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Article

Human Capital Development and Industrial Sector Performances in Nigeria. An Error Correction Mechanism Approach

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Abstract: This study examines the relationship between human capital development and industrial sector in Nigeria from 1980-2024. Industrial sector was used as the independent variable in the model for the study while the dependent variables are government expenditure on education, government expenditure on health, mortality rate and labour force. The techniques applied are the Ordinary Least Square of multiple regression analysis, unit root test, co-integration tests and error correction mechanism. Unit root results revealed that the variables are integrated of order 1(0) and 1(1). The study also discovered that a long run association among the variables used subsists. The result of the R2 is 58 per cent indicating that the degree of association between industrial sector and human capital development is 58 per cent. Again, the stability tests confirmed that stability was found given the result of the CUSUM and CUSUM sum of square tests. The ECM result is 51 % meaning that it can adjust speedily from its long run equilibrium to the short run equilibrium. The study concludes that human capital development promotes industrial sector in Nigeria Finally, the study thus calls for appropriate investment in human capital development through increment in budgetary allocation to education and health aimed at bringing the desirable growth level in the industrial sector of the economy.

Keywords: Education, Health, Mortality Rate, Labour Force, Human Capital Development

1. Introduction

Human capital plays a vital role in the expansion and sustainability of the industrial sector as a critical factor of production, which includes the entrepreneur and labor (Anugwu and Nwosu, 2021). Alluding to this view, Attahir, Ahmad and Abdullahi (2020) opine that enhancing industrial sector growth and economic development requires human capital development. Conceptually, the knowledge, skills, talents, and experience within every worker denote their human capital (Ezeliora, Nwakobi and Aguh, 2017, Adeyemi and Ogunsola, 2017). Human capital development (skilled workforce, education, health) is crucial for Nigeria's industrial sector performance, with studies showing positive links, though results vary: education investment generally boosts long-term growth, while health's impact is inconsistent; increased government spending, better training, and infrastructure are key recommendations, alongside fostering innovation for enhanced productivity and competitiveness in manufacturing and beyond (Popoola et al. (2019). Human capital drive national development in all countries around the world (Isola and Alani, 2012). Human capital

development (HCD), encompassing education, skills, and health, is crucial for Nigeria's industrial growth, driving productivity and innovation, but challenges remain with inconsistent investment, impacting performance as studies has shown that education spending boosts long-term industrial output while health's impact is mixed, needing focused government investment in infrastructure and quality training to align skilled workers with industry needs for sustainable growth and diversification away from oil (Ogunleye et al, 2017; Aza and Dodo, 2014). Hence, human capital development has become a central issue for policy making and parties engaged in economic development at both national and regional levels given the global economy's shifts towards more knowledge-based sectors such as manufacturing of ICT devices, pharmaceuticals and telecommunication and skills (Amadeo, 2016).

World Bank development indicators show that the industrial sector provided only 13% of Nigeria's total employment in 1991. This however, dropped to 10.86% in 2007 and rose to 12% in 2019. As employment in sectors experience drastic reduction, the services sector kept experiencing increase in its employment (Ogunleye et al, 2017). The employment rate in the service sector in 1991 was 36.7% and this increased to 43.61% in 2005 and 53.03% in 2019. Most previous studies on human capital development and its impact on Nigeria's economy have considered human capital development in individual sectors or on the Nigerian economy. Saka and Olanipeku (2021) examined the role of human capital in the relationship between industrialization process and growth in Nigeria. Okumoko et al. (2018) examined the dynamics of human capital development and industrial growth in Nigeria. James (2021) probed the association between human capital development, national security and agricultural growth in Nigeria. Human capital drive national development in all countries around the world (Isola & Alani, 2012). Hence, human capital development has become a central issue for policymakers and parties engaged in economic development at both national and regional levels, as the global economies shifts towards more knowledge-based sectors (Ibeinmo, Anyanwu, Adam, Obi and Yelwa, 2015; Kida and Angahar, 2020).

