ENVIRONMENTAL QUALITY AND MANUFACTURING SECTOR OUTPUT IN NIGERIA

Oto-obong Friday Ekpe[1], Aishatu Ogiri Ibrahim[2], and Christiana Ihotu Oduh[3]

[1] *Université Cheikh Anta Diop, Dakar, Senegal*

[2] *Department of Economics, Federal University of Lafia, Nasarawa State, Nigeria*

ABSTRACT

This study examines the relationship between environmental quality and manufacturing sector output in Nigeria, focussing on the moderating role of government policy on ecological sustainability. Using annual data from 1990 to 2023, the analysis employed Johansen cointegration tests, Vector Error Correction Models (VECM), and Autoregressive Distributive Lag (ARDL) with moderation analysis. The Johansen cointegration results indicate no long-run equilibrium relationship between ecological footprint and manufacturing value added, suggesting that environmental quality does not consistently influence manufacturing performance over time. However, short-run estimates reveal a significant negative effect of environmental degradation on manufacturing output, while government policy exerts a positive impact. Moderation analysis further shows that government policy partially moderates the relationship, highlighting the potential of institutional interventions to buffer the effects of environmental pressures. These findings imply that short-term environmental shocks can disrupt manufacturing performance, emphasizing the need for timely interventions. Policy recommendations include strengthening environmental regulation enforcement, incentivizing cleaner production technologies, integrating environmental objectives into industrial policy, and institutionalizing periodic monitoring of manufacturing sub-sectors.

Keywords: Environmental quality, Manufacturing sector output, Government policy, Ecological footprint, Nigeria.

JEL classification: Q53, O14, L60, H11, C32

1. Introduction

A nation's industrialization and growth process are significantly influenced by the manufacturing sector, as it provides the productive base for value addition, employment generation, technological advancement, and structural transformation. It presents unique opportunities for capital accumulation, fosters economies of scale through technological advancement and strong inter-industry linkages, exhibits higher productivity relative to other sectors, and has greater potential for employment generation (Abdulrahman & Ajayi, 2022).

The manufacturing sector contributes to a decrease in income disparities and poverty by promoting productivity and sustained economic growth (Ogunjinmi, 2022). This industry sector includes the food and beverage, textile, chemical, and pharmaceutical sectors. In recent times, Nigeria's manufacturing sector has significantly increased the GDP of the nation. In 2019, it accounted for 11.52% of Nigeria's GDP; in 2020, it accounted for 12.67%; in 2021, it accounted for 14.61% of GDP; in 2022, it declined to 13.59%; and in 2023, it accounted for 15.36 % (CBN, 2023**)**. Manufacturing employs millions of Nigerians, making it a major source of employment. Additionally, it contributes significantly to economic diversification, reduces the country's reliance on oil revenues, and promotes economic stability (African Development Bank, 2021).

Nigeria's manufacturing growth, as shown in Figure 1 in the Appendices, has been highly volatile, with significant contractions in the 1980s and a strong rebound in 2019-2021. A detailed year-by-year breakdown is also provided in Table 1 in the Appendices. The trend, as illustrated, shows that manufacturing value-added growth (%MVAG) in Nigeria between 1981 and 2023 demonstrated a highly volatile pattern characterized by alternating periods of contraction and expansion. The early 1980s (1981-1983) witnessed severe decline averaging -16.9%, reflecting the adverse effects of post-oil-boom instability, import dependence, and a weak industrial policy. A brief recovery in 1984, with a growth of 5.2%, was followed by another contraction in 1985 (-9.2%), underscoring the sector's structural fragility. Throughout the late 1980s and 1990s, manufacturing growth fluctuated between negative and low single digits, revealing stagnation associated with the Structural Adjustment Programme, limited industrial financing, and infrastructural deficits. From the early 2000s, the sector began a gradual resurgence, as the percentage of

manufacturing value added growth (%MVAG) rose from 3.76% in 1999 to 12.7% in 2006, supported by modest policy reforms and renewed private-sector activity.

A peak of 17.8% in 2010 marked a short period of expansion, after which growth slowed, dipping to -4.61% in 2014 due to macroeconomic shocks and declining oil revenues. A sharp rebound occurred in 2018, with a remarkable 26.89% increase, showing the positive impact of renewed industrial policy and investment drive. However, from 2019 to 2022, the sector experienced mixed outcomes, alternating between moderate growth and mild contractions, before recovering to 15.36% in 2023. Overall, Figure 1 underscores the cyclical nature of Nigeria's manufacturing performance, which remains highly sensitive to macroeconomic policies, industrial financing, and infrastructure quality. The persistent fluctuations highlight the urgent need for stable industrial policies, improved power supply, and technology-driven strategies to sustain long-term growth in the manufacturing sector.

Although Nigeria's manufacturing sector contributes significantly to economic growth. its performance is constrained by inadequate and poorly maintained infrastructure, particularly in the areas of power supply and transportation networks (Onye et al., 2023). As industries increasingly rely on alternative energy sources like generators, the unpredictable power supply continues to be a major bottleneck that raises production costs (World Bank, 2020). Productivity is further impacted by the inefficient movement of commodities and raw materials caused by the poor condition of roads and transportation networks. Problems with regulations and policies also seriously impede the expansion of the industry. Manufacturers may experience uncertainty and higher compliance costs due to the intricate and sometimes uneven regulatory structure. Furthermore, the problems with governmental inefficiency and corruption might impede corporate operations and deter investment (Nwokoro & Chima, 2018). Another major problem is access to financing, particularly for small and medium-sized businesses (SMEs), who find it difficult to get capital for growth and technology improvement (International Finance Corporation, 2019).

The manufacturing sector has been further affected by environmental conditions and quality due to rising pollution levels, deforestation, and insufficient waste management from manufacturing industries. Nigeria's

environmental quality has deteriorated significantly in recent years (Nadabo, 2023). In addition to posing serious health hazards to the populace, these environmental issues have an impact on the nation's economic operations, notably in the industrial sector. The manufacturing industry, one of the key engines of Nigeria's economy, both impacts and is impacted by the status of the environment. It is important to comprehend the complex correlation that exists between manufacturing efficiency and environmental quality to advance environmental sustainability and economic expansion in Nigeria (Mesagan & Nwachukwu, 2018). Numerous urgent concerns, mostly brought on by the country's fast growth in manufacturing, urbanization, and population increase, characterize Nigeria's natural landscape. In metropolitan areas like Lagos and Kano, significant levels of environmental pollutants, such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM), pose a substantial threat to public health. The main sources of these pollutants are open burning of garbage, vehicle exhaust, and emissions from factories (Alege & Ogundipe, 2013).

The World Bank (2021) estimates that air pollution in Nigeria causes around 94,000 premature deaths yearly due to severe respiratory and cardiovascular disorders. Water contamination is yet another serious environmental issue that impacts manufacturing sector output. Groundwater, lakes, and rivers have been contaminated by inappropriate waste disposal, run-off from agriculture, and industrial effluents. Many water bodies around industrial zones contain dangerous compounds such as organic pollutants and contaminants like heavy metals, which pose serious threats to human health and ecosystem functioning, according to the Nigerian Environmental Study/Action Team (NEST, 2022). The expansion of illicit dumpsites brought about by inadequate waste management infrastructure has further exacerbated soil and water contamination. Nigeria also has serious problems with deforestation and land degradation. According to estimates from the Food and Agriculture Organization (FAO, 2019), there has been a significant loss of forest cover due to the growth of urban areas, logging, and farming operations. Deforestation affects rural lives and agricultural production because it causes soil erosion, disrupts water cycles, and reduces biodiversity.

