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Analysis of Environmental Degradation and its Determinants in Nigeria: New Evidence from ARDL and Causality Approaches

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Abstract

This paper extends the previous studies to re-examine the functional relations and causal links between environmental degradation and its possible determinants in Nigeria, covering 1977 to 2015. With the aid of ARDL model estimation, the study found a positive relationship between economic growth (measured by real GDP per capita and environmental degradation. A positive relation was also established between energy consumption and carbon emission. Similarly, this study reported a positive relationship between transport services in the import and export sectors and carbon emission. Through the Granger causality test, the study established a unidirectional causality running from carbon emission to economic growth. Similarly, there was a unidirectional causality from real GDP per capita to transport services in the export sector. Based on these findings, there is an increasing need for the authorities to regulate economic activities that directly and indirectly contribute to systematic environmental degradation in Nigeria.

Key Words: Environmental degradation, Transport services, Economic growth, ARDL, Granger causality.

JEL Classification Codes: C22, O13, O44

1. Introduction

Globally, issues around environmental degradation have taken the centre stage in qualitative and quantitative studies attributable to the recent challenge of climate change. Air, water pollution and global warming are mostly traced to unpredictable activities of man at various economic development stages, such as, the pre-industrial, industrial and services-driven stages (Ejuvbekpokpo, 2014). It is a commonplace to attribute environmental degradation to fossil fuel or carbon emission, otherwise known as CO2. Sanglimsuwan (2011) viewed carbon emissions as organic matters that stem from fossil fuel and manufacturing activities' combustion. Half of the world's fossil fuel escape into the atmosphere, thereby responsible for the increase in global temperature, while the natural land and ocean carbon reservoirs had absorbed the other half (Putman et al., 2016). According to Garber (2011), the take-off stage of a country towards development into a more industrialized economy contributes significantly to environmental degradation. In essence, the greater the consumption of natural resources using outdated and energy-intensive technologies, the higher the rate of environmental pollution.

Meanwhile, environmental degradation is one of the factors that significantly contribute to economic growth and development. For instance, Xie et al. (2017) argued that China's growth and development in recent years has contributed significantly to carbon emissions across the globe. Concerning the issues around the correlation between economic growth and environmental quality in Nigeria, Alege and Ogundipe (2013) submitted that air pollution (mainly caused by smoke and noise), loss of forest areas, municipal waste problems, habitat destruction, threats to biodiversity, global greenhouse gases and the resource depletion are not unconnected to economic growth. The authors further argued that environmental degradation in Nigeria could be traced to the era of crude oil discoveries. The oil-induced economic performance has heightened the depth of environmental degradation, especially in the major oil-producing areas in the Niger-Delta region. Oil spillage by multinationals operating in the region has resulted in socioeconomic deprivation for farmers and traders without adequate compensation to the affected groups and communities. Despite the growth of natural resource endowment in most African countries, poor institutional quality, absence of accountability and weak rule of law, as well as, endemic corruption have, in most part, been responsible for environmental degradation on the continent (Simulders, 2000).

Considering the relationship between transportation services and environmental degradation, a handful of the literature has only focused on private transport means, such as car traffic, aviation and freight transports1. Stern (2006) opined that all types of transportation means were responsible for 14% of the world's total CO2 emission in 2000 and has the tendency of increasing its level if appropriate measures are not taken very urgently. According to World Bank (2017), CO2 emission from transport services in Nigeria accounted for 51% of the overall fossil fuel combustion between 2000 and 2005 and 36% between 2006 and 2014.

Saidi and Hammami (2017) submitted that the nexus between transport, economic growth and environmental degradation has been treated along the three strands of the extant literature. First and in no particular order, is the relationship between income and freight transportation, with particular focus on the issue of coupling/decoupling freight transportation2. Second is the nexus between economic growth and the efficiency of energy use, with particular reference to the Environmental Kuznets Curve (EKC) or the Pollution-Haven hypothesis3. The third strand of the literature examined the direction of causality between transport services and carbon emission (as an indicator for environmental degradation). The last strand has increasingly spurred researchers' interest in identifying the other important factors contributing to environmental degradation (see, Léonardi and Baumgartner, 2004; Tanczos and Torok, 2007).

Studies on Nigeria have also exhausted these three strands of the literature (see Saidi and Hammami, 2017). They include, among others, Ejuvbekpokpo (2014); Asaju and Arome (2015); Mesagan (2016); Otene, Murray and Engine (2016); Agarana, Bishop and Agboola (2017); Appiah et al. (2017); Onokala (2017). Although their findings have been largely inconclusive, they have equally been too biased, because they failed to take into account the probable influences of other factors (such as, transport services) that contribute to CO2 emission in the economy. This paper, therefore, extends the previous studies on Nigeria with a focus on re-examining the functional relation and the causal link between environmental degradation and its supposed determinants in Nigeria. The rest of the study is structured as follows. Section 2 takes account of the empirical

[1]See, for instance, Tanczos and Torok (2007); Riha and Honcu (2012); Saidi and Hammami (2017).
[2]See, Joignaux and Verny (2004); McKinnon (2007); Mraihi (2012); Meersman and Van de Voorde (2013).
[3]See, Borhan et al. (2012); Zhu et al. (2012); Chandran and Tang (2013); Omri et al. (2014); Magazzino, 2014; Shahbaz et al. (2015); Dogan and Turkekul (2016).

literature. Section 3 entails theoretical framework and methodology. While Section 4 is devoted to empirical analysis and discussion of results, Section 5 concludes the study.

2. Empirical Literature Review

The extant empirical literature review was carried out under three subheadings: Carbon Emission and Economic Growth; Transportation and Carbon Emission; Economic Growth, Transportation, and Carbon Emission. Most of the literature on Carbon Emission and Economic Growth nexus reported a robust bidirectional relationship between the two variables. With respect to Transportation and Carbon Emission, there appears to be a consensus that the former strongly impacts the latter. Besides, most studies on the nexus among Economic Growth, Transportation, and Carbon Emission established a strong linkage among the three key variables and thus, confirmed the EKC's existence for both country-specific and multiple countries cases. Table 1 summarizes the empirical literature across these three strands. The recent study corroborates the co-existing literature by re-examining the functional and causal relationship between environmental degradation and the possible determinants in Nigeria using ARDL and Granger causality approaches.

