is succinct. Black as it were, connotes "evil", while gold typifies what is worthwhile. Expectedly, the Nigerian economy has experienced this dual attribute of oil. Oil has been vital in financing the nation's economic growth and development. Oil fuels power and social transformation. As of now, oil is the basis of the existence of the Nigerian nation state. In spite of the stupendous wealth that Nigeria has generated from the production and sale of oil, one of the negative externalities from the oil industry is pollution occasioned by oil spillage and discharge of effluents. Pollution is generally believed to be the necessary price for the development ushered in by the petroleum industry. It has been asserted that even in the best oil field practice, oil spillage cannot be completely eliminated (Ekpu 1996; Aghalino 1999).

World pollution caused by the oil industry is enormous. With an estimated 3.6 million tons of oil spilt into the sea annually, mainly as a result of shipping accidents involving oil tankers and deliberate flushing of tanks and engines as well as offshore and onshore oil well blowouts, the issue of pollution has taken an international dimension (World Resource Institutes 1990). Arguably, the most important pollution in the marine environment and coastal waters as well as agriculture therefore, is petroleum and its products. Memorable cases of large scale pollution of the marine, coastal environments and agriculture by petroleum include such tanker disasters in the North Atlantic sea route as the Torrey Canyon (1967) and the Amoco Cadiz (1978). Over 120,000 and 223,000 tons of crude oil were released into the sea off Cornwall (South west England) and the coast of Brittany (France).

Although Nigeria has recorded several cases of marine pollution, it would appear, there are two outstanding cases namely, the Funiwa-5 oil well blow-out of 1980 in which, well over 400,000 barrels of crude spilled into the marine

environment of Nigeria, as well as Mobil's Qua Iboe oil spillage of 1998 which resulted in the spillage into the marine environment of about 40,000 barrels of crude oil. These two notorious cases draw attention to the peculiar and precarious circumstances of the oil-barring enclave and the degree of risk to which they are exposed to on account of oil exploitation in the area. In consonance with this, this paper attempts to examine the Funiwa-5 and the Mobil Qua Iboe oil spillage as these two incidents appeared to have impacted heavily on the marine environment. In doing this, a synoptic appraisal of the causes of these incidents, their dynamics as well as their effect are evaluated.

2. Literature Review

2.1 Oil Production in Nigeria

It is no news that Nigeria is one of the leading oil producers in the World (the 9th), and that the fragile Niger Delta region is the seat bench (or hub) of oil and gas production of the country. Presently, 90% of Nigeria's gross domestic product (GDP) comes from revenues accruing from crude oil sales. The country operates a joint venture with the TNCs. The government, through the Nigerian National Petroleum Corporation (NNPC), owns 55% share in the Joint Venture; SPDC 30%, ELF Petroleum Nigeria Limited (a subsidiary of TotalFina) 10% and Agip 5%. Table 1 below shows the physical presence of the oil industry in the Niger Delta. As at 2005, Nigeria's daily production of crude oil reached 2.2 million barrels (b.p.d.) and was still on the increase. In recent times, however, production rates keep fluctuating due to insecurity occasioned by threats of local militias in the delta.

Table 1: The physical presence of the oil industry in Nigeria.

1) Land area within which the networks of pipelines are located	31,000 km ²
2) Number of oil wells drilled	5,284
3) Number of flow-stations	257
4) Length of main oil and gas pipelines in the region (flowlines between oil wells and flow-stations not included)	7,000km
5.) Number of export terminals	10
6). Number of communities hosting oil/gas facilities	1,500

Source: Steiner (2008)

2.2 Frequency of Oil Spillage in Nigeria

According to Steiner (2008), oil spills in the Niger Delta have been extensive, difficult to assess (?) and often under-reported. In our opinion, one uncomplimentary value shared by the bulk of oil companies operating in Nigeria is the deliberate under-reporting of the actual environmental impacts of such oil spills, especially those resulting from equipment failures, in terms of volume of crude oil spilled into the already fragile and over-stretched ecosystem. Government and the operating companies maintain their own data on spills but these cannot be considered reliable as both the government and operators seek to limit their legal liability for commensurate claims and compensations from oil spill damage (Steiner, 2008). In worst cases, oil spillages in the delta are never reported or merely branded minor without minimum post-spill containment, recovery and remediation responses.