The relevance of the industrial sector remains crucial in any economy, considering its effectiveness in driving innovation, promoting economic growth and development, and alleviating poverty (Ezeliora, Umeh and Dilinna, 2020). Specifically, the industrial sector generates employment, improves trade performance, increases income level, and enhances the export competitiveness of an economy in the international environment (Uzodigwe, Umeghalu and Ozoh, 2019). The role of the industrial sector is more pronounced through the enhancement and steady transition of many developing economies from traditional productions and sectors such as agriculture to the curtain-edge manufacturing sector driven by technology and innovation (Ayeyemi, 2013). Empirical evidence has affirmed that the industrial sector maximizes a nation's factor endowments, thereby minimizing its dependence on the external sector for sustained growth and survival (Sullivan and Sheffrin, 2018; Ofuoma, Aniekwe, Edeme and Okotie 2021).

2. Research GAP

In other studies, Ifunanyachukwu (2019) assessed education, health expenditure and quality of life in Nigeria. Popoola et al. (2019) and Ogunleye et al. (2017) examined impact of human capital development on economic growth in Nigeria within the different time frames. In China, Xuewei et al. (2020) studied effects of government healthcare expenditure on economic growth in 31 provinces. Ethem and Merve (2021) considered effect of health spending on economic growth in Turkey. While these studies have analyze impact of human capital on economic growth; the dynamic nature of human capital and the need to continual update of literature inspired this study. The study thus chooses to examine human capital development and industrial sector growth in Nigeria from 1986 to 2025 with the inclusion of new variables. This study diverges from previous works built on the addition of other variables to depict human capital apart from education and health.

3. Theoretical Literature Reviewed

Human Capital Theory

Romer (1986) proposed the human capital idea. This idea holds that a workforce with higher levels of competence makes it simpler for a business or nation to use and apply new technical know-how, hence increasing the returns on training and education. This is due to the fact that education raises workers' skill levels, which in turn increases their productivity and efficiency. Additionally, this idea demonstrates how education raises workers' cognitive abilities, which in turn increases their production and efficiency. The idea that individuals invest in education or to expand their stock of human capabilities which may be created by combining intrinsic qualities with engagement in human beings was first proposed by Theodore, Schultz, Bucker and Mincer (Babalola, 2000). Spending on education, health, nutrition, and on-the-job training are a few examples of these investments. But only when gross investment surpasses depreciation over time, whether due to heavy or occasional usage, can the stock of human capital grow. According to proponents of the human capital hypothesis, investing in education is a constructive use of human capital, which is just as valuable as or even more so than investing in physical capital. Human capital theorists have demonstrated that people in low-skilled jobs are more productive when they possess a basic level of reading. They added that people in high- skilled professions and positions have higher marginal output when they get training that requires logical and analytical thinking in addition to technical and specialized knowledge. Furthermore, the more educational opportunities society has, the higher the level of economic growth and national production will rise. Broadly speaking, health facilities and services encompass all costs that impact people's life expectancy, endurance, strength, energy and vitality.

Output-Based Approach

The Output-Based theory of human capital is a conceptual framework within the field of human capital theory that emphasizes the importance of evaluating education and training outcomes based on the skills, knowledge and capabilities acquired by individuals rather than solely focusing on inputs such as years of schooling or training. The theory emphasizes the importance of assessing the actual skills, competencies and capabilities acquired by individuals through education, training, and experiential learning. It recognizes that the value of human capital lies in people's potential and productive ability to use their knowledge, skills, and abilities to support innovation, economic progress and societal development. The method's shortcoming is that students' efficacy may be evaluated following their involvement in production activities. Apart from using school enrollment rates and education achievement to express the current state of human capital, Romer (1990) proposed the Skilled-Adults to Total-Adults ratio to measure human capital stock in the national economy. This suggestion was based on the proposition that the number of a person's years of schooling rises in direct proportion to the number of his/her productivity. Thus, it illustrates that productivity with twelve years of schooling can be twelve times productive and can be positively correlated with an individual's productivity (Usman and Adeyinka, 2016).