Table 1: Summary of the Empirical Literature

S/n	Author(s)	Title of article	Variables used in the study	The methodology used an econometric	Results and findings	Conclusion
Nexus between carbon emission and economic growth						
1	Azomahou et al. (2005)	Economic Development and CO2 Emissions: A Nonparametric Panel Approach	CO2 emission per capita, real GDP per capita,	Nonparametric panel model, OLS	There is between carbon emissions per capita and Gross Domestic Product (GDP) per capita.	There is a static link between carbon emissions and GDP per capita.
2	Grubb et al. (2007)	Analysis of the Relationship between Growth in Carbon Dioxide Emissions and Growth in Income	Population, National Income, carbon emissions, and GDP per capita	Trend Analysis Approach	Established that an increase in economic growth do not associate with an increase in carbon emissions	carbon emission does not have a significant relationship with income per capita
3	Akpan and Akpan (2012)	Electricity Consumption, Carbon Emissions and Economic Growth in Nigeria	Carbon dioxide emissions, index of electricity consumption, real income per capita, and real income square.	Autoregressive Distributed Lag (ARDL) and Multivariate Vector Error-Correction Model (VECM)	Electricity consumption and carbon emission significantly influence growth in the short-run and long-run	There is a need for efficient energy products.
4	Borhana et al. (2012)	The Impact of CO2 on Economic Growth in ASEAN 8	GDP per capita, carbon emission, labour, physical capital, government spending, foreign direct investment, net export, population density, GDP	Fixed Effect Panel Regression Model.	There is a simultaneous relationship existing between carbon emission, population density, and income	Even though growth in population leads to carbon emission, carbon emission reduces population density and income

5	Essien (2012)	The Relationship Between Economic Growth and CO2 Emissions and the Effects of Energy Consumption on CO2 Emission Patterns In Nigerian Economy	Real GDP Per Capita (RGDPPC), Carbon dioxide Emissions (CE), Electricity Consumption (EC), Natural Gas (NG), Crude Oil (CO), Fuel Wood (FW) and Solid Biomass (SB).	Standard Version of Granger, Vector Error Correction Model, Generalized Impulse Response and Variance Decompositions	Real GDP, carbon emissions, electricity consumption, natural gas, crude oil, fuelwood, and solid biomass are all cointegrated.	There is a need to designed policies to reduce carbon emissions.
6	Alege and Ogundipe (2013)	Environmental quality and economic growth in Nigeria: A fractional cointegration analysis	Carbon emission, trade openness, control of corruption, and population density.	Fractional Integration and Co-integration.	No significant evidence to support the existence of Environmental Kuznets Curve in Nigeria,	EKC proposition is not real in Nigeria.
7	Kulionis (2013)	The relationship between renewable energy consumption, CO2 emissions and economic growth in Denmark	GDP per capita, carbon emissions per capita, and renewable energy consumption per capita.	Vector Auto-regressive (VAR) model, Unit Root Test, Co-integration, and Granger Causality.	GDP does not Granger cause carbon emissions.	There is no relationship between carbon emission and economic growth, as well as renewable energy consumption and economic growth
8	Alam (2014)	On the Relationship between Economic Growth and CO2 Emissions: The Bangladesh Experience	Value Added of GDP in Agriculture, Value Added of GDP in Industries, Value Added of GDP in Services, carbon emissions,	Trend Analysis Approach	An increase in the GDP contribution of industrial and services sectors increases carbon emission.	Environmental awareness, environmental policy, global cooperation, improved and polluting abatement technologies are the identifiable means of reducing carbon emissions.
9	Annicchiarico et al. (2014)	150 Years of Italian CO2 Emissions and Economic Growth	carbon emission per capita, and Gross	CVAR, Linearity Tests, MR-STAR, MS-VAR	The carbon emissions path is closely related to the income time path.	Confirmed EKC.

			Domestic Product (GDP) per capita			
10	Ejuvbekpokpo (2014)	Impact of Carbon Emissions on Economic Growth in Nigeria	Gross Domestic Product, Emissions from Fossils fuel, Emissions from Gas fuels, Emissions from Liquid fuels, Emissions from solid fuels, Emissions from cement production	Ordinary Least Square Method.	Fossil fuels, gas fuels, liquid fuels, cement fuels have a significant impact on gross domestic product except for emission from solid fuels.	Carbon emissions reduce growth in Nigeria
11	Muftau, Iyoboyi, and Ademola (2014)	An Empirical Analysis of the Relationship between CO2 Emission and Economic Growth in West Africa	Gross Domestic Product (GDP), Money Supply (M2), Population size (POP), Domestic credit to the private sector (DC), Openness (OPN), and the square of Gross domestic product (GDP2).	Fixed Effect Panel Regression Model, and Vector Error Correction Model (VECM)	There is the existence of an N-shape relationship among the variables	Economic growth is liable for increases in carbon emission in West African Countries.
12	Palamalai et al. (2015)	Relationship between energy consumption, CO2 emissions, economic growth and trade in India.	energy consumption, CO2 emissions, Gross domestic product (GDP) and foreign trade	VECM	there is a long-run relationship between energy consumption, carbon emissions, GDP and trade, while in the short run, a causal relationship exists from carbon emissions to economic activities	It is necessary to implement energy efficiency measures to maintain sustainable growth and environmental quality.
13	Omri et al. (2015)	Financial development, environmental	per capita GDP, per capita CO2 emissions, per capita total energy	Panel Unit root test, GMM	A bi-directional causal relationship between	Policy such as; energy-efficient technologies and adoption of trade

		quality, trade and economic growth: What causes what in MENA countries	consumption, per capita gross fixed capital formation, domestic credit to the private sector, total trade, urban population, foreign direct investment net inflows, and consumer prices.		carbon dioxide emissions and economic growth	liberalization should be taken to reduce carbon emissions.
14	Jong-Chao and Chih-Hsiang (2016)	Impact of population and economic growth on carbon emissions in Taiwan using an analytic tool STIRPAT	Carbon emission, total population, percentage of non-independent population, per-capita GDP, percentage of the urbanized population, and industries-contributed per-capita GDP	ARDL and STIRPAT model	Positive logarithmic polynomial coefficients with respect to population, and negative logarithmic polynomial coefficients with respect to GDP per capita	In the Year 2025, an inverted U-Shape will be identified.
15	Mesagan (2016)	Economic Growth and Carbon Emission in Nigeria	carbon emission, economic growth, trade openness, and capital investment	Error correction model	Economic growth has a positive impact on carbon emission	Economic growth is an essential determinant of carbon emissions in Nigeria.
16	Mohiuddin et al. (2016)	The relationship between carbon dioxide emissions, energy consumption, and GDP: A recent evidence from Pakistan	CO2, EPC, EPG, EPL, EC, GDP	Co-integration, VECM, Augmented Dickey-Fuller, Phillips–Perron unit root tests, Granger-causality analysis,	evidence of long-run equilibrium relationship from energy consumption, electricity production from coal, electricity production from oil and GDP to carbon emissions	carbon emissions are fuel by energy consumption, energy production from gas, and GDP