Environmental conditions have a direct impact on how well Nigeria's manufacturing industry performs. The industry, which encompasses sectors

including cement, textiles, food and beverage, and chemicals, is both a cause and a sufferer of environmental deterioration (Ogbuabor et al., 2020). Deforestation, garbage production, and contamination of the air and water are all greatly influenced by industrial activity. For instance, during the production process, the cement sector releases a significant amount of greenhouse gases (GHGs) and particulate matter into the atmosphere (Dangote Industries Limited, 2021). The performance of production is negatively impacted by environmental deterioration, on the other hand. Inadequate air quality can cause health issues for employees, which lowers output and raises absenteeism. Higher operating expenses might result from water contamination affecting the availability of clean water for manufacturing processes. Deforestation and soil degradation can impede the flow of raw resources needed by several manufacturing sectors, including lumber and agricultural products (Adeoti, 2020).

Several policy actions and efforts have been adopted by the Nigerian government, together with other relevant parties, to address these difficulties, improve the profitability of the manufacturing sector, enhance environmental standards, and encourage environmentally-friendly production methods. For instance, environmental laws and regulations enforced by the National Environmental Standards and Regulations Enforcement Agency (NESREA) have led to increased industry compliance, although resource limitations mean enforcement remains uneven (Afolayan & Aderemi, 2019; NESREA, 2019). Complementing these efforts, the Nigerian Industrial Revolution Plan (NIRP) also plays a key regulatory role by emphasizing the adoption of cleaner technologies and sustainable industrial processes. Under this initiative, industries are encouraged to implement strategies that reduce waste, conserve energy, and cut emissions. Some industrial enterprises have already begun utilizing environmentally-friendly energy sources, such as solar power, to lower their ecological impact and improve operational efficiency (Federal Ministry of Industry, Trade and Investment, 2020).

Previous researchers, such as Afolayan & Aderemi, 2019; Ajide & Oyinlola, 2016; Alege & Ogundipe, 2013; Edame & Okoi, 2015; Mesagan & Nwachukwu, 2018; Ngwakwe, 2008; Ogboani et al., 2023; Ogbuabor et al., 2020, studied the manufacturing sector's impact on economic development in Nigeria, environmental quality and growth performance in Nigeria,

institutional quality and economic performance in Nigeria, while others looked at environmental responsibility and firm performance in Nigeria. No study has examined how stringent environmental regulations and government policies on the environment improve manufacturing output and promote sustainable practices. In view of this, the present study seeks to examine the long-run relationship between environmental quality and manufacturing sector output in Nigeria, and also assess the moderating effects of government policies on environmental quality on the nexus between environmental quality and manufacturing sector output in Nigeria.

1.2 Research hypotheses

The following are the hypotheses that were investigated for this study in their null form:

i. **H_1:** Environmental quality has no long-run relationship with manufacturing sector output in Nigeria
ii. **H_2:** Government policies have no moderating effect on the relationship between environmental quality and manufacturing sector output in Nigeria.

2. Literature Review

2.1 Manufacturing in Nigeria

2.1.1 Definition of Manufacturing

Manufacturing is the process of transferring resources into industrial sectors and creating the total output of a country's manufacturing subsidiaries. It concerns the establishment and growth of enterprises inside a certain nation, area, or place (Szalavetz, 2019). Manufacturing, according to Anyanwu et al. (1997), is the process of enhancing a country's ability to transform inputs and raw materials into completed commodities as well as items for further production or consumption. With the technology available in the nation, manufacturing improves the use of resources such as labour and capital, that are productive inputs, to create capital goods, intermediate products, and non-durable and durable consumer items that may be exported or used for the expansion of production (Ajide & Oyinlola, 2016). Accordingly,

manufacturing could be defined as the process of converting raw materials into (a) consumer products, (b) novel capital products that enable the production of greater quantities of consumer products (including food) with the same employees, and (c) socially-generated capital that, when combined with human resources, offers new services to customers as well as companies (Ekpo, 2005). According to Landesmann and Stöllinger. (2019), manufacturing entails several changes in a nation's economic structure, including an increase in the manufacturing sector's relative importance, a shift in manufacturing output's composition, and adjustments to production methods and suppliers of particular commodities.

2.1.2 *Development Patterns and Production Output*

Several internal and external variables have affected the manufacturing sector's production output in Nigeria. According to data from the National Bureau of Statistics (NBS, 2022), the manufacturing sector contributed approximately 9% to Nigeria's GDP in 2021, indicating a relatively moderate performance when compared to other sectors of the economy. This GDP contribution underscores the strategic importance of the manufacturing sector while also highlighting significant opportunities for productivity enhancement and structural transformation (Sanusi, 2019). Furthermore, the sector recorded an average annual growth rate of about 5% between 2015 and 2023 (Oyelakin, 2024). This is encouraging, but not fast enough to propel the kind of substantial economic change that a country the size and potential of Nigeria needs (World Bank, 2020). This poor rate of expansion can be ascribed to an economic downturn marked by volatile currency rates alongside elevated inflation, as well as deficiencies in infrastructure, notably in the areas of logistics and electricity supply.

2.1.3 *Efficiency and Capacity Utilization*

Capacity utilization, which gauges how well the industry makes use of its installed capacity for productivity, is a crucial sign of industrial success. According to the Manufacturers Association of Nigeria (MAN, 2022), the manufacturing sector's capacity efficiency has averaged 54% in the last several years. The aforementioned statistic suggests a notable underutilization of

existing resources, mainly because of irregular power supply, insufficient infrastructure, and elevated operational expenses (Banjoko et al., 2012). To enhance capacity utilization, these fundamental problems must be resolved. For example, improving power supply dependability can minimize industrial disruptions and cut the price of expensive but widely used alternative forms of energy, like generators powered by diesel (African Development Bank, 2021).

2.1.4 *Competitiveness and Export Outcomes*

Nigeria's industrial sector's ability to compete internationally is essential to the country's entry into international trade. However, because of sophisticated production methods and economies of scale experienced by manufacturers in other nations, imported items are frequently more affordable and of superior quality, posing a serious threat to the industry. Nigeria's exports of manufacturing products, which made up only 6% of its overall exports in 2021, are still very low (NBS, 2022). This low figure illustrates the difficulties in being globally competitive, such as high manufacturing costs, inadequate quality control, and limited market access. According to the International Industrial Forum's 2019 Competitiveness indices, Nigeria ranked 115th in a list of 141 countries, underscoring the need for major advancements in the economy's infrastructure, capacity utilization for innovation, and commercial dynamism (Anthony & Kenechukwu, 2025).

2.1.5 *Utilizing Green Manufacturing Techniques*

Green manufacturing is a modern production method that considers environmental effects and the utilization of resources. Its primary goals are to coordinate and maximize both the commercial and environmental advantages that enterprises may obtain (Ekundayo & Amarachi, 2017). "Green" manufacturing is composed of three elements: production, ecological effects, and optimizing resource utilization. "Manufacturing" in environmentally friendly manufacturing relates to a product's entire life cycle. It is a "big manufacturing" idea that captures the essence of current manufacturing science's "big manufacturing, big process, and interdisciplinary" qualities (Uzoechina et al., 2025). The development of sustainable manufacturing concepts involves addressing environmental challenges that emerge throughout

the creation cycle. Green manufacturing, as defined by Wang and Yang (2021), is a modern manufacturing strategy that considers resources and sustainability. It is an embodiment of contemporary civilization's long-term expansion strategy (Zhou, 2021).

