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REVIEW

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Industrial output growth and foreign direct investment in Nigeria

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Abstract

This research study investigated the nexus between industrial output growth and foreign direct investment in Nigeria. It is a common belief that no nation is an island on its own; hence countries around the globe interchange economic activities across borders via various mutual business indentures. Notably, despite Nigeria's foreign direct investment level in Africa, the country's industrial output growth still falls short in recent years. Therefore, it is pertinent in this study to unravel why increasing Foreign Direct Investment inflow brings about slow industrial output growth in Nigeria. Interestingly, Autoregressive Distributed Lags (ARDL) and Cointegration and Error Correction Mechanisms (ECM) techniques and diagnostics checks were adopted to investigate whether there is long-run interaction between industrial output growth and foreign direct investments in Nigeria. Notably, post estimations tests were carried out to ascertain the validity of the models adopted in the study. The study showed a short-term and long-term relationship between Foreign Direct Investment and Industrial Output Growth in Nigeria. Therefore, FDI disclosed a negative time-path link with industrial output growth in Nigeria. This asserts that Nigeria's current slow output growth contradicts expected economic intuitions due to a negative link between FDI and industrial output growth, all things being equal. Consequently, the study recommended that a proactive policy framework could be used to promote industrialization via localization of industry across Nigeria. Also, policymakers should adopt protectionist international trade laws to expand the local productivity base.

Keywords Foreign direct investment, Industrial output growth

JEL Classifications G11, L60, O40

Introduction

It is a common belief that no nation is an island. Based on this assertion, countries around the globe economically interact with one another through mutual business agreements. The Nigerian economy, for example, is a small open economy that allows foreign investment through different mutual investment agreements, which is expected to be less than 10 per cent of the voting stock within the economy, alongside local investment volts and posited that any investment across foreign borders of a particular country, whether through the establishment of new business entities or acquisition of existing business properties, is called Foreign Direct Investment (FDI). The purchase of those foreign businesses or properties might be horizontal or vertical [3, 15]. Horizontal FDI implies venturing into a similar chain of business entities simultaneously across different economies, while vertical FDI portrays a collection of investments in diverse business entities across different countries. These investments are expected to complement the local investments in growing and expanding industrial output within an economy [16],Otalu and Keji 2015; [4]. In recent years, most countries have leveraged industrial productivity growth through foreign direct investment. This mode of investment has been one of the significant sources of

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improving industrial output growth, particularly in an emerging economy in which Nigeria is inclusive.

Ozuzu and Isukul (2021) explained the vital roles of the industrial sector in an economy. Ozuzu and Isukul considered an investment in Nigeria's industrial output as one of the various sources to drive productivity growth within the economy, which in turn can translate to economic progress in the long run. Hence, policymakers in Nigeria must open investment in the industrial sector, primarily through foreign direct investment. Interestingly, Maji and Achegbulu [13] preached that there were opportunities for reaching quick and feasible industrial development through dynamic FDI, as in the case of Singapore, Hong Kong, and Thailand. These countries are currently classified among the advanced and industrialized hubs in the world. Likewise, the Nigerian economy, being the largest economy in Africa, has been included in attracting a significant level of FDI inflow in the past years. Based on this belief, the foreign direct investment influx to Nigeria upsurged in 1986 from its previous level of $193.2 million in worth to $1874.04 billion in 2002. Between 2003 and 2013, Nigeria's FDI ascended to $5609 from $2005.4 billion.

Nevertheless, the Nigerian FDI influx declined in 2010 and 2016 by 27% the global oil price collapse alongside the economic recession that disrupted the country's economy. In another circumstance, Nigeria recorded nearly 6% of the total FDI entry to Africa, accounting for about 31% of sub-Saharan Africa. This was due to the mono-economy nature of the Nigerian economy, which was characterized by the lopsided investment of over 60 per cent of foreign investment inflow into the oil sector. That is, a sizable number of Foreign Direct Investment in Nigeria is mainly concentrated in the oil sector; the real sector enjoys very little inflow of FDI, which might have been attributed to low industrial output growth. Also, another problem confronting improved industrial output growth in Nigeria is connected with poor synergy between the oil sector stakeholders and the real sector investors within the Nigerian economy in terms of FDI, which might be responsible for low productivity performance in the industrial sector.

Similarly, another severity of the problems connected to low industrial output performance in Nigeria seems to be caused by unfriendly political and business atmospheres, which often scare away foreign investors owing to persistent disruptions in FDI inflows into Nigeria. For example, the current ugly trend is associated with various anti-social groups such as Bandits and BokoHaram Sects in the Northern part of Nigeria, while Kidnappers and secessionists groups dominate the Southern part of Nigeria, and the activities of these groups are incredibly detrimental to the industrial sector growth and the general performance of the country's economy. Okoli and Agu [15] attributed the emergence of these extremists and kidnappers as a major cause of capital flight, low technological inflow, and the pitiable level of industrialization in Nigeria. Since no rational investor would be willing to lose their investments to local restiveness, irrespective of how viable the investment seems. Therefore, Nigeria had fallen short of creating a favourable and enabling environment for foreign businesses to strive. It is worth noting that FDI is expected to trigger industrial sector growth to promote the general level of employment for the entire citizenry, which is expected to further catalyze economic progress in the long run. Also, the Nigerian nation is characterized by an unstable exchange rate, which has led to the high cost of technology and capital transfers via FDI (Table 1; Author's Computation, 2023).