				Generalized impulse response		
17	Appiah et al. (2017)	Investigation of the Relationship between Economic Growth and Carbon Dioxide (CO2) Emissions as Economic Structure Changes: Evidence from Ghana	carbon emissions, GDP per capita	Ordinary Least Square (OLS)	There is a significant relationship between carbon emissions and economic growth.	There is a need for policy formulation towards the prevention of environmental degradation.
18	Misra (2017)	The inter-relationship between economic growth and CO2 emissions in India	CO2 emissions, GDP, energy intensity, and electricity generation	ARDL model	GDP explains carbon emission at a 10% significance level	The relationship is a long-run phenomenon.
Transportation and Carbon Emission Nexus						
19	Timilsina & Shrestha (2008)	The Growth of Transport Sector CO2 Emissions and Underlying Factors in Latin America and the Caribbean	fuel switching, modal shifting, economic growth and changes in emission coefficients and transportation energy intensity	logarithmic mean Divisia index (LMDI) approach	Transport sector carbon emission growth is fuel by economic growth and transportation energy intensity in Latin American and Caribbean countries.	Both the economic activity effect and transportation energy intensity effect are found responsible for transport sector CO2 emissions growth.
20	AfDB (2010)	Reducing Carbon Emissions from Transport Projects in Asian countries	Production Input materials	MRT emissions model	Local pollution amount to carbon emission, in which expanded road capacity results in a long-term increase in carbon emissions and local air	Construction of transport infrastructure; induced travelling; polluting trucks, cars, and small vehicles sets

					pollution. It increases the amount of traffic.	the carbon emission pace.
21	Makido et al. (2012)	Relationship between urban form and CO2 emissions: Evidence from fifty Japanese cities	BCI, CI, AWMPFD, Income, Pop, AveTemp, Urban, Indus CO2, Comm CO2, Resi CO2, Trans CO2, PassCar CO2, FreiCar CO2	Stepwise multiple linear regression, correlation analysis	Realize that per capita carbon emissions from transport sectors and residential of the Japanese cities have a significant relationship with urban form's spatial variables.	Denser settlement may lead to lower carbon emissions from the residential and passenger transport sector.
22	Chandran and Tang (2013)	The impact of transport energy consumption, foreign direct investment and income on carbon emissions in Asean-5 economies	per capita real GDP, per capita actual FDI, per capita carbon emissions, per capita energy consumption,	Co-integration, and Granger causality method.	In the long run, there is bi-directional causality between economic growth and carbon emissions in Indonesia and Thailand, while in Malaysia, there is evidence of bi-directional causality between energy consumption and economic growth.	Economic growth and road transport energy consumption produce higher carbon emissions.
23	Konur and Schaefer (2014)	Integrated inventory control and transportation decisions under carbon emissions regulations: LTL vs TL carriers	unit transportation cost and unit transportation emissions bt, per truck cost R and empty truck emissions bw	LTL and TL transportation.	Emission generated through trucks consists of the majority.	Transportation costs are not the only factor influencing a retailer's preference, transportation emissions, and carbon emissions.

24	Postorino and Mantecchini (2014)	A transport carbon footprint methodology to assess airport carbon emissions	average emissions due to ground access mode; average emissions due to energy production and consumption for airport terminal activities; average emissions due to landing, take-off and taxiing on-ground aircraft; average emissions due to handling vehicles and airport equipment	general approach	Emissions due to passenger to and from airports are one of the leading causes of airport-related environmental impacts.	Deducing that the airport's primary emissions are carbon emissions from ground access vehicles and the LTO cycle.
25	Wang et al. (2016)	Carbon emission and its decoupling research of transportation in Jiangsu Province	GDP, coal, coke, crude oil, kerosene, gasoline, diesel, fuel oil, LPG, natural gas, and electricity consumption	Tapio decoupling model	GDP and transportation in Jiangsu Province contribute massively to the increase in carbon emissions	There is a need for government policy tremendously in transportation development and depleted carbon emissions.
26	Agarana et al (2017)	Minimizing Carbon Emissions from Transportation Projects in Sub-Saharan Africa Cities Using Mathematical Model: A Focus on Lagos, Nigeria	Electricity expenses	Linear Programming Model	Income is essential for electricity used.	However, the government should enhance quality fuel for transportation, good roads should be constructed, and other transportation means should be introduced.

27	Xie et al. (2017)	The effects of transportation infrastructure on urban carbon emissions	electric power, natural gas, liquefied petroleum gas, and transportation	STIRPAT model	Construction of transportation infrastructure, population size, per capita GDP, energy intensity, and industrial structure lead to rises in carbon emission and intensity.	Large-scale cities and transport infrastructure's construction positively affects urban carbon emissions and carbon intensity; transport infrastructure only increases carbon intensity in medium-scale cities. In small scale cities, transportation infrastructure construction has no significant effects on carbon emission and carbon intensity.
Nexus among Economic Growth, Transport and Carbon Emissions						
28	Gray et al. (2006)	Decoupling the link between economic growth, transport growth and carbon emissions in Scotland	GDP, Road traffic volume, carbon emissions, PM emissions, and NOx emissions	Decoupling method	The policy to reduce the transport sector's carbon emissions and increase the pace of economic growth in Scotland is constrained by political and social acceptability.	To get most of the transport sectors, there is a need to tackle political risk within transport and energy, and inform the public of the nature of the problem and promote their lifestyle change to improve quality of life.

