THE IMPACT OF FOREIGN DIRECT INVESTMENT ON CO_2 EMISSION IN NIGERIA (1980 - 2014)

Olukayode Emmanuel, MAKU[1]

Department of Economics, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria

Soliu Bidemi, ADEGBOYEGA

Department of Economics, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria

Aduralere Opeyemi, OYELADE

University of Ibadan, Nigeria.

The study investigated the impact of foreign direct investment on CO_2 emission in Nigeria over the period 1980 to 2014. Econometric techniques which included correlation analysis, unit root test, co-integration, error correction model were employed to determine the direction and the magnitude of impacts. Findings from the analysis revealed gross domestic product positively influence CO_2 emission in Nigeria and was insignificant while foreign direct investment and energy consumption have negative impact on CO_2 emission in Nigeria but not significant. Also gross domestic product per capita, foreign direct investment and energy consumption in one year lag (-1) have negative impact on CO_2 emission in Nigeria but only energy consumption was significant at 10% level of significant. Furthermore, gross domestic product per capita, foreign direct investment and energy consumption in two year lag (-2) have a negative impact on CO_2 emission in Nigeria but only foreign direct investment is significant at 10% level of significant. Furthermore, gross domestic product per capita, foreign direct investment and energy consumption in three year lag (-3) have a positive impact on CO_2 emission in Nigeria but all the variables are insignificant. The result of ECM indicated that the model seems to be good as it satisfies the diagnostic test and also has an adjusted R-Squared (R^2) value of 0.413645, which indicate that only about 45.64% of the total systematic variation in CO2 emission in Nigeria is not accounted for by the explanatory variables all taken together. The Durbin Watson (DW) statistics value of 1.701254 shows that there is no serious problem of serial correlation and heteroskedasticity. The error term is also found to be normally distributed and it will take approximately six years and some months for full adjustments to take place after a shock has occurred.

Keywords: Foreign Direct Investment, CO_2 Emission and Economic Growth . *JEL Classification: Q43.*

1.1 Introduction

During the last two centuries, human activities have increased the concentration of greenhouse gases (GHG) in the atmosphere considerably. The most important increase has been that of carbon dioxide (CO_2), which is emitted when burning fossil fuels such as coal, oil, and natural gas. For the 10,000 years prior to the 19th century, accumulated CO_2 remained between 260 and 290 parts per million (ppm), then suddenly started to increase rapidly. At present, accumulated CO2 is above 385 ppm and is increasing annually by an average amount of 2 ppm [1] Greenhouse gases form a "blanket" of pollution that traps heat in the atmosphere, causing climate instability characterized by severe weather events such as storms, droughts, floods, heat waves, and rising sea levels. According to the IPCC, an 80 percent reduction in global greenhouse gas emissions by 2050 is essential in order to avert the worst effects of climate change [10]

Earth's surface temperature is the outcome of energy flows that are dynamic, sensitively re-adjusting to a fluid balance of forces. The incoming warmth from the sun and the

internal heat from the molten core beneath the mantle are continuously being radiated out into space, and the difference between these rates of warming and cooling creates the surface temperatures we must cope with [29]. The atmosphere ultimately governs this race between heating and cooling by acting as a "valve" regulating the rate of heat loss from infrared radiation into space, and the size of this valve is mainly due to CO_2. CO_2 captures heat, acting like a gaseous blanket over the planet. Although heat still works its way out through this chemical blanket, the blanket slows its progress enough to retard cooling and raise the global surface temperature. If it were not for naturally occurring levels of atmospheric CO_2 in the past, the surface temperature of our planet would be below freezing (–18c), liquid water would not exist, and life as we know it impossible [29].

Developing countries are increasingly aware of the role of foreign direct investment (FDI) as an engine of growth in their economies. Foreign investors can contribute to growth by providing much needed capital and skills, by sharing risks in large projects and by serving as a vehicle for technology transfer. For many developing countries, FDI is a mechanism by which to promote industries in which they have a potential comparative advantage that cannot otherwise be exploited.FDI contributes to these countries' economic development, which in turn affecting their energy demand and environmental degradation [22]

Furthermore, foreign direct investment (FDI) inflow has increased during the past twenty years in almost every nation of the world including Nigeria revitalizing the long debate in both academic and policy spheres on their advantages and related costs [21] One aspect of the debate argues that FDI provide direct capital financing generating positive externalities and stimulate economic growth via technology transfer. While part of other aspect of the debate is that FDI inflow and their activities in the host country leads to energy consumption and carbon dioxide emissions which release toxic substances that pollute and degrade the natural environment. The increase threat of greenhouse gases and global warming along with climate change has called for more attention and discussion on the danger of its consequences on the natural environment [21]. Therefore, this study is set to investigate the impact of foreign direct investment on CO2 emission in Nigeria.

Specifically, this study intends to determine the effect of foreign direct investment, gross domestic product per capita and energy consumption on CO2 emission in Nigeria, and how relative importance of foreign direct investment, gross domestic product per capita and energy consumption on CO_2 emission in Nigeria. Lastly to examine the short-run and long-run relationship among the variables under study.

The study is organized into five sections. The introduction captures section one, followed by section two that covers the literature review which includes the theoretical review, methodology and empirical review. Section three focuses on theoretical framework and methodology while section four deals with discussion and interpretation of results. Finally, section five deals with summary and conclusion.