Empirical Literature Reviewed

Beneinmo, Nwankwo and Ochuba (2024) study examined the effect of human capital development on industrial growth in Nigeria between 1990 and 2022. The study proxy industrial growth by industrial output while human capital development are government expenditure on health, government expenditure on education, literacy rate and life expectancy. The study made use of time series data sourced from National Bureau of Statistics (NBS) report and Central Bank of Nigeria (CBN) statistical bulletin while the major techniques of data analysis adopted Augmented Dickey Fuller statistic and Autoregressive Distributed Lag (ARDL) technique. The study revealed that while the literacy rate has a positive but insignificant impact on Nigeria's industrial production, government spending on health, education, and life expectancy has a positive and substantial impact

as well. The study concludes that Nigeria's industrial progress is significantly driven by the development of human capital. It was recommended among others that Nigerian government should upsurge its expenditure on healthcare infrastructure, particularly in industrial zones, in order to ensure that the workforce remains healthy and productive since it is believed that better healthcare will improve the overall well-being and productivity of workers, reducing absenteeism and enhancing industrial efficiency. Johnson, Oyeranm, Mijinyawa and Oyakhiromhe (2023) studied the effects of human capital development on Nigeria's industrial sector from 1981-2021. Unit root and co-integration testing, Auto Regression Distributed Lag Bound Test, Augmented Dickey-Fuller Test, and Ordinary Least Square (OLS) to carry out the study while data were sourced from the Central Bank of Nigeria Statistical Bulletin.

The results showed a negative relationship between the manufacturing value added and development of human capital. Additionally, exchange rate and manufacturing value added represent an almost zero correlation. Analysis of the results depicting the correlation between consumer price index and interest rate on the one hand and manufacturing value added on the other revealed that manufacturing value added exhibited a negligible positive link with the consumer price index and interest rate. The result similarly shows the large and positive affiliation between population growth rate and manufacturing value added. It is thus concluded that the variable is favourably correlated with the expansion of Nigeria's manufacturing sector in their study. *Azu and Ugboh* (2023) *study investigate the extent to which human capital investment has impacted on industrial sector performances in Nigeria from 1981 to 2022. An Autoregressive Distributed Lagged model was engaged to study the impacts of education investment, health investment, domestic credit to private sector and the cost of capital on industrial sector performance. The study found that government expenditure on education maintained positive and significant impacts on the measure of industrial sector performances while government expenditure on health exhibited negative and insignificant effect on industrial sector performances. This study recommended that government should increase the amount of expenditure on education and health sector alongside the percentage of its total expenditure accorded to these sectors as they require serious improvement, especially now that the over dependence on oil revenue is rapidly failing the country.*

Ihensekhein and Soriwei (2023) study assessed the impact of human capital on industrial sector growth in Nigeria from 1986 to 2020. The Autoregressive Distributed Lag co-integration method of estimation was applied in the empirical analyses to determine the impact of human capital variables on industrial sector growth. The study empirically discovered that government's recurrent investment in education had significantly negative short-run impact on industrial sector growth while in the long run, there was a significant positive effect. Government recurrent expenditure on health exposed short-run significant impact on industrial sector growth while in the long run, it was observed to be negative. The implication of this on the industrial sector is that for the desired level of industrial sector growth to be achieved, investment in education should be increased by government policy. The study submits that there should be a premeditated government investment in education and health to achieve the desired level of industrial sector growth in Nigeria in the nearest future. Saheed et al. (2021) examined public health expenditure and economic growth in Nigeria from 2000 to 2016 using Autoregressive distributed lag estimation techniques. The study revealed the existence of a long-run association between public health expenditure and economic growth. The study also found that, while there is no causal connection between public health expenditure and gross domestic product (GDP), there is evidence of long-run link between the two.

