The Effects of Manufacturing Sector Output on Environmental Sustainability in Nigeria from 1990 to 2019

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ABSTRACT: *The study examined the effects of manufacturing sector output on environmental sustainability in Nigeria from 1990 to 2019. The variables used in the study are CO_2 emissions as the dependent variable, and manufacturing sector output as the independent variable, with foreign direct investment, electricity production and population density applied as control variables. Co-integration tests indicated the presence of a long-run relationship among the variables of the study. The study employed the Autoregressive Distributed Lag Model (ARDL) for regression analysis. The result of the regression analysis indicates that the second lagged period of CO2 emissions has a negative impact on CO_2 emissions in the current period. Also, manufacturing output has an insignificant effect on the rate of carbon dioxide emissions in Nigeria, both in the first and second lagged periods. However, electricity production has a significant effect on CO_2 emissions in Nigeria. In addition, among the control variables of the study (FDI, PPD and EPD), foreign direct investment exhibits an insignificant effect on environmental sustainability in Nigeria. The study recommends that the government institutes and empowers environmental regulatory agencies that will help check environmentally harmful practices by manufacturing firms and industrial areas in the country.*

KEYWORDS: CO_2 emissions, manufacturing sector output, foreign direct investment, electricity production, population density

INTRODUCTION

Background of the Study

The growing rate of environmental debasement occurring around the world, particularly in Nigeria, has raised serious concerns about environmental sustainability (Adeboyejo and Ogunkan, 2013; Ndubusi-Okolo, 2020). The emerging environmental sustainability questions have produced different perspectives on the preservation of the environment and how to make it sustainable (Adeboyejo and Ogunkan, 2013). However, the dominant perspective suggests that environmental sustainability is contingent upon the effective management of environmental and natural resources. In developing countries like Nigeria, environmental sustainability questions and issues are rising due to these countries pursuing industrialization

and improvements in their manufacturing systems. Whether an increase in their manufacturing activities affects environmental sustainability concerns is what motivated this study.

The manufacturing sector is a vibrant sector that spurs growth in every other sector of the economy. For instance, the creation of a manufacturing firm in a particular environment increases demand for raw materials, labour, infrastructural facilities, etc., within the area. In Nigeria's setting, the efforts towards spurring industrialization by increasing the output of manufacturing firms have proved abortive. The output of the manufacturing sector and its contribution to GDP remains quite insignificant compared to what it ought to be. The reason behind the still shaky nature of the manufacturing sector in Nigeria can be linked to the variations of economic wide variables over time (Egbunike & Okerekeoti, 2018). The irregular nature of business activities in the country around the '70s and '80s necessitated the need for economic reforms both in policy and institutions. This erratic trend was caused by substantial windfall revenues gained from increases in oil prices and the subsequent fall in oil prices.

The manufacturing sector transforms raw materials into finished and intermediate products for local consumption and export. The absence of a functional manufacturing sector would lead to over-dependence on the importation of foreign goods which constitutes a leakage in the economy. The manufacturing sector, therefore, is expected to potentially achieve import substitution of foreign consumer goods and consumer durables (Chete, Adeoti, Adeyinka, & Ogundele, 2016). Manufacturing for export creates employment within the domestic economy as well as enhances value addition to primary products for export. The combined effects of a viable manufacturing sector invariably result in a favourable balance of trade (BOT). Globalization, therefore, is a process that transcends national borders, combines national economies, cultures, technologies and governance, and produces complex relationships of interdependence (Gygli, Haelg, Potrafke, & Sturm, 2018). These and many more are the benefits to be derived from vamping up the manufacturing sector of a country. However, there are always two sides to a coin.

In the face of growing attempts at promoting industrialization and manufacturing in Nigeria, it comes at a cost. A close look at some of the most developed countries of the world, that can boast of industrialization, shows that they are the highest producers of chlorofluorocarbons that harm the environment. Nigeria is a giant of Africa endowed with human, material and natural resources. Despite the huge natural and human resource base, the Nigerian potential for environmental sustainability and sustainable development remains unfulfilled and its future is being hampered by environmental degradation and deteriorating economic conditions. Environmental degradation signifies damage inflicted on the biosphere as a whole owing to precarious and nefarious activities of human elements. This transpires when nature's resources are being consumed faster than nature can replenish them, when pollution results in irreparable damage inflicted on the environment, or when human beings destroy the ecosystem in the process of development, (Ugochukwu, Ertel, & Schmidt, 2008).