29	Říha and Honců (2012)	Transport Energy and Emissions and their Relation to Economic Output.	Total emissions, population, transport energy consumption, traffic output (vehicle. km), transport output (tkm), GDP, and GDP per capita	Kuznets environmental curve	The environmental Kuznets curve is invalid regarding carbon dioxide, whereas the environmental Kuznets curve is established for nitrogen emissions and some other pollutant from road transport.	Road transport leads to an increase in economic output, in which economic growth is believed to reduce emissions.
30	Atte-Oudeyi et al. (2016)	Road Transport, Economic Growth and Carbon Dioxide Emissions in the BRICS: Conditions For a Low Carbon Economic Development	Road Carbon emission, Per capita GDP, Population Density, Government Effectiveness Index	Fixed-effects and random-effects	Economic growth and carbon emissions per capita confirm the existence of an inverted U-shaped EKC due to road transport of BRICS countries, whereas, when Russia is absent from the group, EKC does not hold	That increasing per capita GDP level is not enough to reduce carbon emissions in BRICS countries.
31	Saidi and Hammami (2017)	Modelling the causal linkages between transport, economic growth and environmental degradation for 75 countries	GDP per capita, energy consumption, freight transport, carbon emissions, financial development, capital stock, trade openness, population, foreign direct investment, urbanization	Generalized Method of Moments.	There is the existence of a bi-directional causal relationship between freight transport and economic growth for four panels; unidirectional causality running from freight transport to environmental degradation for the four panels.	Transport positively relates to carbon emission and economic growth, i.e., an increase in transport service leads to increased environmental pollution and GDP growth.

32	Neves et al. (2017)	Is energy consumption in the transport sector hampering both economic growth and the reduction of CO2 emissions? A disaggregated energy consumption analysis	Gross Domestic Product per capita (GDP), TS fossil fuels (coal, crude, oil and natural gas) consumption per capita (FF), TS electricity consumption per capita (EL), TS renewable fuels consumption per capita2 (RES), total CO2 emissions from TS (CO2), total energy consumption in the economy minus that of the TS per capita (EN), and rail investment (RAIL).	Driscoll-Kraay fixed effects estimator; Autoregressive Distributed Lag (ARDL)	Railway investment did not reduce carbon emissions but increased electricity demand, thereby contributing to more significant carbon emissions.	Transport sector electrification harms economic growth and a positive effect on carbon emission
33	Mbarek and Zghidi (2017)	Dynamic links between ICT, transport energy, environmental degradation and growth: empirical evidence from Tunisia.	LICT, LGDP, carbon emissions, FFEC	Johansen cointegration analysis, Vector Error Correction Model (VECM)	Transport energy increases carbon emission in Tunisia, while ICT has no significant relationship with carbon emissions.	Policy measures infer the use of railway transport to reduce carbon emissions on transport energy and attain economic growth.
34	Fan and Lei (2017)	Responsive Relationship between Energy-Related Carbon Dioxide Emissions from the Transportation Sector and Economic	CO2 emissions, Energy consumption, net calorific value, traffic volume and GDP,	Tapio decoupling analysis	There was a complex decoupling relationship between carbon emissions from the transportation sector and economic growth, expansive negative	Industrial operating efficiency and industrial development decoupling positively affect the decoupling situation between carbon emissions from

		Growth in Beijing — Based on Decoupling Theory			decoupling, weak decoupling, and expansive decoupling.	the transport sector and economic growth.
35	Liang et al. (2017)	Factors Affecting Transportation Sector CO2 Emissions Growth in China: An LMDI Decomposition Analysis	CO2 from Energy Structure, CO2 from Energy Efficiency, CO2 from Transportation form, CO2 from Transportation Development, CO2 from Economic development, CO2 Population size, GDP, energy consumption	decomposition model, Logarithmic Mean Divisia Index (LMDI) decomposition analysis technology and modified fixed growth rate method	The increment in transportation services in China has led to high growth speed in carbon emission.	Significant factors affecting transportation carbon emission growth are energy structure, energy efficiency, transport form, transportation development, economic development, and population size.
36	Danish and Baloch (2017)	Dynamic linkages between road transport energy consumption, economic growth, and environmental quality: evidence from Pakistan	GDP, Road Infrastructure, Road Transport Energy Consumption, Urbanization, and Sulfur dioxide emissions.	ARDL cointegration approach.	Long-run, road infrastructure, road transport energy consumption, urbanization, and economic growth are positively related whereas, economic growth and emissions are negatively related.	Expansion in road infrastructure, transport energy consumption and economic growth will worsen environmental quality.

3. Theoretical Framework & Methodology

3.1 Theoretical Framework

The IPAT model of Dietz and Rosa (1994) explains the impact of population, affluence and technology on the environment; where I is the environmental impact, P is population, A is per capita economic output (referred to as affluence), and T is the impact of per-unit activity (referred to as technology). The model is written as:

$$I = P^{*}A^{*}T \tag{1}$$

In specific application purpose, Dietz and Rosa (1994) explained that data are obtained on Impact, Population and Affluence to solve for T, which is the technology used. The model is specified as:

$$T = I/(P^{*}A) \tag{2}$$

Considering the importance of the stochastic term in the Model, Dietz (1994) reformulated the model in a stochastic form:

$$I = aP^{b}A^{c}T^{d}e \tag{3}$$

I, P, A and T remain environmental impact of population growth, per capita economic activity and impact per unit economic activity. For the model, b, c, and d are the parameters, while a and e are residual terms. To estimate these parameters, Dietz and Rosa (1994) submitted that data on I, P, A and T can be used.

Xie et al. (2017) modified equation (3) by arguing that transportation infrastructure's construction affects urban carbon emissions through population scale, economic growth, and technological innovation. Therefore, they added the transportation infrastructure (Road) factor to the model. The logarithm of equation (3) was taken to present the linear form of the model. The model is reformulated as:

$$In\, I = \alpha_0 + \alpha_1 InRoad + \alpha_2 InP + \alpha_3 InA + \alpha_4 InT + \varepsilon \tag{4}$$

$\alpha_1 - \alpha_4$ are the coefficients of the parameters, ε is the error term, while α_0 is the intercept.

Xie et al. (2017) further decomposed and expanded the model to include other variables that contribute to environmental degradation and re-specified the model as;

$$In\, I_{it} = \alpha_0 + \alpha_1 InRoad_{it} + \alpha_2 InP_{it} + \alpha_3 InA_{it} + \alpha_4 InT_{it} + \alpha_5 InEI_{it} + \alpha_6 InUrban_{it} + \alpha_7 InOpen_{it} + \alpha_8 InIndustry_{it} + \varepsilon_{it} \tag{5}$$

Where i represents cities, t is year, α_0 is a constant term, and ε_{it} is an error term. I stands for carbon emissions and intensity, $Road$ is transportation infrastructure, P is the population size, A is affluence, T is technical progress, EI is energy intensity, $Urban$ is the urbanization level, $Open$ is the trade openness, $Industry$ is industrial structure and ε is the error term. For this study, we followed Xie et al. (2017) model, this is because the study included transportation infrastructure, which is similar to our study. We modified the model based on the proxy for transportation infrastructure, which contributed to environmental degradation and included some other variables contributing to Nigeria's environmental degradation.