2. Literature Review

2.1 Theoretical Review

2.1.1 Environmental Kuznets curve (EKC)

In 1991, [13] found that the long-term relationship between economic growth and environment quality was an inverted U-shaped curve. The phenomenon has been labeled as Environmental Kuznets Curve (EKC) by [24] later. The EKC hypothesizes that environment quality deteriorates with the increase of per capita income at the early stage of economic growth and gradually improves when the country reaches to a certain level of affluence. Developed countries have fairly stable production structures, whereas rapidly industrializing

and developing countries have unstable production structure and the effects of structural change on emissions may be less obvious. The primary sector (agriculture, fisheries, forestry, and mining) tends to be more resource-intensive than either the secondary (industry) or tertiary (services) sectors. The industry (especially manufacturing), on the other hand, tends to be more pollution-intensive than either agriculture or services. Since the structure of the economy (sectoral composition of output) changes with economic growth, part of the effect of increases in income per capita on environmental degradation reflects the effects of changing composition of output. In the case of pollution, economic structure is represented by the share of industry in GDP and expects a positive relationship with environmental degradation. Since the share of industry in GDP first rises with economic growth and then declines as the country moves from the pre-industrial to the post-industrial stage of development, an inverted-U shaped relationship between environmental pollution and income level are expected while controlling for all other influences transmitted through income.

The importance of trade in combination with composition of economic activity is investigated in the decomposition of EKC for CO_2 concentrations across countries [17]. People, at low-income levels, are more concerned with food and other material needs and less concerned with environmental quality. People, at higher income levels, begin to demand higher levels of environmental quality to go along with their increased prosperity. The modified EKC analysis can be used to compare the differences in EKC between countries (developed and developing specifically, as long as enough data exists) due for instance to inter-country variations in the presence of corruption. One of the determinants of environmental policy is the socio political regime of a particular country. Corruption and rent-seeking behaviour can influence the relationship between income and environment [20]. However, for any level of per capita income, the pollution levels corresponding to corrupt behavior are always above the socially optimal level. So, the turning point of EKC takes place at income and pollution levels above those corresponding to the social optimum, which depends on the existing social institutions. Institutional changes triggered by citizens' demand for cleaner environments are more likely to occur in developed countries than in developing.

2.1.2 Halo Effect Hypothesis

The halo effect follows the productivity literature in spirit, which examines the productivity spillovers by FDI both at the firm and macroeconomic levels. The rationale behind potential environmental spillovers is that the possibility that multinaltional corporations (MNCs) encourage the dissemination of environmentally clean technologies and management practices. This occurs if the foreign firm engages in contracts only with environmentally responsible domestic counterparts. This may happen under shareholder pressure at the MNC or because of practices established at the MNCs based on its home country environmental regulations and standards. Further environmental knowledge can disseminate through the movement of trained workers from foreign to domestic firms or because of a direct competition of domestic firms with the MNCs. The literature on environmental spillovers from FDI confines to only case studies of specific countries' manufacturing industry firms. The evidence with respect to the halo hypothesis has been mixed.

2.1.3 Pollution Haven Hypothesis

The original pollution haven hypothesis [8] states that as trade is liberalized, industries that pollute shift from rich

countries with tight regulation to poor countries with weak regulation and conversely, clean industries migrate towards rich countries. The pollution haven hypothesis has three dimensions. The first is the relocation of heavy polluting industries from developed countries with stringent environmental policies to developing countries where similar policies do not exist, are lax or not enforced. Accordingly, global free trade would encourage polluting industries and processes to move to countries with weak environmental policy. The second dimension is the dumping of hazardous waste generated from developed countries (industrial and nuclear energy production), in developing countries. This issue was the subject of the Basle Convention on hazardous waste. The last dimension is the unrestrained extraction of non-renewable natural resources in developing countries by multinational corporations engaged in producing petroleum and petroleum products, timber and other forest resources, etc. All the dimensions relate to conscious decisions on environmental policy and how they impact on the environment, future production and trade.

This theory addressed pollution haven in three ways. (i) The relation between exports and regulation. Since regulation increases cost, the exports of countries with more stringent regulations become relatively more expensive than those with lax regulation. Therefore their exports decline and their imports of relatively dirty goods rise. (ii) The shift in the pattern of trade in pollution-intensive goods: despite evidence supporting this hypothesis [11], this may be due to various factors such as increase in demand for products in the developing countries, development of endowments that develop these industries. (iii) Accordingly, high regulatory costs are likely to deter firms' investment decisions. At the international level, the specific question that is addressed is whether FDI in polluting industries increased towards developing countries.

2.1.4 Porter Hypothesis

According to [25] "Strict environmental regulations do not inevitably hinder competitive advantage against rivals; indeed, they often enhance it." He went on to suggest various mechanisms by which environmental regulations might enhance competitiveness, such as reduction in the use of costly chemicals or lower waste disposal costs. The traditional view of environmental regulation held by virtually all economists until that time was that requiring firms to reduce an externality like pollution necessarily restricted their options and thus by definition reduced their profits. After all, if profitable opportunities existed to reduce pollution, profit maximizing firms would already be taking advantage of those opportunities.

The traditional view among economists and managers concerning environmental protection is that it comes at an additional cost imposed on firms, which may erode their global competitiveness. Environmental regulations (ER) such as technological standards, environmental taxes, or tradable emissions permits force firms to allocate some inputs (labor, capital) to pollution reduction, which is unproductive from a business perspective. Technological standards restrict the choice of technologies or inputs in the production process. Taxes and tradable permits charge firms for their emissions pollution, a by-product of the production process that was free before. These fees necessarily divert capital away from productive investments. This traditional paradigm was challenged by a number of analysts, notably Professor Michael Porter [25] and his coauthor Claas van der Linde [26]. Based on case studies, the authors suggest that pollution is often a waste of resources and that a reduction in pollution may lead to an improvement in the productivity with which resources are used. More stringent but properly designed environmental regulations (in particular, market-based instrument such as taxes or cap-and-trade emissions allowances) can "trigger innovation [broadly

defined] that may partially or more than fully offset the costs of complying with them" in some instances [26]. Figure 2.1 summarizes the main causal links involved in the PH. As Porter and van der Linde first described this relationship, if properly designed, environmental regulations can lead to "innovation offsets" that will not only improve environmental performance, but also partially—and sometimes more than fully—offset the additional cost of regulation.

