IMPACT OF SECTORAL ECONOMIC GROWTH ON ENVIRONMENTAL DEGRADATION IN NIGERIA

By

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Abstract

This study investigated the applicability of the Environmental Kuznets Curve (EKC) hypothesis using Autoregressive Distributed Lag (ARDL) bound approach in examining the impact of GDP growth per capita of agricultural, industrial and service sectors on ecological footprint in Nigeria. Findings revealed that agriculture sector growth per capita has a positive impact on ecological footprint in the long run, a percent change in agriculture will lead to a 0.47percent significant change in ecological footprint. The industrial growth per capita has a negative non-significant impact as a percent change in IND will lead to a 0.1 percent decrease on ecological footprint in the long run and per capita growth of service sector has negative significant impact as a percent change in SEV will lead to a 0.6 percent decrease on ecological footprint in the long run. Other control variables such as population growth also has a negative non-significant impact on ecological footprint, a percent change in POPG will lead to a 0.8 percent decrease on ecological footprint while trade openness in the long run has a positive significant impact of 0.5 percent on ecological footprint. The findings confirm the long run inverse u-shaped relationship between sectoral economic growth and ecological footprint during the period of study as we see the change from the positive impact of agriculture to the negative impact service sector has on ecological footprint. The paper concludes that sectoral economic growth in Nigeria follows the predictions of the EKC, confirming that as the economy evolves, economic growth will have a negative relationship with environmental degradation. The study recommends given more attention to reducing pollution due to agricultural activities such as excess fertilizer chemicals and application, overgrazing and deforestation and agricultural greenhouse emission in the downstream agriculture sub-sector.

Keywords: Ecological Footprint; Environmental Degradation; Environmental Kuznet Curve; Economic Growth

1. Introduction

The challenges posed by economic growth and development on environmental wellbeing has been a subject of enduring interest such that it has gained audience as one of the objectives of the ongoing Sustainable Development Goals (SDGs) (United Nations, 2016). Even though this argument of intergenerational dependency due to consumption of resources and its impact on environment and future wellbeing is considerably new in the empirical sense (Berry et al., 2015),

the premises on which it is based stretches out of well-established and much investigated theoretical underpinning. The environment Kuznet hypothesis was developed in mid-1950s with the major proposition of the presence of an inverted U-shaped relationship between economic growth and environmental degradation, explained through increase in per capita income (Grossman & Krueger, 1991).

With the rise and intensity of the growth impact on environmental degradation in developing economies, the relationship between growth and environmental degradation has attracted much empirical interests. Nigeria for example has over the years recorded a sustained long-term increase in economic growth. With a remarkable increase in Gross Domestic Product (GDP) from 4.2 billion USD in 1960 to 538,336 billion USD in 2022. This growth in GDP is attributed to the country's shift from being an agriculture dependent to an oil dependent economy (World Bank, 2022). This feat however is argued to have come with huge prices on the environment, which questions the country's energy consumption efficiency. In Nigeria, increased activities in the industrial sector which mostly utilizes heavy duty machines that burn more fossil fuel in manufacturing and transportation are most notable causes of greenhouse gasses emission. Other activities of the industrial scale such as gas mining, irrigation, forest clearing and application of chemical fertilizers to virgin lands all together amount to environmental degradation, overall, in an attempt to speed the growth of the Nigerian economy (Usman, 2022).

While energy consumption is widely recognized as essential to an economy's ability to function and grow, increase in energy use is attributed to growing stock of pollution that hinders further growth into the next generation (Kalt et al., 2019). This phenomenon is described by the environmental Kuznets curve (EKC) (Shahbaz et al., 2015). The hypothesized existence of a trade-off between economic growth and environmental degradation as proposed by the EKC is expected to hold in the case of Nigeria as the result of the country's exceptional desire for more energy supply to raise its GDP. Investigating the hypothesized relationship between growth and

environmental degradation in Nigeria is not only inevitable in the current concerns of inter-generational dependency, but also, the long-term growth of the Nigerian economy is dependent on the ability of its environment to regenerate itself (Falade & Adeyemi, 2022).

