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Impact of industrialisation on economic growth in Nigeria

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Orientation: The industrial sector contributes to the growth of other sectors of the economy. Despite the number of industries in various sectors of the economy, inclusive economic growth is still not met in Nigeria.

Research purpose: This article examines the impact of industrialisation on the growth of Nigeria's economy.

Motivation for the study: There exists a divergence in the results of the existing empirical investigations conducted on Nigeria in comparison with other developing economies.

Research approach/design and method: The Johansen co-integration and Granger causality tests are utilised to determine the long-term relationship and causality among variables.

Main findings: Industrial output has a significant direct effect and an aggregate effect of 86% on the real gross domestic product (GDP). A unidirectional causal impact of industrial output on real GDP was also established.

Practical/managerial implications: Fund managers, international traders, policymakers and designers of business strategies and policies should take note of the dynamics of Nigerian industrialisation. This study recommends that government should encourage more foreign direct investment through the adoption of industrialisation policies such as tax holidays, provision of land for industrial uses to foreign investors and also ensuring that the lending interest rate for the real sector is lowered during low production to stimulate growth in the sector. The government should also increase electricity supply, ensure green industrialisation, encourage renewable energy consumption and control the exchange rate that may stimulate industrialisation and increase growth of the economy.

Contribution/value-add: This article contributes to existing economic development literature by filling the gap related to the dynamic effect of industrialisation on the Nigerian economy.

Keywords: industrial output; exchange rate; foreign direct investment; interest rate; gross domestic product.

Introduction

This article investigates the impact of industrialisation on the growth of Nigeria's economy as there exists a gap in the existing pool of knowledge regarding the role of industries in Nigeria. Industry is usually synonymous with manufacturing. However, industrialisation refers to the transformation of raw materials into finished goods or products of more valuable goods. Industry is often also seen as the organised human skills and efforts put into the production of more valuable goods from natural resources (Ndiaya & Lv 2018).

Developing countries such as Nigeria still need more industries, especially manufacturing to promote economic growth and development to an optimal level. Developing countries especially need adequate resources to promote the production and exportation of goods by industries to achieve the desired economic growth and development (Olusegun 2021). The overriding objective of industrial policy may also be to accelerate the pace of industrial development by radically increasing the value added at every stage of the value chain (Jelilov, Enwerem & Isik 2016). Djeudo (2013) suggested that in achieving industrialisation among developing economies such as Nigeria, the government must continue to create enabling environments that are conducive to the private sector and formulate good policies that enhance innovativeness.

Industries are an important indicator of economic growth because the marginal revenue products of labour in industries are usually higher than that of the agricultural sector. Jelilov et al. (2016), for instance, asserted that labour force movement from agricultural to industrial sectors results in marginal product of labour appreciation in the agricultural sector with a consequential impact on the overall revenue and output of the country. That was also the fundamental assumption of the Lewis model (Todaro & Smith 2020). Given this, Kida and Angahar (2016) remarked that industrialisation sets the condition to achieve sustainable economic growth in all economies. It can also be stated that the dynamic benefits of the manufacturing sector are activating economic transformation in this modern-day economy. Industrialisation is also responsible for speeding up investment capital in the agricultural sector (Afolabi & Ogoh 2017).

Kida and Angahar (2016) and CBN (2020) found a 3.2% share of manufacturing value in total gross domestic product (GDP) in 1960. In 1977, the manufacturing share of GDP rose to 5.4% and grew to 13% in 1992. Manufacturing share in GDP fell, however, to 6.2% in 1993, while the manufacturing capacity utilisation (MCU) rate declined to 2.4% in 1998 and increased by 3.4% from 2001 to 2009. By 2020, value-added manufacturing as a percentage of the GDP reached 12.67% (World Bank 2022).

To improve the growth of the Nigerian economy, the government implemented some industrial policies such as the Structural Adjustment Programme (SAP) in 1986. This policy structure was an alternative framework to address the weaknesses and ineffectiveness of previous development planning efforts. The motives of these policies were to achieve economic growth, full employment and balance of payment equilibrium. Economic growth is, however, a long-term expansion of the total productive potential of the economy (Kleynhans & Pradeep 2013). The growth of an economy implies the expansion of all sectors of the economy, high levels of productivity, high standards of living and overall achievement of all the macroeconomic objectives of an economy such as high levels of employment, reduced inflation and high outputs (Unugbro 2010).