Environmental sustainability is an issue that deserves a lot of traction due to its importance to everything else. Energy-efficient and environmentally friendly technologies that reduce

emissions from electricity generation and transport, build compactly and use renewable energy sources such as wind, solar, geothermal, biomass, hydro or biomass energy. Greenhouse gases (GHG) contribute primarily to global warming because they capture heat in the atmosphere. Of all the anthropogenic greenhouse gases emitted in 2004, 56 % came from carbon monoxide (CO), which is caused by the use of fossil fuels, while the second part came from CO_2 from deforestation (17 %) (Shahsavari & Akbari, 2018).

Furthermore, with the gradual erosion of the features and resources of the environment, there is a huge risk of an increased lack of these resources and features in the future. Nigeria for instance, which has an abundant supply of fuel resources needs to moderate its activities so that there will be some left in the future for future generations. Manufacturing companies in the country are heavy consumers of fuel and electricity which are derived from fuel combustion. Therefore, it is only logical that their activities will impact environmental sustainability in one way or the other. As already mentioned, environmental sustainability has been a vital policy issue for most governments, and the role of manufacturing sector activities in either increasing or reducing environmental sustainability concerns is worth investigating in the Nigerian context. In light of these problems, the objectives of the study include;

i.   To determine the presence of a long-run relationship between manufacturing sector output and environmental sustainability in Nigeria.
ii.   To examine the effect of manufacturing sector output on environmental sustainability in Nigeria.

REVIEW OF RELATED LITERATURE

Manufacturing Output
Manufacturing is concerned with the addition of utility or value to raw materials. The core function of the manufacturing sector is to add value to goods and transform such into finished goods. According to Nwanne (2015), the manufacturing sector is concerned with the development and processing of raw materials and indulging or giving free rein in either the creation of new commodities or value addition. One major reason for this is the nature of the activities the sector undertakes that have a link across every sector of the economy (Odiora, 2013). According to Adofu, Taiga and Tijani (2015), manufacturing is viewed as the production of merchandise for sale or use through the application of tools, machines, labour, and chemical and biological formulation. It involves both handicrafts of human activities and high tech by transforming unfinished goods into finished goods.

Manufacturing activities are bound to cause pollution in the environment. Manufacturing companies such as pharmaceutical companies, agrochemical companies and others release dangerous chemicals into the environment. Therefore, it is safe to say that a relationship exists between the output of manufacturing firms and environmental sustainability efforts. USEPA (2022) noted sustainable manufacturing is the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources. Sustainable manufacturing also enhances employee, community

and product safety. However, most importantly, it helps in reducing the chances of harm to the natural environment.

Green Manufacturing Technology

Green manufacturing is a modern manufacturing mode that comprehensively considers the environmental impact and resource efficiency. Its goal is to coordinate and optimize the economic benefits and social benefits of enterprises. Green manufacturing involves three parts: manufacturing, environmental impact and resource optimization. The "manufacturing" in green manufacturing refers to the whole life cycle of a product. It is a "big manufacturing" concept and reflects the characteristics of "big manufacturing, big process and interdisciplinary" of modern manufacturing science. Manufacturing concepts related to green manufacturing are generated around environmental problems in the manufacturing process. Green manufacturing is a modern manufacturing mode that fully considers resources and the environment (Lin and Hao, 2020). Green manufacturing is the embodiment of the sustainable development strategy of human society in the modern manufacturing industry.