3.2 Methodology

The study used the ARDL model and Granger causality test to analyze the study's two specific objectives. The ARDL model – developed by Pesaran et al (2001) - is used to analyze the long-run and short-run relationships between the variables employed. In contrast, the Granger causality test – developed by Granger (1969) - is used to model the causal link between economic growth, transport services and environmental degradation.

3.2.1 ARDL Model Specification

$$LCO_{2t} = \alpha_0 + \beta_1 TR_t + \beta_2 LRPCI_t + \beta_3 (TR_t * LRPCI_t) + \beta_4 LEGY_t + \beta_5 TOP_t + \varepsilon_t \quad (6)$$

$$TR_t = \{TR\_X_t, TR\_M_t\} \quad (7)$$

From equations (6) and (7), LCO_{2t} implies log form of carbon emissions, a proxy for environmental degradation, TOP_t is trade openness captured as the ratio of trade to GDP, $LRPCI_t$ is log form of real gross domestic product per capita, $LEGY_t$ is the log form of energy use in Kg oil equivalent per capita, TR_t is transport services decomposed into TR_X and TR_M, where TR_X_t is transport services as a percentage of commercial services export and TR_M_t is transport services as a percentage of commercial services import and ε_t is the error term. The data on the variables were obtained from the World Bank's World Development Indicators (2017 edition). t implies time period, α_0 is the model intercept, while $\beta_1 - \beta_5$ are the coefficients of the parameters.

The study reformulates equations (6) and (7) using ARDL model to capture the long-run and short-run impact of economic growth and transport on environmental degradation. The ARDL version is as follows:

$$\Delta LCO_{2t} = \vartheta_1 LCO_{2t-1} + \vartheta_2 TR_{t-1} + \vartheta_3 LRPCI_{t-1} + \vartheta_4 (LRPCI * TR)_{t-1} + \vartheta_5 TOP_{t-1} + \sum_{k=1}^{n-1} \rho_{1k} \Delta LCO_{2t-k} + \sum_{k=0}^{n-1} \rho_{2k} \Delta TR_{t-k} + \sum_{k=0}^{n-1} \rho_{3k} LRPCI_{t-k} + \sum_{k=0}^{n-1} \rho_{4k} \Delta (LRPCI * TR)_{t-k} + \sum_{k=0}^{n-1} \rho_{5k} \Delta TOP_{t-k} + \varepsilon_t \quad (8)$$

The error correction representation is derived as follows:

$$\Delta LCO_{2t} = \vartheta_1 \left(LCO_{2t-1} - \left[-\frac{\vartheta_2}{\vartheta_1} TR_{t-1} - \frac{\vartheta_3}{\vartheta_1} LRPCI_{t-1} - \frac{\vartheta_4}{\vartheta_1} (LRPCI * TR)_{t-1} - \frac{\vartheta_5}{\vartheta_1} TOP_{t-1} \right] \right) + \sum_{k=1}^{n-1} \rho_{1k} \Delta LCO_{2t-k} + \sum_{k=0}^{n-1} \rho_{2k} \Delta TR_{t-k} + \sum_{k=0}^{n-1} \rho_{3k} LRPCI_{t-k} + \sum_{k=0}^{n-1} \rho_{4k} \Delta (LRPCI * TR)_{t-k} + \sum_{k=0}^{n-1} \rho_{5k} \Delta TOP_{t-k} + \varepsilon_t \quad (9)$$

By letting,

$$ect = LCO_{2t-1} - \mu_1 TR_{t-1} - \mu_2 LRPCI_{t-1} - \mu_3 (LRPCI * TR)_{t-1} - \mu_4 TOP_{t-1} \quad (10)$$

Where,

$$\mu_1 = -\frac{\vartheta_2}{\vartheta_1}, \quad \mu_2 = -\frac{\vartheta_3}{\vartheta_1}, \quad \mu_3 = -\frac{\vartheta_4}{\vartheta_1}, \quad \mu_4 = -\frac{\vartheta_5}{\vartheta_1} \quad (11)$$

Eq. (9) is therefore re-written as:

$$\Delta LCO_{2t} = \vartheta_1 ect + \sum_{k=1}^{n-1} \rho_{1k} \Delta LCO_{2t-k} + \sum_{k=0}^{n-1} \rho_{2k} \Delta TR_{t-k} + \sum_{k=0}^{n-1} \rho_{3k} LRPCI_{t-k} + \sum_{k=0}^{n-1} \rho_{4k} \Delta (LRPCI * TR)_{t-k} + \sum_{k=0}^{n-1} \rho_{5k} \Delta TOP_{t-k} + \varepsilon_t \quad (12)$$

Recall that, $TR_t = \{TR\_X_t, TR\_M_t\}$

From equations (11) and (12), the Δ denotes the short-run variables' changes, n is the lag length, ε_t- error term at time t. The parameters μ_i $(i = 1, 2, 3, 4)$ are the corresponding long-run multipliers, and the parameters $\rho_{ik} = (i = 1, 2, 3, 4, 5)$ are the short-run dynamics of the ARDL model. ϑ_1 is the adjustment parameter on the error correction term $e$tc. The convergence criteria hold that the parameter must be negative, less than one in absolute value, and statistically significant at the conventional levels of 1%, 5%, and 10%. Based on eq. (12), the a priori expectations for the regression coefficients are as follows: ρ_{1k}> or < 0; ρ_{2k}> 0; ρ_{3k}> 0; ρ_{4k}< 0 (depending on whether or not growth supports the use of energy-saving transportation technologies); ρ_{5k}> 0.