Many researchers (Adelegan & Otu, 2020; Akpan & Akpan, 2012; Falade & Adeyemi, 2022, Huanchi & Calsin, 2018; Mougenot et al., 2021; Solarin, et al., 2021; Wagner, 2015; Zaidi et al., 2019) have empirically examined the Kuznet hypothesis with conflicting evidences. While Adelegan and Otu; Falade and Adeyemi, 2022 and Zaidi et al., 2019 found environmental degradation to be well-explained by the EKC, findings in Akpan and Akpan, 2012; Solarin, et al., 2021 and Wagner, 2015 suggest that measures of environmental degradation do not strongly follow the propositions of the EKC. Despite these efforts, there seem to be major gaps in existing literature. This is to the extent that previous attempts have relied on different measures of environmental degradation such as carbon dioxide emission (Olusegun, 2009 and Mougenot et al., 2021) sulfur dioxide emission, Huanchi and Calsin (2018), industrial pollution (Fang et al., 2018). However, a careful observation of these measures reveled a common limitation in them as they all measure the demand required by humans from the environment without capturing the extent of affordable supply offered by nature. Hence, conclusions on environmental sustainability using such measures are made in terms of environmental resources consumed only. This paper overcomes this limitation by measuring environmental degradation using ecological footprint indicator introduced by Rees (1992) and developed by Reiger and Schor (2021) which captures both the demand and supply sides of environmental resource use efficiency.

Similarly, most studies that have empirically tested the Kuznets hypothesis especially in the context of Nigeria have relied on GDP per capita, its square and cubic definitions as a composite indicator of economic growth. The econometric soundness of this approach however has faced major criticisms including: simultaneity, heteroskedasticity and most importantly, omitted variable bias (Stern, 2004). Moreover, following the argument of Panayotou (2016) that environmental

degredation occurs to different degrees across different sectors of the economy, hence, the need to measure the sectoral impact of growth on environmental degradation, this paper overcomes the limitation of overreliance on composite GDP, by looking at the impact of sectoral contributions to GDP as disaggregated measures of economic growth on environmental degradation in Nigeria. Even though a pioneering approach by Falade and Adeyemi (2022) has preceded in adopting a disaggregated sectoral GDP approach in the Nigerian context. However, their approach is limited as they have measured environmental degradation using carbon emission which measures only the demand-side effect of growth on environmental degradation.

This paper contributes to existing literature by presenting empirical evidence on the impact sectoral economic growth has on ecological footprint in Nigeria. It therefore addresses the question: to what extent does the relationship between growth in key sectors of the economy and ecological footprint justifies the EKC hypothesis in Nigeria? Time series data from 1986-2022 was adopted to reflects period of Nigeria's economic liberalization and Nigeria's commitment to SDGs 15 of sustainable use of terrestrial ecosystem. Following this introduction, the next section of this paper contains review of relevant literature. While methodological issues are discussed in section three, section four discusses empirical finding while section five concludes the paper by presenting policy implications of findings.

2. Literature Review

The relationship economic growth and the environment has a firm basis in economic theory. From Thomas Malthus theory of population growth to Mill's steady-state hypothesis and the neoclassical resource use theory that branched off from the efficient market hypothesis and ecological modernization theory. Various scholars have theorized and exposed the relationship between economic growth and environmental resources utilization. One important hypothesis that has maintained a dominating relevance is the EKC hypothesis developed by Kuznets (1955). The

EKC proposed an inverted U-shaped relationship between economic growth and environmental degradation. It contends that at the beginning of economic growth and development, environmental degradation increases at an increasing rate, but after a certain threshold, the co-movement reverses at higher levels of economic progress. Hence, an inverted U-shaped nexus is established between income per capita and environmental degradation (Kuznets, 1955).

An economy must use natural resources in order to progress to a higher level, which will result in long-term sustainable development that will also unintentionally have some lingering impacts on the environment. Due to the focus being placed on developing and expanding material productivity rather than output, pollution grows more quickly. People become less sensitive, as a result they start to care more about their financial well-being than the environment they live in. Since natural resources are used more often due to the rapid expansion, there is a corresponding increase in pollution, which lowers the quality of the environment (Panayotou, 2016).