Although, the government has made some frantic efforts to address the downward trends of industrial output in Nigeria through various policies map out. For example, the latest among those policies is the ease of doing business in Nigeria, enacted by the Buhari government, to boost Foreign Direct Investment inflow into the Nigerian economy for general industrial productivity growth to be achieved. Also, other dominant and relevant policies designed by the Nigerian government towards increasing none oil exports goods were the Structural Adjustment Programme (SAP) of 1986, and tax holidays, among others, to boost industrialization as well as to reduce dependency on the oil sector as the major sources of national income in Nigeria [15, 16],Eboh 2011; CBN 2020). Despite those government efforts and in spite of the country's pole position on the foreign direct investment rank in Africa, the expected productivity growth from the industrial sector still needs to catch up. Notably, in recent times, the Nigerian economy has been ravaged by other socio-economic problems such as macro-economic vulnerability in terms of the rising inflation rate, increasing exchange rate, persistent rises in the unemployment rate, bureaucracy, mirage surrounding the ease of doing business in Nigeria, among other

Table 1 Variables for a priori Expectations

VARIABLES	A PRIORI EXPECTATIONS
Industrial Output (IDT)	$\beta_1 > 0$
Labour Participation Rate (LPR)	$\beta_2 > 0$
Exchange Rate (EXR)	$\beta_3 < 0$
Inflation Rate (INF)	$\beta_4 < 0$
Trade Openness (TOP)	$\beta_5 > 0$
Gross Capital Formation (GCF)	$\beta_6 > 0$
Foreign Direct Investment (FDI)	$\beta_7 > 0$

Source: Author's Computation

socio-economic problems such as banditry, kidnapping, and insurgency, militate the choices of foreign investors towards committing their resources for industrial output growth in Nigeria (NBS 2021).

In a nutshell, the present slow industrial growth in Nigeria amidst increasing foreign inflows contradicts the assumption of extant economic theory, which states that output growth is caused by investment. Also, empirical arguments around the relationship between Foreign Direct Investment and industrial output in the case of Nigeria remained inconclusive. For example, studies from Akinmulegun and Oluwole [1] and Otalu and Keji (2015) posited that industrial output growth performances have not been proactive in Nigeria due to a lack of the necessary stimulus to grow. Whereas, Ayanwale [2] argued that slow economic growth was due to poor synergy between the foreign expatriate and local professionals in the cause of mobilizing available resources for productive growth. This study intends to investigate the nexus between foreign direct investment and industrial output growth in Nigeria between 1985 and 2020. This is to unravel further and address questions emerging from the problem statement; thus, what is the trend of FDI and industrial output growth in Nigeria? Is there any nexus between industrial sector growth and foreign direct investment in Nigeria? How does FDI impact industrial sector growth in Nigeria?

In this article, the first objective is to assess the trend of industrial output growth in Nigeria, while the second objective is empirically to evaluate the nexus between industrial output growth in Nigeria. Other post-estimation techniques would be carried out to establish the validity of the empirical techniques. By so doing, this study's findings would greatly benefit policymakers, government and international agencies. Also, this study's recommendations would be counted as a guide for the creation of general employment in the near future.

Furthermore, this paper is grouped into five sections: Section one explains the introduction and statement of the problems. Section two addresses the literature and empirical reviews. Whereas section three explains the research methodology. Meanwhile, section four reveals the analysis of the data collected and interpretations of the results. Finally, section five explains the conclusion and policy recommendations.

Main text

Literature review

Foreign direct investment is said to be the sum of liquid and non-liquid capital stock, investment of returns and short-term investments as reflected in a country's balance of payments over a designated period. At the same time, industrial sector output is the general output produced across all the sectors of the economy over a given period. The industrial sectors comprise both the real and oil sectors of the economy, which are charged with the economic responsibility of transforming raw materials into finished goods or intermediate goods, as the case may be. The industrial sector of any economy remains a source of FDI attraction. Obichukwu (2013) opined that industrial output is the products produced as a demonstration of total countrywide output.

The arguments on the nexus between foreign direct investment and industrial output in Nigeria

Agreeing with conceptual and theoretical intuitions, gains from foreign direct investment are expected to impact industrial output growth directly. This is because capital income from the FDI is meant to acquire the necessary machines and machinery to improve operations and other logistical chain activities [8]. Similarly, Ayanwale [2] put forward that foreign direct investment pushed output to rise due to the likelihood of synergy between the foreign expatriate and local professionals, which would give room for efficient utilization of human capital and physical capital. Also, Imoudu [9] resolved that the connections between FDI and industrial output growth can lead to fast diversification of the Nigerian economy. This is because more productive units would be improved through the real sector of the economy to complement the gains from the oil sector.

On the contrary, gains from FDI seem to be minimal, which had not reflected in the output growth in Nigeria, as it is extensively shown that the Nigerian economy has been affected by hyperinflation (NBS 2021). Hence, this might be connected with low productive capacity from the industrial sector, which was compounded by Nigeria's persistent expansionary monetary policy. Automatically, when few commodities are being chased by the large volume of currency in an economy, inflation subsists. From another perspective, slow industrial output growth in Nigeria might be the inability of the country's policymakers to move the economy towards diversification.

Theoretical literature

The neoclassical growth model of the Cobb–Douglas formula underpins this study, as postulated by Solow-Swan (1956), which is an economic model of a long-run unit of output growth that was set within the neoclassical framework. This model explains long-run output growth through capital accumulation, labour or population growth and technological progress as sources of productivity growth. As its core is a neoclassical (aggregate) production function, often specified to be of Cobb–Douglas type, which enables the model "to make contact with microeconomics decisions on productivity (Akinola

& Mboniga, 2019). This model allows technologically advanced aspects of productivity, which is associated with FDI technological transfers. Typically, the Cobb–Douglas model was independently designed by Robert Solow and Trevor Swan in 1956, and it superseded the Keynesian and Harrod–Domar models in this study.

Mathematically speaking, the Cobb–Douglas model is a nonlinear system consisting of a single ordinary differential equation that models the evolution of the per capita stock of capital, primarily through internal investments and FDI. Under this scenario, the implication of capital stocks on output growth can be seen through its effect on both domestic and foreign investments, which are eventually used as investments in an open model [3], Bokana & Akinola 2017; Akinola & Mbonigaba 2019).