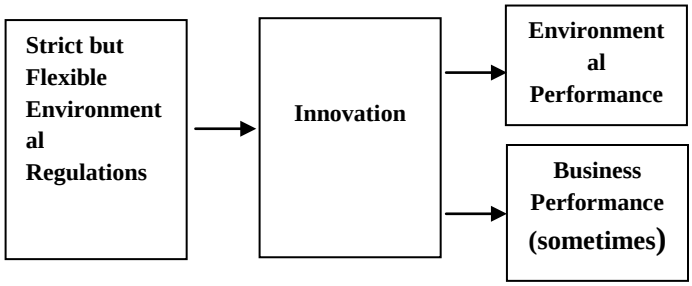

Figure 2.1 Schematic Representation of the Porter Hypothesis

Author Computation from Doytchand Uctum (2011)

Porter and van der Linde go on to explain that there are at least five reasons that properly crafted regulations may lead to these outcomes:

- First, regulation signals companies about likely resource inefficiencies and potential technological improvements.
- Second, regulation focused on information gathering can achieve major benefits by raising corporate awareness.
- Third, regulation reduces the uncertainty that investments to address the environment will be valuable.
- Fourth, regulation creates pressure that motivates innovation and progress.
- Fifth, regulation levels the transitional playing field.
- Finally, they note, "We readily admit that innovation cannot always completely offset the cost of compliance, especially in the short term before learning can reduce the cost of innovation-based solutions" [26].

The Porter Hypothesis has met with great success in political debate, especially in the United States, because it contradicts the idea that environmental protection is always detrimental to economic growth. The PH has been invoked to persuade the business community to accept environmental regulations, as it may benefit from them in addition to other stakeholders. In a nutshell, well-designed environmental regulations might lead to a Pareto improvement or "win– win" situation in some cases, by not only protecting the environment, but also enhancing profits and competitiveness through the improvement of the products or their production process or through enhancement of product quality. The PH has been criticized for being incompatible with the assumption of profit maximizing firms [23].

2.1.5 Pollution Leakages

Pollution leakage has emerged as a potentially important factor in the relationship between economic growth and environmental quality [3] Critics of the Environmental Kuznets Curve hypothesis have suggested that whilst economic growth in country A may lead to lower domestic emissions due to structural changes in the domestic economy, continued consumption of pollution intensive products imported from overseas may lead to increases in pollution in the exporting country [5] Moreover, measures to reduce emissions in country A – such as a pollution tax – may result in increased emissions in exporting countries, partly through changing incentives for the location of dirty industries when factors of production are mobile across international borders [28]. Modelling studies of the effects of energy efficiency improvements on domestic pollution reveal a third channel

for pollution levels in trading countries to be codetermined, due to competiveness effects on energy-intensive (and thus, typically, carbon-intensive) export sectors [14]

2.2 Empirical Review

[2] examined the impact of environmental policy on location decision, the outflow of "dirty" Foreign Direct Investment (FDI) from 1990 to 2000 for fourteen developing countries and eleven developed/OECD. The study also examined the impact of "dirty" FDI in host countries, on annual CO_2 total emission; total emission of known particulate matters; rising temperature; and total energy use. Using disaggregated FDI data, panel data regression, and the paper found that, "dirty" FDI outflow is positively correlated with environmental policy in eleven OECD countries.

[1] examined two most important benefits and costs of foreign direct investment in the Indian context - GDP growth and the environment degradation. The paper found a statistically significant long run positive, but marginal, impact of FDI inflow on GDP growth in India during 1980-2003. On the other hand, the long run growth impact of FDI inflow on CO2 emissions is quite large. The actual impact on the environment, however, may be larger because CO2 emission is one of the many pollutants generated by economic activities. But CO2 being a global air pollutant, the paper finding has some far reaching implications for the global environment as well, with India having emerged as the fourth highest in the global ranking of CO2 emissions by turn of this century.

[29] examined the impact of foreign investment dependence on carbon dioxide emissions 1978 to 2008 in China. In a time series regression analysis, the author finds that foreign capital penetration has a significant negative effect on the growth of CO2 emissions, which is due to the spill-over effect. It does not mean that FDI does no harm to us. Chinese are aware that foreign capitals of pollution-intensive industries have poured into China. The paper must be strict with the inflow of foreign capital. Exports aggravate the pressure on CO2 emissions. It was the evidence of "Pollution Haven". Economic growth, however, has no systematic effect. The paper finds negative effect of domestic investment and agriculture shares on total CO2 emissions over the same period.

[7] investigated the existence of the environmental Kuznets curve (EKC) for carbon dioxide (CO2) emissions and its causal relationships with economic growth and openness by using time series data (1971-2006) from China (an emerging market), Korea (a newly industrialized country), and Japan (a developed country). The sample countries span a whole range of development stages from industrialized to newly industrialized and emerging market economies. The environmental consequences according to openness and economic growth do not show uniform results across the countries. Depending on the national characteristics, the estimated EKC show \different temporal patterns. China shows an N-shaped curve while Japan has a U-shaped curve. Such dissimilarities are also found in the relationship between CO2 emissions and openness. In the case of Korea and Japan it represents an inverted Ushaped curve, while China shows a U-shaped curve. We also analyze the dynamic relationships between the variables by adopting a vector auto regression or a vector error correction model. These models through the impulse response functions allow for analysis of the causal variable's influence on the dynamic response of emission variables and it adopts a variance decomposition to explain the magnitude of the forecast error variance determined by the shocks to each of the causal variables over time. Results show evidence of large heterogeneity among the countries and variables impacts.