The EKC, due in part to its simplicity and proposition of a staged-growth of the economy has maintained an empirical appeal to researchers, becoming a well-established baseline model in development and energy economics. In this direction, many empirical investigations of the EKC have been carried out in Nigeria. For example, Falade and Adeyemi (2022) investigated the validity of the EKC in Nigeria by examining the impact of growth in key sectors of the Nigerian economy including: agricultural, industrial, service and construction sectors on environmental degradation measured by carbon dioxide emission (CO_2) using the Autoregressive Distributed Lag (ARDL) technique during 1981 to 2018 period. Major findings from this study revealed that the industrial sector and the service sector confirms the EKC in the short run and long run, while agriculture and construction only confirm the EKC in the long run, hence, concluding that key growth sectors of the Nigerian economy have different effects on environmental degradation, thus, the EKC makes more sense when viewed from a sectoral perspective.

Solarin, et al. (2021) examined the EKC by investigating the impact of economic growth on ecological footprint in Nigeria, via Dynamic Simulation of Autoregressive Distributed Lag Model (DARDL). The study explores the effect of economic growth and urbanization on ecological footprint, accounting for foreign direct investment and trade in Nigeria from 1977 to 2016. Empirical result showed the existence of long-run relationship among the variables. Economic growth deteriorates the environmental wellbeing in the short-run. Urbanization has no harmful impact in the short-run, foreign direct investment and trade have a long-run positive relationship while economic growth has a negative long-run relationship, hence, justifying the EKC in Nigeria.

The finding in Solarin, et al (2021) is contrasted with that of Mougenot et al. (2021) who also investigated the validity of the EKC in the Peruvian economy by analyzing the relationship between per capita income and environmental degradation during the period between 1980 and 2019 using the Vector Autoregressive (VAR) and Granger Causality techniques. The finding showed a long-term impact of per capita income on environmental degradation. This long-term impact was found to be stable throughout the period investigated, which carries the existence of a u-shaped impact of growth on pollution as suggested by the EKC. This finding supports earlier works such as Huanchi and Calsin (2018), who also found a linear impact of economic growth on environment and also Wagner (2015) who found the EKC to be inadequate in measuring the relationship between economic growth and environmental degradation.

Another important empirical contribution to the EKC debate is the work of Zaidi et al. (2019) which investigated the EKC by examining the impact of globalization and financial development on carbon emissions in oi rich countries during 1990-2016 period using cointegration technique. The findings revealed that carbon emission significantly increased financial development and globalization and significantly reduced with economic growth, which justifies the EKC hypothesis for the OPEC countries. The findings by Zaida (2019) is contrasted with earlier study

in Nigerian context, the work of Akpan and Akpan (2012) who using the ARDL technique on time series data between 1970 and 2008 found that a long-term increase in economic growth positively impacts carbon emission, hence, failing to justify the existence of EKC in Nigeria.

Adelegan and Otu (2020) also sought to validate EKC by investigating the impact of economic growth on CO_2 emission in Nigeria. The study captured a scope of 1980-2018 on a time series data sourced from World Bank and Central Bank of Nigeria (CBN) while relying on the ARDL technique. Major findings were revealed to support the validity of EKC hypothesis for CO_2 emissions which informed the conclusion in favor of a U-shaped relationship between economic growth and environmental degradation in Nigeria, as growing economy with keen monitoring of the effects of growth on environment.

3. Methodology

The objective of this study was to examine the validity of the EKC on the Nigerian economy by investigating the impact of economic growth on ecological footprint in Nigeria. In order to guarantee robustness, validity and reliability of results, the study followed Falade and Adeyemi (2022) by adopting disaggregated economic growth based on sectoral contributions to GDP during the 1986-2022 period. The ARDL approach developed by Pesaran and Shin (1999) was used to examine whether the long run sectoral growth of the Nigerian economy followed the inverse U-shaped trend.