Consequently, in Solow's model, all things being equal, investment via capital accumulation along with population growth are fundamental causes of output growth. "Higher investment rates lead to more capital per worker accumulation, especially when technology is being transferred between the countries." In the absence of technological change and innovation, an increase in capital per worker would not be matched by a proportional increase in output per worker because of diminishing returns. Hence capital deepening through technology transfer from FDI would raise the rate of return on output.

Empirical review

There have been diverse views regarding the link between the related topics to industrial output growth and foreign direct investment in Nigeria by previous scholars. Several conclusions were drawn from different perspectives on the link between cross-broader investments and productivity growth in the case of Nigeria. For example, Chandran and Krishnan [6] investigated the short and long-run dynamics of foreign direct investment on Malaysian manufacturing growth between 1970 and 2003. The writers used Autoregressive Distributed Lag (ARDL) approach to examine foreign direct investment dynamics on manufacturing performances. The results showed that FDI had short-run and long-run effects on the manufacturing performance in Malaysia. Henceforward, the authors recommend the need to restrategize foreign relations for further improvements in the Malaysian manufacturing sector. Similarly, Patience [22] assessed the effects of foreign direct investment on manufacturing output growth in West Africa. The study covered ECOWAS countries, with annual data drawn from the Apex Bank's reviews and bulletins. The author revealed that foreign direct investment significantly influences manufacturing output growth in West Africa.

Remarkably, Ebekozien et al. [3] adopted regression and Granger causality methods to examine the influence of foreign direct investment on the Nigerian construction industry. The study showed a descending trend of FDI in the construction sector of the Nigerian economy when compared with other sectors of the economy, like oil, tourism, and entertainment, among others. Whereas Orji, Anthony-Orji, Nchege, and Okafor (2015) used a linearized regression model through time series annual data drawn from Central Bank of Nigeria (CBN) statistical bulletins between 1970 and 2010 to disclose that foreign direct investment had a negative and significant impact on the manufacturing sector. Based on this outcome, the authors suggested that the inverse link can be overturned if the country can allow more FDI influx into the productive sectors of the economy in order to encourage local production by the home industries. However, Idoko and Taiga [8] came up with different results by examining the impact of FDI on the manufacturing sector output in Nigeria. The study revealed that foreign direct investment has a positive and insignificant impact on the manufacturing sector growth in Nigeria. The authors employed vector Autor-regressive and Johansen co-integration techniques to establish the minimum effect of FDI on the manufacturing sector growth. Okoli and Agu [15] adopted Ordinary Least Squares and Vector Error Correction Mechanism techniques to examine the effects of foreign direct investment influx on the manufacturing firms' performance in Nigeria for 40 years. The authors concluded that FDI inflows had a positive and significant influence on manufacturing firms in the long-run but insignificant effects in the short run. Hence, the authors recommended more government actions towards deliberate and sustainable policies, which could encourage FDI influx into the Nigerian economy to promote an efficient and viable environment for thriving manufacturing firms.

Bank-Ola, Akintaro, and Adediwura (2020) recently examined Nigeria's foreign direct investment and manufacturing output through the Autoregressive Lags technique between 1986 and 2018. The authors drew data on FDI, trade openness, gross fixed capital formation and inflation rate as independent variables while manufacturing output was proxy as the dependent variable. The findings revealed that foreign direct investment positively influences Nigerian manufacturing output.

In a similar study, Osabohien, Awolola, Matthew, Itua, and Elomien [17] examine the nexus between foreign direct investment inflow and employment rate in Nigeria through the Fully Modified Ordinary Least Squares (FMOLS) and the Johansen co-integration econometric techniques. Time series data were drawn straddling

through the period of thirty-two years in the analysis, in which the results showed that foreign direct investment has a significant and positive link with the level of employment rate in Nigeria. Meaning that a 1 unit rise in the inflow of foreign direct investment to the Nigerian economy brings about a 0.97 units rise in the level of employment. As a result, the authors suggested that the Nigerian economy should be viable through effective trade policies and frameworks, which can accommodate foreign direct investment into the Nigerian economy for future employment generation. Again, Oyegoke and Aras [20] studied the impact of foreign direct investment on economic growth in Nigeria through Ordinary Least Squares (OLS), using time series data between 1970 and 2019. The scholars discovered that foreign direct investment has a positive and significant impact on economic growth in Nigeria.

In conclusion, it has been observed that most of the previous works emphasize either the impact of foreign direct investment on economic growth or the effect of foreign direct investment on manufacturing sectors, but they seem to have shifted their focus away from the nexus between foreign direct investment and industrial output growth in Nigeria, which is the focus of this study. This study has accommodated mediating variables of industrial output, such as labour participation rate, to examine the level of synergy between foreign expatriates and local experts during the production process. How does this synergy catalyst industrial output growth? Which form part of the novel in this study. It is interesting to note that conclusions from this study would provide new insights into the body of the literature. Additionally, this study intends to bolster the empirical analysis by introducing other determinants variables, such as inflation rate, terms of trade, exchange rate, labour participation rate, and gross capital formation, to come up with a more encompassing technique to be adopted in the cause of our data analysis for robust findings.

Research methodology

This section discloses the necessary methodology concerning the nexus between foreign direct investment and industrial output growth in Nigeria. Also, other issues relating to model specification, theoretical framework, estimating techniques, and data sources are discussed in this section.

Model specification

Cobb Douglas Production function underpins this study as adopted by (Bokana & Akinola, 2017; [8], Akinola and Mbonigaba, 2019) with necessary modification by encompassing the AK model. The AK model, which is the modest endogenous model out of many proponents of the endogenous theories via unit input of labour and the AK model allows a constant savings rate of endogenous growth and assumes a constant, exogenous saving rate [23] &1990). Its components allow technological progress with a single parameter (normally denoted as A). Notably, the AK model is the unique case of a Cobb–Douglas function with a constant [8]. Cobb–Douglas function is expressed thus:

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

where Y = output, K = Capital input, L = Labor input, α and 1-α are the output elasticity of capital 1 and labour, respectively, and α is a number between 0 and 1. In another version, integrating Eq. (1) to form Y = AK, where K embodies both physical capital (K) and human capital (L). Therefore Eq. (1) is derived through:

$$Y = AK \tag{2}$$

In the above Eq. (2), A is the level of technology that can be transferred via foreign direct investment, which denoted volumes of capital investment in an economy. Therefore, output per unit of capital K/L and unit input of labour (Y/L) to output growth is:

$$Y/L = A.K/L, \quad \text{that is } y = AK \tag{3}$$

On this note, the model implicitly assumes that the average product of capital investment is equal to the marginal product of capital or the average product of labour unit is equal to the marginal product of labour unit, which is equivalent to A > 0.