[12] developed a model of trade with heterogenous firms, where firms invested in abatement technology and

thereby have an impact on their level of emissions. The model shows how firm productivity and firm exports are both positively related to investments in abatement technology. Emission intensity was, however, negatively related to firms' productivity and exports. The basic reason for these results is that a larger production scale supports more fixed investments in abatement technology and, in turn, lowers emissions per output. In contrast to the standard models of heterogeneous firms, firms' productivity, and thus export performance, was not exogenous, but endogeneously determined by firms' investment in abatement technology. The paper derived closed form solutions for firm-level abatement investments and emissions per output, and tests the empirical implications of the model using detailed Swedish firm level data. The empirical results strongly support the model.

[10] examined the determinants of Carbon dioxide (CO2) emissions for 15 Post-Soviet Union Independent (PSI) countries given their recent transition to market-based economies and their relatively high levels of corruption. They examined the direct and indirect effects of economic growth on CO2 emissions for the PSI countries using a system generalized method of moment (GMM) approach to account for simultaneity among corruption, growth, and CO2 emissions. They find a linear relationship between GDP and CO2 emissions. Furthermore, GDP influences CO2 emissions directly, but also indirectly through its impact on corruption. Similarly, corruption affects CO2 emissions directly, as well as indirectly through its impact on GDP. They find that political democracy and economic freedom increase CO2 emissions indirectly through their impact on economic growth. Improved energy efficiency and the EU climate policy reduce CO2 emissions, while FDI inflows tend to increase CO2 emissions.

[18] examined the causal relationship between CO2 emissions, energy consumption, output and FDI (foreign direct investment) in ANICs (Asian newly industrialized countries: Hong Kong, Republic of Korea, Singapore, Taiwan) from 1971 to 2011. The result based on VECM (Vector Error Correction Model) implied that there is a long run co-integrated relationship between CO2 emissions, energy consumption, output and FDI. The result supports the environmental Kuznets curve hypothesis in this region. Short run dynamics show the Granger Causality from economic growth to CO2emissions. There is an also indirect causality from FDI (inward FDI and outward FDI) to CO2emissions in the short run. In the long run, there was unidirectional granger causality from the other variables to CO emissions.

[4] investigated that the role of Foreign Direct Investment (FDI) in environmental pollution besides other factors and resources of investment have been greatly considered by lots investigators. Existence of foreign direct investment or multi-national enterprises may show positive marginal spillover effects on technologic characteristics of national enterprises. The national enterprises may tend to enjoy from technologic activities of multi-national enterprises or their technical knowledge for coping environmental problems as well. As long as products of these technologies replace with product of traditional resources, it can be expected that residual loading will also reduce. Therefore, foreign direct investment will probably leave important positive effects on decrease of residual loading and environmental pollution. The main purpose of this research is to find the relationship between FDI and the quality of environments. To do so, firstly some countries are selected from Non-OECD countries, then by using panel data method for period 1996-2007 the relationship between FDI and chemical pollution of water was investigated. The results show that increasing inflow of FDI in Non-OECD countries,

increasing FDI causes the amount of water pollution. In other words, Foreign Direct Investment causes environmental disturbances in Non-OECD countries. (selected countries). This study shows that among these countries the ratio of water chemical.

[21] examined the impact of economic growth, energy consumption and foreign direct investment inflows on CO_2 emission in Nigeria, using autoregressive distributed lag (ARDL) approach to co-integration and a time series data from 1971 to 2010. The result suggested existence of long run equilibrium relationship among the variables. The empirical finding reveals that the coefficients of economic growth are significant and positively related to CO_2 emissions both in the long and short run. Furthermore, the estimates of foreign direct investment inflows are also significant but inversely related to CO_2 emissions in the long and short run. On the other hand, the estimates of energy consumption although positive, are statistically not significantly different from zero in the long and short run.

[27] examined the impact of carbon dioxide emission on trade liberalization in Pakistan. The research work used secondary data from 1980-2010. The variables were taken as CO_2 emission and openness of trade. Granger causality test was applied to analyze the dynamic relationship between variables under study. Empirical results show that bi-directional causality is running between openness of trade (OT) and carbon dioxide emission
(CO_2).

[19] investigated the dynamic causal relationships among environmental degradation, economic growth, foreign direct investment (FDI) and energy consumption in the 12 most populous countries in Asia. This panel sample shows evidence that supports the Environmental Kuznets Curve (EKC), and that CO_2 emissions begin to decline when income level reaches to 8.9341 (in logarithms). Applying Granger causality test, we find the existence of both short and long-run causality relationships among these variables, and economic growth, FDI, energy consumption and CO_2 emissions of 12 Asian most populous countries have relationships with Japanese income. On the other hand, our estimated results suggest that these countries have been exchanging the environmental degradation to implement economic activities. Furthermore, these results support the pollution haven hypothesis, which indicate the less stringent environmental regulations of the host countries have attracted FDI inflows.

3. Theoretical Framework and Methodology

3.1 Theoretical Framework

The theoretical framework for this study is based on the environmental Kuznets curve (EKC) propounded by [13] to found that the long-term relationship between economic growth and environment quality was an inverted U-shaped curve. The phenomenon The EKC hypothesizes that environment quality deteriorates with the increase of per capita income at the early stage of economic growth and gradually improves when the country reaches to a certain level of affluence.

$$CO_2 = f(GDPPC) \quad \ldots\ldots\ldots (3.1)$$

(+/-)

Also, the importance of trade in combination with composition of economic activity is investigated in the decomposition of EKC for CO_2 concentrations across countries (Kaufmann et al., 1998).

$$CO_2 = f(FDI) \quad \ldots\ldots\ldots (3.2)$$

(+)

People, at low-income levels, are more concerned with food and other material needs and less concerned with environmental quality. People, at higher income levels, begin to demand higher levels of environmental quality to go along with their increased prosperity.