Records between 1976 and 2001 alone indicate that 6,817 oil spills occurred in Nigeria resulting in the loss of approximately three million barrels of oil (UNDP, 2006). This represents an average of 273 oil spills and 115,000 barrels/year spilled in the Niger Delta during the aforementioned period. However, Shell's report for the period 1990-2007 has it that a total volume of 284,000 barrels of oil were spilled or about 28,000 barrels were spilled/year. In a related report by IUCN/CEESP (2006), it was shown that between 9 and 13 million barrels of oil were spilled into the Niger Delta ecosystem over the past 50 years. Some notable oil spills recorded in Nigeria include Bomu 11 oil well blowout (1970), GOCON's Escravos spill (1978), Forcados Terminal Spillage (1980), Oyakama pipelines spill (1980), Texaco Funiwa 5 blow out in (1980), Abudu Pipeline Spill (1982), Ikata Pipeline Spill (1984), Okoma Pipeline Spillage (1985) and Oshika Pipeline Spill (1993), the massive Oloibiri Well 14 oil spill (2004), and very recently, Bodo oil spills (August 2008 and February 2009) and K. Dere spill (April 2009) – We chose to refer to the latter spill as SPDC 'Easter Gift' to the Ogonis because while others were celebrating Easter, the Ogoni people of K. Dere were running helter skelter to escape the deadly flame from Bomu flow station which exploded on Easter eve. Oil Spill in the Niger Delta: A Spill with a History

Adelana S. et al (2011) describe oil spillage as the release of a liquid petroleum hydrocarbon into the environment

due to human activity. Oil Spill is a form of pollution and the term is also applied to marine oil spills (release of oil into the ocean/coastal waters). Oil spills include releases of crude oil from tankers, offshore platforms, drilling rigs and wells as well as spills of refined petroleum products (such as gasoline, diesel) and their by-products, including heavier fuels used by large ships such as bunker fuel, or the spill of any oily white substance refuse or waste oil.

As at June 2010 it was estimated that about 546 million gallons of oil or the equivalent of an Exxon Valdez spill per year, have poured into the ecosystems of the Niger Delta over 50 years of oil production (National Oil Spills and Detection and Response Agency (NOSDRA), Between 1976 and 2001 a total of 6,817 oil spills were recorded, with only 70% recovered (UNDP 2006). The NOSDRA recorded another 2,405 spills between 2006 and mid-2010, with an increasing trend year-on-year: 252 in 2006, 598 in 2007, 927 in 2008 and 628 in 2009. It rose again in 2010 partly because the over 7,000 square km of pipelines linking 606 oil wells are old and begging replacement in the region. The major international oil companies operating in the Niger Delta include Shell Petroleum Development Company Ltd; Chevron (Chevron Nigeria, Ltd.); ExxonMobil; Eni (Nigerian Agip Oil Company); Total (Elf) (Total E&P Nigeria Limited). Since 2000, the following major spills have occurred:

Date	Location	Quantity (Gallons)	Vessel/Oil Company
21/12/2011	Bonga Field	1,694,000	Shell
01/05/2010	Niger Delta	29,414,000	Exxon Mobile
2009	Bodo	4,310,040	Shell
25/08/2001	Ogbodo	2,926,000	Shell
May 2001	Ogoniland	Unknown (but significant)	Shell

Source: guardian.co.uk, businessweek.com, urhobohistoricalsociety.com, wikipedia.com

Many of the previous spills, arising from a number of causes, were not completely accounted for and were not properly cleaned up and often take many months to stop the spills. This made the UNDP claim that it would take upwards of thirty years to clean up the Niger Delta's oil spills and associated environmental degradations.

2.3 Causes of Oil Spills in the Niger Delta

Oil companies have often blamed most spills on sabotage, however, the following shows the ranking of causes of oil spills in the Niger Delta: 42% of failures were mechanically induced, 18% by corrosion, third party activity contributed 24%, 10% through operational error, and 6% by natural hazards (Gas and Oil Pipeline Standards [GOST] of Nigeria). It is also noted that of the sour line failures, about 86% were leaks and 14% were rupture. The severity of spillage, measured by the amount of oil spilled, is higher in the Niger Delta than in Western Europe. The reason could be poor contingency planning for rapid response to spills; poor detection procedures; long distances between emergency shutdown valves; or the larger average diameter of pipelines".