Hence, the novelty and efficiency of this study rest on where the study built its model from the empirical models of Bokana and Akinola 2017; [8], Akinola and Mbonigaba 2019, with the necessary modifications for econometric analysis. Given this, the Eq. (1) is explicitly expressed as:

$$Y = F(A, K, L) \tag{4}$$

This is to allow the model for empirical analysis through econometrics data analysis. Where Y is the proxy as industrial output, A, K, and L capture the level of foreign direct investment into Nigeria. Hence, to achieve robust results, other control factors or determining factors are included: the exchange rate, inflation rate, terms of trade, labour participation rate and gross capital formation in the model. The Eq. (4) above is hereby specified as

$$\text{IDT} = f(\text{FDI}, \text{LPR}, \text{EXR}, \text{INF}, \text{TOP}, \text{GCF}) \tag{5}$$

So that we have the model in its transformed state as:

$$\text{IDT} = \beta_0 + \beta_1 \text{ FDI} + \beta_2 \text{ LPR} + \beta_3 \text{ EXR} + \beta_4 \text{ INF} + \beta_5 \text{ TOP} + \beta_6 \text{ GCF} + \mu \quad (6)$$

where: $IDT = Industrial\ Output$, $FDI = Foreign\ Direct\ Investment$, LPR=Labour Rate Participation, $EXR = Exchange\ Rate$, $INF = Inflation\ Rate$, $TER = Term\ of\ Trade$, $gcf = Gross\ Capital\ Formation$ μ=Stochastic error term, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$, =slope of the regression equation. The model is specified in its log-linear form:

Log IDT$=\beta_0 + \beta_1 logFDI + \beta_2 LPR + \beta_3 EXR + \beta_4 INF + \beta_5 logTOP + \beta_6 logGCF + \mu$.

Note: Series were linearly logged due to the large nature of some numbers; series in rate forms were not linearly logged.

Estimating techniques

Secondary data sources were considered for empirical analysis, using the study combined the use of descriptive statistical analysis, autoregressive distribution lag cointegration and error correction techniques. It tested for time series properties of each variable using Augmented Dickey-Fuller (ADF) unit root test approach.

Based on the pre-estimating unit root techniques that were carried out in the study, which are mixed with I(0) and I(1). In view of this, ARDL and ECM estimating techniques examine the short-run and long-run relationships between foreign direct investment and industrial output growth performance in Nigeria. So, the simple mathematical expression of the co-integrating relationship between the estimates under consideration becomes:

$$Yt = \gamma_{0j} + \sum_{i=1}^{p} \alpha_j Y_{1-i} + \sum_{i=1}^{R} \delta_j^{'} X_{1-i} + \mu j\boldsymbol{t}$$

where $\mathbf{Y}_{t\ is}$ a vector and variables in (**X**'t) are allowed to be purely I(O) or I(1) or integrated; α and δ are coefficients; γ is the constant; j = 1, 2, …k; optimal lag orders; μjt is a vector of error terms, i.e. unobserved zero mean white vector process (serially uncorrelated or independent).

Note: the lag length **P**, **R** may not be necessary the same: **P** Lag is used for the dependent variable, while **R** are used for exogenous variables where variables and coefficients are based on the theories supporting the model.

A priori expectation

The above theoretical assumptions explain that a priory expected to have a positive relationship between Industrial Output growth and all the independent variables [i.e. Foreign Direct Investment (FDI), Labour Participation Rate (LPR), Gross Capital Formation (GCF), and Trade Openness expected to have positive relationships except for Exchange Rate (EXR) and Inflation Rate (INF), where Consumer Price Index (CPI) was used to estimate inflation in the study. The INF = $\frac{CPI_x - CPI_y}{CPI_y} x100$ explains the percentage change in the price of a basket of goods and services consumed by households [7]. CPI_y implies Consumer Price Index at previous year, while CPI_x infers Consumer Price Index at current year, which are expected to have a negative link with Industrial Output based on economic intuition.

Concept of unit root test

This technique is employed to check for the availability of unit roots in the estimates, whether the series is stationary or not. According to the econometric rule, the null hypothesis of the Augmented Dickey-Fuller (ADF) technique estimation is that there is no unit root. If the ADF test statistic is greater than the 5 per cent critical value, we accept the null hypothesis. While if otherwise, the ADF test statistic is less than the 5 per cent critical value, we reject the null hypothesis and go ahead to conduct our analysis.

Concept of co-integration test

After the test for the order of unit root integration, the next step is to test for co-integration through the Bounding test. This test is used to check if a long-run relationship exists among the variables in the model [18],Idoko and Tiaga 2018).

Error Correction Model (ECM)

The Error Correction Model (ECM) shows the speed of adjustment from the short-run to the long-run equilibrium point. The a priori expectation is that the ECM coefficient must be negative and significant for errors to be corrected in the long run. It indicates that the higher the ECM, the higher the speed of adjustment.

Data requisites and sources

In this study, secondary data were drawn from the relevant sources. These data cut across different sub-sectors of Nigeria's economy, where foreign investment inflows, and exchange rates, among others, covered the period from 1985 to 2020. The relevant agencies where the data was collected were the Central Bank of Nigeria Statistical Bulletins 2020, the National Bureau of Statistics and the World Bank development index data bank.