Environmental Sustainability

Environmental sustainability is the maintenance of natural capital and is a concept apart from, but connected to, both social sustainability and economic sustainability (Goodland, 1995). Sustainable development was defined in the report as "development that meets the needs of the present without jeopardizing future generations' ability to meet their own needs." The traditional conception of the concept of sustainable development was built on an environmentalism framework that prioritizes ecological degradation issues (Nurse 2006). When discussing the connection between environmental sustainability and the broader concept of sustainable development, Morelli (2011) defines environmental sustainability "as a state of balance, resilience, and interconnectedness that enables human society to meet its needs while not exceeding the capacity of its supporting ecosystems to regenerate the services required to meet those needs, nor by our actions reducing biological diversity".

Theoretical Framework

The study is anchored on the stakeholder theory. Stakeholder theory views corporations as part of a social system while focusing on the various stakeholder groups within society (Ratanajongkol, Davey, & Low, 2006). According to Gray, Owen & Adams (1996), stakeholders are identified by companies to ascertain which groups need to be managed to further the interest of the corporation. Stakeholder theory suggests that companies will manage these relationships based on different factors such as the nature of the task environment, the salience of stakeholder groups and the values of decision-makers who determine the shareholder ranking process (Donaldson & Preston, 1995). This study however anchored the stakeholders' theory which states that "those whose relations to the enterprise cannot be completely contracted for, but upon whose cooperation and creativity it depends for its survival and prosperity" (Slinger & Deakin, 1999). Stakeholder theory explains specific corporate actions and activities using a stakeholder-agency approach and is concerned with how relationships with stakeholders are managed by companies in terms of the acknowledgement of the society where they operate.

Empirical Review

Hami, Muhamad and Ebrahim (2015) empirically investigated the impact of sustainable manufacturing practices (SMP) on sustainability performance (SP) among manufacturing firms in Malaysia. Using the PLS-SEM approach, the survey data collected from 150 firms were analyzed. The findings reveal that both underlying variables of SMP, internal SMP and external SMP, have a positive and significant impact on environmental and social sustainability. Surprisingly, while internal SMP proved a significant positive influence on economic sustainability, external SMP failed to do so.

Ezejiofor, John-Akamelu & Chigbo (2016) did a study on the effect of sustainability environmental cost accounting on the financial performance of Nigerian Corporate Organizations. Ex post facto research design and time series data were adopted. Data for the study were collected from annual reports and accounts of the company in Nigeria. Formulated hypotheses were tested using Regression Analysis. Based on the analysis, the study found that environmental costs do not impact positively the revenue of corporate organizations in Nigeria. Again, also environmental cost impact positively on profit generation of corporate organizations in Nigeria.

Obara, Ohaka, Nangih & Odinakachukwu (2017) examined the effect of accounting for waste management expenditure on the profitability of oil and gas companies in Nigeria. The study investigated four operational variables which were: Waste management, Return on Assets, Return on Equity and Operating Profit. The results of the study, tested at 0.05 level of significance, showed that Waste management has a high positive and significant influence on the Return on Assets, Return on Equity and Operating Profit Level of the oil and gas companies in Nigeria.

Moses, Alhassan and Sakara (2017) investigated the effect of industrial activities on the neighbouring surrounding Atonsu-Kaase- Ahinsan industrial/residential area in the Ashanti region of Ghana. The observation method was used to collect data on the level of environmental pollution. The study revealed air and water pollution as the most dominant type of pollution in the area. There is also a close association between the different types of pollutants and certain types of diseases. Water pollution is associated with waterborne diseases and this is evidenced by the common diseases reported by the Atonsu-Agogo health officer. The study also indicates that the industries adopted inadequate measures of solving environmental problems.

Sengupta, Sinha and Dutta (2019) investigated the dynamic relationships between economic and environmental performances in manufacturing industries on a comparative basis in India and China, from 1970 to 2016. Several unit root tests are conducted for all-time series variables before applying the Johansen co-integration test followed by vector auto-regression models to find their causal relationships. Findings show a unidirectional causal linkage between manufacturing production and CO_2 emissions in both countries, the degree of the effect of the manufacturing sector on CO_2 emissions is remarkably higher in China than in India. Manufacturing export is also found as a significant factor in the high level of CO_2 emissions in China.