Over the years, Nigeria experienced great improvements in GDP, but with a high rate of poverty, unemployment, illiteracy and low human development. Kida and Angahar (2016) refered to such growth as jobless growth; that is, growth without development. It also shows that a large percentage of the population does not benefit from the expenditures of the government, which also led to a decline in consumable goods. In 1981, Nigeria experienced a GDP per capita growth rate of 3.6%, which decreased to –15.4% in 1983, and this reduction continued until 1989 to –13%. Gross domestic product per capita growth rate kept fluctuating until 2006 when a very high increase of 30% GDP per capita growth rate occurred after which there was a drastic fall again to 4.9% in 2012 (World Bank 2022).

The dwindling in the GDP of Nigeria within these periods can be attributed to the deterioration of the fiscal balances that were experienced in the Nigerian public sector and the policies designed to solve the issues concerning the economy proved abortive (Ahmed 1990). The drastic fall after 2006 can also be attributed to the impact of oil prices and the impact of the financial sector, which culminated in the global financial crisis of 2008. The country also experienced negative growth of 1.6% in 2016 and about 0.8% in 2017, which can be attributed to a collapse in the prices of oil after 2014, which resulted in a fall in the revenue of the federal government, a trade deficit and a recession. The economy of Nigeria started experiencing normal growth in 2018 after 2 years of abnormal growth (UNCTAD 2018).

Nigerian industrial sector is characterised by high importation of industrial inputs, declining output, high production costs, diminishing capacity utilisation, low value-added, low employment generation and inadequate linkages to various sectors in the economy (Ijaiya & Akanbi 2009). The Nigerian government attempted to improve the growth of the economy by implementing some industrial policies like disinvestment, privatisation, commercialisation, devaluation and SAPs. The main aims of these policies were to address the problem of economic growth, unemployment, the balance of payment deficit, technical progress and technology transfer. After several attempts to stabilise the economy by different governments, the country experienced fluctuating growth.

Kaldor's law of economic growth is relevant in explaining the fluctuations in the economic system and the incapability of the economic policies to achieve economic stability in Nigeria. Therefore, Kaldor's first law explains manufacturing as a condition or an engine of economic growth. The second law explains how output and labour influence each other positively in manufacturing (Libanio & Moro 2006).

The relevance of the manufacturing sector towards achieving economic growth and development of the country has attracted several empirical investigations (Afolabi & Ogoh 2017; Iheoma & Jelilov 2017; Isiksal & Himesie 2016; Kida & Angahar 2016; Ndiaya & Lv 2018; Obioma, Anyanwu & Kalu 2015). The growth of the investigations concerning the manufacturing sector and economic growth and development in developed and developing countries have not been without divergence in the results. Some studies found the manufacturing sectors to have a positive impact on economic growth (Obioma et al., 2015; Sutikno & Sri-Wahyudi 2017). Whereas Iheoma and Jelilov (2017) found manufacturing to inhibit economic growth among the Economic Community of West African States (ECOWAS) countries. However, against the result of the investigation on ECOWAS countries, Nigeria and Senegal are part of the ECOWAS countries, but Obioma et al. (2015), Ndiaya and Lv (2018) found a positive relationship between manufacturing and economic growth for Nigeria and Ghana, respectively.

Based on the contradictory findings by these researchers, the present study raised an empirical question of what the causal relationship between industrialisation and economic growth in Nigeria is. The current study is consequently aimed at

determining this causal relationship between industrialisation and economic growth in Nigeria. This study also intends to ascertain whether a long-term relationship exists between industrialisation and economic growth in Nigeria. Nigeria is taken as the laboratory in this study because of the characteristics of her industrial sector and the divergence in the results of the investigations conducted on Nigeria in comparison with other developing economies. The study shall adopt the Johansen co-integration techniques. This technique is preferred to others in this study as it has a well-defined asymptotic distribution or limiting distribution. It can be said that the test will be affected by parameter instability experienced with the use of techniques like the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) tests. We also adopted the Granger causality test as it takes advantage of the data gathered at different levels of frequencies.

This article is structured as follows: In the following section, related research in the literature is reviewed. This is followed by a description of the methodology and model specifications that were followed in this study and reporting on the empirical research findings of the current study. Then the research findings are presented, followed by an interpretation of these empirical results, a discussion, recommendations and a conclusion.