The Department of Petroleum Resources (DPR) of Nigeria reports that of the 17,644 barrels of crude oil (or 723,404 gallons) spilt in 2000, 88% are traceable to equipment failure (Opukri and Ibaba 2008). The major culprits are oil spills and gas flaring. As a result of equipment failure and sabotage, oil spills have become endemic and devastating in the Niger Delta. (Opukri and Ibaba, 2008).

Related to oil spill is gas flaring. According to Baghebo, et al (2012) gas flaring is as old as the oil industry in Nigeria. Nigeria flares about 75 percent of gas it produces, more than any country in the World. Available information indicates that a total of 5.0 Trillion cubic feet of associated gas was flared in Nigeria between 1958 and 1999. This represents 85 percent of the 5.7 Trillion cubic feet that was produced within the period. Gas flaring is associated with many of devastating health ailments that affect human beings. Apart from this, the heat it generates kills vegetation around the flare area, destroys mangroves, swamps and salt marsh, suppresses the growth and flowering of plants, induces soil degradation and diminishes agricultural products.

Gas flaring destroys the buffer covering of the atmosphere that guides against ultra-violet of sun (The Ozone Layer) in the region and Nigeria at large. Chlofluorocarbons and other trace gases are on their way to the atmosphere as a result of the activities of oil exploration and exploitation.

As opined by Baghebo, et al (2012) the point however, is that the oil multinationals operating in the region do not conform to international standard. For example, the oil companies adopt the "open pipe flare" method to flare gas in the area. This method is obsolete, and is not used by these same companies in the developed countries. The "Open pipe flare" method degrades the environment more than accepted types, such as the "ground open flare" with Sand Banks.

Most of the black smoke associated with... the open pipe type contains element derived from the products of incomplete combustion, including soot and various sizes of carbon particles which are both hazardous.

3. Theoretical Literature

Currently, much of the debate on FDI and the environment centers around the 'pollution havens' hypothesis. This basically states that companies will move their operations to less developed countries in order to take advantage of less stringent environmental regulations. In addition, all countries may purposely undervalue their environment in order to attract new investment. Either way this leads to excessive (non-optimal) levels of pollution and environmental degradation. Of course, pollution havens effect must not be conveniently aggregated away as an insignificant determinant of total investment flows. There is clear evidence that, even though full environmental costs are not internalized, certain resource and pollution intensive industries have a location preference for areas of low environmental standards. There is also evidence that host countries do not enforce domestic standards in order to attract and retain investors, and that international investors have often encouraged such behavior (Mabey and McNally, 1999). As Gary (2002) mentions, the race to the bottom is a subject in pollution Haven phenomena and consists of a positive action by a government lowering environmental standards that attract FDI inflows. Pollution havens may be states that lower their standards but they might also be based on existing relative differences in environmental regulation between countries without any action by the host state. Government efforts to regulate and enforce environmental laws can be restrained by a volume of institutional limitations characteristic in developing countries. Fu (2008) suggests that the host country's absorptive capacity (which is determined by the level of human capital) plays an important role in explaining the technology that accompanies FDI is diffused. Thus, the regions with higher technological capabilities due to levels of high human capital are able to adopt more advanced technologies and consequently reduce the pollution.

In the 1950's, some economists discovered that human capital was the primary element to raise individuals' wages compared to other components such as land, financial capital and labor force (Salamon, 1991). Throughout the investment of human capital, an individual's acquired knowledge and skills can easily transfer certain goods and services with practical values (Romer, 1990). Up to late 1950 and early 1960 physical capital use to be known as nation wealth. Since beginning of 1960, when researchers tried to analyze advancement of industrial countries and backwardness of majority of third world countries, conceptual and cultural changes were formed based on the principle that human is the main key of development. This caused the capital concept of "human" to be entered to the economic analyses beside other factors. Although, offering a precise definition and measurement of human capital is not easy, it is generally measured by accumulated educational investment in labor force. As a stock variable, educational attainment and the entire education received by working individuals which are measured by average years of schooling and school enrollment rate in different grades are often considered as the human capital variable in calculations. So far, researchers such as Barro and Lee (1993), Krueger and Lindahl (2001), Wang and Yao (2003) and Cohen and Soto (2007) tried to make educational data as an agent of human capital stock (Lan et al., 2012).