Afolade and Laseinde (2019) examined the impact of manufacturing sector output on economic growth in Nigeria from 1981 to 2016. The study employed secondary data sourced from the Central Bank of Nigeria statistical bulletin for the Autoregressive Distributed Lag (ARDL) model and the Granger causality techniques. The results showed that MCU has a positive influence on RGDP while LMO also affects RGDP positively. It also showed that GINVEXP has negative effects on RGDP whereas LM2 influenced RGDP positively. Moreover, the result indicated a unidirectional causality between RGDP and MCU, LMO and LM2.

Odebode and Aras (2019) examined the impact of globalization on manufacturing output in Nigeria. Using structural vector autoregressive (SVAR) approaches, from 2010Q1 to 2018Q4, the findings reveal that manufacturing output and transportation responded significantly to the foreign shocks emanating from globalization. The study established that the manufacturing output reacted negatively to exchange rate fluctuations, implying that the exchange rate is very important to the manufacturing sector in Nigeria.

Ezenekwe (2020) examined the effect of environmental factors on firms' productivity in manufacturing firms in Anambra State, Nigeria. The population of the study is one thousand nine hundred and twenty-nine (1929). Descriptive statistics and multiple regression analysis were employed to analyze the data generated. The study found that the economic environment; Technological environment has a significant positive effect on a firm's productivity. While the political environment has a significant negative effect on a firm's productivity.

Kabore and Rivers (2020) analyzed the effects of extreme temperature on manufacturing output using a dataset covering the universe of manufacturing establishments in Canada from 2004 to 2012. Using a panel fixed effects method, the results suggest a nonlinear relationship between outdoor extreme temperature and manufacturing output. Each day where outdoor mean temperatures are below -18◦C or above 24◦C reduces annual manufacturing output by 0.18% and 0.11%, respectively, relative to a day with mean temperature between 12 to 18◦C. In a typical year, extreme temperatures, as measured by the number of days below -18◦C or above 24◦C, reduce annual manufacturing output by 2.2%, with extremely hot temperatures contributing the most to this impact.

Okore (2021) examined the effect of environmental costs on the performance of some selected manufacturing firms in Nigeria from 2011 to 2020. Stationarity of the data was tested using the Augmented Dickey-Fuller unit root test statistic and the data were analyzed using the Panel Least Square. The signs and significance of the regression coefficients were relied upon in explaining the nature and influence of the independent variable on the dependent variable to determine both the magnitude and direction of impact. Findings from the study showed that environmental training costs, donations and charitable costs, waste management costs and corporate social responsibility costs had a positive and significant impact on the return on assets of manufacturing firms in Nigeria.

Karedla, Mishra and Patel (2021) examined the impact of economic growth, trade openness and manufacturing on CO_2 emissions in India. The study employed an autoregressive

distributive lag (ARDL) bounds test approach and uses CO2 emissions, trade, manufacturing and GDP per capita to examine the relationship from 1971 to 2016. Results depict that there exists a long-run relationship between CO2 emissions and other variables. Trade openness significantly reduces CO2 emissions, whereas manufacturing and GDP have a significant and positive impact on CO2 in the long run.

Olusegun (2021) examined the determinants and sustainability of manufacturing sector performance in Nigeria from 1994-2019. Error Correction Model (ECM) and Pairwise Granger Causality (PGC) techniques were used for the formulated objective. The Johansen co-integration established a long-run relationship. The ECM corrected the disequilibrium at an annual rate of 77.5%. Also, the real exchange rate, tax rate and trade openness had a direct and significant effect on the manufacturing sector output. While interest rate and money supply were non-significance. The PGC result revealed a bi-directional causality between the real exchange rate and the manufacturing sector and the tax rate and manufacturing sector.

Ahmed, Ali and Kousar (2022) examined the gone thorough impact of industrialization and foreign direct investment on environmental degradation, utilizing panel data from 55 countries of the Asia-Pacific region from 1995 to 2020. It applied an autoregressive distributed lag (ARDL) model. The results showed that FDI, in general, has a significant negative impact on the environment and causes to increase in methane and CO2 emissions. Moreover, industrialization has a positive and significant impact on the environment. However, the size of the impact is moderate. The study also concludes that in the Asia-Pacific region, the environment Kuznets curve (EKC) and pollution heaven (PH) hypothesis are accepted.