The empirical framework of this study is based on the reduced original linear model developed by Grossman and Krueger (1995) stated in equation 1.

$$CO_{2t} = f(GDP_t) \quad \ldots\ldots\ldots\

Parameterizing equation I in an econometric version, it is stated in equation 2

$$CO_{2t} = \beta_0 + \beta_1 GDP_t + \mu_t \quad \text{.....2}$$

Where: β_0 is the intercept, $\beta_1$is the parameter of the explanatory variable and μ_t is the white noise error term. Introducing the vector of other important determinants of environmental quality X_t, equation 2 is respecified as:

$$CO_2 = \beta_0 + \beta_1 GDP_t + \beta_2 X_t + \ldots + \mu_t \quad \text{.....3}$$

Following the approach of Paraskevopoulos (2009) of disaggregating GDP into their sectoral contributions while investigating the EKC, this study adapts its baseline model to the work of Falade and Adeyemi (2022) whose stochastic form model was specified as:

$$CO_2 = \beta_0 + \beta_1 AGR_t + \beta_2 XCON1_t + \beta_3 IND_t + \beta_4 SEV_t + \beta_5 POP_t + \mu_t \quad \text{..... 4}$$

Where $AGR_t, XCON1, IND_t, SEV_t$ and POP_t are agriculture per capita, construction per capita, industry per capita, service per capita and population growth. In response to major limitations in past studies, equation 4 is restated in equation 5 with adjustment in the proxy of dependent variable and introduction of Trade openness as it was a significant variable in the work of Solarin et al, (2021) to suit the peculiarities of this study, CO_2 emissions is a weak and inefficient measure, hence, the ecological footprint (EF) is a far better option as the EF captures the environmental consequences of the production of goods, as well as, services (Rashid et al, 2018). Taking logs of the variables give:

$$EF_t = \beta_0 + \beta_1 LAGR_t + \beta_2 LIND_t + \beta_3 LSEV_t + \beta_4 LTO_t + \beta_5 POPG_t + \mu_t \quad \text{..... 5}$$

Where *EF* is ecological footprint, LTO and $POPG$ are log of trade openness and population growth which are employed as control variables. Re-parameterizing the model in equation 5 in an

ARDL form to allow for accounting of underlying dynamics in the data, the transformed model is presented in equation 6.

$$\Delta EF_t - \varphi_{0i} + \sum_{t-1}^{m} \varphi_{1i} \Delta LEF_{t-1} + \sum_{t-1}^{m} \varphi_{2i} \Delta LAGR_{t-1} + \sum_{t-1}^{m} \varphi_{3i} \Delta LIND_{t-1} + \sum_{t-1}^{m} \varphi_{4i} \Delta LSEV_{t-1} + \sum_{t-1}^{m} \varphi_{5i} \Delta LTO_{t-1} + \sum_{t-1}^{m} \varphi_{6i} \Delta POPG_{t-1} + \varphi_{0i} ECT_{t-1} + a_1 LAGR_{t-1} + a_2 LIND_{t-1} + a_3 LSEV_{t-1} + a_4 LTO_{t-1} + a_5 POPG_{t-1} + u_t$$

…….. 6

The dynamic impacts of variables: LAGR, LIND, LSEV, LTO and POPG variables on LEF are captured by the $\varphi_{2i,}$ φ_{3i} *and* φ_{4i} respectively, while the long run impact of each policy tool on EF are captured by sum of the immediate impact and the distributed lag impact scaled by one less the sum of the autoregressive coefficients. Moreover, the ECT coefficient captures the adjustment process towards the long-run equilibrium.

Data on ecological footprint were sourced from Global Footprint Network (GFN) while data on agricultural GDP, Industrial GDP, service GDP, population growth, and trade openness were soured from the World Bank meta database. The sources and expected behaviors of variables are further explained in table 1.

Table 3.1
Summary of Data, Measurement, Source and Expected Sign

Variable	Measurement	Source	Expected Sign
EF	Global hectare average (Nigeria)	GFN	
LAGR	Agriculture GDP Per capita	WDI	+
LIND	Industry GDP Per capita	WDI	+/-
LSEV	Service GDP Per capita	WDI	-
LTO	Trade to GDP ratio	WDI	+
POPG	% Weighted average annual	WDI	+

Source: Researcher's Compilation.