According to IMF and OECD, foreign direct investment reflects achieving sustainable advantages by a resident institution in an economy (direct investor) in an economic firm resident in another economy (direct investment firm) that sustainable advantages implies on the existence of a long-run relationship among investor and investing firm (Duce and España, 2005). In fact, by an accurate policy frame FDI will lead to financial stability, enhancement of economic development and welfare. That's why FDI data and statistics have always been one of the matters in center of attention of policy makers who think of maximizing the usage of international investments.

So far, various studies have been carried out about the effects of environmental rules severity and crackdown on trade and capital currencies, but the effectiveness of FDI mechanism on pollution and transmission of this mechanism from one country to one another have been hardly ever investigated.

In this paper the effect of FDI, openness, gross fixed capital formation on air pollution is investigated in Nigeria covering the period 1970-2013.

4. Materials and Method

The study made use of secondary data sourced from various publications of the Central bank of Nigeria, National Bureau of Statistics and others. We adopted three stage methodology. First we examine the stationary status of the data using Augmented Dickey Fuller (ADF) unit Root test. The long run equilibrium relationship of the variables in the model was investigated using Johansen cointegration test. The third stage is the estimation of the short run dynamic adjustments necessary to establish a stable long run relationship using the ARDL approach. The main advantage of this approach lies

in the fact that it can be applied irrespective of whether the variables are 1(0) or 1(1) (Pesaran and Pesaran 1997). Another advantage of this approach is that the model takes sufficient numbers of lags to capture the data-generating process in a general- to-specific modeling. Moreover, a dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation. The ECM integrates the short-run dynamics with the long-run equilibrium without losing information. It is also argued that using the ARDL approach avoids problems resulting from non-stationary time series data (Laurenceson and Chai, 2003).

5. Model Estimation

The models to be estimated are hereunder stated:

$$GDPG = \alpha_0 + \alpha_1 OPN + \alpha_2 CFI + \alpha_3 GFCF + \mu_1 \quad \text{--- (1)}$$

$$CO_2 = \beta_0 + \beta_1 CFI + \beta_2 OPN + \beta_3 GDPG + \mu_2 \quad \text{--- (2)}$$

Where, GDPG is the yearly GDP growth level, OPN is the degree of trade openness measured as the ratio of trade to GDP, CFI is the cumulative foreign direct investment, GFCF is the gross fixed capital formation all in million Naira, CO₂ is the carbon dioxide emission (kt) from burning of fossil fuels and the manufacture of cement (includes CO₂ produced during consumption of solid, liquid and gas fuels and gas flaring), μ_1 , μ_2 are respectively the error terms of the growth equation and the pollution equation.

This study employed cointegration and error correction methods to estimate the growth equation and the pollution equation since the models are not simultaneous but recursive, so simple OLS will produce an unbiased and consistent estimators. This study utilizes the error correction mechanism based on Johanson cointegration approach. If variables are non-stationary and integrated of the same order, if cointegration is confirmed, it means that although those variables are individually non-stationary, combining them in the same equation will bring about an equilibrium relationship in the long run even if there can be divergence from equilibrium in the short run. That is, they are stationary since the linear combination of these variables cancel out the stochastic trends in the individual series. The estimation of static or long-run relationship using the Ordinary Least Squares (OLS) can be estimated. The changes in the dependent variables are regressed on all the independent variables as well as the one-year lagged value of the error term obtained from the static OLS.

The error correction models are hereunder stated:

$$DGDPG = \alpha_0 + \alpha_1 DOPN + \alpha_2 DCFI + \alpha_3 DGFCF + \alpha_4 DECM_{1t-1} + \mu_1 \quad \text{--- (3)}$$

$$DCO_2 = \beta_0 + \beta_1 DCFI + \beta_2 DOPN + \beta_3 DGDPG + \beta_4 DECM_{2t-1} + \mu_2 \quad \text{--- (4)}$$

Where, DGDPG is the change in GDP growth level, DOPN is the first difference of trade openness, DCFI is the first difference of the cumulative foreign direct investment, DGFCF is the first difference of the gross fixed capital formation, DCO₂ is the yearly change in carbon dioxide (kt) emission from burning of fossil fuels and the manufacture of cement (includes CO₂ produced during consumption of solid, liquid and gas fuels and gas flaring), DECM_{1t-1}, DECM_{2t-1} are respectively the error correction terms of the growth equation and the pollution equation. All the α s and β s are the parameters of the model to be estimated.