Sulaiman, Abdul-Rahim, Samad, Muhammad-Jawad, Abidiin and Shaari (2022) investigated the impact of manufacturing value-added on environmental degradation in India over the 1965-2016 period. The study used an autoregressive and distributed lag (ARDL) model to achieve its objective. Carbon dioxide emission was used to proxy environmental degradation in the model. The estimated result showed that manufacturing value added has a positive impact on environmental degradation in India. It infers that the increasing production in the manufacturing sector is degrading the environment through carbon emissions. This suggests that an increase in the manufacturing sector value added contributes to reducing the quality of the environment in India.

Quadri and Bukola (2022) examined the impact of electricity consumption on manufacturing output in Nigeria from 1980 to 2021. A different diagnostic test was carried out which include descriptive statistics, correlation, unit root test and Autoregressive Distributed Lag. Descriptive statistics were used to examine if the explanatory variables and the dependent variable exhibit time-varying volatility and leptokurtosis characteristics. The ARDL bounds testing procedure revealed that in the long run, labour, capital and electricity consumption are the only variables that determine manufacturing output in Nigeria but in

METHODOLOGY

The study adopted an *ex post facto* (after the facts) research design. Asika (2005) opines that *ex post facto* research is expected to provide a systematic and empirical solution to research problems with historical concern. The research adopted an *ex post facto* design because it made use of data which are already in existence in the CBN Statistical Bulletin of Nigeria, and the World Development Indicators of the World Bank. The study period ranged from 1990 to 2019. Descriptive Statistics, unit root tests and co-integration tests, with autoregressive distributed lag model regression were used as the statistical tool for data analysis.

Model Specification

Multiple regression model was specified as follows:

$$CO_{2t} = \beta_o + \beta_1 MAO_t + \beta_2 FC_t + \beta_3 FDI_t + \beta_4 PP_t + \mathcal{E}_t$$

Where,

CO_2	= Carbon Dioxide Emission
MAO	= Manufacturing Output
FC	= Fuel Consumption
FDI	= Foreign Direct Investment
PP	= Petrol Price
$\mathcal{E}$	= Stochastic disturbance (Error) Term
β_o	= Coefficient to be estimated
$\beta_i - \beta_4$	= Parameters of the independent variables to be estimated

DATA ANALYSIS

Table 4.1 Johansen Co-integration Results

Hypothesized No. of CE	Trace Statistics	0.05% Critical Value
None*	139.687	69.8189
At Most 1*	69.6314	47.8561
At Most 2*	32.7704	29.7971
At Most 3	10.1040	15.4947
At Most 4	0.02063	3.8415

Source: Eviews 10.0 Output

From the Table, it is evident there exists a long-run relationship since three of the trace statistics are greater than the 0.05 critical value. The co-integrating rank is two (i.e., the number of variables of study minus the number of co-integrating vectors: 5 – 3 = 2). Thus, at a 0.05 level of significance, we reject the null hypothesis and conclude that there is a co-integration among the variables in the model. This suggests the long-run relationship between manufacturing sector output and environmental sustainability in Nigeria.

Regression Results (Autoregressive Distributed Lag Model)

After the application of the autoregressive distributed lag mode (ARDL) estimation method on the model earlier suggested in section three, the following results shown in the table below were obtained.