2.2 Environmental quality

Environmental quality refers to the state of the natural environment, including air, water, soil, and ecosystems, as well as its ability to support life and human activity. Clean air and water, robust soils, abundant biodiversity, and the lack of major pollution or environmental deterioration are all indicators of high environmental quality (Convention on Biological Diversity, 2021). It is essential for maintaining ecological equilibrium, economic success, and human health. According to Goodland (1995), the sustainability of the environment is the preservation of inherent wealth. It is distinct from social and economic sustainability yet linked to them both. Development that meets the needs of the present without jeopardizing future generations' ability to meet their own needs" is how the study characterized sustainable development. Ecological deterioration concerns are given priority in the conventional understanding of long-term growth, which is based on environmentalism (Nurse, 2006). Morelli (2011) opined that environmental sustainability is 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.

2.2.1 *Obstacles and Difficulties*

The manufacturing industry faces formidable obstacles. These include:

a. **Inadequate Infrastructure:** One of the key obstacles continues to be the absence of dependable infrastructure, notably in the areas of transportation and power. Energy expenses account for a large percentage of manufacturers' operational costs, which lowers their competitiveness and financial performance (World Bank, 2020).

(b) **Policies and Regulations:** Nigeria's frequently convoluted and erratic regulatory landscape raises the cost of compliance and introduces uncertainty

into business operations. A complex commercial setting is produced by several overlapping rules from various authorities (Nwokoro & Chima, 2018).

(c) **Financial Accessibility:** A major obstacle is the inability to obtain inexpensive finance, particularly for (SMEs). Manufacturers find it challenging to obtain the funds required for development and technical advancements due to financial institutions' strict lending policies and high costs of borrowing (International Finance Corporation, 2019).

(d) **Skilled Personnel Shortage:** The manufacturing sector's capacity to function depends on adequate supply of skilled personnel. Nigeria struggles to find enough skilled labour, which hinders the country's capacity to embrace innovative industrial practices and reduces productivity (Adeoti, 2020).

2.2.2 *Opportunities and Outlook for the Future*

Resolving these identified core issues will determine the industrial sector's prognosis in Nigeria. Nigeria may lower manufacturing costs and improve productivity by investing in infrastructure, especially in transportation and energy conservation (African Development Bank, 2021). A more favourable economic environment for manufacturers can also be achieved by streamlining the regulatory framework and expanding access to capital through creative economic instruments (Federal Ministry of Industry, Trade and Investment, 2020). Innovation in technology and skill improvement are also essential. Productivity and competitiveness may be increased by promoting the use of cutting-edge industrial technology, like automation and intelligence from machines. The workforce can also be prepared to fulfil the growing needs of a modern industrial sector by investing in educational and professional development programmes (Adeoti, 2020).

2.2.3 *Environmental Quality and Manufacturing Sector Output*

Environmental conditions increasingly shape the location choices of manufacturing firms, encouraging movement toward more environmentally-sustainable areas. Across the globe, industrialization is expanding to meet the needs of a growing population, enhance living standards, and address rising pressure on limited ecosystem resources (Banjoko et al., 2014). The water and air we breathe are becoming more contaminated due to industry’s increased use

of explosives and carbon-based fuels. Since the manufacturing sector is negatively impacting the environment, we must focus on the significance of environmental quality today. Industry-related pollution harms not just the environment but also the community at large (Presberger et. al., 2024). These repercussions include ozone depletion, emissions of substances such as carbon dioxide, modifications to the climate, and the greenhouse effect. In addition to the previously stated problems, an excessive number of automobiles and commercial vehicles on the highways also contributes to pollution (Dimnwobi et al., 2021; Mohamed et al., 2025). Particular duties are also detailed for the issues of the manufacturing sector's level of knowledge at the moment, the conservation of the environment industry, and the discrepancy between what is known at the moment and what needs to be understood (Uzoechina et al., 2025).

The industries that create and market environmentally-friendly products and services are referred to as "the safeguarding of the environment industry." Since the deterioration of the environment is currently to blame for a struggling manufacturing sector, the environmental conservation industry's approach has created several significant challenges, including the need to measure and assess the sector (Ekundayo & Amarachi, 2017). On the other hand, this strategy can be seen as distinct from the regulated sectors. It was proposed that the growth of industrial advantages would primarily finance the additional expenses incurred by the ecologically-conscious sector to regulate these companies (Obamen et al., 2021).

The manufacturing sector's output is positively impacted by protecting the environment through industry and legislation. "Where there is a will, there is a way" is a well-known aphorism that holds in this situation (Nadabo, 2023). New production techniques that protect the ecosystem from further deterioration while also increasing productivity will emerge if the government controls environmental standards reforms. Industry possesses the capacity to develop innovative production methods, introduce new product designs, and adopt improved techniques that reduce manufacturing waste. However, establishing a regulatory framework that protects environmental quality while remaining acceptable to businesses remains a critical and highly challenging task for regulatory authorities (Cainelli et al., 2015).

2.2.4 *Policies and Initiatives of the Government*

The effectiveness of government regulations greatly affects the manufacturing sector's performance. By encouraging local content, improving value addition, and drawing foreign direct investment (FDI), the Nigerian Industrial Revolution Plan (NIRP) seeks to increase the sector's GDP contribution (Federal Ministry of Industry, Trade and Investment, 2020). This strategy calls for actions to finance manufacturing, streamline regulatory systems, and enhance infrastructure. To improve manufacturers' access to financing, the Central Bank of Nigeria (CBN) has also launched several intervention programmes, including the Manufacturing Sector Development Fund and the Real Sector Support Facility (RSSF) (CBN, 2022). Lower costs of borrowing and long-term funding are the goals of these programmes, which are meant to encourage investment in the industry (Mohamed et al., 2025).

2.3 Empirical literature

Several empirical studies have examined how economic activities influence environmental quality. For example, Mesagan and Nwachukwu (2018) employed the ARDL bounds testing approach to investigate the determinants of environmental quality in Nigeria, highlighting the role of financial development, income, energy consumption, and trade in environmental outcomes. Empirical results showed that finances, monetary growth, usage of energy, commerce, and urbanization are important factors influencing environmental quality. Additionally, no causal association was found between industrial expansion, investment in infrastructure, and environmental quality, although increasing urbanization and affluence create environmental degradation in a unidirectional manner.

Similarly, the works of Alege and Ogundipe (2013) aimed to investigate the impact of industrial expansion on environmental performance while accounting for the influence of trade openness, density of populations, and institutional quality. The study discovered that the degree of environmental degradation brought on by environmental dumping is increased by feeble institutions and unfettered trade openness. The study demonstrates that higher population densities accelerate environmental mitigation efforts and raise awareness of the need for better environmental conditions. Nevertheless, the

study was unable to identify a plausible tipping point, and as a result, the EKC did not exist in Nigeria.

Also, Egbetokun et al. (2020) studied Nigeria's institutional quality, economic development, and environmental pollution. The study adopted the autoregressive distribution lag technique. The results show that there is an Environmental Kuznets Curve for suspended particulate matters and CO_2, among other things. This suggests that with coordinated efforts, Nigeria may pursue the goal of green growth. Also, the study shows that there was no discernible impact of any environmental contamination measures on economic development. In light of economic expansion, the study advised that the institutional quality of Nigeria be improved in order to reduce degradation of the environment.

Ogbuabor et al. (2020) studied the performance of Nigeria's manufacturing sector and institutional quality. The ARDL method was used to examine the association between the variables. The results show that growth in Nigeria is negatively but not considerably impacted by institutional quality, both overall and by sector. Trade, on the other hand, is shown to hinder growth, whereas starting production growth levels, capital, and labour are identified as key drivers of the nation's growth. The results reveal that Nigeria must enhance the calibre of its political and socioeconomic frameworks in the post-COVID-19 era in order for these institutions to have stronger overall and sector-specific influence on the economic health of the country.