The data for the models are obtained as follows. CO₂ data in kt for 1970 to 2009 were obtained from carbon dioxide information analysis centre, environmental sciences division. OLS estimates were made to forecast for 2010 to 2012. GDP, gross capital formation, total trade and cumulative foreign direct investment data (in million Naira) were obtained from the central bank of Nigeria statistical bulletins 2009 and 2011. 2012 figures for GDP, gross capital formation and total trade were obtained from the National Bureau of Statistics various issues. Data for 2009 to 2012 were forecasted from a regression of OLS against time. Trade openness was obtained as the ratio of trade to GDP.

6. Data Analysis and Interpretation of Results

Table one below shows the result of the Augmented Dickey-Fuller results of the variables of the models. Testing for stationarity of each variable at levels indicate that none of the variables is stationary at level. A test of stationarity at first difference however indicates that each variable is indeed stationary at first difference implying that they are all integrated of order one.

Table 1: Unit Root Test on Variables of the Model

Variables	Augmented Dickey-Fuller Statistics		Macinnon critical values at 1% significance level		Remarks
	LEVEL	1 ST DIFFERENCE	Level	1 st Difference	
CFDI	2.011623	-5.530992	-2.6196	-2.6211	I(1)
CO2	0.295776	-4.222777	-2.6196	-2.6211	I(1)
GFCF	-0.120060	-4.021698	-2.6196	-2.6211	I(1)
OPN	0.085341	-5.791929	-2.6196	-2.6211	I(1)
RFDI	-2.432291	-4.847008	-3.5973	3.6019	I(1)
GDPG	-0.969866	-6.778779	-2.6211	-2.6227	I(1)

Having met the condition for conducting a stationarity test, we utilized the Johansen cointegration test and the results are presented as follows in tables 2 and 3.

Table 2: Johansen Cointegration Result for the growth model

Sample: 1970 2013
Included observations: 40
Test assumption: Linear deterministic trend in the data
Series: GDPG OPN CFDI GFCF
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.812794	98.37165	47.21	54.46	None **
0.377381	31.34992	29.68	35.65	At most 1 *
0.266353	12.39709	15.41	20.04	At most 2
0.000200	0.008018	3.76	6.65	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 2 cointegrating equation(s) at 5% significance level

The Result in table 2 indicate that there are 2 cointegrating equations. This suggests that although each variable is not stationary at level, a linear combination of these variables in a model cancel out the stochastic trends in the individual series and therefore are stationary and will not produce a spurious result.

Table 3: Johansen Cointegration Result for the Pollution model

Sample: 1970 2013
Included observations: 40
Test assumption: Linear deterministic trend in the data
Series: CO2 CFDI OPN GDPG
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.650584	75.68732	47.21	54.46	None **
0.470309	33.62762	29.68	35.65	At most 1 *
0.121564	8.209148	15.41	20.04	At most 2
0.072829	3.024680	3.76	6.65	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 2 cointegrating equation(s) at 5% significance level

Table 3 also depicts the variables of the pollution model, and the result just like the growth equation indicates that there is cointegration relationship among the variables suggesting that although they are not integrated of order zero (non-stationary) individually, their combined use in an equation will achieve stationarity and the result so obtained will be reliable and meaningful. Based on tables 2 and 3 results, we therefore present the static model results (long run results) for the two models.

Table 4: The Result for the Static (long run) growth Model

Dependent Variable: GDPG				
Method: Least Squares				
Sample(adjusted): 1971 2013				
Included observations: 42 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-475484.3	681366.0	-0.697840	0.4895
OPN	1602751.	1435398.	1.116590	0.2712
CFDI	-2.731107	2.967186	-0.920437	0.3632
GFCF	1.482604	0.316190	4.688966	0.0000
R-squared	0.643314	Mean dependent var		965225.3
Adjusted R-squared	0.615154	S.D. dependent var		1784875.
S.E. of regression	1107264.	Akaike info criterion		30.76308
Sum squared resid	4.66E+13	Schwarz criterion		30.92857
Log likelihood	-642.0246	F-statistic		22.84538
Durbin-Watson stat	2.499401	Prob(F-statistic)		0.000000

Table 4 presents the long run determinants of growth which includes trade openness, cumulative foreign direct investment, and gross fixed capital formation. The result indicates that the independent variables have been able to capture about 64 percentage of the variability in economic growth. This is a sign of a good fit. Also the joint contribution of the independent variables in explaining growth is confirmed by the significance of the F-statistic.