Equating equation (3.1) with equation (3.2)

CO2 = f(GDPPC, FDI)

…….. (3.3)

(+/-, +)

This study will incorporate energy consumption as the control variable.

CO2 = f(GDPPC, FDI & EC)

……... (3.4)

3.2 Research Methodology

3.2.1 Model Specification

The followings three macroeconomic variables are used as regressors to estimate the impact of foreign direct investment on CO2 emission in Nigeria.

CO2 = f(GDPPC, FDI & EC)

…… (3.5)

Where CO2 = CO2 Emission (measure by metric tons per capita)

f = Functional notation

GDPPC = Gross Domestic Product Per Capita (measure by constant 2005 US$)

FDI = Foreign Direct Investment (measure in by BOP, current US$)

EC = Energy Consumption (measure by kg of oil equivalent per capita)

$CO2 = ß_0 + ß_1GDPPC + ß_2FDI + ß_3EC + u$-

…….. (3.6)

In other to normalize the variables, both the explanatory and explained variable will be log.

$LOGCO2 = ß_0 + ß_1LOGGDPPC + ß_2LOGFDI + ß_3LOGEC + u$…….. (3.7)

Where:

- $ß_0$ tells us the expected value of CO2 emission when all the explanatory variables have zero effect.
- $ß_1$ is the effect of a change in gross domestic product per capita on CO2 emission while holding all explanatory variables constant.
- $ß_2$ is the effect of a change in foreign direct investment on CO2 emission while holding all explanatory variables constant.
- $ß_3$ is the effect of a change in energy consumption on CO2 emission while holding all explanatory variables constant.
- u is the stochastic or error term with all the standard attributes. It captures the effect of other variables that could affect the gross domestic product but which are not included in the model.

3.2.2 Definition of the Variables

CO2 Emissions (Metric tons per Capita)

Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid and gas fuels and gas flaring.

Gross Domestic Product per Capita (GDPPC)

Per capita GDP is a measure of the total output of a country that takes the gross domestic product (GDP) and divides it by the number of people in the country. The per capita GDP is especially useful when comparing one country to another because it shows the relative performance of the countries. A rise in per capita GDP signals growth in the economy and tends to translate as an increase in productivity. According to [21], GDPPC is positively related to CO2 emission. GDP data

will be source from World Development Indicator (WDI) 2015.

Foreign Direct Investment (FDI)

A foreign direct investment (FDI) is an investment made by a company or entity based in one country, into a company or entity based in another country. Foreign direct investments differ substantially from indirect investments such as portfolio flows, wherein overseas institutions invest in equities listed on a nation's stock exchange. Entities making direct investments typically have a significant degree of influence and control over the company into which the investment is made. Open economies with skilled workforces and good growth prospects tend to attract larger amounts of foreign direct investment than closed, highly regulated economies.

According to [21] FDI is positively related to CO2 emission. FDI data will be source from World Development Indicator (WDI) 2015.

Energy Consumption (EC) (kg of oil equivalent per capita)

Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. EC is positively related to CO2 emission. FDI data will be source from World Development Indicator (WDI) 2015.

Table 3.1: Apriori Expectation

The apriori expectation is that a positive relationship would be established between CO2 emission and each of the explanatory variables [4] and [21]

Explanatory variables	**Symbols**	**Hypothesis**	**Expected sign**
Gross Domestic Product Per Capita	GDPPC	Gross domestic product per capita has a positive relation with CO2 emission.	+
Foreign Direct Investment	FDI	Foreign direct investment has a positive relation with CO2 emission.	+
Energy Consumption	EC	Energy consumption has a positive relation with CO2 emission.	+

Source: Author's Computation

3.2.3 The Data Requirement and Source

Annual data covering the period from 1980 to 2014 will be employed and the data would be sourced from World Development Indicator (WDI) 2015. CO2 emission (measure by metric tons per capita), gross domestic product per capita (measure by constant 2005 US$), foreign direct investment (measure in by BOP, current US$) and energy consumption (measure by kg of oil equivalent per capita) would be the variables of interest. Essentially, for the reason of uniformity in measurement, and clarity in the interpretation of findings, the variables will be transformed to their natural logarithms to eliminate any serial correlation.

3.2.4 Estimation Technique

The ordinary least square (OLS) technique will be adopted in this study. The study will considered the both the short-run and long-run simultaneously, the econometric methodology of the error correction mechanism (ECM) will be also employed. In order to undertake the empirical analysis using the ECM technique, the variables involved in the model must be non-stationary and integrated of the same order, or they

should be stationary (see Nelson and Polser 1982; Stock and Watson 1988; and Campbell and Perron 1991). Thus both the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979, 1981) and Phillips-Perron (PP) (1988) unit root tests will be utilized to test for the order of integration of the variables. In the process of testing for co-integration, two separate methods will be used. First, the presence of unit roots in the residuals from the regressions of variables in levels will be tested. Then, the [16] and [15] full information maximum likelihood of an ECM model will be utilized.

4. Discussion and Interpretation of Result

This section presents the estimated results of equations (3.7) to analyze the impact of foreign direct investment on CO2 emission in Nigeria.