Furthermore, Afolayan and Aderemi (2019) investigated the relationship between environmental quality and healthcare effects in Nigeria using Granger causality and dynamic ordinary least squares (DOLS). The study's findings are as follows: CO2 emissions and the number of deaths have a negative, however insignificant, relationship; however, there is a positive correlation (significant at the 5% level) between the total amount of energy used and mortality rates, suggesting that the amount of power used is inadequate to promote good health and enhance individuals' standard of life. The mortality rate and the burning of fossil fuels are significantly positively correlated. This implies that burning fossil fuels poses a risk to human health and welfare.

Ngwakwe (2013) examined the potential link between corporate success and sustainable business practices. A field survey approach was used to examine a sample of sixty Nigerian manufacturing enterprises. The companies

were divided into two categories: "responsible" and "irresponsible" corporations concerning the environment. The prospective association between company performance and three chosen metrics of business sustainability practices: waste disposal (WD), personnel safety and wellness (PSW), and fostering community growth (CG), which are typical among the thirty "responsible" enterprises was investigated. The results of empirical research show a considerable relationship between company success and the environmentally-conscious procedures of responsible enterprises. Furthermore, there is an inverse relationship between sustainable behaviours and monetary punishments.

On their part, Ogboani et al. (2023) studied how Nigeria's manufacturing sector production affected sustainable development between 1990 and 2019. Regression analysis was performed using the autoregressive distributed lag model (ARDL). The regression analysis outcome shows that the present period's CO2 emissions were negatively impacted by the second delayed period's emissions. Additionally, both in the first and second delayed periods, the rate of greenhouse gases emissions in Nigeria was not significantly impacted by manufacturing production. Nonetheless, Nigeria's CO2 emissions were significantly impacted by the generation of power. Furthermore, out of the three research control variables, FDI, PPD, and EPD, FDI had no impact on Nigeria's ecological sustainability.

However, Ahmed et al. (2022) examined the impacts of industrialization and foreign direct investment on the degradation of the environment using panel data from 55 Asia-Pacific countries from 1995 to 2020. The autoregressive distributed lag model was used. The results show that FDI typically increases CO2 and methane greenhouse gases and harms the ecosystem. Furthermore, industrialization has a positive and substantial impact on nature. However, the influence is only somewhat significant. The study concluded that the Asia-Pacific region recognizes the pollution heaven (PH) and environmental Kuznets curve (EKC) theories.

Similarly, Sulaiman et al. (2022) investigated how India's manufacture of value-added products affected environmental deterioration between 1965 and 2016. To accomplish its goal, the study employed an autoregressive and distributed lag (ARDL) model. In the model, carbon dioxide emissions served as a stand-in for environmental damage. According to the estimated outcome,

value-added manufacturing in India has a favourable effect on environmental deterioration. It suggests that rising industry production is causing carbon emissions to harm the environment. This implies that a rise in the value-added of the industrial sector is a contributing factor to India's declining environmental quality.

Also, Quadri and Bukola (2022) studied how Nigerian industrial production was affected by energy use between 1980 and 2021. A variety of diagnostic tests were performed, including the autoregressive distributed lag, unit root test, correlation, and descriptive statistics. The dependent variable and the explanatory factors were examined for time-varying volatility and leptokurtosis features using descriptive statistical techniques. The results of the ARDL bounds testing procedure showed that the only factors influencing industrial production in Nigeria over the long term are labour, capital, and power consumption.

Olusegun (2021) looked at the factors that affected the manufacturing sector's success in Nigeria between 1994 and 2019. The articulated aim made use of Pairwise Granger Causality (PGC) and the Error Correction Model (ECM). A long-lasting partnership was built by the Johansen co-integration. The imbalance was addressed by the ECM at a 77.5% yearly rate. The output of the manufacturing sector was also directly and significantly impacted by the real exchange rate, the tax rate, and trade openness. However, there was little difference in the money supply as well as the interest rate. The PGC finding demonstrated a bidirectional causal link between the actual rate of exchange and the overall manufacturing industry, as well as between the industrial sector and the rate of taxation.

Nevertheless, Okore (2021) investigated how some Nigerian manufacturing companies performed from 2011 to 2020 with environmental expenses. The stationarity of the data set was evaluated using the modified Dickey-Fuller test, and panel least squares analysis was used to examine the data. How the independent variables affect the dependent and the nature of its impact were explained by the regression coefficients' signs and significance, which were used to calculate the impact's size and direction. The study's conclusions demonstrated the favourable and substantial effects of environmental training expenses, charity contributions, and donations, waste

management expenses, and social responsibility and corporate responsibility expenses on the return on assets of Nigerian manufacturing companies.

Finally, the work of Ezenekwe (2020) investigated how environmental conditions affect the productivity of industrial companies in Nigeria's Anambra State. Nine hundred and twenty-nine people made up the study population (1929). The data was analysed using a combination of multiple regression and descriptive statistics. The study discovered that a firm's profitability is significantly positively impacted by both the technological and economic environments, while a firm's production is significantly impacted negatively by the political landscape.

3. Theoretical Framework and Methodology

3.1 Theoretical framework

This study adopted both Porter's hypothesis and the endogenous growth theory. These theories clarify the connections between the important factors, including government policy, economic growth, Nigeria's manufacturing sector growth, and environmental quality. According to the endogenous growth hypothesis, innovation, technical advancement, and human capital are examples of internal forces that propel economic growth. This theory may be used in the context of this study to comprehend the nexus between Nigeria's manufacturing sector output and environmental quality. Conversely, Porter's hypothesis theory suggests that environmental laws can promote competitiveness and innovation, which will enhance environmental performance and have a positive economic impact. The success of Nigeria's manufacturing sector, and environmental quality may all be examined using this approach. It implies that more competition from manufacturing endeavours may force businesses to embrace greener practices and technology in order to stay competitive. This framework will be useful in assessing the performance of Nigeria's manufacturing sector, taking into account indicators like value-added contribution to GDP, and technological innovation as well as how well environmental laws and policies have promoted sustainable practices in the industry. This connection between Porter’s hypothesis (PH) and the Endogenous Growth Theory demonstrates how the PH operates. This demonstrates even further how strict environmental regulations and government policies on environmental sustainability may

increase productivity of manufacturing output and spark original thought, strengthening organizations' ability to compete (Porter, 1991).

3.2 Methodology

3.2.1 *Nature and Source of Data*

The study examined the period from 1990 to 2023, employing statistical tools such as unit root tests, Johansen cointegration tests, and ARDL with moderation analysis. Data were obtained from the World Bank and the Global Footprint Network (2023).

3.2.2 *Model Specification*

This study employed the Johansen cointegrating testing procedure to examine the cointegrating (long-run) relationship between environmental quality and manufacturing sector performance in Nigeria. The Johansen procedure is based on vector error correction models (VECMs), which explicitly model the long-term equilibrium connections between variables and short-term dynamics. By capturing the long-run relationships, the Johansen procedure offers a more comprehensive analysis of the data. To examine the existence of a long-run relationship between environmental quality and manufacturing sector performance in Nigeria, the model below is specified to achieve Hypothesis 1. The standard form of the VAR model with lag order p is represented in the equation:

$$Y_t = C_o + \sum_{t=1}^{P}(A_i Y_{t-1} + \varepsilon\tau) \quad (1)$$

where: Y_t represents the vector of endogenous variables, C_o is a vector of constants, A_i denotes the matrices of autoregressive coefficients and $\varepsilon\tau$ is a vector of white noise processes.