A serious look at the result shows that only the gross fixed capital formation that significantly explained economic growth in Nigeria. It positively contributes to economic growth in the long run. The FDI result is counter-intuitive as it is negatively related to economic growth in Nigeria. The reasons for this may not be too far from the fact that FDI positively contributes to growth in some sectors and in others, it did not contribute so that on the overall, the result may be negative as observed by Ayadi (2010). Another factor negating the impact of FDI on growth may be the contributory roles of Infrastructural decay on investment. A specific example is the poor power supply in Nigeria among others. There is a positive relationship between trade openness and economic growth on the long run for Nigeria, although the relationship is not a significant one. This makes trade component of economic integration beneficial while the FDI component is unimpressive.

Table 5: The Result for the Static (long run) pollution Model

Dependent Variable: CO2				
Method: Least Squares				
Sample(adjusted): 1970 2013				
Included observations: 42 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	72456.35	8936.504	8.107908	0.0000
CFDI	0.077393	0.025965	2.980731	0.0050
OPN	-37579.41	18516.21	-2.029541	0.0494
GDPG	0.004086	0.001719	2.376769	0.0226
R-squared	0.494955	Mean dependent var		64875.95
Adjusted R-squared	0.455083	S.D. dependent var		19970.05
S.E. of regression	14741.59	Akaike info criterion		22.12513
Sum squared resid	8.26E+09	Schwarz criterion		22.29062
Log likelihood	-460.6276	F-statistic		12.41359
Durbin-Watson stat	0.686438	Prob(F-statistic)		0.000008

Table 5 above presents the long run result of the pollution model in which carbon dioxide emission from all sources are related to the two variables of economic integration (trade openness and FDI inflows) and output growth. Our model has been able to capture about fifty percent variability in carbon dioxide emission. The joint significance of our independent variables in explaining our dependent variable is confirmed by the significant F-statistic. Our Durbin-Watson statistic

result however indicates that there is the likelihood of the presence of serial correlation which may be caused by omission of an important variable in our model. This variable is the strictness of environmental regulation which is difficult to capture. I do not feel that the extent of autocorrelation has affected the result of the model.

A serious look at the results indicate that cumulative foreign direct investment, trade openness, and output growth significantly explained carbon dioxide emission in Nigeria. Trade openness is negatively related to carbon dioxide emission. A unit rise in trade openness, other things being constant can bring about 37,579.41 (kt) reduction in carbon dioxide emission in the long-run. This agrees with the findings of Radetzki (1992) and Lucas, Wheeler and Hettige (1992) who explained that inasmuch as trade makes economies wealthier, it can be categorized as beneficial to the environment, since high income economies are having high willingness to pay to protect the environment.

Expectedly however, growth in output is positively related to pollution. A unit increase in output level, *ceteris paribus* will bring about 0.004086 (kt) increase in carbon dioxide emission in the long-run. In the same vein, inflow FDI positively contributed to pollution. This indicates that imported technologies to Nigeria are "dirty". This lend support to the reality of pollution haven hypothesis.

Table 6: The Result for the short run Model of Pollution

Dependent Variable: DCO2				
Method: Least Squares				
Sample(adjusted): 1973 2013				
Included observations: 40 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	947.0795	2035.516	0.465277	0.6446
DCFDI	0.014267	0.062255	0.229169	0.8201
DOPN	-14329.18	16499.55	-0.868459	0.3911
DGDGP	0.001968	0.001420	1.385369	0.1747
DECM1(-1)	-0.045866	0.168446	-0.272287	0.7870
R-squared	0.104727	Mean dependent var		1140.175
Adjusted R-squared	0.002410	S.D. dependent var		11757.69
S.E. of regression	11743.51	Akaike info criterion		21.69646
Sum squared resid	4.83E+09	Schwarz criterion		21.90757
Log likelihood	-428.9292	F-statistic		1.023556
Durbin-Watson stat	2.129448	Prob(F-statistic)		0.408719

Table 6 above shows the result of the short run model for pollution. The coefficient of determination is very low and it is implying that the independent variables could only capture about 11 percent variability in the dependent variable in the short run. The F-statistic also points to the fact that the independent variables did not jointly explain the dependent variable (carbon emission growth) in the short run.