3.2.2 Granger Causality Test

The Granger causality enables endogeneity of variables; that is, it permits each variable to be assumed as the dependent variable. The causal link models from transport services (% of commercial exports and % of commercial imports) and economic growth to environmental degradation are specified as:

$$\Delta L\mathrm{CO}_{2t} = \vartheta_0 + \sum_{q=1}^{n} \theta_{1t} \Delta LCO_{2t-k} + \sum_{q=1}^{n} \gamma_{1t} \Delta TR\_X_{t-k} + \sum_{q=1}^{n} \gamma_{2t} \Delta LRPCI_{t-k} \quad (13)$$

$$\Delta L\mathrm{CO}_{2t} = \vartheta_0 + \sum_{q=1}^{n} \theta_{1t} \Delta LCO_{2t-k} + \sum_{q=1}^{n} \gamma_{1t} \Delta TR\_M_{t-k} + \sum_{q=1}^{n} \gamma_{2t} \Delta LRPCI_{t-k} \quad (14)$$

Transport services are decomposed into transport services as a percentage of commercial services from export and import.

$$\Delta TR\_M_t = \vartheta_0 + \sum_{q=1}^{n} \theta_{1t} \Delta LCO_{2t-k} + \sum_{q=1}^{n} \gamma_{1t} \Delta TR\_M_{t-k} + \sum_{q=1}^{n} \gamma_{2t} \Delta LRPCI_{t-k} + \varepsilon_{1t} \quad (15)$$

Equation (15) presents causality from economic growth, environmental degradation and transport services in the export sector to transport service in the import sector.

$$\Delta TR\_X_t = \vartheta_0 + \sum_{q=1}^{n} \theta_{1t} \Delta LCO_{2t-k} + \sum_{q=1}^{n} \gamma_{1t} \Delta TR\_X_{t-k} + \sum_{q=1}^{n} \gamma_{2t} \Delta LRPCI_{t-k} + \varepsilon_{1t} \quad (16)$$

Equation (16) presents the direction of causality from economic growth, environmental degradation and transport services in the import sector to transport service in the export sector;

$$\Delta LRPCI_t = \vartheta_0 + \sum_{q=1}^{n} \theta_{1t} \Delta LCO_{2t-k} + \sum_{q=1}^{n} \gamma_{1t} \Delta TR\_M_{t-k} + \sum_{q=1}^{n} \gamma_{2t} \Delta LRPCI_{t-k} + \varepsilon_{1t} \quad (17)$$

Equation (17) presents the direction of causality from transport service in the import sector and environmental degradation to economic growth.

$$\Delta LRPCI_t = \vartheta_0 + \sum_{q=1}^{n} \theta_{1t} \Delta LCO_{2t-k} + \sum_{q=1}^{n} \gamma_{1t} \Delta TR\_E_{t-k} + \sum_{q=1}^{n} \gamma_{2t} \Delta LRPCI_{t-k} + \varepsilon_{1t} \quad (18)$$

Equation (18) presents the direction of causality from transport service in the export sector and environmental degradation to economic growth.

4. Empirical Analysis & Discussion of Results

This section presents the results of empirical analysis ranging from preliminary analysis to model estimation and post-estimation tests.

4.1 Descriptive Statistics

Table 2 shows the summary of descriptive statistics on all variables used throughout this study over the period of 1977 and 2015, implying a total observation of 38 years. The average values of carbon emission (co2) (in log levels), transport services (% of commercial exports), transport services (% of commercial imports), real GDP per capita (in log levels), energy use (in log levels), and trade openness are 11.08, 42.14%, 35.15%, 12.4, 6.57 and 50.63%, respectively. In terms of the spread of the series around its mean value, the most volatile series is transport services (% of commercial exports), with the highest standard deviation of 28.79% (corroborated by the most significant gap between the maximum and minimum values of the variable among others). In comparison, the least volatile series is the natural log of energy use with the lowest standard deviation of 0.06% (corroborated by the smallest gap between the maximum and minimum values of the variable, among others).

Table 2: Summary of Descriptive Statistics

Variable	No of Observation	Mean	Maximum	Minimum	Standard Deviation
LCO_2	38	11.082	11.572	10.469	0.362
TR_X	38	42.135	93.352	2.879	28.785
TR_M	38	35.152	53.207	9.998	11.268
$LRPCI$	38	12.401	12.862	12.061	0.259
$LEGY$	38	6.566	6.682	6.455	0.057
TOP	38	50.626	81.813	21.124	16.015

Note: LCO2 – carbon emissions (log-levels); TR_X - transport services as % of commercial services export; TR_M - transport services as % of commercial services import; LRPCI - real GDP per capita (log-levels); LEGY - energy use in oil equivalent per capita (log-levels); TOP – trade openness defined as trade % of GDP.

Source: Authors' Computation

4.2 The Unit Root Test Result

Table 3 presents the result of the augmented Dickey-Fuller (ADF) unit root test for each variable to determine their stationarity status. It can be observed that all the variables become stationary only after first differencing, implying that they have to be differenced once before they become stationary. Hence, all variables are described as being integrated of order one: I (1).

Table 3: Result of ADF Unit Root Test

Variable	Level			First Difference			Remark
	A	B	C	A	B	C	
LCO_2	-1.742	-1.389	0.546	-6.099***	-6.188***	-6.204***	I(1)
TR_X	-1.841	-1.811	-0.823	-6.196***	-6.214***	-6.301***	I(1)
TR_M	-2.068	-2.031	-0.989	-6.146***	-6.214***	-6.300***	I(1)
$LRPCI$	-1.729	-0.122	0.518	-5.586***	-4.837***	-4.842***	I(1)
$LEGY$	-2.957	-1.451	1.593	-5.527***	-5.611***	-5.384***	I(1)
TOP	-0.876	-2.045	-0.719	-8.508***	-8.389***	-8.479***	I(1)

Note: *** indicates the rejection of the null hypothesis of a unit root at 1% level of significance; A, B and C denote models with intercept and trend, with intercept only and with none, respectively

Source: Authors' Computation.

4.3 The ARDL Bounds Cointegration Test Result

Table 4 shows the result of the autoregressive distributed lag (ARDL) bounds test for cointegration to check if there exists a long-run relationship between environmental degradation (measured by carbon emission) and its determinants. Two models are specified based on the measure of transport services used. Model 1 employs transport services (% of commercial exports) while Model II employs transport services (% of commercial imports). Since the associated F-statistics in both cases fall below the lower (I1) critical bound, it can be concluded that no long-run equilibrium relationship exists between environmental degradation (carbon emission) and its determinants in Nigeria irrespective of the measure of transport services used.

Table 4: Result of ARDL Bounds Cointegration Test

	Model I	Model II
F-statistic	0.572	1.599
	Critical Values	
Significance levels	I1 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Source: Authors' Computation

4.4 Discussion of Regression Results

The regression results, comprising the ARDL/short-run estimates of the relationship between environmental degradation and its determinants, as well as vital statistics (R2 and F-statistic) and post-estimation tests, are presented in Table 5. Two models are reported depending on which of the two transport services used: while Model I captures transport services (% of commercial exports), Model II captures transport services (% of commercial imports).