Literature review

Theoretical framework

Kaldor's first law brings together the rate of growth of the aggregate output, which is measured by the GDP growth rate and the output of the manufacturing sector. This is referred to as the 'engine of growth'. Kaldor's first law is stated in Equation 1. Where the explanatory variable is represented as 'm', which is manufacturing output growth rate and the dependent variable is 'q' stands for GDP growth rate. Kaldor is of the view that since the manufacturing sector accounted for about 25% – 40% of the total output, it is expected that a positive relationship exists between the growth rate of the total output and the excess growth achieved from manufacturing (Marconi et al. 2016; Pons-Novell & Viladecans-Marsal 1999):

$$q_1 = b_0 + b_1 m_1 + \varepsilon_1 \quad \text{[Eqn 1]}$$

The introduction of the growth rate of the nonmanufacturing sector (nm) to the economy will generate a new law that can be written as in Equation 2:

$$q_1 = b_2 + b_3(m_1 - nm_1) + \varepsilon_1 \quad \text{[Eqn 2]}$$

Equation 2 shows the growth rates of different sectors of the economy as a result of differences in the activities that are involved in productivity. The manufacturing sector has a greater return to scale or experiences increasing returns to scale because of the advantages gained from technical productivity that can be achieved by producing in the industrial sector (Marconi et al. 2016; Pons-Novell & Viladecans-Marsal 1999).

The engine of growth model and the Kaldor-Mirrlees model that sees investment as a means of achieving technical progress can be linked to the Keynesian investment theory. In Keynesian terminology, investment, such as in the industrial sector, refers to real physical investment that adds to capital equipment (Keynes 1937). Keynes' theory emphasises that interest rates are important in investment decision-making, which then leads to industrial development and economic growth (Mankiw 2020). He is of the view that interest rates should affect planned investment taken up by private businesses like the industrial sector and other sectors of the economy.

There are so many empirical investigations on the effect of industrialisation in developed and developing economies. Khan and Majeed (2022) investigated the effect of urbanisation and industrialisation in achieving economic growth without emission in Pakistan from 1980 to 2018 by employing the Johansen Joselius co-integration and impulse response function (TRF) techniques to determine the impact of the decoupling drivers. The study found industrialisation and urbanisation as the two factors of economic growth and carbon emission. Sutikno and Sri-Wahyudi (2017) investigated the effect that industrialisation has on community welfare and regional economic development in Gresik regency one of the largest industrial areas in east Java by adopting the ordinary least square (OLS) approach. The result shows that industrialisation is positive and non-significant at the conventional level. The study concludes that industrialisation in Gresik has not had a substantial impact on the community in Gresik regency but on the nearby residents. The study, therefore, recommends a strong commitment to the industrial sector by the Gresik local government.

Attiah (2019) examined the impact of manufacturing and the service sectors on the economic growth of developed and developing countries from 1950 to 2015. The study utilised data from 50 countries (40 developing and 10 advanced economies). The results of the empirical study were in line with the manufacturing engine of growth hypothesis, which is Kaldor's first law that brings together the rate of growth of the aggregate output measured by the GDP growth rate and the output of the manufacturing sector. Total manufacturing as a ratio to GDP was significant and has a direct relationship with economic growth. The significance of the positive relationship is more pronounced for poorer countries. The study also found no effect on the service sector. The impact of the manufacturing and service sectors in the growth acceleration periods showed that the effects of manufacturing were higher in periods of growth acceleration.

Wang and Su (2019) investigated the impact of industrialisation on the decoupling of economic growth from carbon emission in China from 1990 to 2015 by adopting the Johansen co-integration and Granger causality techniques. The study found a strong decoupling of carbon emission and economic growth within a few years with a weak decoupling for the remaining part of the period of study. In a nutshell, the study found that a greater impact of industrialisation on economic growth than causing environmental pollution in China.

Szirmai and Verspagen (2012) tested the relationships between the ratio of manufacturing and services sectors to GDP and the growth of GDP per capita by gathering data from developed and developing countries for three different periods, which are 1950 to 1970, 1970 to 1990 and 1990 to 2005. The study found that manufacturing serves as an engine of growth for low and middle-income countries with high levels of human capital. The study did not find a positive relationship between economic growth and the service sector. The result implies that a higher level of human capital is needed to ensure that manufacturing plays a role in achieving growth in developing countries.

Sahar (2020) investigated the effect of industrialisation on economic growth from 1976 to 2015 in Pakistan using autoregressive distributed lag (ARDL). In the study, the dependent variable is GDP, while the explanatory variables are industrial output, inflations, foreign direct investment (FDI) and savings. The results of the ARDL bounds tests revealed that there is a long-term relationship between industrial output and economic growth or GDP. This study also revealed a direct relationship between industrial output and GDP in Pakistan. The CUSUM (cumulative sum) test also revealed the stability of the results. A similar study in the same country by Ajmair (2014) investigated the impact of industrialisation on GDP from 1950 to 2010 by collecting data from the Economic Survey of Pakistan, the State Bank of Pakistan and the Pakistan Bureau of Statistics. The study adopted GDP growth as the dependent variable, while the explanatory variables are the growth of some sectors such as the industrial sector, mining and quarrying, manufacturing small scale, construction, electricity, gas and water supply distribution. The result of the study revealed a positive relationship between all components of the industrial sector with GDP.