To ascertain the association between environmental quality and manufacturing sector production in Nigeria, this paper used the vector auto-regression approach conceived by Johansen in 1988 (Johansen and Juselius, 1990). In econometric terms, this may be expressed as follows:

$$\triangle lnMVA_t = \alpha_0 + \sum_{i=0}^{P} \delta i \ \triangle lnMVA_{t-1} + \sum_{k=0}^{P} \beta_k \ \triangle EFP_{t-k} + \sum_{k=0}^{P} \epsilon_k \triangle CAPU_{t-k} + \sum_{l=0}^{P} \gamma_k \triangle GOVP_{t-l} + e_{1t}$$

$$\triangle EFP_t = \alpha_0 + \sum_{i=0}^{P} \delta i \ \triangle EFP_{t-1} + \sum_{k=0}^{P} \beta_k \ \triangle lnMVA_{t-k} + \sum_{k=0}^{P} \epsilon_k \triangle CAPU_{t-k} + \sum_{l=0}^{P} \gamma_k \triangle GOVP_{t-l} + e_{2t}$$

$$\triangle GOVP_t = \alpha_0 + \sum_{i=0}^{P} \delta i \ \triangle GOVP_{t-1} + \sum_{k=0}^{P} \beta_k \ \triangle lnMVA_{t-k} + \sum_{k=0}^{P} \epsilon_k \triangle CAPU_{t-k} + \sum_{l=0}^{P} \gamma_k \triangle EFP_{t-l} + e_{3t}$$

$$\triangle CAPU_t = \alpha_0 + \sum_{i=0}^{P} \delta i \ \triangle CAPU_{t-1} + \sum_{k=0}^{P} \beta_k \ \triangle lnMVA_{t-k} + \sum_{k=0}^{P} \epsilon_k \triangle EFP_{t-k} + \sum_{l=0}^{P} \gamma_k \triangle GOVP_{t-l} + e_{4t}$$

where:

lnMVA = logarithm of manufacturing value added used as a measure for manufacturing sector output,

EFP = ecological footprint used as a measure for environmental quality,

CAPU = capacity utilization,

GOVP = government effectiveness on ecology used as a measure for government policy on environmental sustainability

ξ = error term,

β_0 = coefficient to be estimated as well as $\beta_1 - \beta_4$ *p*arameters of the independent variables to be estimated.

The paper used ARDL with moderation analysis for Hypothesis 2. The aim is to explore how the effect of an independent variable on a dependent variable change, depending on the level of values of a moderating variable. The goal of moderating analysis is to determine whether there are variations in the connection between the independent and dependent variables at various phases of the moderating factors. A common conceptualization of the variable that acts as a moderator is that it affects the direction or intensity of the link between both independent and dependent factors.

The typical moderation process assumed the expression below;

$$\ln MVA_t = \alpha_0 + \alpha_1 EFP_t + \alpha_2 GOVP_t + \alpha_3 (EFP_t * GOVP_t) + e_t \quad (3)$$

where:

MVA	=	Outcome Variable
EFP	=	1st Explanatory Variable
GOVP	=	2nd Explanatory Variable (Moderator)
*EFP*GOVP*	=	Interaction Variable

4. Analysis and Results

4.1 Unit root test

The outcomes of the unit root test for the variables used are shown in Table 1. All of the parameters are stationary at first difference (order 1), according to the results. The results reveal that every variable was integrated in the first order. Therefore, to determine if the variables in the model have a long-term connection, the test for cointegration must be performed.

Table 1: Unit Root Result

Variables	ADF Test (C & T)	Critical Value (5%)	Result
ln*MVA*	-3.965586 (0.0205)	-3.557759	1(1)
EFP	-4.772112 (0.0030)	-3.557759	1(1)
CAPU	-3874091 (0.0252)	-3.557759	1(1)
GOVP	-8.478324 (0.0000)	-3.557759	1(1)

4.1.1 *Optimal Lag Selection*

This study will adopt the lag length specified by the Akaike information criterion (AIC), one lag as the ideal lag order selection for the model.

Table 2: Optimal Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-25.98381	NA	7.66e-05	1.873988	2.057205	1.934720
1	63.58323	151.1444*	7.79e-07*	-2.723952*	-1.807867*	-2.420296*
2	76.49084	18.55469	9.96e-07	-2.530678	-0.881725	-1.984096

4.2 Cointegration test

Having established that all of the parameters are integrated of order one, or I (1), we next ascertain whether the variables are co-integrated or not. The null hypothesis states that there is no cointegrating equation among the variables. The decision to accept or reject the null hypothesis of no cointegration among the variables under study is based on two key criteria. First, the null hypothesis is rejected if the calculated trace statistic exceeds the corresponding critical value. Second, rejection also occurs when the associated probability (p-value) is less than the 5% significance level.

In Table 3, the trace and max-eigenvalue results reveal that the null hypothesis specifying that all of the variables under investigation are not cointegrated can be accepted, while the alternative hypothesis identifying the presence of cointegration among the variables can be rejected. This is because the trace statistics values (46.71958 and 17.01482) are less than the corresponding critical values (54.07904 and 35.19275). Similarly, the max-eigen statistics value (10.85655) is less than the critical value (22.29962). Although the max-eigen statistics value of 29.70476 is greater than the critical value of 28.58808, the probability value of 0.0359 is significant at 5%. Hence, the result of the test shows the existence of no long-run relationship between environmental quality and manufacturing sector performance in Nigeria.

Table 3: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.** Critical Value
None	0.604765	46.71958	54.07904	0.1920
At most 1	0.287708	17.01482	35.19275	0.8856
At most 2	0.132170	6.158261	20.26184	0.9430
At most 3	0.049423	1.621946	9.164546	0.8511

Trace test indicates no cointegration at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigen Value)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.604765	29.70476	28.58808	0.0359
At most 1	0.287708	10.85655	22.29962	0.7629
At most 2	0.132170	4.536315	15.89210	0.9248
At most 3	0.049423	1.621946	9.164546	0.8511

Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level

Since there is no long-run relationship between environmental quality and manufacturing sector performance in Nigeria, it is necessary to present the short-run estimate of the result (see Table 4). The first row of values represents the coefficients of the speed of adjustment. The second row's standard error is represented by the figure in parentheses, while the third row's T-statistics are in brackets. From the table, the short-run result signifies that 8.5% of the disequilibrium in the short run is corrected each year, when the system drifts away from its long-run path in the short run. The short-run coefficients show that environmental quality has a negative and significant relationship with manufacturing sector performance in the short run, with the t-statistic figure of 4.6842 greater than 1.96. Similarly, government policy has a positive and significant impact on the manufacturing sector's performance. However, capacity utilization was not significant, though it has a positive relationship with manufacturing sector performance in Nigeria.

Table 4: Short-run Result

D(LNMVA)	D(EFP)	D(CAPU)	D(GOVP)
0.085788	-0.364994	1.666962	1.022532
(0.08865)	(0.07792)	(8.04783)	(0.38130)
[0.9677]	[-4.6842]	[0.2071]	[2.6817]

Source: Authors' computation.

The Baron and Kenny (1986) approach was used to assess the moderating influence of government policy on the ecological sustainability of the relationship between environmental quality and manufacturing sector output in Nigeria. Baron and Kenny (1986) asserted that "moderation can only be substantiated if the relationship between the intersection of the pathways of the variable being tested and the moderator variable is significant." According to Baron and Kenny (1986), to determine whether moderation has taken place, one might apply one of three decision rules. The first of these rules states that moderation is taking place if there is a significant change in R^2 following the addition of the interaction term, along with a significant effect from the new interaction time. The second decision rule states that complete moderation has taken place if the interaction term is included and neither the predictor nor the moderator remains significant. The third decision criterion states that moderation has taken place provided the main effects remain significant and the predictor and moderator are significant when the interaction term is included.