4. Results and Discussion

This section discusses results elicited from the investigation of the impact of sectoral growth per capita on ecological footprint in Nigeria. The results of investigation are presented in the tables.

Table 4.1
Summary Statistics

Statistic	EF	AGR	IND	SEV	TO	POPG
Mean	1.137838	24.63052	2.540692	25.50044	4.461940	0.953846
Median	1.100000	24.76067	2.539021	25.40197	4.461425	0.950439
Maximum	1.300000	25.52512	3.045457	26.50043	4.813125	1.016701
Minimum	1.000000	23.63773	1.879895	24.51408	4.012878	0.867103
Std. Dev.	0.095310	0.672505	0.365882	0.708153	0.212885	0.038990
Skewness	0.158518	-0.086488	-0.093340	0.109382	-0.316493	-0.253802
Kurtosis	2.137140	1.371343	1.592372	1.371269	2.519174	2.283988
Jarque-Bera	1.302770	4.135432	3.108409	4.163462	0.974127	1.187599
Probability	0.521323	0.126474	0.211357	0.124714	0.614428	0.552225
Sum	42.10000	911.3292	94.00561	943.5163	165.0918	35.29231
Sum Sq. Dev.	0.327027	16.28147	4.819310	18.05329	1.631516	0.054729
Observations	37	37	37	37	37	37

Source: Extract from E-views 9 Output, 2024

The data for the estimation period provide a detailed overview of the key variables under study, with distinct statistical characteristics for each. The ecological footprint (EF) ranges between 1.00 and 1.30, indicating a relatively narrow fluctuation in ecological impact per hectare during the period. The mean growth rate of EF is 1.14 per hectare, suggesting moderate and consistent growth in ecological footprint. The standard deviation of 0.10 signifies low variability around the mean, implying that the growth rates are closely clustered, and the positive skewness indicates that most of the EF values are concentrated below the mean, with a tail extending towards higher values. This right-skewed distribution suggests occasional periods of higher-than-average ecological footprint growth.

The agricultural growth rate (AGR) has a mean of 24.63, indicating a typical growth rate in agriculture during the estimation period. The range of AGR is from 23.63 to 25.52, demonstrating moderate variation in agricultural growth rates. The standard deviation of 0.67 points to a slightly higher variability compared to EF. The negative skewness of AGR indicates that the majority of

AGR values are above the mean, with a longer tail towards the lower values, suggesting that lower growth rates in agriculture are less frequent but do occur.

Industrial growth (IND) shows a range between 1.87 and 3.04, with an average value of 2.54. This range highlights a more significant fluctuation in industrial growth rates compared to EF and AGR. The standard deviation of 0.36 reflects moderate variability around the mean. The negative skewness in IND implies that most industrial growth values are above the mean, with a left-tailed distribution, indicating that instances of lower-than-average industrial growth are present but less common.

Services growth rate (SEV) is observed with a mean of 25.50, ranging from 24.51 to 26.50. The standard deviation of 0.71 shows a notable variability around the mean. SEV is positively skewed, indicating that most values are below the mean, with a longer tail towards higher values, reflecting occasional higher growth rates in services.

The maximum value among the variables is SEV at 26.50, and the minimum is population growth (POPG) at 0.86. These extreme values suggest substantial variability in the performance of these measures, with SEV showing the highest recorded growth rate and POPG the lowest. This variability implies diverse performance levels across the different sectors.

Jarque-Bera statistics indicate that all variables are normally distributed at the 5% significance level. This normality implies that the sample data do not significantly deviate from a normal distribution, validating the appropriateness of using parametric statistical tests for analysis. The normal distribution of the data also suggests that the mean and standard deviation are reliable measures of central tendency and dispersion, respectively, enhancing the robustness of statistical inferences drawn from the data.