In another view, Majeed and Tauqir (2020) investigated the impact of urbanisation and industrialisation on carbon emissions for the period 1990–2014 from a panel of 156 countries comprising various income groups by employing the first- and second-generation tests. The study used the dynamic generalisation method of moments (GMM), dynamic common correlated effects mean group (CCEMG) estimation procedure and the CCEMG. The variables adopted are carbon emissions, economic growth, industrialisation, financial development, urbanisation and energy consumption. The results showed that urbanisation and industrialisation are significant and positively related to carbon emissions across all panel groups. The implication of the environmental Kuznets curve was validated as economic growth exerted heterogeneous effects on environmental pollution. A similar study in Senegal, by Ndiaya and Lv (2018), from 1960 to 2017, which employed the OLS technique, showed a significant and positive relationship between industrial output and economic growth in Senegal. This implies that there is a significant impact of industrial development on economic growth in Senegal.

Elfaki, Handoyo and Ibrahim (2021) employed the ARDL approach to determine the short- and long-term relationship between financial development, industrialisation, trade openness, energy consumption and economic growth in Indonesia from 1984 to 2018. The result shows that there is co-integration among the variables and industrialisation, trade openness, financial development and energy consumption assist in economic growth in the long run.

Parveen, Khan and Farooq (2019) examined the causal relationship that exists between industrialisation, economic growth, environmental degradation and urbanisation of Pakistan for the period 1975 and 2017, by adopting the Granger causality test and Johansen co-integration test to determine the long-run relationships among the variables. The study found no causality between economic growth and industrialisation. The study also found no causality between industrialisation and urbanisation.

A study in 10 selected ECOWAS member states from 2000 to 2013 was carried out by Iheoma and Jelilov (2017) using the panel least square technique and *F*-test analytical techniques. The study revealed that industrialisation inhibits economic growth, which is evident in the *F*-test value (559.02). A similar study was carried out by Ibbih and Gaiya (2013) on a cross-sectional analysis of 54 African countries on the link that exists between industrialisation and economic growth by adopting the generalised least square regression method on the cross-country data of 54 African countries. The study used GDP as the dependent variable and domestic credit to the private sector, GDP growth, GDP per capita, industry value-added, growth of industry value-added, manufacturing value-added and growth of manufacturing value-added were taken as independent variables. The result shows a weak relationship between industrialisation and economic growth.

Su and Yao (2017) examined the direction of causality between the manufacturing sector and the services sector growth by adopting the long-term Granger causality tests, cross-sectional regression and panel regression. The study found unidirectional causality running from the manufacturing sector growth to the services sector growth without feedback. Montagu (2017) investigated industrialisation and economic growth using Latin America as the case study. The study adopted the ARDL technique. The ARDL confirmed that quantitative analysis based on the study of growth rates and productivities was non-significant in the region. Cherniwchan (2010) examined the compositional shift from agricultural to industrial production industrialisation using a simple two-sector model of neoclassical growth by adopting the sulphuric emissions data for 68 countries from 1970 to 2000. The study found that the process of industrialisation has a significant increase in emissions, as a 1% increase in the industrial share of total output results in a 24% increase in emissions per capita.

Khan and Ahmed (2012) examined the impact of trade liberalisation on the industrial production of Pakistan. The study selected data from 1972 to 2012 from the Pakistan Economic Survey and the State Bank of Pakistan. In the

study, the independent variables were GDP, industrial value-added, agriculture value-added, industrial sector labour force and private investment in the industrial sector. The results of the study revealed that trade liberalisation had both direct and indirect impacts on industrial productivity. Gylych and Enwerem (2016) examined the impact of industrialisation on the growth of the economy. The study adopted the OLSs technique on 10 countries from the ECOWAS for the period 2000 to 2013. Their empirical result reveals that industrialisation has an indirect relationship with the economic growth of the selected countries in the long term.

Kida and Angahar (2016) investigated the effect of industrialisation on economic growth in Nigeria from 1981 to 2013 by adopting the OLS. The study also adopted the Johansen co-integration test, error correction method (ECM) and ADF unit root tests. The results showed that industrialisation was significant and directly contributes to economic growth at a 5% significant level.