Based on the foregoing, the coefficient of determination (R^2) increased markedly across the estimation steps. Specifically, R^2 rose from 0.004397 in the first step to 0.635142 in the second step, indicating a substantial improvement in explanatory power, with the inclusion of the predictor (GOVP) and the moderator (EFP). When the interaction term was introduced, R^2 slightly adjusted to 0.621031, suggesting a marginal change in model fit. Furthermore, the inclusion of the interaction term led to a significant change in the F-statistic, with values of 52.43969 for the model with the predictor and moderator and 17.40794 for the model including the interaction term, confirming that the interaction effect contributed meaningfully to the overall model. Going by the outcome of decision rule one, which shows a significant change in R^2 as well as the new interaction term, the overall results conclusion follows that

moderation is occurring and that government policy on environmental sustainability partially moderates the nexus between environmental quality and manufacturing sector output in Nigeria.

Table 5: Estimated Moderation Analysis Result

Variable	Coefficient	Std. Error	T-statistic	Prob.
C	13.07197	0.658268	19.85812	0.0000
EFP	-0.511031	0.678240	-0.753467	0.4570
GOVP	-0.574385	0.643181	-0.893037	0.3789
EFP*GOVP	0.506519	0.664705	0.762022	0.4520
R-squared	0.635142			
Adjusted R-squared	0.598656			
F-statistic	17.40794			
Durbin-Watson stat	0.340750			

Source: Authors' computation.

4.3 Test of hypotheses

The following decision rule was applied for testing the hypotheses: The decision rule, as per Gujarati and Porter (2009), is to accept the alternative hypothesis (H_1) if the coefficient's sign is positive or negative, the t-statistic's modulus is greater than 2.0, and the t-statistic's P-value is less than 0.05. If not, acknowledge H_0 and disregard H_1.

Hypothesis One H_0: Environmental quality has no long-run relationship with manufacturing sector output in Nigeria.

The Johansen cointegration results presented in Table 3 indicate that both the trace and maximum-eigenvalue statistics fail to reject the null hypothesis of no cointegration among the variables under investigation. Consequently, the alternative hypothesis of the existence of a long-run cointegrating relationship among the variables is rejected, implying the absence of a stable long-run equilibrium relationship. This is because the trace statistics values (46.71958 and 17.01482) are less than the corresponding critical values (54.07904 and 35.19275). Similarly, the max-eigen statistics value (10.85655) is less than the critical value (22.29962). Although the max-eigen statistic of 29.70476 is greater than the critical value of 28.58808, the probability value of 0.0359 is

significant at 5%. Hence, the result of the test shows the existence of no long-run relationship between environmental quality and manufacturing sector output in Nigeria.

Hypothesis Two H_0: Government policies have no moderating effect in the relationship between environmental quality and manufacturing sector output in Nigeria.

From the moderation result in Table 5, going by the outcome of decision rule one, which shows a significant change in R^2 as well as the new interaction term according to the stated rule of moderation by Baron and Kenny (1986), the results conclude that moderation is occurring and that government policy on environmental sustainability partially moderates the nexus between environmental quality and manufacturing sector output in Nigeria. This is because of the significant change in R^2 from 0.004397 when the interaction term is not added to 0.635142 when the interaction term is added.

Table 6: Post-Estimation Diagnostic Results

Test	Test Statistic	Probability (p-value)	Decision/Interpretation
Breusch Godfrey Serial Correlation LM Test	1.482016	0.2498	No serial correlation (fail to reject H_0)
Breusch Pagan Godfrey Heteroskedasticity Test	0.974312	0.4485	No heteroskedasticity (fail to reject H_0)
Jarque Bera Normality Test	1.672049	0.4332	Residuals are normally distributed
Ramsey RESET Test (Functional Form)	2.107589	0.1613	The model is correctly specified
CUSUM Stability Test		Stable (within 5% boundaries)	Model parameters are stable over time

Source: Authors' computation.

4.4 Discussion of findings

This study examined the relationship between environmental quality and manufacturing sector output in Nigeria, and the moderating role of government policy. The Johansen cointegration results indicate no long-run relationship between ecological footprint (EFP) and manufacturing value added (lnMVA), suggesting that changes in environmental quality do not consistently move with manufacturing performance over time. This contrasts with some studies

showing long-run environmental economic linkages in Nigeria (Egbetokun et al., 2022; Maduka et al., 2022; Ogbuabor et al., 2023), though they focused on broader economic growth or energy sectors rather than manufacturing specifically. The absence of cointegration implies that policymakers cannot rely on stable long-term co-movements and must address short-run environmental pressures directly.

Short-run results reveal that environmental degradation has a significant negative impact on manufacturing output, while government policy exerts a positive effect. This aligns with recent findings by Ohioze et al. (2024), Popoola (2022), and Afolayan et al. (2019), highlighting the detrimental effects of environmental degradation and the supportive role of governance in Nigeria's industrial sector. The short-run sensitivity indicates that manufacturing firms are vulnerable to environmental shocks, emphasizing the need for timely interventions such as adoption of cleaner production options, waste reduction, and energy-efficient technologies.

Moderation analysis shows that government policy partially moderates the relationship between environmental quality and manufacturing output, with the interaction term improving model explanatory power, though not statistically significant. This partially corroborates studies showing the moderating role of governance on environmental-economic outcomes (Usman et al., 2025; Wang et al., 2025; Maduka et al., 2022 and Bhat et al., 2025). The limited significance suggests that current policies may be insufficiently enforced or unevenly applied across sub-sectors, indicating a gap between policy intent and practical impact. The findings suggest that while Nigeria's manufacturing sector is currently responsive to short-run environmental pressures, long-term sustainability requires stronger institutional support and integrated environmental-industrial policies.

5. Recommendations and Conclusion

Based on the study's findings, several policy actions are recommended to enhance manufacturing sector performance while safeguarding environmental quality in Nigeria. First, given the short-run negative impact of environmental degradation on manufacturing output, government should strengthen enforcement of environmental regulations and provide incentives for firms to

adopt cleaner production technologies, energy efficient processes, and renewable energy sources. Second, the positive effect of government policy on manufacturing performance underscores the need to expand institutional support, including capacity building for regulatory agencies, streamlined policy coordination, and targeted interventions for vulnerable sub-sectors. Third, since government policy partially moderates the relationship between environmental quality and manufacturing output, policies should be designed to integrate environmental sustainability explicitly into industrial development strategies, such as linking industrial incentives to environmental compliance and promoting green manufacturing roadmaps. Finally, periodic monitoring and evaluation of manufacturing sub-sectors should be institutionalized to ensure that environmental policies are effectively implemented and yield measurable improvements in both ecological outcomes and sectoral productivity.

In conclusion, while environmental quality does not exhibit a long-run relationship with manufacturing sector output in Nigeria, it significantly affects performance in the short run, and government policy plays a supportive role. The partial moderation by policy highlights the potential of effective governance to buffer environmental pressures on manufacturing.

References

Abdulrahman, B. S., & Ajayi, O. E. (2022). Impact of infrastructure on foreign direct investment inflow to Nigeria. *Journal of Economics and Allied Research*, *7*(2), 42–52.