4.1 Summary Statistics Result

Table 4.1: Summary Statistics Output

	Log(CO2)	Log(GDPPC)	Log(FDI)	Log(EC)
Mean	-0.526353	6.517568	2.620009	7.487479
Median	-0.439439	6.406478	1.350009	6.551426
Maximum	-0.078194	7.001282	8.840009	6.496711
Minimum	-1.133078	6.203019	-7.390008	6.496711
Std. Dev.	0.297055	0.252284	2.810009	3.812179
Skewness	-0.452522	0.640871	1.036442	3.814912
Kurtosis	2.187510	1.877750	2.601678	15.55620
Jarque-Bera	2.157229	4.232532	6.497612	314.8140
Probability	0.340066	0.120481	0.038821	0.000000
Sum	-18.42236	288.1149	9.160010	262.0618
Sum Sq. Dev.	3.000209	2.164010	2.690020	494.1120
Observation	35	35	35	35

Source: Author's Computation from E-view 7

Table 4.1 above gives a summary statistics of series for the model. The reported statistics include the mean with their corresponding maximum, minimum and standard deviation. The distributional properties are also examined through their skewness and kurtosis, while the Jarque-Bera test statistic is used to test for normality in the distribution**.** As shown in the tables below all the series exhibit positive average values except CO2 emission. Consequently, energy consumption has the highest yearly mean value while CO2 emission has the lowest yearly mean value. The weighted average mean of CO2 emission over the period is -0.526353, with its minimum value of -1.133078 and maximum value of -0.078194. The weighted average value of gross domestic per capita is 6.517568 with its minimum value of 6.203019 and maximum value of 7.001282. The mean of foreign direct investment over the period of study is 2.620009 having a negative minimum value of -7.390008 and maximum value of 8.840009. Energy consumption mean value is 7.487479; it ranges between 6.496711 and 6.496711.

Given the standard deviation values of the six series under consideration, energy consumption seems to be more volatile while gross domestic product per capita appears to be least volatile. Also, there are strong significant differences between the minimum and maximum values of the series in the model energy consumption which recorded little significant difference. This by implication suggests that the series are relatively not stable for the model. This finding is however, in agreement with the statistical properties of the series. With respect to the statistical distribution of the variables, three series are positively skewed while the remaining three are negatively skewed.

4.2. Correlation Analysis Result

Table 4.2 shows the correlation analysis result of the variables. The correlation between CO2 emission and gross domestic product per capita is weak positive correlation which is 0.117602 while the correlation between CO2 emission and foreign direct investment is -0.293805 which is weak negative correlation. The correlation analysis between CO2 emission and energy consumption is -0.075686 which show a weak negative correlation while the correlation analysis between gross domestic product per capita and foreign direct investment is 0.754519 which show a weak positive correlation. The correlation analysis between gross domestic product per capita and energy consumption is 0.481820 which show a weak positive correlation while the correlation between foreign direct investment and energy consumption is 0.327404 which is a weak positive correlation. This shows that there is no multicolinearity in the model which is the one of the econometric problem.

Table 4.2: Correlation Analysis Output

	CO2	GDPPC	FDI	EC
CO2	1			
GDPPC	0.117602	1		
FDI	-0.293805	0.754519	1	
EC	-0.075686	0.481820	0.327404	1

Source: Author's Computation from E-view 7

4.3 Stationarity Test

The study test for unit roots on CO2 emission, gross domestic product per capita, foreign direct investment and energy consumption. The stationarity of the variables was tested by conducting the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The study use both ADF and PP because ADF procedure is mostly commonly used test, it nevertheless required homoscedastcity and uncorrelated errors in the underlying structure. The PP non-parametric test generalized the ADF procedure, allowing for less restrictive assumption for the time series in question. The study makes use of unit root in order of guarantee that our inference regarding the important issue of stationarity is unlikely driven by the choice of testing procedures used. The results, as presented in Table 4.3 showed strong evidence(s) that all the variables were integrated of order one, that is, I(1).

Table 4.3: Stationarity Test of the Variables using both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root Test

Variable		Unit Root Tests		Conclusion
		ADF	PP	
LOG(CO2)	Level	-0.226838	-0.226838	I(1)
	First Difference	-1.090902 *	-1.090902 *	
LOG(GDPPC)	Level	-0.004165	-0.004165	I(1)
	First Difference	-0.740580 *	-0.740580 *	
LOG(FDI)	Level	-0.027634	-0.069124	I(1)
	First Difference	-1.351577 *	-1.351577 *	
LOG(EC)	Level	-26.43220	-0.023119	I(1)
	First Difference	-1.030317 *	-1.030317 *	
Critical Value	1%	-3.639407	-3.646342	
	5%	-2.951125	-2.954021	
	10%	-	-	

		2.614300	2.615817

Source: Author's Estimation from E-view 7.

NB: *,** & *** represent significant at 1%, 5% and 10% respectively

4.4 Co-integration Analysis

The next step was to test for the presence of long-run relation among the variables, that is, co-integrating relationships. Table 4.4 shows the results of the co-integration tests which suggested at least one co-integration equation at the 5 percent level of significance. This means that there is a long run relationship among the variables.

Table 4.4: Co-integration Output using both Trace and Maximum Eigen-value

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.304393	11.97801	3.841466	0.0005

Trace test indicates 1 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.304393	11.97801	3.841466	0.0005

Max-eigenvalue test indicates 1 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integrating Coefficients (normalized by b'*S11*b=I):

LOG(CO2)
4.240949

Unrestricted Adjustment Coefficients (alpha):

D(LOG(CO2))	-0.100893

Source: Author's Computation from E-view 7

4.5 Empirical Analysis and Discussion

4.5.1 Effect of Gross Domestic Product per Capita, Foreign direct investment and energy Consumption on CO2 Emission

Under this sub-section, the powerful econometric techniques were carried out which is parsimonious regression analysis to investigate the impact of government expenditure on the economic growth in Nigeria. This techniques help use to know the dynamic of short-run to long-run that is the speed adjustment of short-run to long-run.