Afolabi and Laseinde (2019) examined the manufacturing sector output impact on economic growth for the period 1981 to 2016 in Nigeria by employing the ARDL and Granger causality techniques. The variables utilised were manufacturing output (LMO), real gross domestic product (RGDP), money supply (LM2), government investment expenditure (GINVEXP), MCU and interest rate (INR). The study found the presence of long- and short-term relationships among the variables. The result also showed a positive effect of MCU on RGDP, and LMO is also positive on RGDP. The study also found a negative effect of GINVEXP on RGDP, whereas a positive effect of LM2 was found on RGDP. Additionally, the result indicates a unidirectional causality from RGDP to MCU and LMO to LM2.

Afolabi and Ogoh (2017) found the relationship between industrial output and economic growth in Nigeria from 1981 to 2014 by utilising the ARDL approach. The ARDL result found that the long-term coefficient of industrial output and agricultural value-added (AVA) was significant and directly related to economic growth. The study concluded that an increase in industrial coupled with agricultural output increases its value-added to the economy. Obioma et al. (2015) examined the effect of industrial development on economic growth in Nigeria from 1973 to 2013. The result showed a positive but insignificant impact of industrial output on economic growth, whereas savings have a positive and significant impact on the economy. The result also showed a negative effect of inflation on economic growth, while a positive and significant impact of net FDI on economic growth was found.

A study by Isiksal and Himezie (2016), on the impact of industrialisation in Nigeria for the period 1997 to 2012, adopted the Johansen co-integration technique to determine the long-term relationship between agriculture, services and industry. The investigation revealed a significant positive impact of agriculture, industry and services on GDP. Ou (2015) also investigated the effect of industrialisation on the economic development of Nigeria. The time-series data for the period 1973 to 2014 was used, employing mainly National Statistical Bulletin data. They used GDP as the dependent variable, and FDI, industrial output, total savings and inflation represent the independent variables. The result revealed a positive but insignificant relationship between industrial output and economic growth.

Muhammed, Muhammed and Alege (2014) and Adamu (2014) found industrialisation and sustainable development in Nigeria from 1981 to 2012 using the OLS technique. The study adopted unstructured interviews and other secondary sources of data collection. It was confirmed from the study that industrialisation is directly and significantly related to sustainable development. A study by Naudé and Szirmai (2012), on the manufacturing sector and economic development (1982–2010), used OLS and established a significant and direct relationship and concluded that, in advanced economies, productivity growth in agriculture is more rapid than in manufacturing.

Oburota and Ifere (2017) investigated the impact of industrialisation on economic growth in Nigeria. The study adopted the capital-industrial output ratio and the labour-industrial output ratio as the explanatory variables and per capita output as the dependent variable. The study found a negative impact of industrialisation on economic growth in Nigeria. Olorunfemi et al. (2013) find the impact of interest rates on manufacturing output by adopting a system equation approach from 1973 to 2009. The study also found a unique long-term relationship between capacity utilisation of the manufacturing sector, lending rates and manufacturing output. The result of the study implies that bank lending rates and capacity utilisation have significant impacts on manufacturing. In a related study, Akpan, Yilkudi and Opiah (2016) investigate the impact of lending rates on the output of the manufacturing sub-sector by utilising the vector error correction model (VECM) from 1981 to 2014. The empirical findings show that high lending rates limit output in the long term.

It is evident from the above that there are disparities in the results of different investigations. For example, Sutikno and Sri-Wahyudi (2017) found industrialisation to have a positive and non-significant effect on the welfare and regional economic development of the people of Gresik regency. On contrary, there is a significant effect of industrialisation on the nearby residents. Attiah (2019) also found divergence in the study of the impact of the manufacturing sector and economic growth among developing and advanced countries as the author finds a more pronounced significance among the developing countries. As against the result of a pronounced significant effect of the manufacturing sector on economic growth for the poorer nations, Obioma et al. (2015) found an insignificant but positive impact of the industrial sector on economic growth in Nigeria. Iheoma and Jelilov

(2017) also found manufacturing to inhibit economic growth among 10 ECOWAS member states.

Methodology

Model specification

The Keynesian model is also the basis of the Sahar (2020) model with little modification. The basic model for Sahar (2020) states that the GDP (GDP at current US$) is a function of industrial output (IND in$ million), FDI (FDI as % of GDP), saving (SAV as % of GDP) and inflation (INF) using the GDP deflator (% of GDP):

$$GDP = f(IND, FDI, SAV, INF) \quad [Eqn\ 3]$$

The modified version of the model for this study highlights interest rates (INT) and the exchange rate (EXCH) as:

$$RGDP = f(IND, FDI, INT, EXCH) \quad [Eqn\ 4]$$

Given in an explicit form as:

$$RGDPt = \alpha_0 + \alpha_1 IND_t + \alpha_2 FDI_t + \alpha_3 INT_t + \alpha_4 EXCH_t + u_t \quad [Eqn\ 5]$$

Where RGDP represents the real GDP (%), α_0 is the constant value representing the intercept while α_1 to α_4 are the parameter coefficients of IND, FDI, INT and EXCH. As usual, μ*t* represents the error term.