In the short run however, carbon emission growth, is positively related to (although insignificantly), change in the foreign direct investment inflow into Nigeria and change in output growth indicating that FDI and output growth exerts some positive pressure on pollution growth in Nigeria even though the pressures are not so significant. Growth in trade openness on the other hand has negative relationship with output growth (although not significantly) this tends to confirm the long run result which showed that trade is beneficial to the environment.

Table 7: The Result for the Short run growth Model

Dependent Variable: DGDGP				
Method: Least Squares				
Sample(adjusted): 1973 2013				
Included observations: 40 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	289107.5	165208.7	1.749954	0.0889
DOPN	667614.5	1214173.	0.549851	0.5859
DCFDI	-23.27974	3.953475	-5.888426	0.0000
DGFCF	0.349173	0.615697	0.567118	0.5743
DECM2(-1)	-0.638457	0.087295	-7.313831	0.0000
R-squared	0.799424	Mean dependent var		75013.75
Adjusted R-squared	0.776501	S.D. dependent var		1855828.
S.E. of regression	877356.1	Akaike info criterion		30.32368
Sum squared resid	2.69E+13	Schwarz criterion		30.53479
Log likelihood	-601.4736	F-statistic		34.87429
Durbin-Watson stat	2.166075	Prob(F-statistic)		0.000000

The short run growth model indicates that only the FDI significantly retards growth in Nigeria. This may be due to the crowding out effects. Trade openness and gross capital formation promotes growth in the short run although their impacts are insignificant. If changes in the independent variables are zero and $\beta_4 \text{DECM}_{t-1}$ (or $\beta_4 \Delta \mu_{t-1}$) is negative. This means GDPG_{t-1} is too low to be in equilibrium.

7. Conclusion

Based on the above results, we can say that carbon dioxide emission (a measure of environmental pollution) is positively linked with foreign direct investment inflow and output growth in the short run but negatively related to trade openness. Generally, none of these variables significantly explained pollution in the short run. In the long run, foreign direct investment inflow, output growth and trade openness significantly explained pollution. Output growth and inward foreign direct investment flow significantly fuelled pollution in Nigeria. The FDI result is a clear confirmation of the reality of pollution haven hypothesis in Nigeria. Trade openness however is beneficial to the environment as revealed by the negative relationship between pollution and trade openness. This is in agreement with the postulates that trade promotes efficiency and better use of country's endowment including the environment. Trade also enhances income growth which leads to higher living standards and encourages the stronger demand for the environment.

Based on the above we can conclude that trade is beneficial to growth and the environment in Nigeria. Foreign direct investment inflow has not been able to be harnessed in Nigeria to act as a stimulator of growth and environmental improvement. Caution must be made on the conclusion here as only one measure of environmental condition is considered here. The study did not examine the issue of resource depletion.

8. Recommendation

African countries must intensify their natural resource-based activities so as to avoid irreversible damage especially to their non-renewable natural resources and should manage their renewable natural resources so that the rate of harvest must not outgrow the regenerative capacity of those resources.

In addition, economic integration suggests that government of Developing countries must put in place sound environmental policy taking into cognizance the integration effects on the environment. In addition, they must adhere to strict environmental enforcement to avoid excessive pollution discharges, indiscriminate deforestation, over exploitation of the flora, fauna and marine resources, and ill-defined property rights among others.