Table 4.2
Unit Root Tests without Structural Break

Panel A: Phillip-Peron (PP)					
	LEVEL		FIRST DIFFERENCE		
Variable	**Constant**	**Trend and constant**	**Constant**	**Trend and constant**	**I(d)**
EFP	1.7254	2.1165	6.6867**	6.9244	I(1)
	(0.4103)	(0.5253)	(0.0000)	(0.0000)	
LAGR	0.5375	1.6096	5.6487**	5.6091	I(1)
	(0.8720)	(0.7693)	(0.0000)	(0.0003)	
LIND	1.4633	0.2981	4.9810**	5.1563	I(1)
	(0.5404)	(0.9877)	(0.0003)	(0.0010)	
LSEV	0.2813	1.6147	3.3310**	3.2832	I(1)
	(0.9180)	(0.7672)	(0.0209)	(0.0857)	
LTO	2.2462	2.3712	8.8031**	20.963	I(1)
	(0.0944)	(0.0875)	(0.0000)	(0.0000)	
POPG	0.3900	0.2903	3.1431**	3.4235	I(1)
	(0.9004)	(0.9879)	(0.0324)	(0.0645)	
Panel B: Kwiatkowski-Phillips-Schmidt-Shin (KPSS)					
EFP	0.2860**	0.1773	0.2888	0.0594	I(0)
	(0.4630)	(0.4600)	(0.4630)	(0.1460)	
LAGR	0.7059	0.1105	0.1566**	0.1492	I(1)
	(0.4630)	(0.1460)	(0.4630)	(0.1460)	
LIND	0.4941	0.1553	0.3187**	0.1362	I(1)
	(0.4630)	(0.1460)	(0.4630)	(0.1460)	
LSEV	0.7018	0.1024	0.1468**	0.1457	I(1)
	(0.4630)	(0.1460)	(0.4630)	(0.1460)	
LTO	0.4407**	0.1878	0.2217	0.1472	I(0)
	(0.4630)	(0.1460)	(0.4630)	(0.1460)	
POPG	0.1704**	0.1457	0.3289	0.1661	I(0)
	(0.4630)	(0.1460)	(0.4630)	(0.1460)	

Source: Extract from E-views 9 Output, 2024
NB: ** indicates significance 5%

Table 4.2 presents unit root stationarity test of the variables employed in this paper using the conventional tests without structural breaks. It shows in panels A and B, Phillip-Peron (PP) and Kwatkowski-Phillips-Schmidt-Shin (KPSS) unit root results at level I(0) and first difference I(1) for all the variables in the two categories of equations (that is, equations that include intercept or intercept & trend). The results as revealed are of mixed order of integration. Under PP unit root test EFP, LAGR, LIND, LSEV, TO and POPG are all stationary at first difference I(1). In the KPSS result however, in addition to LTO, EFP and POPG are stationary at level while LAGR, LIND and LSEV became stationary at first difference.

Table 4.3

Unit Root Tests with Structural Break

Minimized Dickey-Fuller (DF)							
	LEVEL			FIRST DIFFERENCE			
Variable	**Break Date**	**T-statistic**	**P-value**	**Break Date**	**T-statistic**	**P-value**	**I(d)**
EFP	2014	1.9577	0.9845	2004	7.5647**	<0.01	I(1)
LAGR	2001	23.704**	< 0.01	2010	5.7699	<0.01	I(0)
LIND	1998	2.2289	0.9589	2012	6.1042**	<0.01	I(1)
LSEV	2003	5.3436**	<0.01	2014	5.7088	<0.01	I(0)
LTO	2002	3.0065	0.6822	2021	8.7038**	<0.01	I(1)
POPG	2001	3.3030	0.5017	2015	4.7520**	0.0205	1(1)

Source: Extract from E-views 9 Output, 2024
NB: ** indicates significance 5%

On Table 4.3, the unit root test with structural break using the Minimized Dickey-Fuller methodology also indicates mixed order of integration, but on series different from previous tests done without structural break points. Here, variables LAGR and LSEV are found to be stationary at level while exhibiting structural break at different years. Conversely, EFP, LIND, LTO and POPG became stationary after taking their first difference, and also exhibiting structural break at different years.