Source of data

The study used annual data on economic growth proxy with the RGDP, industrial output (IND) and FDI being collected from the Bureau of Federal Statistics, while the exchange rate (EXCH) and interest rate were obtained from Central Bank of Nigeria Statistical Bulletin (1986–2019).

Data analysis and interpretation of results

Descriptive statistics and basic tests

Table 1 shows the descriptive statistics of the results. The mean value showed that, on average, the exchange rate (EXCH) has the highest contribution to RGDP with a mean value of 108 units, followed by others. Furthermore, the median value established that an unstable nature of the exchange rate (EXCH) contributed more to the RGDP within the years of study.

TABLE 1: Descriptive statistics.

Variables	RGDP	IND	FDI	INT	EXCH
Mean	37.351	27.665	0.423	2.41	108.013
Median	29.48	26.985	0.295	5.105	119.769
Std. dev.	20.054	4.798	0.451	10.27	91.708
Skewness	0.544	0.116	2.109	-1.134	0.669
Kurtosis	1.684	2.152	7.039	4.83	2.744
Jarque-Bera	4.13	1.094	48.319	12.03	2.63
Probability	0.127	0.579	0.000	0.062	0.269
Observations	34	34	34	34	34

RGDP, real gross domestic product; IND, industrial; FDI, foreign direct investment; INT, interest; EXCH, exchange.

The standard deviation implies that the exchange rate shows the highest values around the mean; followed by interest rate, industrial output and FDI. It was, also, revealed that the selected variables were skewed to the right and left; where the RGDP, industrial output, FDI and exchange rate were skewed to the right with the interest rate skewed to the left.

The Jarque-Bera test statistics confirmed that RGDP, industrial output, FDI, interest rates and exchange rates are normally distributed as their corresponding *p*-value is greater than 0.05 or 5%.

Table 2 shows the ADF result of the test at level and test at first differences. The findings inferred that, at a level, no variable was stationary, while at the first level, RGDP, industrial output, FDI, interest rates and exchange rates were stationary (S) at the first level difference I(1); that is, they are not characterised by unit root problem, as their *t*-statistics are greater than the critical values at 5% level of significance in absolute term.

The result of the Johansen co-integration test is presented in Table 3. The reason for adopting the Johansen co-integration technique as earlier stated that it has a well-defined asymptotic distribution or limiting distribution, which means that the test will not be affected by parameters. The Johansen (1988) and Johansen and Juselius (1990) techniques can be said to be the best technique to avoid the problems that can be inherited from Engle and Granger (1987) and gives room for the estimation of the available and possible co-integrating vectors in the existing variables (Johansen 1988; Johansen & Juselius 1990; Katircioglu 2009). The findings show the co-integration among RGDP, IND, FDI, INT and EXCH at None ($r = 0$) using both the trace and maximal Eigen statistics. Therefore, this leads to the rejection of the null hypothesis of ($r = 0$) at a 5% level of significance. The findings from the study, therefore, show that a long-term relationship exists

TABLE 2: Results of unit root test.

Variable	Test at level			Test at first-level difference			Level of integration
	ADF	1% C.V	5% C V	Test statistic	1% C.V	5% C V	
RGDP	-0.537	-3.646	-2.954	-6.65	-3.654	-2.957	I(1)
IND	-1.252	-3.662	-2.96	-6.206	-6.206	-2.96	I(1)
FDI	-2.642	-3.67	-2.976	-6.985	-3.67	-2.964	I(1)
INT	-3.464	-3.646	-2.954	-4.788	-3.67	-2.964	I(1)
EXCH	-0.984	-3.646	-2.954	-4.034	-3.654	-2.957	I(1)

ADF, Augmented Dickey-Fuller; RGDP, real gross domestic product; IND, industrial; FDI, foreign direct investment; INT, interest; EXCH, exchange.

TABLE 3: Johansen co-integration test.

H_0	Trace statistics			Max-Eingen statistics		
	Trace stats.	Critical value at 0.05 (5%)	Prob.	Max-Eingen stats.	Critical value at 0.05 (5%)	Prob.
$r = 0$	75.154	69.819	0.0176**	38.292	33.877	0.014**
$r = 1$	36.862	47.856	0.354	17.143	27.584	0.568
$r = 2$	19.72	29.797	0.442	15.162	21.132	0.278
$r = 3$	4.558	15.495	0.854	3.279	14.265	0.926
$r = 4$	1.279	3.842	0.258	1.279	3.842	0.258

Note: Trace test and Max-eigenvalue indicates 1 cointegrating eqn(s) at the 0.05 level, I** indicates statistically significant.