James (2021) studied the affiliation between human capital development, national security and agricultural sector growth in Nigeria from 1981-2017. The Autoregressive Distributed Lag model was used to estimate the association between the variables. The study discovered that there is no long run link between the variables. Saka and Olanipekun (2021) study examined the factors that impact industrialization in Africa using annual panel data from 1990 to 2018. The study employed the Two-Stage Least Square (TSLS) approach to avoid problems of endogeneity and to estimate the significant determinants of industrialization. The study found that foreign direct investment, total

natural resources, and financial development significantly and positively predicted industrialization. Trade openness had a significant and negative effect on industrialization. Human capital and inflation were not significant determinants of industrialization. The study thus establishes that a significant aspect of an economy's ability to industrialize is the synchronization of public policies in its external arrangements. Governments of various African economies should strive to augment foreign direct investment, preserve and explore more natural resources, and intensify financial development. Musa, Titilola and Ahuchaogu; (2021) assessed the contribution of human capital to Nigeria's industrial sector's expansion between 1981 and 2015. The result from the examination of the OLS regression results indicates that human capital is a variable that, over time, improves Nigeria's industrial sector.

The ECM results also show that Nigeria's industrial sector impacted in the short run by human capital development. This means that human capital development holds the potential of driving industrial sector growth in Nigeria but certain vital factors including government spending on education, primary and secondary education sub-sectors have negligible impact on the industrial sector of Nigeria. Obasanjo and Idogun (2020) investigated the impact of human capital development on real-sector growth in Nigeria from 1990 to 2018 using time series data to estimate the Error Correction Mechanism (ECM). The result of the Johansen co integration test discloses that there is a long-term association between human capital development and production growth in the two sectors studied. The study found that government spending on education and health caused increased output of Nigeria's oil and gas sector, but not the agricultural sector. Xuewei et al. (2020) studied effect of government healthcare expenditure on economic growth in 31 provinces in China from 2005 to 2017. The study engaged the panel data for the analyzes by constructing a spatial Durbin model, and the result from the analysis displays that government healthcare expenditure in China significantly and positively affects economic growth under three spatial weight matrices.

Model Specification

In this study, industrial sector output is the dependent variables while the dependent variables are government expenditure on education, government expenditure on health, labour force and mortality rate.

The functional model of the variables is specified as follows:

$$IDS = f(GXE, GXH, MTR, LBF).....(1)$$

And the econometric functional notation is

$$IDS_t = f(GXE_t + GXH_t + MTR_t + LBF_t + \mu_t).....(2)$$

Where

IDS = Industrial sector, GXE = Government expenditure, MTR = Mortality rate, LBF= Labour force, α_o = Intercept, $\alpha_1 - \alpha_5$ = Coefficients of the respective independent variables, U_t = Error term and T = Time frame

The ECM model is represented as

$$\Delta IDS = \beta_0 + \sum_{t=1}^{p} \beta_1 \Delta GXE_{t-1} + \sum_{t=1}^{p} \beta_1 \Delta GXH_{t-1} + \sum_{i=1}^{q} \beta_2 \Delta MTR_{t-1} + \sum_{i-1}^{q} \beta_3 \Delta LBF_{t-1} + \sum_1 t).....(3)$$

Where,

β_0 = constant parameter to be estimated, $\beta_1 - \beta_4$ are short run parameter, $\alpha_1 - \alpha_4$ are long run parameter, D = 1st difference parameter and $\sum_1 t$ = error term

Aprior expectation; $\beta_1 - \beta_4 > 0$

Unit Root Test

Table 1: The Augmented Dickey Fuller (ADF) unit root test is use to establish the stationarity of the time series data used in the study

Variables	Levels		First Difference		Order of Integration	P-value
	ADF Statistics	5% Critical Value	ADF Statistics	5% Critical Value		
IDS	-1.048907	-3.529758	-8.167176	-3.520787	1(1)	0.0000
GXE	-4.364292	-3.515523	-6.880059	-3.518090	1(0)	0.0062
GXH	-3.876087	-3.515523	-8.319269	-3.518090	1(1)	0.0000
IMR	-6.790714	-3.515523	-4.543982	-3.540328	1(0)	0.0000
LBF	-3.514633	-3.515523	-7.634847	-3.518090	1(1)	0.0000

Source: Author Computation from E-Views 2025* Level of significance at 5%

This study engaged the Augmented Dickey-Fuller (ADF) unit root test to check the order of integration of the variables and the results are presented above. From results of Augmented Dickey-Fuller (ADF) unit root test, it was observed that variables had mix order of integration i.e. order 1(0) and order 1(1). The rule is explicit on the order of integration whether they are integrated of order 1(0) or order 1(1), there is co-integration among the variables and thus, a long run relationship subsists among the variables.