Adeoti, J. (2020). Sustainable manufacturing practices in Nigeria: Challenges and opportunities. *Journal of Cleaner Production*, *247*, 119158.

Afolayan, O. T., & Aderemi, T. A. (2019). Environmental quality and health effects in Nigeria: Implications for sustainable economic development. *SSRG International Journal of Economics and Management Studies (SSRG-IJEMS)*, *6*(11), 44-55.

African Development Bank. (2021). Nigeria Economic Outlook. Retrieved from; https://www.afdb.org/.

Ahmed, F., Ali, I., & Kousar, S. (2022). The environmental impact of industrialization and foreign direct investment: Empirical evidence from Asia-Pacific region. *Environmental Science and Pollution Research*, *29*, 29778-29792.

Ajide, K. B., & Oyinlola, M. A. (2016). Does the Level of Economic Growth Influence Environmental Quality in Nigeria: A Test of Environmental Kuznets Curve (EKC) Hypothesis? April 2010. https://doi.org/10.3923/pjssci.2010.325.329

Alege, P. O., & Ogundipe, A. A. (2013). Environmental quality and economic growth in Nigeria: A fractional cointegration analysis. *International Journal of Development and Sustainability*, *2*(2), 580–596.

Anthony, A., & Kenechukwu, O. (2025). Impact of exchange rate on manufacturing sector performance in Nigeria. *NAU Eco Journals*, *22*(1), 91-112.

Anyanwu, J. C., Oaikhenan, H., Oyefusi, A., & Dimowo, F. A. (1997). *The Structure of the Nigerian Economy (1960-1997)*. Onitsha. Joadee Educational Publishers.

Banjoko, S. A., Iwuji, I. I., & Bagshaw, K. (2012). The performance of the Nigerian manufacturing sector: A 52-year analysis of growth and retrogression (1960-2012). *Journal of Asian Business Strategy*, *2*(8), 177-191.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173.

Bhat, M. N., Beg, A., & Ikram, F. (2025). Navigating the global knowledge economy: Temporal effects of regulatory environment and FDI on sustainable development in Asia–Pacific. *Journal of the Knowledge Economy*, *16*(2), 9972-10003.

Cainelli, G., D'Amato, A., & Mazzanti, M. (2015). Adoption of waste-reducing technology in manufacturing: Regional factors and policy issues. *Resource and Energy Economics, 39*, 53–67. https://doi.org/10.1016/j.reseneeco.2014.11.004.

CBN. (2022). Real Sector Support Facility Guidelines. Central Bank of Nigeria. Retrieved from: https://www.cbn.gov.ng/.

Central B N. (2023). *Third Quarter Economic Report 2023*. Abuja, Nigeria: Central Bank of Nigeria. https://www.cbn.gov.ng

Convention on Biological Diversity (CBD). (2021). *Global biodiversity outlook 5: Summary for policymakers*. Secretariat of the Convention on Biological Diversity, Montreal, Canada.

Dangote Industries Limited. (2021). *Sustainability Report 2021*.

Dimnwobi, S. K., Ekesiobi, C., Madichie, C. V., & Asongu, S. A. (2021). Population dynamics and environmental quality in Africa. *Science of the Total Environment, 797*, 149172.

Edame, G. E., & Okoi, O. B. (2015). Energy consumption, institutional quality and the performance of the manufacturing sector in Nigeria (1999-2013). *International Journal of Energy Economics and Policy*, *5*(3), 801-804.

Egbetokun, S., Osabuohien, E., Akinbobola, T., Onanuga, O. T., Gershon, O., & Okafor, V. (2020). Environmental pollution, economic growth, and institutional quality: exploring the nexus in Nigeria. *Management of Environmental Quality*, *31*(1), 18-31.

Ekpo, A. S. (2005). Industrialization and Nigeria's economics development in the challenges of industrialization. A pathway of Nigeria becoming a highly industrialized country in the

year 2015. Nigerian Economic Society proceedings; Ibadan, pp 3-26.

Ekundayo, P., & Amarachi, C. (2017). *The Role of Social and Economic Infrastructure in Manufacturing Sector Performance in Nigeria*. *Munich Personal RePEc Archive 78310*.

Ezenekwe, C. I. (2020). Effect of environmental factors on firm productivity in manufacturing firms in Anambra State, Nigeria. *International Journal of Innovative Social Sciences & Humanities Research*, *8*(1), 133-143.

FAO. (2019). Deforestation in Nigeria: Causes, Effects, and Solutions. Food and Agriculture Organization. Retrieved from; https://www.fao.org/

Federal Ministry of Industry, Trade and Investment. (2020). Nigerian Industrial Revolution Plan.

Goodland, R. (1995). *The concept of environmental sustainability*. Annual Review of Ecology and Systematics, 26, 1-24. https://doi.org/10.1146/annurev.es.26.110195.000245.

Gujarati, D.N., & Porter, D.C. (2009). *Basic econometrics*. New York: McGraw-Hill Education.

International Finance Corporation. (2019). Green Finance in Nigeria. Retrieved from; https://www.ifc.org/ IFC.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration -- with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, *52*(2), 169-210.

Landesmann, M. A., & Stöllinger, R. (2019). Structural change, trade and global production networks: An 'appropriate industrial policy' for peripheral and catching-up economies. *Structural Change and Economic Dynamics*, *48*, 7-23.

Maduka, A. C., Ogwu, S. O., & Ekesiobi, C. S. (2022). Assessing the moderating effect of institutional quality on economic growth carbon emission nexus in Nigeria. *Environmental Science and Pollution Research*, *29*(43), 64924-64938. https://doi.org/10.1007/s11356-022-20346-3.

MAN. (2022). Capacity Utilization Report. Manufacturers Association of Nigeria.

Mesagan, E. P., & Nwachukwu, M. I. (2018). Determinants of environmental quality in Nigeria: Assessing the role of financial development. *Econometric Research in Finance*, *3*(1), 55-78. https://doi.org/10.33119/ERFIN.2018.3.1.3.

Mohamed, Z. F., Anwar A. S., & Hakan A. (2025). Determinants of green growth in sub-Saharan Africa: A quantile regression analysis of renewable energy, FDI, and urbanization. *The Nigerian Journal of Economic and Social Studies*, 67 (2): 311 - 340.

Morelli, J. (2011). Environmental sustainability: A definition for environmental professionals. *Journal of Environmental Sustainability*, *1*(2), 21-30.

Nadabo, Y. S. (2023). Nexus between infrastructure development and manufacturing sector performance in Nigeria: the moderating role of institutional quality. *Journal of Economics and Allied Research*, *8*(1), 151-165.

National Bureau of Statistics. (2022). GDP Report Q1 2022. Retrieved from; https://www.nigerianstat.gov.ng/.

NESREA. (2019). Annual Report 2019. National Environmental Standards and Regulations Enforcement Agency. Retrieved from; https://www.nesrea.gov.ng/.

NEST. (2022). Environmental Impact Assessment in Nigeria. Nigerian Environmental Study/Action Team.

Ngwakwe, C. C. (2013). Environmental responsibility and firm performance: Evidence from Nigeria. *In Proceedings of the International Conference on Business and Economics Research* (pp. 1–X). World Academy of Science, Engineering and Technology. https://doi.org/10.5281/zenodo.1079958.

Nurse, K. (2006). Culture as the fourth pillar of sustainable development. *Small States: Economic Review and Basic Statistics*, *11*, 28-40.

Nwokoro, C., & Chima, P. (2018). Environmental regulation and industrial performance in Nigeria. *Environmental Economics and Policy Studies*, *20*(1), 139-153.