Table 4.5: Parsimonious Regression Result

Dependent Variable: D(LOGCO2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGGDPPC)	-5.500005	0.000507	-0.108635	0.9149
D(LOGGDPPC(-1))	0.000494	0.000557	0.885846	0.3897
D(LOGGDPPC(-2))	-6.710005	0.000577	-0.116244	0.9090
D(LOGGDPPC(-3))	0.000692	0.000467	1.481225	0.1592
D(LOGFDI)	-4.070011	2.480011	-1.640237	0.1218
D(LOGFDI(-1))	-4.770011	2.790011	-1.713197	0.1073
D(LOGFDI(-2))	-5.200011	2.870011	-1.811551	0.0901
D(LOGFDI(-3))	3.050011	2.950011	1.033082	0.3179
D(LOGEC)	-5.930012	1.970011	-0.300493	0.7679
D(LOGEC(-1))	-3.620011	2.000011	-1.809797	0.0904
D(LOGEC(-2))	-0.000440	0.001677	-0.262328	0.7966
D(LOGEC(-3))	0.002693	0.001840	1.463666	0.1639
ECM(-1)	-0.154952	0.009825	-2.688408	0.0017

R-squared	0.556822	Mean dependent var	-0.007247
Adjusted R-squared	0.543645	S.D. dependent var	0.109154
S.E. of regression	0.102764	Akaike info criterion	-1.406438
Sum squared resid	0.158407	Schwarz criterion	-0.666316

		Hannan-Quinn	-
Log likelihood	37.79979	criter.	1.165177
Durbin-Watson stat	1.701254		

Source: Author's Computation from E-view 7

Note: D(-1), D(-2), D(-3) means differenced at lag one, two and three respectively.

Table 4.5 shows the result of impact of foreign direct investment on CO2 emission in Nigeria. The long run coefficients of the determining variables have different signs and magnitude in term of relationships with CO2 emission. Gross domestic product positively influence CO2 emission in Nigeria and is insignificant while foreign direct investment and energy consumption have negative impact on CO2 emission in Nigeria but not significant. Also gross domestic product per capita, foreign direct investment and energy consumption in one year lag (-1) have negative impact on CO2 emission in Nigeria but only energy consumption is significant at 10% level of significant. Furthermore, gross domestic product per capita, foreign direct investment and energy consumption in two year lag (-2) have a negative impact on CO2 emission in Nigeria but only foreign direct investment is significant at 10% level of significant. Lastly, gross domestic product per capita, foreign direct investment and energy consumption in three year lag (-3) have a positive impact on CO2 emission in Nigeria but all the variables are insignificant.

The result of ECM indicates that the model seems to be good as it satisfies the diagnostic test and also has an adjusted R-Squared (R^2) value of 0.413645, which indicate that only about 45.64% of the total systematic variation in CO2 emission in Nigeria is not accounted for by the explanatory variables all taken together. The Durbin Watson (DW) statistics value of 1.701254 shows that there is no serious problem of serial correlation and heteroskedasticity. The error term is also found to be normally distributed. The coefficient of the error correction term with one period lag [ECM(-1)] is negative as expected with a value of -0.154952. This signify that the long run relationship of the estimated model is stable and any disequilibrium created in the short run will be temporary and will get corrected over a period of time.

In order to find out how long it will take to fully correct any distortion in the long-run relationship, we imply divide one by the ECM coefficient that is,($\frac{1}{0.154952} = 6.454$). Since the value is greater than six (6), it implies that it will take approximately six years and some months for full adjustments to take place after a shock has occurred.

The apriori expectation is that a positive relationship would be established between CO2 emission and each of the explanatory variables [4] and [21]) but foreign direct investment and energy consumption do not follow.

5. Summary and Conclusion

This study investigated the impact of foreign direct investment on CO2 emission in Nigeria over the period 1980 to 2014. The result investigated by the use of descriptive statistics, correction analysis, unit root, Johansen co-integration test and parsimonious regression analysis reviewed that the impact of foreign direct investment on CO2 emission in Nigeria over the period 1980 to 2014have a negative relationship (associated) with CO2 emission, the position of this study is that as both foreign direct investment and energy consumption increases within the period covered in this study, CO2 emission also decreases and vice versa. Thus, increase in foreign direct investment and energy consumption will not increases CO2 emission in Nigeria.

However, the foregoing findings bear some implications for policy formulation ion order to reduce the cumulative emissions of carbon dioxide in Nigeria, scientists and policy makers should take more care for clean or environment friendly energy production as well as appropriate technology

and adapt some policies regarding the reduction of carbon dioxide emission rather to increase the GDP only. Government of Nigeria should implement such policies that are not harmful for the environment such as the agreement which allow the receiving of dirty technology which is good for producers to earn high profit but bad for the environmental quality. Government should only sign that trade agreements with countries where the compensation for rehabilitation of environment is paid. Government needs to do cause benefit analysis before the inflow of FDI to examine if it will cause benefit to our country or it will be harmful for our country if cost is more than the loss then it should sign the trade agreement with its opponent

Therefore, the Environmental Kuznets curve (EKC) was used in the study but other theories like Halo effect hypothesis, pollution haven hypothesis, porter hypothesis and pollution leakages could also be used to determine the impact of foreign direct investment on CO2 emission in Nigeria. There is still need for further research to be conducted along this line, especially by using another model aside from Environmental Kuznets curve (EKC). Also, the study had been mainly aggregative; a disaggregated analysis would be more informative. The use of a more robust co-integration approach like the auto-regressive distributed lag (ARDL) model would also be very insightful.

References

[1] Acharyya J., (2009) "FDI, Growth and the Environment:Evidence from India on CO2 Emission duringthe last two Decades". *Journal of Economic Development*. Vol. 34, pp 43 – 58.