Table 2: Johansen Co-integration test: Trace Statistic

Hypothesized		Trace	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.781331	106.9962	69.81889	0.0000
At most 1	0.395395	41.62786	47.85613	0.1694
At most 2	0.254006	19.99109	29.79707	0.4235
At most 3	0.130849	7.390444	15.49471	0.5327
At most 4	0.031137	1.360186	3.841465	0.2435

Source: Author Computation from E-Views 2025* Level of significance at 5%

Table 3: Johansen Co-integration test: Max-Eigen

Hypothesized		**Max-Eigen**	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.781331	65.36838	33.87687	0.0000
At most 1	0.395395	21.63677	27.58434	0.2396
At most 2	0.254006	12.60065	21.13162	0.4896
At most 3	0.130849	6.030258	14.26460	0.6093
At most 4	0.031137	1.360186	3.841465	0.2435

Source: Author Computation from E-Views 2025* Level of significance at 5%

The result of the Johansen co-integration tests presented submits that there is one co-integrating equation amongst the variables and is line with the rule. The existence of one co-integrating variables justifies the existence of co-integration among the variables from both the Trace Statistic test and Max-Eigen test. The rule states that even if there is the existence of one co-integrating variable, there is a long run equilibrium association in the model hence we conducted the Error Correction Mechanism test.

Table 4: ECM Short-run Result

Variable	Coefficient	Std. Error	t-Statistics	Prob
C	2.690275	2.689730	1.000203	0.3252
D(GXE)	-0.054216	0.323572	-0.167556	0.8681
D(GXE(-1))	-0.171515	0.218499	-0.784971	0.4386
D(GXE(-2))	-0.270459	0.253482	-1.066975	0.2945

D(GXH)	-0.360514	1.266971	-0.284548	0.7779
D(GXH(-1))	0.748810	1.292777	0.579226	0.5668
D(MTR)	0.026100	0.090157	0.289493	0.7742
D(MTR(-1))	0.003424	0.104894	0.032640	0.9742
D(MTR(-2))	0.001084	0.091175	0.011889	0.9906
D(LBF)	0.062973	0.283702	0.221969	0.8258
D(LBF(-1))	-0.169235	0.197954	-0.854922	0.3994
ECM(-1)	-0.507660	0.181332	-2.248137	0.0321
Adj R^2 = 0.245517	F*= 2.887482	DW = 1.843465		

Source: Author Computation from E-Views 2025* Level of significance at 5%

The Error correction sign which is negative is appropriate and suggests that for any shocks that would cause a drift away from equilibrium, the model has the inbuilt stabilizer to return or adjust back to equilibrium in the long run at a speed of about 51 percent. The coefficient of estimated result from the error correction mechanism (-1) has a negative value of -0.507660 or 51 percent which is significant given the t* value of -2.248137 with a probability level of 0.0321 at the 0.05 level of significance suggesting that the model will reach short-run equilibrium at a speed of 51 % every year. Thus, a yearly adjustment speed of 51 % may fix the mistake from the previous year. The F-statistic value of 2.887482 suggest that the overall model is statistically significant and hence good for policy forecast. Furthermore, the Durbin-Watson Statistic value of 1.843465 falls within the acceptable region and designates that the model is free of serial correlation problem (Dickey and Fuller, 1997).