It can be observed that irrespective of the measures of transport services used, there is a positive association between carbon emission in the current period and its previous levels. The coefficients of autocorrelation (0.682 for Model I and 0.677 for Model II) are statistically significant at a 1% level of significance. This implies that the increasing carbon emission in the current period has precedents in the previous period. Also, in Model I, there is a positive relationship between transport services in commercial exports and carbon emission. The short-run impact coefficient (0.191) implies that every one percentage point increase in transport services leads to a (0.191*100) 19.1% increase in carbon emission on average, keeping other variables constant. The coefficient is also statistically significant at a 10% level of significance. The implication of this result is that increasing transport services with the attendant high fuel consumption contribute more to environmental degradation in terms of emission of poisonous gas (CO2).

Similarly, in Model II, it can be observed the share of transport services in commercial imports has an overall short-run positive effect on carbon emission. However, carbon emission responds with some considerable lags to growing transport activities. Only the second leg of transport services (% of commercial imports) is statistically significant at the 5% level. In both models, real GDP per capita has positive effects on carbon emission. In Model I, the short-run impact coefficient (0.662) implies that for every 1% increase in real GDP per capita, carbon emission increases on average by 0.662%, whereas in Model II, 1% increase in real GDP per capita results in a 1.637% rise in carbon emission. This result implies that carbon emission is more associated with transport activities in the import sector than in the export sector. Both coefficients are statistically significant at the 10% level. This follows the a priori expectation that increasing economic activities drive up fuel consumption with the attendant higher carbon emission arising from greater industrial activities. The intensity of energy consumption has overall positive effects on carbon emission in both models, as the associated impact coefficients on the energy use variable take opposing signs across periods in both cases. Since the short-run impact coefficients of energy use in the current and previous periods for both models are statistically significant at 1% to 5% level of significance, it can be concluded that carbon emission responds instantaneously though positively to changes in energy use in the current period and with lags though negatively to changes in energy use in the previous period, thereby yielding an overall positive impact over the short-term period. This, therefore, indicates that increasing energy use in terms of fuel consumption for domestic and industrial purposes leads to increasing carbon emission. The short-run impact of energy use is even more significant when transport activity in the import sector is controlled for Model I than in Model II, where transport activity in the export sector is controlled.

Moreover, trade openness in both models, though they having opposing effects on carbon emissions has no statistically significant impact coefficients at the 10% level. Considering the role of economic growth in carbon emission through the transport services in the export sector (Model I) and transport services in the import sector (Model II), it can be observed that a negative contribution exists in both cases. There is a possibility that the more modernized and technologically advanced a country is (that is, as the scope of economic activities expands), the more it switches to energy-saving means of transportation, with the attendant reduction in the rate of carbon emission. However, the interactive term's impact coefficient involving real GDP per capita and transport activity in the export sector in Model I (that is, -0.015) is statistically significant at the 10% level. However, the interactive term involving real GDP per capita and transport activity in the import sector in Model II (that is, -0.037) is not statistically significant at the 10% level.

The adjusted coefficients of determination show that approximately 80% (in the model) and 78% (in Model II) of the total variation in carbon emission is explained by transport services, real GDP per capita, energy use, and trade openness having accounted for the number of degrees of freedom. The F-statistics in both models (22.903 in Model I and 14.123 in Model II) indicate that the partial slope coefficients on the variables in the two models are jointly significant at a 1% level of significance since the associated probability values are less than 0.01 (that is, $p < 0.01$). Lastly, the result of post-estimation tests shows the absence of specification error due to nonlinearity of the models, serial correlation in the residuals and non-equal residual variance in both models since the probabilities values associated with each of Ramsey RESET linearity test, Breusch-Godfrey serial correlation test and Breusch-Pagan-Godfrey heteroscedasticity test, respectively, are greater than 0.1 (that is, $p > 0.1$).

Table 5: ARDL/Short-run Estimates of Determinants of Environmental degradation

Dependent variable	LCO_{2t}	
	Model I	Model II
LCO_{2t-1}	0.682***(0.150)	0.677***(0.155)
TR_X_t	0.191*(0.094)	
TR_M_t		0.449(0.267)
TR_M_{t-1}		-0.002(0.006)
TR_M_{t-2}		-0.008**(0.004)
$LRPCI_t$	0.662*(0.343)	1.637*(0.908)
$LEGY_t$	3.954***(1.083)	3.508**(1.362)
$LEGY_{t-1}$	-2.555***(0.834)	-3.124***(1.040)
TOP_t	0.001(0.002)	-0.005(0.003)
$LRPCI_t * TR\_X_t$	-0.015*(0.007)	
$LRPCI_t * TR\_M_t$		-0.037(0.022)
C	-13.936*(7.578)	-18.319(12.395)
Adjusted R^2	0.806	0.782
F-stat	22.903[0.000]	14.123[0.000]
Ramsey RESET linearity test	0.751[0.459]	1.129[0.270]
Breusch-Godfrey serial correlation LM test	1.467[0.248]	0.072[0.931]
Breusch-Pagan-Godfrey heteroscedasticity test	0.484[0.838]	1.112[0.391]

Note: ***, **, * indicate the statistical significance of coefficients at 1%, 5% and 10%, respectively; the values in parentheses and block brackets are, respectively, the standard errors and the probabilities. Model I captures transport services (% of commercial exports) while Model II captures transport services (% of commercial imports).

Source: Authors' Computation

4.5 The Granger Causality/Short-run Causality Result

Table 6 presents the Granger causality test result, also called the short-run causality, as the first differences of all variables are utilized since all the variables are only stationary in their first differences. It can be observed that there is a unidirectional causality running from carbon emission to per capita real GDP (a measure of increasing economic activities or economic growth) at a 10% level of significance since the p-value is less than 0.1. Similarly, real GDP per capita is found to Granger-cause the share of transport services in commercial exports at 10% level of significance since the p-value is less than 0.1. However, there is no causality between carbon emission and none of the transport services measures at a 10% level of significance since the p-value is greater than 0.1.

Table 6: Result of Granger Causality Test

Null Hypothesis	Obs.	F-statistic	Prob.	Remarks
$\Delta LRPCI$ does not Granger-cause ΔLCO_2	32	1.377	0.273	No causality
ΔLCO_2 does not Granger-cause $\Delta LRPCI$		2.376	0.069*	Unidirectional causality
ΔTR_X does not Granger-cause ΔLCO_2	32	0.972	0.471	No causality
ΔLCO_2 does not Granger-cause ΔTR_X		1.078	0.410	No causality
ΔTR_M does not Granger-cause ΔLCO_2	32	0.858	0.553	No causality
ΔLCO_2 does not Granger-cause ΔTR_M		1.228	0.363	No causality
$\Delta LRPCI$ does not Granger-cause ΔTR_X	32	2.317	0.076*	Unidirectional causality
ΔTR_X does not Granger-cause $\Delta LRPCI$		0.319	0.919	No causality
$\Delta LRPCI$ does not Granger-cause ΔTR_M	32	1.115	0.413	No causality
ΔTR_M does not Granger-cause $\Delta LRPCI$		0.587	0.734	No causality

Note: * implies the rejection of the null hypothesis of no causality at 10% level of significance.