Evidence from correlation matrix results showed that the options of the specified variables in the study are correct because they are free from possible incidence of multicollinearity (Table 2). It can be observed that the set of correlation coefficients are either moderately associated or weakly correlated, and none of the interactions revealed strong association-ship. Also, an outcome of

Table 2 Correlation matrix

	idt	fdi	exr	top	gcf	inf
idt	1.0000					
fdi	0.2699	1.0000				
exr	−0.1683	−0.0682	1.0000			
top	0.0913	0.0426	0.0661	1.0000		
gcf	0.1941	0.0423	−0.0017	0.1133	1.0000	
inf	−0.1969	−0.1812	−0.3232	−0.5688	−0.0434	1.0000

Source: Author's computation

this nature justifies the right choice of the explanatory variables versus the dependent variable. Hence, it is evident that there is a correlation (relationship) between the dependent variable idt and all the independent variables (fdi ex-top gcf inf). Notably, the correlation outcome among the key variables idt and the explanatory variables are both positive and negative, which conform to the extant economic theory that formed our apriori expectation. Generally, the neoclassical theory suggests that a rise in capital stock, such as investment, can cause a rise in output growth, all things being equal (Solow 1956).

Empirical data analysis

This study employed time series data for the investigation between FDI and industrial output growth in Nigeria between 1985 and 2020 to evaluate the specified models in the study.

Unit root and statistical attributes in Table 3 represent all the estimates in the model. It showed the mixture of variables at the level and at the first difference for each of the unit-root tests carried out in the model. The null hypothesis states that there is a unit root in each of the series. That is, some of the variables are stationary at level, while some are not. Therefore, the null hypothesis cannot be rejected because the ADF statistic is greater than the critical value at various significance levels. Augmented Dickey-Fuller reveals that IDT, LPR, EXR, INF, TOP, GCF and FDI are integrated of order one and zero, i.e. I(1) and I(O). In view of this, the condition for Autoregressive Distributed Lags and Error Correction Mechanism techniques have been met. The next is to test for lag length criteria and the Bound test.

Table 4 disclosed the lag length selection outcomes from the variables "*" points out lag order as selected according to the criterion. The criterion order was carried out at a 5% significance level on each test. The study compared five alternative methods of lag length selection such as the sequential modified LR test statistic (LR); final prediction error (FPE); Akaike information criterion (AIC); Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). The outcomes from this selection criterion revealed that lag length two (2) of the Akaike information criterion (AIC) is the most appropriate for the estimated model in the study. It was premised on the fact that 61.09850* is the least figure among the suggested information criterion under the lag (2) row.

Bound test

The Bound test result was adopted in the study to check for long-run relationships or whether co-integration exists among the series. Thus, given the unit root test result above, the most appropriate co-integration test is the Pesaran Bounds test. This is because the test allows the combination of fractionally integrated variables, i.e. combines variables of different orders of integration. The Bounds Cointegration test result is provided thus:

Table 3 Unit root tests results

UNIT ROOT TEST	ADF T-STATISTICS	ORDER OF INTEGRATION	PROB. VALUE
Industrial Output (IDT)	−5.8682	I(0)	0.0000
Foreign Direct Investment (FDI)	−6.9108	I(0)	0.0000
Exchange Rate (EXR)	−5.6475	I(1)	0.0000
Inflation Rate (INF)	−4.5208	I(1)	0.0014
Trade Openness (TOP)	−5.6295	I(0)	0.0000
Gross Capital Formation (GCF)	−8.9938	I(0)	0.0000
Labour Participation Rate (LPR)	−5.7269	I(1)	0.0000

Source: Author's computation

Table 4 Lag length selection outcomes from the indicators between 1985 and 2020

VAR Lag Order Selection Criteria						
Endogenous variables: IDT, FDI, EXR, INF, TOP, GCF and LPR						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	− 1117.768	NA	1.28e + 20	66.16281	66.47706	66.26998
1	− 1003.984	174.0230	3.01e + 18	62.35197	64.86598*	63.20932
2	− 933.6745	78.58073*	1.27e + 18*	61.09850*	65.81226	62.70603*

Source: Author's computation

*indicates lag order selected by the criterion

AIC: Akaike information criterion, FPE: Final prediction error, LR: sequential modified LR test statistic (each test at 5% level), SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

Table 5 ARDL bounds test

Test Statistic	**Value**	**k**
F-statistic	5.4958	6
Critical value bounds		
Significance	**I(0)Bound**	**I(1)Bound**
10%	2.12	3.23
5%	2.45	3.63
2.50%	2.75	3.99
1%	3.15	4.43

Source: Author's computation

The ARDL Bounds test result in Table 5 showed the assumption of weak homogeneity on industrial output, labour participation rate, exchange rate, inflation rate, trade openness, gross capital formation and foreign direct investment. The hypothesis of no long-run relationship can be rejected at 5% significant levels as the F-statistic for the model is greater than 5% of both I (0) and I (1) bounds of 2.39 and 3.38, respectively. Hence, the long-run relationship between industrial output and labour participation rate, exchange rate, inflation rate, trade openness, gross capital formation and foreign direct investment subsists.

Cointegrating autoregressive distributed lags analysis

This subsection presents the result obtained from the co-integrating Auto-regressive Distributed Lags (ARDL-Model), unrestricted error correction model and the ARDL long-run (static) model are displayed in Table 6. With this outcome, the researcher tried to examine both the short-run and the long-run relationships between industrial output, labour participation rate, exchange rate, inflation rate, trade openness, gross capital formation and foreign direct investment.

The results obtained from Table 6 revealed a positive relationship between IDT and foreign direct investment (FDI), inflation rate (INF), labour participation rate (LPR), lag of gross capital formation (GCF), trade openness (TOP) and two years lag of exchange rate (EXR).