Table 5: The OLS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-22.45258	16.52654	-1.358577	0.1819
GXE	0.491473	0.213067	2.306665	0.0263
GXH	0.722659	0.850776	2.509411	0.0407
IMR	-0.054830	0.146441	-0.374418	0.7101
LBF	0.630397	0.183737	3.430983	0.0514
R^2 = 0.579046	F* = 13.75558	DW= 1.818455		

Source: Author Computation from E-Views 2025. Level of significance at 5%

The R^2 was 0.579046 or 58 percent implying that human capital development and industrial sector output in Nigeria included in the model accounted for 60 percent of the variation in the study while other variables not included in the model accounted for the remaining 40 percent. F* value was 13.75558 and probability value of 0.000000 is significant at the 5% level of significance. Without serial correlation, the model would not work, according to the Durbin-Watson statistics of 1.818455, which is close to 2.

4. Discussion of Findings

Government Expenditure on Education and Industrial Sector Output in Nigeria

Government expenditure on education (GXE) is seen to have positive relationship with industrial sector output in Nigeria. The coefficient of GXE is 0.491473 units. This implies that 1 point increase in GXE increases industrial sector output in Nigeria by 0.491473 units. It is equally statistically significant given the t* value of 2.306665 and a P-value of 0.0263. Budgetary allocations to government expenditure on education should be improved. This can be achieved by providing free education access to schools for the impoverished citizen of this country, Nigeria.

Government Expenditure on Health and Industrial Sector Output in Nigeria

Government expenditure on health is seen to have a positive connection with industrial sector output in Nigeria. This is because the coefficient of government expenditure on health is 0.722659 units. 1 point increase in government expenditure on health increases industrial sector output in Nigeria by 0.722659 units. It is equally statistically significant given its t* value as 2.509411 and with a P-value of 0.0407. This implies that a unit increase in government expenditure on health will lead to an improvement in industrial sector output in Nigeria. Government should equally improve budgetary allocation on the health sector.

Mortality Rate and Industrial Sector Output in Nigeria

Mortality rate coefficient value appears with a negative sign of -0.054830. 1 point increase in mortality rate decreases industrial sector output by -0.054830 units. It is statistically insignificant given the t* value of -0.374418 with a P-value of 0.7101. By implication, as the country's mortality rate increases, industrial sector output declines. Government should strengthen efforts geared towards reducing mortality rate in Nigeria. This can be done by providing free medical access to the hospital by the indigent citizen of the country, Nigeria.

Labour Force and Industrial Sector Output in Nigeria

The coefficient value of labour force 0.630397 is positive. This means that 1 point increase in labour force by 0.630397 increases industrial sector output by 0.630397 units. Labour force impact on Nigeria's industrial output is positive and statistically significant given the t* value of 3.430983 with a P-value of 0.0514. These results suggest that the labour force will improve the more in terms of productivity if government can adequately address lingering problems of desired improvement in wages and salaries of workers and other relevant conditions of work.

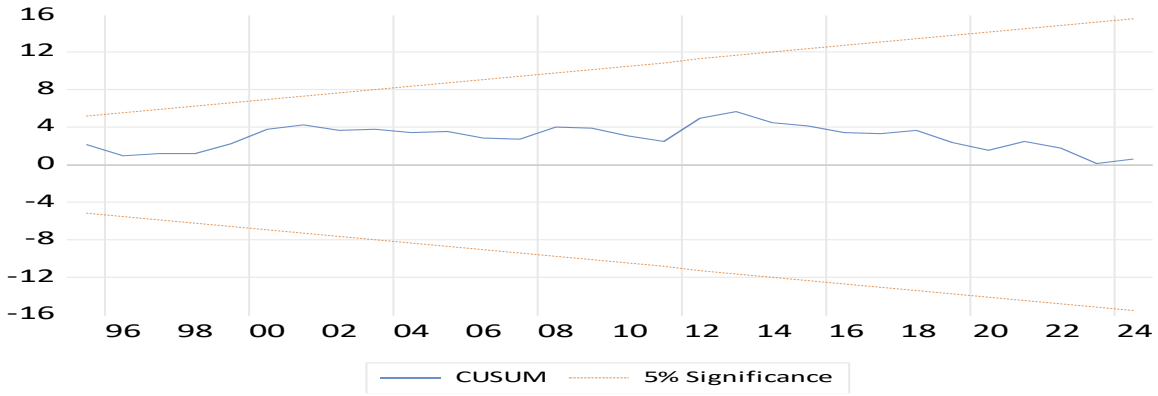
Table 6: Diagnostics result of Estimated Industrial Sector Test