Obamen, J., Omonona, S., Oni, O., & Ohunyeye, O. F. (2021). Effect of environmental management practices and sustainability on some selected manufacturing firms in South East Nigeria. *Sustainability*, *13*(18), 10372. https://doi.org/10.3390/su131810372.

Ogboani, H. O., Chikezie-Aga, C. D., & Inyiama, O. I. (2023). The effects of manufacturing sector output on environmental sustainability in Nigeria from 1990 to 2019. *European Journal of Accounting, Auditing and Finance Research*, *11*(1), 86–97. https://doi.org/10.37745/ejaafr.2013/vol11n18697.

Ogbuabor, J. E., Onuigbo, F. N., Orji, A., & Anthony-Orji, O. I. (2020). Institutional quality and economic performance in Nigeria: New evidence. *International Journal of Economics and Statistics*, *8*(2020), 38-49.

Ogunjinmi, O. O. (2022), Estimating the growth effects of population, poverty and unemployment in Nigeria. *Journal of Economics and Allied Research*, *7*(1), 178-190.

Ohioze, W. F., Ojo, T. J., Odior, E. S., & Dauda, R. O. (2024). Unbundling socioeconomic living condition: Analyzing environmental quality impact on sustainable development for Nigeria. *Timisoara Journal of Economics and Business*, *17*(2), 139-164.

Okore, O. A. (2021). Effect of environmental cost on performance of manufacturing firms in Nigeria. *Journal of Accounting and Financial Management*, *7*(5), 19-33.

Olusegun, O. F. (2021). Determinants and sustainability of manufacturing sector performance in Nigeria: The roles of selected macroeconomic variables. *Applied Finance and Accounting*, *7*(2), 31-40.

Onye, K. U., Daasi, G. L., & Etuk, S. M. (2023). On the manufacturing sector performance and Nigeria's economic growth. *International Journal of Social Sciences*, *15*(1), 54-79.

Otali, M., & Monye, C. (2023). Implementation of green finance as a catalyst for green infrastructure development in Nigeria. *Journal of Contemporary Research in the Built Environment*, *2*.

Popoola, O. A. (2022). Governance environment and manufacturing sector performance in Nigeria. *Economic and Policy Review*, *20*(2), 25-31.

Porter, M. E. (1991). America's Green Strategy. *Scientific American*, 264(4), 96.

Presberger, D., Kolcava, D., & Bernauer, T. (2024). Protecting the environment at home or abroad? *Environmental Research Letters*, *19*(11), 114074.

Quadri, S. T. and Bukola, O. M. (2022). Impact of Electricity Consumption on Manufacturing Output in Nigeria from 1980 – 2021. Retrieved from https://assets.researchsquare.com/files/rs-2134279/v1/a51dfef9-d23e-46e0-8273-6cd9bbeb1dec.pdf?c=1665163620.

Sanusi, K. A., & Sanusi, O. O. (2019). *Environmental sustainability reporting practices in Nigeria: Are clouds darker or fairer in the manufacturing industry? International Journal of Social Sciences and Humanity Studies*, *11*(2), 39–60.

Sulaiman, C., Abdul-Rahim, S., Samad, N., Muhammad-Jawad, M., Abidin, Z. & Shaari, N. (2022). Impact of Manufacturing Value Added on Environmental Degradation: empirical evidence from India. 4th International Conference on Tropical Resources and Sustainable Sciences 2022.

Szalavetz, A. (2019). Industry 4.0 and capability development in manufacturing subsidiaries. *Technological Forecasting and Social Change*, *145*, 384-395.

Usman, A., & Olubusayo, O. (2019). *Analysis of the impact of manufacturing sector performance on economic growth in Nigeria*. GE-International Journal of Management Research, 7(9). Association of Academic Researchers and Faculties.

Usman, B. M., Johl, S. K., & Khan, P. A. (2025). Enhancing energy sector sustainability through robust green governance mechanisms for carbon neutrality. *Discover Sustainability*, *6*(1), 1-24.

Usman, B. M., Johl, S. K., & Khan, P. A. (2025). *Enhancing energy sector sustainability through robust green governance mechanisms for carbon neutrality*. *Discover Sustainability, 6*, 216. https://doi.org/10.1007/s43621-025-01064-5

Uzoechina, B. I., Okeyika, O. K., Okafor, L. O., & Ozulumba, J. I. & Ekwoh, G. A. (2025). Drivers of international trade and private sector investment in Nigeria. *Interdisciplinary journal of African & Asian studies (IJAAS)*, *11*(2).

Wang, F., Gillani, S., Sharif, A., & Shafiq, M. N. (2025). Balancing well-being and environment: The moderating role of governance in sustainable development amid environmental degradation. *Journal of Environmental Management, 386*, 125803. https://doi.org/10.1016/j.jenvman.2025.125803

Wang, Y., & Yang, Y. (2021). Analysing the green innovation practices based on sustainability performance indicators: a Chinese manufacturing industry case. *Environmental Science and Pollution Research*, *28*(1), 1181-1203.

World Bank. (2020). Nigeria: Air Pollution Levels and Health Impacts. Retrieved from; https://www.worldbank.org/.

Zhou, X. (2021). Ecological civilization in China: Challenges and strategies. *Capitalism Nature Socialism*, *32*(3), 84-99.

APPENDICES

Figure 1.

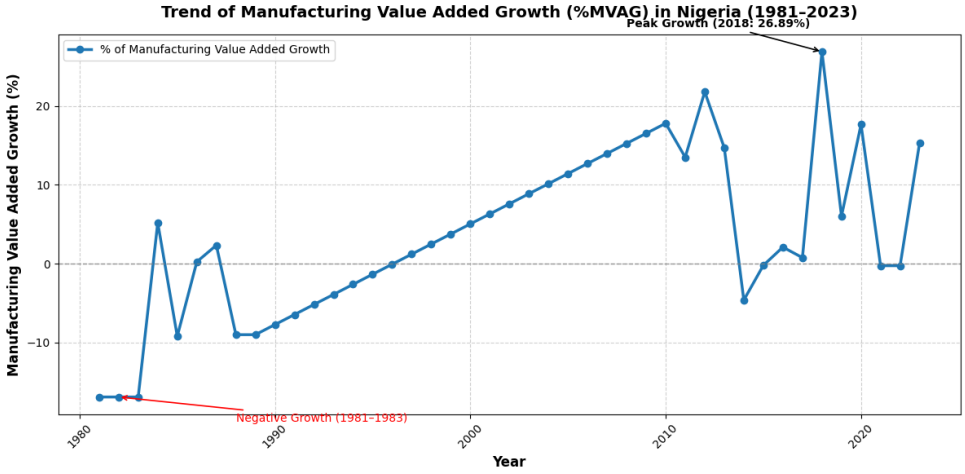

Table 1.

Year	% of MVAG
1981	-16.9
1982	-16.9
1983	-16.9
1984	5.2
1985	-9.2
1986	0.24
1987	2.34
1988	-9
1989	-9
1990	-7.72
1991	-6.45
1992	-5.17
1993	-3.9
1994	-2.62
1995	-1.34

Year	% of MVAG
1996	-0.07
1997	1.21
1998	2.49
1999	3.76
2000	5.04
2001	6.31
2002	7.59
2003	8.87
2004	10.14
2005	11.42
2006	12.7
2007	13.97
2008	15.25
2009	16.52
2010	17.8
2011	13.5
2012	21.8
2013	14.7
2014	-4.61
2015	-0.21
2016	2.1
2017	0.77
2018	26.89
2019	6.03
2020	17.65
2021	-0.25
2022	-0.25
2023	15.36

Source: WDI, 2024.