At the same time, TOP disclosed a negative relationship with IDT. Notably, four of the variables, i.e. previous year's industrial output-IDT(-1), current year foreign direct investment-FDI, previous year's exchange rate-EXR(-2), where industrial output growth is inelastic to EXR at about 0.67 degree of responsiveness to change in exchange rate, hence the exchange is weak in attracting productivity growth via foreign inflows, labour participation rate-LPR and current and previous years inflation rate-INF were significant at the five per cent level, ten per cent level respectively within the short and the long run in the model, while variables of GCF and TOP are not significant across all the three conventional levels. Hence, the cointegrating equation is expressed thus;

Table 6 ARDL and error correction outcomes

Variables	Coefficient	Std. Error	t-Statistic	Prob.*
D(IDT(-1))	– 0.31776	0.175345	– 1.81219	0.0950
D(FDI)	0.646131	0.317691	2.033837	0.0570
D(EXR(-2))	0.668432	0.112803	5.925677	0.0000
D(LPR(-1))	– 0.302348	0.103863	– 2.911040	0.0093
D(GCF)	– 0.036245	0.046294	– 0.782922	0.4439
D(GCF(-1))	0.267522	0.045075	5.935077	0.0000
D(INF)	0.235221	0.074247	3.168104	0.0053
D(INF(-1))	– 0.120516	0.054713	– 2.202673	0.0409
D(TOP)	– 0.000126	0.000169	– 0.743744	0.4666
CointEq(-1)*	– 0.824432	0.117462	– 7.018701	0.0000

Source: Author's computation, 2023: (E-views 10). CointEq(-1)* implies speed of adjustment. Prob.* explains coefficients of probability

$$\begin{aligned} \mathrm{IDT} = &-9.5253 - 2.0024 * \mathrm{FDI} + 0.1043 * \mathrm{EXR} \\ &+ 0.6822 * \mathrm{INF} + 0.0035 * \mathrm{TOP} - \\ &(-4.726423)\ (2.216448) \\ &(-1.559050)\ (-1.944513) \end{aligned}$$

$$0.0678 * LPR + 0.8505 * GCF\ (-1.908587)\ (-0.367467)$$

Note: *The figures in parenthesis are the t-statistics results.*

From the model outcomes, there exist long-run effects of FDI subsists on industrial output in Nigeria. That is, foreign direct investment and labour participation rate have long-run significant effects on Nigerian industrial productivity growth. Whereas data from inflation rate and gross capital formation showed insignificant long-run effects on Nigeria's industrial output paths. Notably, when there is long-run nexus, the Engle-Granger Theorem states the need for encompassing power of the error correction mechanism over other forms of dynamic specifications. Hence, it is pertinent to estimate the Error Correction Mechanism results in Table 6, as indicated that the estimated ECM in the models adjusts at 82.4% speed. The error Correction Mechanism calculates the speed of adjustment from the short run to the long run. The estimated models in the study can adjust from short run to long run at a top speed of 82.44 high. This figure implies that the models can quickly re-adjust from unexpected disequilibrium points at some points to equilibrium points within the shortest possible time. Hence, with these results, the estimated models in the study are valid and consistent economic intuitions. In addition, different post-estimation analyses were conducted to back the validity of our empirical findings.

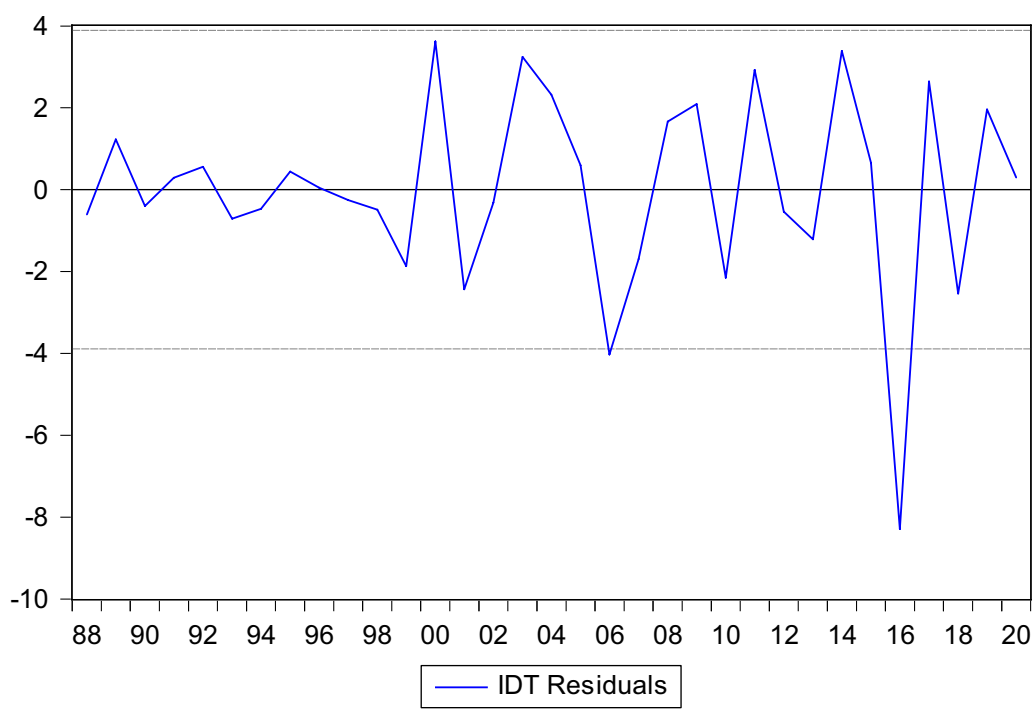

Fig. 1 Residual test

Findings from diagnostics tests

Evidence from Fig. 1 reveals that the residual series from the result revolves around the mean. The Heteroskedasticity Test and Breusch-Godfrey Serial Correlation (LM) test, and Breusch-Pagan-Godfrey Heteroskedasticity test suggest that we cannot reject the null hypothesis that the model is free from autocorrelation and Heteroskedasticity. Since the probability values are not statistically significant at any conventional level, which means that the research models are free from any form of outliers and autocorrelation. The CUSUM test was conducted to test the stability of our models in the study. The outcome from CUSUM statistics disclosed consistency and stability in the empirical models adopted in the study. Also, the trend of the CUSUM square in Fig. 3 showed that the previous post-estimation tests of the models in the study were stable and valid over time. The implication of this is that our results are consistent and valid.