Table 4.4
Bound Cointegration Test

ARDL Bound Test			
F-Statistic	I(0)	I(1)	**Significance**
5.9408**	2.26	3.35	10%
	2.62	3.79	5%
	3.41	4.68	1%

Source: Extract from E-views 9 Output, 2024
NB: ** indicates significance 5%

From result on Table 4.4, it is established that the F-statistic derived from the bound test is 5.94 which is the value obtained from the Pesaran table at 5% level of significance. Comparing this to the critical value, it is observed that the F-statistic is greater than the critical values at upper bound (3.79). This informs the rejection of the null hypothesis at 5% level of significance and the conclusion that variables are cointegrated. In other words, there is a long run cointegrating relationship among the variables employed. Existence of cointegration necessitates the interest in the error correction components of the models.

Table 4.5
ARDL Estimation

Panel A: Long Run			
Variable	**Coefficient**	**t-Statistic**	**Prob.**
C	3.150299	1.175877	0.2645
LAGR	0.475690**	3.811794	0.0029
LIND	-0.100400	-0.756246	0.4654
LSEV	-0.601599**	-3.576686	0.0043
LTO	0.586366**	7.383593	0.0000
POPG	-0.821662	-1.237099	0.2418
Panel B: Short Run			
@TREND(-1))	-0.098984	-0.389382	0.7044
@TREND(-2))	-0.378823	-1.479269	0.1671
D(LAGR)	0.204103	1.455563	0.1735

D(LIND)	0.091940	0.733588	0.4785
D(LIND(-1))	0.296214**	2.206417	0.0495
D(LIND(-2))	0.116781	0.973998	0.3510
D(LSEV)	0.043928	0.150777	0.8829
D(LSEV(-1))	0.719217**	2.670361	0.0218
D(LTO)	0.177182**	3.541679	0.0046
D(LTO(-1))	-0.311440**	-4.030932	0.0020
D(LTO(-2))	-0.178351	-2.146972	0.0549
D(POPG)	0.383950	0.352354	0.7312
D(POPG(-1))	0.509362	0.292659	0.7752
D(POPG(-2))	2.447205	1.576967	0.1431
D(POPG(-3))	-2.247766**	-2.378979	0.0366
ECT(-1)	-1.315348**	-3.683380	0.0036

Source: Extract from E-views 9 Output, 2024
NB: ** indicates significance 5%

The findings shown in Table 4.5 are produced by automatically selecting the lag length and using the Schwarz Criterion (SIC) model selection. (3, 1, 3, 2, 3, 4). The long run results as seen on panel A of Table 6 shows that holding other explanatory variables constant, there exist a positive long run relationship between LAGR and EFP. This implies that a percentage increase in agriculture per capita will lead to 0.47 unit increase in environmental degradation at 5% level of significance. On the contrary, LSEV is found to impact negatively on EFP in the long run. A percentage increase in service per capita reduced environmental degradation by 0.60% in the long run, holding other things constant at 5% level of significance. TO also had a significant impact on EFP implying that a percentage increase in the level of export has increased the level of environmental degradation by 0.59% during the period investigated.

From the short run regression results on panel B of Table 6, it is inferred that all explanatory variables have short run significance on EF, with the exception of LAGR which have short run insignificant impact on ecological footprint. Specifically, a percentage point increase in the first

lagged values of industrial growth and service per capita, having all things being equal resulted in a short run rise in environmental degradation by 0.29% and 0.71% respectively, with both predictors being significant at 5% level of statistical significance. Moreover, the level and first lagged value of trade openness and the third lagged value of population growth had negative short run significant impacts on environmental degradation during the period investigated.

The error correction coefficient (ECT) parameter is -1.32. The large absolute value indicates that the errors made in one period are fixed in the preceding period at a very fast pace. Additionally, supporting evidence of a consistent long-term relationship between the dependent variable and its predictors is the significant and negative ECT coefficient.

