



INDUSTRIALISATION AND ECONOMIC GROWTH IN AFRICA: EVIDENCE FROM HIGHLY INDUSTRIALISED AFRICAN COUNTRIES

ABSTRACT

This study examines the impact of industrialisation on economic growth in Africa, with particular attention to highly industrialised countries. Panel data of 20 sampled nations were sourced from the World Bank's World Development Indicators, covering the period from 2002 to 2024, and Panel fixed-effects estimation with Driscoll–Kraay standard errors was employed. This estimation technique is appropriate given evidence of heteroskedasticity, first-order serial correlation and cross-sectional dependence in the panel data. Economic growth, measured by GDP, is specified as the dependent variable, while industrial output constitutes the principal explanatory variable. Lagged GDP, foreign direct investment, value of merchandise exports and exchange rate are included as control variables. The empirical findings indicated that industrial output has a positive and statistically significant effect on economic growth among the highly industrialised African countries. More importantly, this finding supports the view that industrial expansion contributes to structural transformation by increasing productivity, creating employment, promoting technological progress, and strengthening linkages with other sectors of the economy. The study concludes that industrialisation constitutes an important pathway to economic growth in Africa. It is recommended that governments should continue to prioritise industrialisation as a central pillar of national development strategies. Public investment should focus on expanding manufacturing capacity, agro-processing, mineral beneficiation and value-added production to reduce dependence on primary commodity exports.

Keywords: Industrialisation; Economic Growth; Industrial Output; African Countries; Panel Data; Driscoll–Kraay Standard Errors.

1. Introduction

Industrialisation is central to Africa's development prospects, given the continent's abundant natural resources, youthful labour force, expanding markets, and rapid urbanisation (Szirmai, 2012). Its importance is reflected in the African Union's industrial development agenda, the Sustainable Development Goals, and the African Development Bank's Industrialise Africa initiative, which promotes industrial expansion and productive capacity (AfDB, 2022). Industrialisation involves the transition from predominantly agricultural and resource-based activities towards manufacturing and other higher-productivity sectors. This structural transformation reallocates labour and capital to more productive activities, thereby promoting aggregate productivity and economic growth (McMillan *et al.*, 2014).

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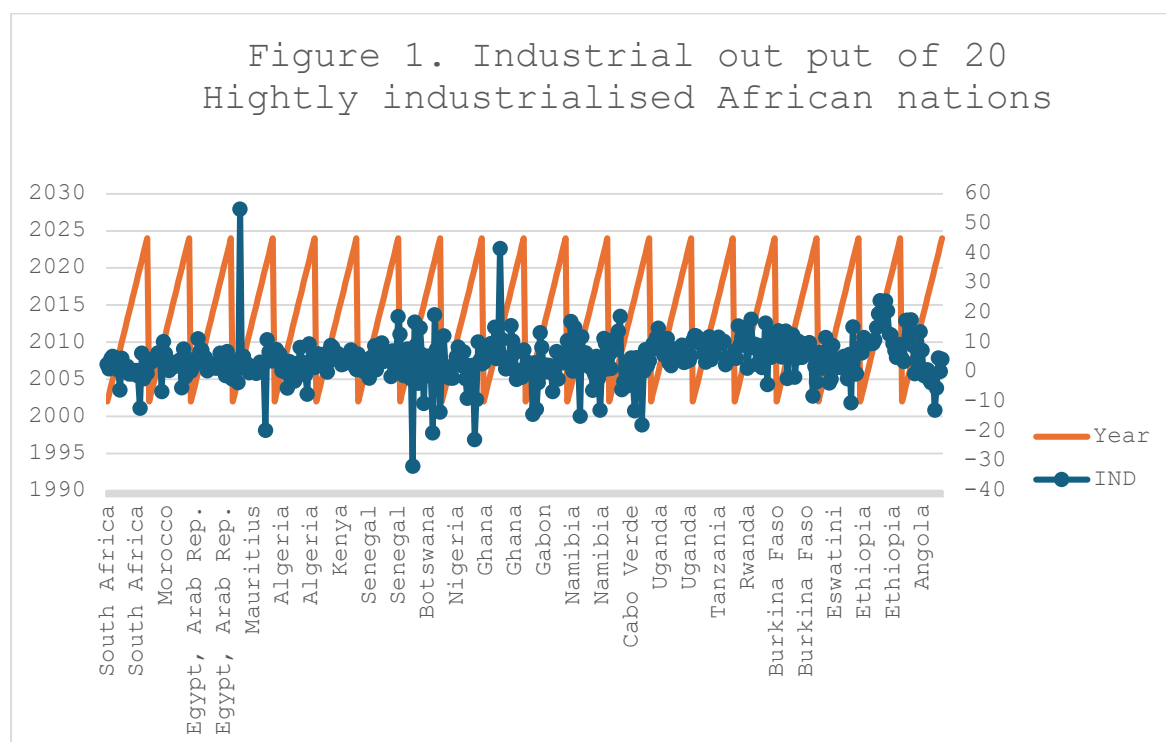
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In developing economies, industrialisation can stimulate capital accumulation, technological advancement, employment creation, productivity growth, and economic diversification (World Bank, 2021). Although manufacturing remains central to this process, contemporary structural transformation also encompasses the expansion of productive services. Previous studies emphasise that industrial development contributes to economic growth through increased productivity and manufacturing output (Krieger & Pearce, 2013; Szirmai, 2009). Furthermore, industrial activities can generate higher returns to labour than agriculture, while the movement of workers into industry may support improvements in agricultural productivity and aggregate income (Bolaky, 2011). Thus, industrialisation remains an important pathway to sustainable economic growth and structural transformation in Africa. Industrialisation is a key strategy for Africa's long-term economic transformation, promoting structural change through higher productivity, value addition, technological advancement, and employment creation. It extends beyond increased industrial output to encompass a sustained shift of labour and other productive resources from low-productivity sectors towards more productive activities (McMillan et al., 2014; World Bank, 2021).