[2] Aminu A. M., (2005) "Foreign Direct Investment and the Environment: Pollution Haven Hypothesis Revisited".Paper prepared for the Eight Annual Conference on Global Economic Analysis, Lübeck, Germany, June 9 - 11, 2005

[3] Antweiler, W., Copeland, B., Taylor, M. (2001) "Is free trade good for the environment?" *American Economic Review.* Vol. 91, pp 877-908.

[4] Avazalipour M. S., Fatemeh Z., Reza S., Nader H. and Marjan D. (2013) "The Impact of FDI on Environmental Resources in Selected Countries (Non- OECD)". *IJRRAS.* Vol. 17 (1), pp 111 – 115.

[5] Bruvoll, A. andFaehn, T., (2006)"Transboundary effects of environmental policy: Markets and emission leakages".*Ecological Economics*.Vol. 59,pp 499-510.

[6] Campbell and Perron, (1991)

[7] Choi E., Heshmati A. and Cho Y., (2010) "An Empirical Study of the Relationships betweenCO2 Emissions, Economic Growth and Openness". *Discussion Paper No. 5304November 2010.*

[8] Copeland, B. R. and Taylor M. S., (2004) "Trade, Growth, and the Environment" *Journal of Economic Literature*.Vol.42(1), pp 7-73.

[9] Dickey, D.A., and W.A. Fuller (1979), "Distribution of the Estimates for AutoregressiveTime Series with a Unit Root," *Journal of the American Statistical Association*, Vol. 74(4), pp 427-431.

[10] Dmitriy D. L., Jeong H. B. and Meenakshi R. (2012) "Determinants of CO2 Emissions for Post-Soviet Independent Countries" *Yangsantaekjiro 20, Hyunjin Evervil 109-301, Bukgu, Gwangju, South Korea.*

[11] Doytch N. and Uctum M., (2011) "Globalization and the Environmental Spillovers of sectoral FDI". University of New Haven, Department of Economics and FinanceBrooklyn College and the Graduate Center of the City University of New York November 2011.

[12] Forslid R., Okubo T. and Karen-Helene U., (2011) "International Trade, CO2Emissions and HeterogeneousFirms" Discussion Paper No. 8583, September 2011. *Centre for Economic Policy Research.*

[13] Grossman, G. M. and Krueger A. B., (1991) "Environmental Impact of a North American Free Trade Agreement", NBER Working Paper 3914.

[14] Hanley, N., et al.(2009), "Do increases in energy efficiency improve environmental quality and sustainability?".*Ecological Economics*. Vol. 68,pp 692-709.

[15] Jian, W. and Rencheng, T. (2007) Environmental effect of foreign direct investment in China, 16th international input-output conference, Turkey.

[16] Johansen S., (1988) "Estimation and hypothesis testing of cointegration vectors in Gassian vector autoregressive models". *Econometrica*, Vol. 59, pp 1551-1580.

[17] Kaufmann, R. K., Davidsdottir, B., Garnham, S., and Pauly, P., (1998) "Thedeterminants of atmospheric SO2 concentrations: reconsidering the environmental Kuznets curve", *Ecological Economics*. Vol. 25, pp 209-220.

[18] Kim D.D., (2013) "Does FDI inflow crowd out DI in Korea quest". ,*Journal of Economic Studies.* Vol. 30, pp 605-622.

[19] Linh S. H. and Lin S., (2015) "Dynamic Causal Relationships among CO2 Emissions, Energy Consumption, Economic Growth and FDI in the most Populous Asian Countries". *Advances in Management & Applied Economics.* Vol. 5, pp 69-88.

[20] Lopez R., and S. Mitra (2000), 'Corruption, pollution and the environmental Kuznets curve', *Journalof Environmental Economics and Management.* Vol.40, pp 137-150.

[21] Maji I. K. and Habibullaha M. S., (2015) "Impact of Economic Growth, Energy Consumption andForeign Direct Investment on CO2 Emissions: Evidence from Nigeria". *World Applied Sciences Journal*. Vol. 33 (4), pp 640-645.

[22] Minh Nguyen, T. B. and Nurul, A. A. T. M. (2002) "The Role of Foreign Direct Investment in Urban Environmental Management: Some Evidence from Hanoi, Vietnam".*Environment, Development and Sustainability.*Vol. 4, pp 279-297.

[23] Palmer, K et al (1995), "Tightening Environmental Standards: The Benefits-Cost or the No-Cost Paradigm?" *Journal of Economic Perspectives*.Vol. 9(4), pp 119-132.

[24] Panayotou T. (1993), 'Empirical tests and policy analysis of environmental degradation at differentstages of economic development'.*WEP 2-22 Working Paper No. 238, International Labour Office, Technology and Employment Programme, Geneva.*

[25] Porter, M. (1991), "America's Green Strategy", *Scientific American* Vol. 264(4), pp 168.

[26] Porter, M., and Van Der Linde C., (1995), Toward a New Conception of the Environment-Competitiveness Relationship, *Journal of Economic Perspective.* Vol.9(4), pp 97–118.

[27] Salam S., Sattar A. and Gilani S. W., (2015) "An Empirical Research on Trade Libralization and CO2 Emissionin Pakistan". *Journal of Economics and Sustainable Development.* Vol.6, pp 39 – 46.

[28] Sheldon, I. (2006), "Trade and environmental policy: a race to the bottom?"*Journal ofAgricultural Economics.* Vol. 57(3), pp 365-392.

[29] Yanchun, Y. (2010). FDI and China's carbon dioxide emissions 1978–2008. In *Proceedings of the 7th*

international conference on innovation andmanagement (pp. 289–293). Wuhan University of Technology.

Dr.**Olukayode Emmanuel, MAKU** is a lecturer at the Department of Economics, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria.

S**oliu Bidemi, ADEGBOYEGA** Is a lecturer at the Department of Economics, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria.

Mr. Aduralere O., OYELADE is a lecturer at the University of Ibadan, Nigeria