Empirical findings and discussion

The results obtained from the Autoregressive Distributed Lags in Table 4 explained a direct link between Industrial Output (IDT) and Inflation (INF), Labour Participation rate (LPR), Gross Capital Formation (GCF) and the Exchange Change rate (EXR), of the previous year. While TOP disclosed a negative relationship with IDT. Notably, four of the variables, i.e. previous year's industrial output-IDT(-1), previous year's exchange rate-EXR(-2), current year's labour participation rate-LPR and current year foreign direct investment-FDI were significant at a five per cent level and ten per cent level respectively, within the short and the long run in the model, while variables of INF and TOP are not significant across all the three conventional levels. From the long-run results, there exist long-run effects of FDI subsists on industrial output in Nigeria. That is, foreign direct investment and labour participation rate have long-run significant effects on Nigerian industrial productivity growth. Contrariwise, data from inflation rate and gross capital formation displayed insignificant long-run effects on the Nigeria's industrial output paths. Notably, the Engle-Granger Theorem is employed to estimate the error correction mechanism over other forms of dynamic specifications when there is long-run nexus. Hence, it is pertinent to estimate the Error Correction Mechanism results as presented in Table 4, which indicates that the estimated models adjust at 47.2% speed. Error Correction Mechanism calculates the speed of adjustment from the short run to the long run. The estimated models in the study can adjust from short run to long run at a top speed of 47.174 high. This figure implies that the models can quickly re-adjust from unexpected disequilibrium points at some to equilibrium points within the shortest possible time. Hence, with these results, the estimated models in the study are valid and consistent economic intuitions. The Nigerian industrial sector poses challenges that are predominantly connected with external shocks in which the industrial

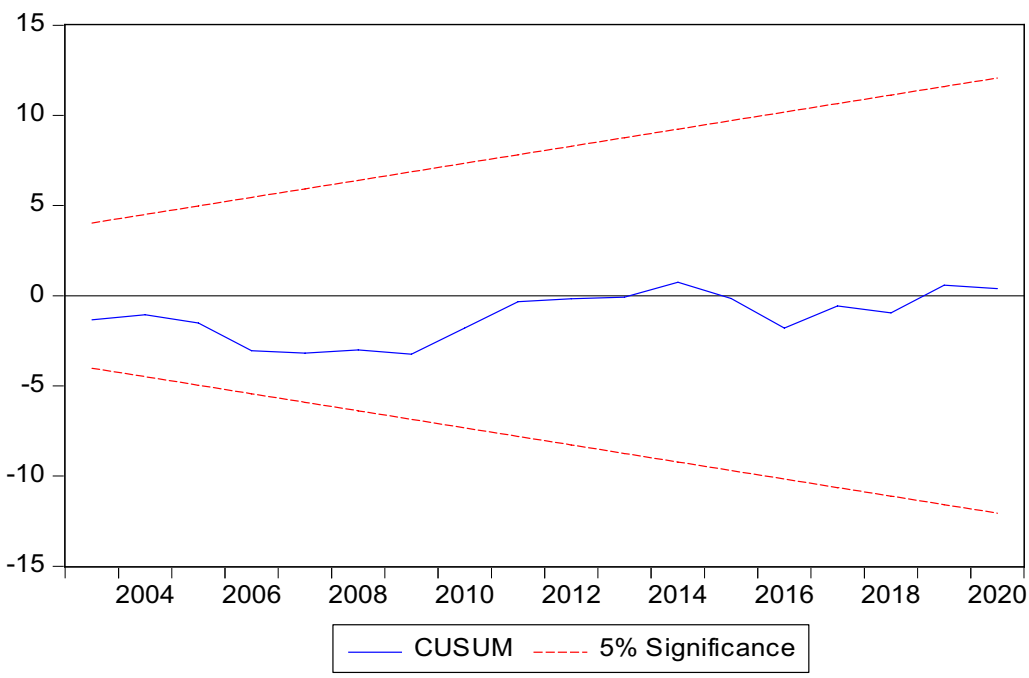

Fig. 2 Model stability test 1

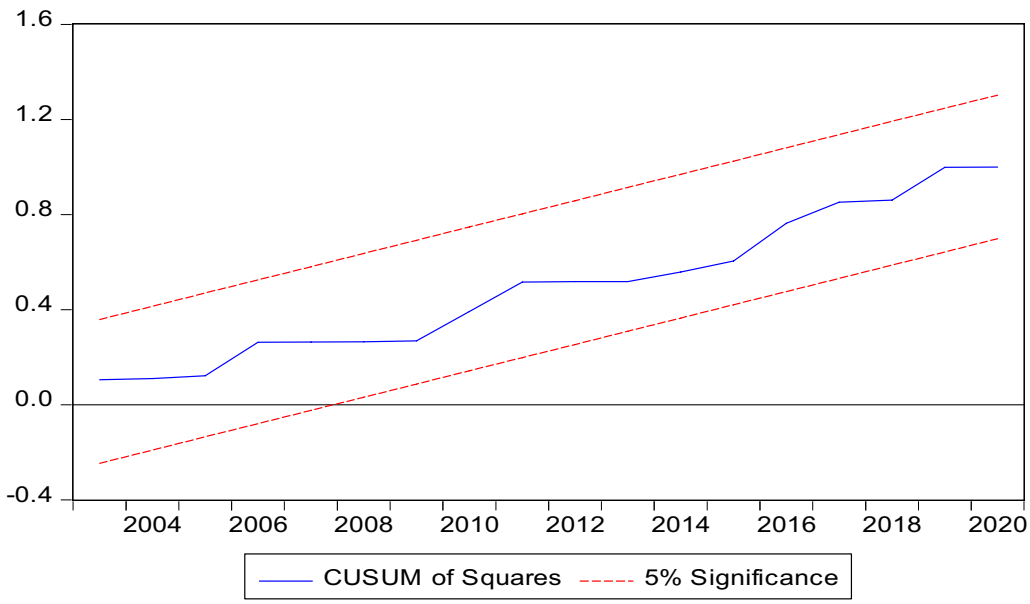

Fig. 3 Model stability test 2

Table 7 Heteroskedasticity Test: Breusch-Pagan-Godfrey Test

F-statistic	Obs*R-squared	Prob. F(20,12)	Prob. Chi-Square(20)
0.2284	9.0973	0.9982	0.9818