Table 4.1.2 ARDL Estimation Result [Dependent Variable: CO_2 Emission]

Variable	Coefficient	Standard Error	t-Stat	p-Value
CO2(-1)	0.186730	0.195966	0.952868	0.3558
CO2(-2)	-0.379383	0.177482	-2.137582	0.0494
LMAO	0.083298	0.149929	0.555580	0.5867
LMAO(-1)	0.230456	0.243032	0.948254	0.3580
LMAO(-2)	-0.264662	0.150900	-1.753885	0.0999
LFDI	-0.022325	0.022143	-1.008206	0.3293
LFDI(-1)	-0.027667	0.023770	-1.163913	0.2626
LFDI(-2)	-0.029856	0.027631	-1.080509	0.2970
PPD	-0.867073	1.214367	-0.714012	0.4862
PPD(-1)	2.206170	2.291497	0.962764	0.3509
PPD(-2)	-1.351840	1.099482	-1.229524	0.2378
EPD	-0.013709	0.004657	-2.943843	0.0101
C	2.218207	1.877020	1.181770	0.2557
$R^2 = 0.93$, Adjusted $R^2 = 0.88$, F-Stat = 18.09170, Prob(F-stat) = 0.000001, D.W. Stat. = 2.25				

Source: Computed by Researcher Using Eviews 10.0 Statistical Software

Test of Hypotheses

The hypotheses were tested using the following decision rule: According to Gujarati and Porter (2009), the decision rule involves accepting the alternate hypothesis (H_1) if the sign of the coefficient is either positive or negative, the modulus of the t-Statistic > 2.0, and the P-value of the t-Statistic < 0.05. Otherwise, accept H_0 and reject H_1.

Hypothesis One H_0: Manufacturing output has no significant effect on environmental sustainability in Nigeria.

From the regression analysis result in the table above, the calculated p-value for LMAO is 0.5867, 0.3580 and 0.0999 respectively, for the current period, first and second lagged periods, which is greater than the alpha value of 0.05. It falls in the acceptance region; hence, we do not reject the null hypothesis (H_0). This means that manufacturing output has an insignificant and negative impact on carbon dioxide emissions in the current year, which is a proxy for environmental sustainability in Nigeria.

DISCUSSION OF RESULTS

The result of the regression analysis indicates that the second lagged period of CO2 emissions has a negative impact on CO_2 emissions in the current period. Also, manufacturing sector output has t-statistics with a value (-0.073150 < 2) and the probability of the t-statistic (0.9423 > 0.05) shows that manufacturing output has an insignificant effect on the rate of carbon dioxide emissions in Nigeria, both in the first and second lagged periods. However, electricity production has a significant effect on CO_2 emissions in Nigeria, with t-statistics (-2.94 > 2) and the probability of the t-Statistic (0.0.0101 > 0.05) shows that electricity production has a significant effect on the CO_2 emissions in Nigeria in the current period. In addition, among the control variables of the study (FDI, PPD and EPD), foreign direct investment exhibits an insignificant effect on environmental sustainability in Nigeria. In the same way, population density showed negative but insignificant effects on environmental sustainability.

RECOMMENDATIONS AND CONCLUSIONS

The study evaluated the effect of manufacturing sector output on environmental sustainability in Nigeria. The period of the study ranged from 1990 to 2019, given the availability of the data for the study. The variables used were manufacturing sector output, which is the key dependent variable, CO_2 emissions which represent environmental sustainability levels in Nigeria, then foreign direct investment, electricity production and population density were used as control variables. Then, the method of the Autoregressive Distributed Lagged Model was employed in investigating this purported impact of the independent variables on the dependent variable, with the Johansen co-integration test used to check for the presence of a long-run relationship among the variables.

Furthermore, the findings of the study show that these variables employed in the study, both the independent variable and the control variables all negatively impact environmental sustainability in Nigeria. However, manufacturing output was found to have a negative and insignificant effect on environmental sustainability in Nigeria. Then, foreign direct was found to have a negative and insignificant effect on environmental sustainability, while population density and electricity production were also found to have insignificant negative effects on environmental sustainability.

The implications of the studies indicate that while manufacturing output has a negative effect on environmental sustainability levels in Nigeria, the effect is a trivial and insignificant one. However, electricity production has a significant effect, which could be derived from the fact that Nigeria's source of electricity is heavily reliant on fuel combustion processes. Therefore, the study recommends that the government institutes and empowers environmental regulatory agencies that will help check environmentally harmful practices by manufacturing firms and industrial areas in the country. Also, the government should look into other renewable sources of energy that will cause less harm to the environment.

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