Source: Authors' Computation

5. Concluding Remarks

This study investigated the direct and indirect impacts of economic growth and transport services on environmental degradation in Nigeria over the period of 1977 to 2015. The study found a positive relationship between economic growth (measured by real GDP per capita and environmental degradation (measured in terms of carbon emission). Similar studies in the past that have established similar findings include Chandran and Tang (2013), Muftau et al. (2014), Mesagan (2016), Wang et al. (2016), and Xie et al. (2017). A positive relationship was also discovered between energy consumption and carbon emission, which parallels the findings of Mohiuddin et al. (2016). Similarly, this study established a positive relationship between transport and carbon emission, thereby lending empirical support to the previous findings of Chandran and Tang (2013) Wang et al. (2016), Danish and Baloch (2017), Liang et al. (2017), Mbarek and Zghidi (2017), Nerves et al. (2017), and Saidi and Hammami (2017). Moreover, this study contrasts with the findings of Misra (2017) that a long-run relationship exists between economic growth and carbon emission.

Considering the role of economic growth in carbon emission through the transport services in the export sector and import sector sectors, it can be observed that a negative contribution exists in both cases over the short term. However, the interactive effects of the two variables are only statistically significant in the case of transport services in the export sector only. Similarly, our result differs with the findings of Kulionis (2013) that no causality exists between carbon emission and growth. Specifically, our study established a unidirectional causality running from carbon emission to economic growth through the Granger causality test. Also, there was a unidirectional causality running from real GDP per capita to transport services in the export sector. This result reinforces the fact that the indirect impact of economic growth on carbon emission significantly works through the transport services in the export sector channel.

Based on the key findings established in this study, policy recommendations would include the formalisation and regulation of activities that contribute significantly to environmental degradation, the implementation of investment and environmentally friendly policy measures, as well as, the promotion of the use of more energy-efficient products by households, business firms and the government, and the introduction of reviewable policies that ensure effective land use. The realization of the Sustainable Development Goals (SDGs) would remain on hold as long as Nigeria fails to prioritize environmental quality on her path to achieving substantial economic progress. While it is non-contestable that a certain level of pollution – in whatever form, be it air pollution through carbon emission and mineral extraction, as well as, oil spillage which entirely causes water pollution is compatible with some amount of economic progress and prosperity, efforts should be geared towards making compensations, continually, to victims who have had their sources of living and livelihood eroded by oil spillage particularly, in the oil-producing regions of Nigeria The Nigerian government has the herculean task of supporting a manufacturing model that is eco-friendly, considering successful case studies globally. To this end, further studies are encouraged in the specific area of determining the optimal level of environmental pollution that is compatible with high economic growth in Nigeria and globally.

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APPENDIX: Data Summary

Year	Carbon Emission (kt)	Transport services (% of exports)	Transport services (% of imports)	Real GDP per capita (₦)	Trade (% of GDP)	Energy use (kg)
1977	50567.93	43.28859	40.11713	306647.6	47.39527	636.2368
1978	48294.39	60.12567	48.65252	280307.2	43.31484	645.8924
1979	70289.06	74.53226	37.79653	290461.2	43.8784	653.1639
1980	68154.86	80.89286	33.70242	294148	48.57131	665.1001
1981	65958.33	59.14336	45.299	248688.1	48.29332	676.3869
1982	65602.63	61.84211	43.7923	239747.2	37.7485	691.7809
1983	59929.78	60.92784	46.49189	221939.8	27.03717	693.5561
1984	69625.33	59.18675	45.51931	212022.2	23.60888	677.7652
1985	69893.02	73.97163	44.7112	223857.4	25.90006	682.8194
1986	73505.02	27.12984	38.93105	199011.9	23.71676	671.499
1987	59343.06	16.91111	41.08826	173011.9	41.64666	676.8561
1988	70747.43	36.30303	53.20724	181230	35.31198	678.8559
1989	42441.86	2.878937	43.68723	187975.1	60.39176	684.4483
1990	39196.56	3.856043	33.63058	206575.1	53.03022	697.1921
1991	42273.18	11.25681	45.19334	200138.6	64.8766	712.2482
1992	46614.9	14.59544	52.97629	196002.2	61.03097	721.9704
1993	45137.1	17.175	31.81481	195153.1	58.10985	715.4378
1994	35199.53	13.63079	25.29636	192079.8	42.30887	680.7101
1995	35841.26	16.40429	22.44111	186781	59.76783	682.2696
1996	39665.94	10.42017	9.998392	191288.7	57.69099	693.7783
1997	42328.18	11.54923	15.85573	191816.4	76.85999	699.6507
1998	37869.11	12.83536	17.3649	192178.7	66.17325	687.1179
1999	40285.66	12.03237	19.84588	188330.6	55.84639	694.1713
2000	76057.25	12.03001	19.84045	193442.4	71.38053	703.2447
2001	85734.46	12.02969	19.84045	196966.4	81.81285	720.0472
2002	93677.18	12.02999	19.84041	199331.7	63.38364	724.6113
2003	101616.2	10.40499	22.45994	214460.7	75.2189	746.6122
2004	104304.1	20.16828	0	279563.7	48.44813	748.3413
2005	106068	93.35171	44.10792	281813.2	50.74836	757.9587
2006	98891.66	88.82308	27.36251	297095.3	64.60931	744.5452
2007	95055.97	75.58768	32.156	309138.7	64.46291	750.7831
2008	96148.74	65.94274	30.60127	319934.3	64.97297	752.8598
2009	76735.64	62.41181	37.07634	333135.4	61.80285	721.4534
2010	91517.32	75.20162	42.80977	349791.6	42.65138	755.9892
2011	95694.03	68.60197	35.9234	357204.1	52.7941	778.4994
2012	98502.95	67.44708	43.44788	362648.1	44.38014	798.3031
2013	98136.25	57.35984	42.54531	372130	31.04886	779.8515
2014	96280.75	51.37027	37.88696	385227.6	30.88519	763.3914
2015	96026.26	67.63224	42.45132	385142	21.12435	775.2069