TABLE 4: Pairwise Granger causality tests.

Null hypothesis	Direction	Observation	*F*-stats.	Prob.
IND does not Granger cause RGDP	→	32	1.349	0.006**
RGDP does not Granger cause IND			1.172	0.325
INT does not Granger cause RGDP	→	32	0.212	0.0001**
RGDP does not Granger cause INT			1.093	0.35
EXCH does not Granger cause IND	↔	32	4.285	0.024**
IND does not Granger cause EXCH			3.64	0.04**
INT does not Granger cause FDI	↔	32	2.77	0.081**
FDI does not Granger cause INT			4.17	0.026**

Note: **Indicate statistical significance or the rejection of the null hypothesis at 0.05 and 0.1 level.

RGDP, real gross domestic product; IND, industrial; FDI, foreign direct investment; INT, interest; EXCH, exchange.

among the variables identified in the model. This also shows that the estimated series have relationship and can be combined linearly, and if per adventure there is a shock in the short-run with a resultant effect on the individual series that will converge in the long run.

Pairwise Granger causality tests

The Granger causality test shows that industrial output was significant at 5%, while the RGDP was not significant at the 5% level (Table 4). This implies that the null hypothesis that states 'IND does not Granger cause RGDP' was rejected. This shows a unidirectional causality from industrial output to RGDP within the years reviewed. This shows that the industrial output in Nigeria has caused a change in real GDP without a feedback from RGDP to industrial output. Inconsistent with this study, Uddin (2015) found a unidirectional causality from industrial output to GDP growth in Bangladesh.

From the result, it was confirmed that the interest rate Granger caused RGDP without feedback. Therefore, this led to the rejection of the null hypothesis that states 'INT does not Granger cause RGDP', while the null hypothesis of RGDP does not Granger cause was accepted. This implies that there is unidirectional causality from interest rate to real GDP. This implies that interest rate was able to cause a change in real GDP in Nigeria within the reviewed period. Inconsistent with this study, Akinlo (2013) found a unidirectional causality from interest rate to real GDP in Nigeria from 1986 to 2010. A two-way causality was also confirmed between industrial output and exchange rate and likewise between FDI and interest rates. This implies that the exchange rate caused a change in industrial output and likewise industrial output caused a change in the exchange rate within the review period in Nigeria. Inconsistent with this study, Oseni, Adekunle and Alabi (2019) found a bidirectional causality between industrial output and exchange for Nigeria between 1986 and 2017.

Error correction model

The lagged error mechanism ECM (*t*-1) was non-significant at a 5% level with an inverse sign (see Table 5). This finding implies that the selected variables only interact with each other within the short-term period. No speed of adjustment, therefore, occurred at a 5% significance level.

TABLE 5: Error correction model (dependent variables: real gross domestic product).

Variable	R^2 = 0.69; Adjusted R^2 = 0.53; Durbin-Watson stat = 2.27; Prob. (*F*-statistic) = 0.00087			
	Coefficient	Std. error	*t*-Statistic	Prob.
ECM(-1)	-0.305	0.2	-1.523	0.063
Δ(IND)	0.861	0.394	2.18	0.009**
Δ(FDI)	0.262	0.085	3.094	0.0000**
Δ(INT)	-0.402	0.152	2.646	0.0005**
Δ(EXCH)	-0.015	0.03	-0.509	0.615
Constant	1.828	0.598	3.056	0.005*

Note: ** indicate statistical significance at the 0.05 and * at 0.1 level.

ECM, error correction method; IND, industrial; FDI, foreign direct investment; INT, interest; EXCH, exchange.

TABLE 6: Breusch-Godfrey serial correlation LM test.

Test	Stats.	Test	Stats
F-statistic	27.157	Prob. F (2,27)	0.212
Obs**R*-squared	22.71	Prob. Chi-square (2)	0.231

TABLE 7: Heteroskedasticity test: Breusch-Pagan-Godfrey.

Test	Stats.	Test	Stats
F-statistic	1.349	Prob. F (4, 29)	0.276
Obs* R^2	5.332	Prob. chi-square (4)	0.255
Scaled explained SS	3.152	Prob. chi-square (4)	0.5327

The result also revealed that the industrial output and FDI are positive and statistically significant at a 5% conventional level, judging from the *p*-value of the estimated result, which is less than the 0.05 level. The interest rates and the exchange rate are both negative, but only interest rates are significant.