References

Adelana S. Fantong Nadaw D. Duah A.(2011) Ground water and health: Meeting the unmet needs in sub Saharan Africa in Jones J.A.A (ed) sustainable ground resources.. *International year of planet Earth, springer science+ Business Media B.V.* pp 21-33

- Aghalino S.O (1999): Oil and Gas Exploration and Production in the Isoko Area of Delta State of Delta State, Nigeria, 1958-1995. PhD Thesis, unpublished, Ilorin, University of Ilorin.
- Ayadi F.S(2010): Sectoral Analysis of Foreign Direct Investment and Economic Growth in Nigeria. *International Journal of Trade and Global Markets(IJTGM)* Vol.3, Number4. Pp 327-340
- Baghebo M., Ubi P. S. and Eucharia N.N. (2012) Environmental Damage Caused by the activities of multinational Oil Giants in the Niger Delta Region of Nigeria. *IOSE Journal of Humanities and Social Sciences (JHSS)* Vol. 5. Issue 6. Pp 09-13
- Barro, R.J. & Lee, J.W. (1993).International comparisons of educational attainment. *Journal of Monetary Economics* 32(3):363–394
- Cohen, D. & Soto, M. (2007). Growth and human capital: good data, good results. *Journal of Economic Growth* 12(1):51–76.
- Duce, M.&España, B. de.(2005). *Definitions of Foreign Direct Investment (FDI):a methodological note*. Paper prepared as background material for the BIS Meeting of the CGFS Working Group on FDI in the financial sector, to be held on March 11.
- Ekpu O.O. (1996): Oil pollution Damage: The need for Equity. Society for petroleum Engineers (Nigerian Council) 20th Annual International Conference and Exhibition, Petroleum Training Institute Conference Effuren, Nigeria.
- Fu, X. (2008). Foreign direct investment, absorptive capacity and regional innovation capabilities: evidence from China. *Oxford Development Studies* 36(1):89–110.
- Gary, K. (2002). Foreign Direct Investment and Environmental Impacts- Is the Debate Over?.*Recife* 11 (3), 306-313.
- Heywood, V. H. (1995) Global Biodiversity Assessment. *Cambridge University Press, New York*. Pp. 1140.
- IUCN/CEESP (2006): Establishing Payment for watershed services, Gland, Switzerland.
- Krueger, A.B. &Lindahl, M. (2001).Education for growth: why and for whom. *Journal of Economic Literature* 39(4):1101–1136.
- Lan J. Kakinaka M. and Huang X. (2012) Foreign Direct Investment, Human Capital and Environmental Pollution in China. *Environment and Resource Economics*.51:255-275
- Lauresonson j. and J.C.H. Chai (2003). Financial Reform and Economic Development in China. Edward Elgar, Cheltenham, UK.
- Lucas, R. E. B, David Wheeler, and Hemamala Hettige (1992) Economic Growth and the Environment. In Patrick Low, ed.,*International Trade and the Environment*. Discussion Paper no. 159.Washington, D.C. World Bank.
- Mabey, N. &McNally, R. (1999). Foreign Direct Investment and the Environment: From Pollution Havens to Sustainable Development. A WWF-UK Report.
- Opukiri C.O and I.S. Ibaba (2008): Oil induced Environmental Degradation and Internal Population Displacement in Nigeria's Niger Delta. *Journal of Development issues* Vol. 7 issue 1 pp. 41-55
- Pesaran, M. Hasen and Pesaran Bahram (1997). Working with microfit 4.0: *interactive Econometric Analysis*. Oxford University Press, Oxford.
- Radetski, Marian (1992) Economic Growth and the Environment. Patrick Low, ed.,*International Trade and the Environment*. Discussion Paper no. 159.Washington, D.C. World Bank.
- Romer, P. M. (1990).Endogenous Technological Change. *Journal of Political Economy*, 98(5), 71–102.
- Salamon, L. M. (1991). Human Capital and America's Future. Baltimore: Johns Hopkins University.
- Singh, M. P. (1985) Import Policy for a Developing Economy. Chugh Publications, Allahabad, India.
- Steiner C. (2008): Soil Charcoal Amendments maintain soil fertility and Establish a carbon sink. Research and prospects. In soil Ecology Research Development. Eds Tian- Xiao Liu,*Nova Science publishers, Newyork*.
- UNDP (2006): Niger Delta Human Development Report P. 76.
- UNDP (2013) Human Development Report 2013 The Rise of the South: Human Progress in a Diverse World
- Viner J. (1950) The Economics of International Integration. 2nd ed. London. George Allen & Unwin.
- Wang, Y. & Yao, Y. (2003).Sources of China's economic growth 1952–1999: incorporating human capital accumulation. *China Econ Rev* 14(1):32–52.
- World Resource Institute (1990) Water Resources, 1990-1991. Oxford University Press.