Table 4.6
Post Estimation Diagnostics

Post Estimation Test (Robustness Check)			
Panel A: Primary Diagnostics			
Diagnostic Test	**F-statistic**	Df	**Prob.**
R^2	0.9631	-	
Adj R^2	0.8927	-	
DW	2.3094	-	
F-Stat	13.6832**	-	0.0000
Panel B: Secondary Diagnostics			
Linearity (RESET)	0.0053	1, 10	0.9433
Serial Correlation	0.8245	2, 9	0.4690
Heteroscedasticity	1.6070	21, 11	0.2099
JB-Normality	1.0019	-	0.6059

Source: Extract from E-views 9 Output, 2024
NB: ** indicates significance 5%

On Table 4.6, summary of primary and secondary diagnostics are reported. From panel A, the adjusted R^2 revealed that 89 percent of the deviation in economic growth is jointly explained by explanatory variables employed in the regression model which indicates the goodness of fit of the

regression model. The Durbin Watson statistic suggests the non-existence of first-order serial correlation in the regression model. Moreover, the F-statistic indicates that the model is adequately specified. On panel B, further estimation tests of reliability of the regression model revealed that there is absence of specification error, second-order serial correlation and heteroscedasticity, with normally distributed residuals.

4.1 Discussion of Findings

The long run behavior of the primary predictor variables of this study supports the EKC hypothesis as explained by Paraskevopoulos (2009) of an inverse U-shaped relationship between economic growth per-sector and environmental degradation. As predicted by Paraskevopoulos (2009) evidence from this paper suggest a positive long run relationship between economic growth due to agriculture sector growth and environmental degradation, implying early stages of economic growth. Conversely, a negative long run relationship as predicted exists between economic growth due to service sector and environmental degradation, implying later stages of economic growth. Results also suggest that the predicted transition period in the inverse U-shaped curved is explained by the negative impact of the industrial sector per capita. Even though, the long run impact of industrial sector on pollution seems to be marginal, the negative sign implies that the industrial sector in Nigeria is in its matured stage of development. The significant long run impact of all key indicators of economic growth as presented in this study further support the argument of Falade and Adeyemi (2022) and Panayotou (2016) that the impact of economic growth on environmental degradation can best be explained by a sectoral approach since each sector of the economy exert different impact on environmental degradation.

Moreover, the positive impact of trade openness on pollution supports expectations a priori, and can be explained through the activities of multinational corporations (MNCs) in the country. Even though, a net import country, Nigeria is house to large MNCs who are argued to be major

contributors to environmental degradation in the country (Eluka et al., 2016). Overall, major findings of this study are in line with those of Adelegan and Otu (2020), Solarin, et al. (2021) and Zaidi et al. (2019) who also found EKC to explain the relationship between economic growth and environmental degradation. However, they are contradicted by Akpan and Akpan (2012), Huanchi and Calsin (2018), Mougenot et al., (2021) and Wagner (2015) who have found the EKC hypothesis to have a weak power in explaining the relationship between economic growth and environmental degradation.

5. Conclusion and Recommendations

An inverse U-shaped relationship should exist between economic growth and environmental degradation according to the EKC. This study adopted sectoral growth approach to test the applicability of the EKC in Nigeria by investigating the impact of GDP growth per capita in agricultural, industrial and service sectors on environmental degradation in Nigeria during 1986-2022 period. Major findings from the study suggest sectoral impact of economic growth follow the predictions of the EKC. This informs the conclusion that EKC is a good explainer of the extent to which economic growth impacts environmental degradation in the Nigerian context.

This conclusion has major policy implications. As Nigeria places emphasis on both economic growth and environmental preservation, there is need to pay more attention in reducing pollution due to agricultural activities such as excess fertilizer chemicals and application, overgrazing, deforestation and agriculture greenhouse emission in the downstream agriculture sub-sector. This is even more important in light of the renewed investment in agricultural sector as part of Nigeria's effort to diversify its economy.

The environmental degradation increasing impact that trade openness has exhibited in this paper suggests that in addition to curtailing environmental degradation addressed to multinational corporations, further trade policies should not be conceived in isolation of their environmental

consequences. Hence, while more trade openness should be allowed in the service and industrial sectors, a reductionist approach openness to trade is recommended in the agricultural sector of the Nigerian economy.

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