Serial correlation LM

The serial correlation LM (Lagrange multiplier) test suggests that the residual of the ARDL model does not suffer from autocorrelation. The LM test indicates no serial correlation problem as the *p*-value is greater than 0.05. The LM test was conducted to determine if there is an existence of restrictions among the adopted parameters.

Heteroskedasticity test

From the results, the *F*-statistic exceeds 0.05, and therefore the ARCH (Autoregressive conditional heteroscedasticity) test indicates it is free of heteroskedasticity.

Discussion of findings

The result of the present study reveals that the variables were stationary at the first difference, and this prompted the use of Johansen co-integration analysis. The result also showed that a long-term relationship existed among the variables used. Furthermore, the result also reveals that the industrial output is statistically significant at a 5% conventional level, judging from the *p*-value of the estimated result, which is less than the 0.05 level. The result shows a significant and direct relationship between industrial output and RGDP at a 5% level of significance. This implies that industrial output had a direct effect with an aggregate increase value of 86% on RGDPs over the years of the review period. This is in line with the work of Muhammad et al. (2014) and Adamu (2014) and Oburota and Ifere (2017), which

established a direct and significant impact of industrialisation on economic growth at a 5% level of significance.

The coefficient of FDI is 26.19%, which is positive with a *p*-value below the 5% level. This means a 1% increase in FDI led to about a 26.19% increase in the RGDP. The positive sign of FDI is in line with the *a priori* expectation. The findings imply that the Nigerian government formulates good policies in this regard and would encourage FDI in the industrial sector. This increases the value of monetary goods and services produced annually and raises the RGDP and income. This finding supported the claim of Sahar (2020) and Ajmair (2014) that established a positive and significant relationship between FDI and RGDP.

The coefficient of interest rates was negative at 40.1%, indicating that a 1% increase in interest rate results in a 40.1% decrease in RGDP. The negative interest rates agree with the *a priori* expectation. This implies that an increase in lending rates would reduce the demand for funds by listed firms and reduce productivity in the sector. As a result, there would be a decline in the sector's contribution to the annual GDP. According to Charles (2012), the demand for funds depends on the efficient and profitable utilisation of borrowed funds. This affirms that the more profitable the usage of funds, the greater the demand for funds. The finding is also in line with the result of Tomola, Adebisi and Olawale (2012) and Erinwa (2016), who found that interest rates have a negative relationship between the manufacturing sector to GDP and the average capacity utilisation of Nigeria's manufacturing sector. Afolabi and Laseinde (2019), Isiksal and Himezie (2016) and Muhammad et al. (2014) and Adamu (2014) also discovered that an inverse relationship existed between interest rate and RGDP in the past.

The coefficient of exchange rate shows a negative sign but is non-significant at a 5% significance level (holding other variables constant) within the years under review. In the case of the exchange rate, a 1% increase in exchange rate appreciation brought about a 1.5% decrease in the RGDP, meaning that the exchange rate had little effect on the RGDP within the years under review.

Conclusion and policy recommendations

This article examined the impact of industrialisation on economic growth in Nigeria between 1986 and 2019. The results of the study reveal a direct relationship between industrial output and the RGDP at a 5% level of significance, and FDI has a positive significant effect on the RGDP, the interest rate is significant and negatively related to RGDP, while the exchange rate is negative but with an insignificant effect on RGDP. The study, therefore, concludes that industrialisation and FDI into the economy promote growth, while persistent increases in the interest rate and exchange rate depressed economic growth. Based on these findings, this study recommends that government should encourage more FDI through the adoption of industrialisation policies such as tax holidays, provision of land for industrial uses to foreign investors and also ensuring that the lending interest rate for the real sector is lowered during low production to stimulate growth in the sector. The government should increase electricity supply, ensure green industrialisation, encourage renewable energy consumption and control the exchange rate, which may stimulate industrialisation and increase growth of the economy.

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Competing interests

The authors have declared that no competing interest exists.

Authors' contributions

The authors both contributed to the article. O.J.I. did the literature study, empirical analysis and wrote the initial manuscript. A.A.O. developed the initial concept and analysis. E.P.J.K. overviewed and validated the empirical analysis and wrote the final version of the manuscript. A.A.O. is a senior lecturer in Nigeria and Uganda. Dr O.J.I. Ibitoye is a post-doctoral fellow and E.P.J.K. the supervisor.

Ethical considerations

Ethical clearance was obtained from the committee of the Faculty of Economic and Management Sciences, North-West University (EMS-REC NWU – 00647 – 22 – A4).

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Data availability

The research was conducted using freely available data from various sources as indicated clearly in the article.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy, views or position of their affiliated agencies.

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