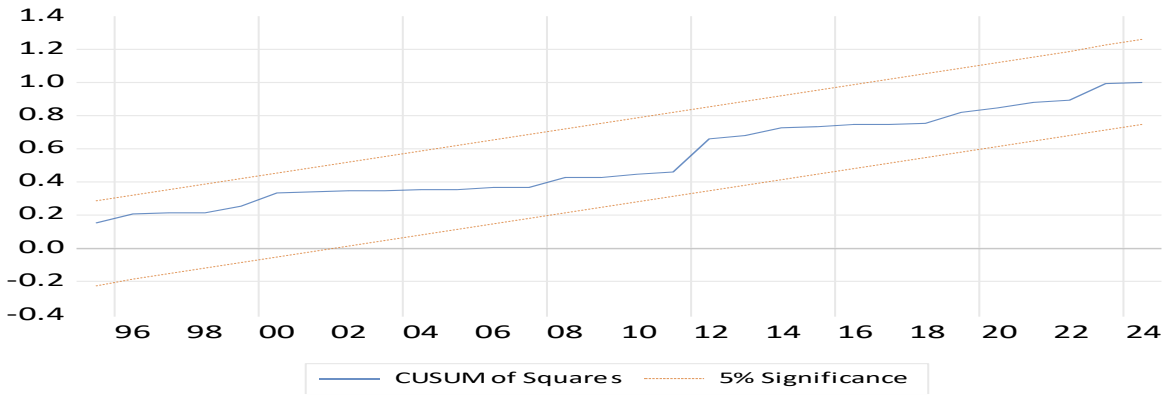
Test	F Stat	DF	Prob
Breusch-Godfrey Serial Correlation LM Tes	1.324842	F(2,14)	0.2520
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.634179	F(12,16)	0.5716

Diagnostics of the estimated industrial sector output is displayed in Table 6. The estimated model had a residual series that had no serial correlation. This was revealed by the Breusch-Godfrey Serial Correlation LM Test with F-statistic value of 1.324, which was not significant at 5% and meant that a hypothesis of no serial correlation in the residual series cannot be rejected. Thus, there is no serial correlation in the model since the probability value of 25% is greater than the 5% level of significance. The Breusch-Pagan-Godfrey heteroskedasticity test indicated that the F-statistic value 0.634 was not significant at 5 % level. As the probability value is 57% greater than the 5% level of significance. This inferred that there was no problem of heteroskedasticity in the industrial sector.

Structural Stability

The CUSUM and CUSUM of squares show that the model is structurally stable from 1980-2025.





5. Conclusion, Recommendations and Policy Implications

Human capital development promotes industrial sector in Nigeria as this has been empirically acknowledged in various literatures. Premised on this, the impact of different components of human capital development was analyzed as it affects the industrial sector. The coefficient of the error correction term is correctly signed with a negative sign and it displays that 51 per cent of the previous year's shocks in the industrial sector is offset every 6 months in the short run considering the significant association between the industrial sector and the variables employed in the study. The study consequently, calls for appropriate investment in human capital development through increment in budgetary allocation to education and health, to bring about the desirable growth in the industrial sector of the economy. Grounded on the estimation results of the industrial sector growth, the government expenditure on education and health in the result had a significant positive impact on industrial sector growth, thus government should enhance more allocations to the two sector, education and health. Finally, to enhance industrial sector growth, the desired level of industrial sector growth should be encouraged by all levels of government and to attain this, budgetary allocations to all levels of education should be surged by government through its policies. In nutshell, government as a matter of necessity should upsurge human capital through deliberate investment in education and health to attain anticipated level of industrial sector growth in Nigeria.

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