Source: Author's computation, 2023. Obs*R-squared denotes observation of R-square of Heteroskedasticity

Table 8 Breusch-Godfrey Serial Correlation LM Test

F-statistic	Obs*R-squared	Prob. F(2,16)	Prob. Chi-Square(20)
0.219433	0.907694	0.8054	0.6352

Source: Author's computation, 2023. Obs*R-squared denotes observation of R-square of Serial Correlation

performance adjusts quickly to these foreign influx shocks.

Further tests revealed the validity of the models adopted in the study.

It is pertinent to check the efficiency, validity, and consistency of the models employed through the necessary statistical rules. For example, Fig. 1 and 2 tests suggest that the residuals for both models are normally distributed since the probability value is greater than 5% significant level. Hence, the hypothesis of normal distribution for residuals cannot be rejected. The Breusch-Godfrey Serial Correlation (LM) test suggests that the null hypothesis of autocorrelation cannot be rejected since the probability value is greater than 5% critical value. Also, the Breusch-Pagan-Godfrey Heteroskedasticity test revealed that our model is free from possible Heteroskedasticity. The CUSUM stability test showed that our model specification is stable, reliable and valid over time. Also, the trend of the CUSUM square in Fig. 3 corroborates the results from the previous post-estimation tests that our models are stable and valid over the time lags. Figures 2 and 3, respectively, demonstrated that both diagrams of stability tests are within 5% of their critical boundaries. This settles that our model is stable and, therefore, reliable for the forecast (Tables 7 and 8).

Comparison of inferences with previous empirical studies

Consequently, the salient facts emerging from the study showed that FDI has a time-path influence through short-run and long-run on industrial output growth in Nigeria. The implication is that foreign direct investment has a time-path link with industrial output, catalyzing industrial productivity growth in Nigeria. Notably, the findings from this study are different from the previous studies, like Otalu and Keji (2015), Okoli and Agu [15] and Idoko and Taiga [8]. For example, Idoko and Taiga [8] adopted Vector Auto-regressive and Johansen co-integration techniques to conclude that foreign direct investment has an insignificant impact on the manufacturing sector growth in Nigeria. Also, Okoli and Agu [15] adopted Ordinary Least Squares and Vector Error Correction Mechanism techniques to conclude that foreign direct investment has an insignificant short-run—effect on Nigerian manufacturing firms' performance. Meanwhile, conclusions from Chandran and Krishnan [6] and Oyegoke and Aras [20] corroborate the findings from this study but with a different focus and approach. For

instance, Chandran and Krishnan [6] adopted Autoregressive Distributed Lag (ARDL) and cointegration techniques to conclude that foreign direct investment has significant effects on Malaysian manufacturing growth between 1970 and 2003. Also, Oyegoke and Aras [20] used Ordinary Least Squares (OLS) to submit that foreign direct investment has a positive and significant impact on economic growth in Nigeria.

Conclusion and policy recommendations

The study examined the nexus between foreign direct investment and industrial output growth in Nigeria, using the ARDL approach spanning annual time series data from 1985 to 2020. To analyze how foreign inflow determines industrial productivity performances in the case of Nigeria.

Discoveries from this research generally resolved that there are short-run and long-run relationships between foreign direct investment and industrial output growth in Nigeria. It can also be deduced that trade openness has negative effects on the Nigerian industrial output growth, in which labour participation rate and foreign direct investment have a significant long-run impact on the industrial output performance in Nigeria. The coefficient estimates of gross capital formation, inflation, and the previous year's exchange rate directly influence industrial output growth with minimum significant effect. Moreover, it was established that Bound test confirmed the cointegration of the variables in the model. That is, there are both short and long nexus between foreign direct investment and industrial output growth in Nigeria.

Based on the findings' outcomes, the study recommends policy guides that are necessary towards addressing the challenges bedevilling improved industrial productivity in Nigeria. In view of this, the study recommends the following policies for quick implementation in Nigeria for industrial output growth. Firstly, the government should redesign international trade laws to address persistent leakages across all the country's borders. By so doing, the local investment in productivity goods would rise without external shocks.

Secondly, since no country is an island on its own, hence, there is a need to redesign the protectionist law in the country through export drive policy support. Thirdly, the government should promote industrialization via the localization of industry in Nigeria. Importantly, the localization of industry should be prioritized across the geo-political zones in Nigeria to escalate output growth. Finally, there is a need for improved and remodelled international terms of trade agreements**.** Trade bargaining and bye lateral agreements should be well coordinated and properly transmitted to general productivity growth. On this note, the Nigerian government should conduct training and re-training exercises for its agencies on the necessary skills needed to achieve better trade agreement terms that would attract better foreign direct investment into Nigeria. Hence, this would guarantee improved output growth. Notably, this recommendation corroborates the views of Otalu and Keji (2015), Oyegoke and Aras [20], Osabohien, Awolola, Matthew, Itua, and Elomien [17].

Abbreviations

ARDL	Autoregressive distributed lags
ECM	Error correction mechanism
FDI	Foreign direct investment
LPR	Labour rate participation
EXR	Exchange rate
INF	Inflation rate
TOP	Trade openness
GCF	Gross capital formation

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Author contributions

I, SAK did everything in the research article-from introduction to conclusion and recommendations.

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Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

I hereby agreed that my submitted manuscript-: "Industrial Output Growth and Foreign Direct Investment in Nigeria." will be published by your firm.

Competing interests

There is no competing interests at all.

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