Empirical evidence on the industrialisation–growth relationship in Africa remains mixed. Fanwell (2022) found a positive and significant relationship between manufacturing value added and economic growth in six SADC countries in both the short and long run. Conversely, Bakari et al. (2018) reported a negative long-run relationship between industrial exports and economic growth in Tunisia, with no short-run causal relationship. Similarly, Bennett et al. (2015) found that industrial output had a positive but statistically insignificant effect on Nigeria's economic growth. These contrasting findings suggest that industrial expansion does not automatically generate economic growth, highlighting the need to examine the structural and institutional conditions under which industrialisation contributes more effectively to economic performance.

Industrialisation is a major driver of economic growth, facilitating the transition from agriculture to manufacturing and other higher-productivity activities. It promotes employment, capital accumulation, technological innovation, productivity, market expansion, and infrastructure development, thereby increasing national income and improving living standards (Crafts, 1985; Szirmai, 2009). UNECA and AUC (2013) identify productivity enhancement, job creation, technological development, investment, trade expansion, diversification, and structural transformation as key channels through which industrialisation supports economic growth. Thus, industrialisation extends beyond manufacturing expansion to encompass broader structural and technological transformation that sustains long-term development (Diao et al., 2021; Szirmai, 2009). Figure 1 illustrates the industrialisation trends in the selected African economies.



Source: Author's construct, 2026, using data from WDI.

Figure 1 illustrates industrial output trends across the 20 highly industrialised African countries during the study period. Generally, industrial output remained relatively high despite periodic fluctuations, suggesting sustained industrial activity and comparatively stronger productive capacity. These variations may reflect changes in global economic conditions, commodity prices, exchange rates, investment, and domestic policy. However, the general pattern indicates that industrial production was maintained at relatively high levels across the sampled economies. This provides a useful descriptive background for the subsequent econometric analysis, which examines the effect of industrialisation on economic growth while controlling for other macroeconomic variables.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature and highlights the study's theoretical and empirical foundations. Section 3 outlines the methodological approach, including the model specification, data sources, variable measurements, and estimation techniques. Section 4 presents and interprets the empirical results, while Section 5 discusses the findings and summarises the key insights emerging from the analysis. Finally, Section 6 concludes the paper and presents policy recommendations based on the study's findings.

2. Literature Review and Theoretical Framework

2.1 Theoretical Framework

The study is anchored in the Lewis dual-sector model of structural change, developed by Lewis (1954) in *Economic Development with Unlimited Supplies of Labour*. The model explains economic development as a process in which labour and other productive resources shift from a traditional, low-productivity agricultural sector to a modern, higher-productivity industrial sector. Lewis (1954) distinguishes between the subsistence sector, characterised by abundant labour and low productivity, and the capitalist sector, which comprises manufacturing and other commercial activities driven by profit and capital accumulation. The model argues that surplus labour can move from agriculture to industry with minimal loss of agricultural output, enabling industrial firms to expand production and employment. Furthermore, the reinvestment of profits in productive capital stimulates further labour

demand, capital accumulation, and economic growth. Thus, the Lewis model provides a theoretical basis for understanding industrialisation as a driver of structural transformation, productivity improvement, and sustained economic growth. The process continues while surplus labour remains available in the traditional agricultural sector, enabling industrial firms to expand employment without substantial wage increases. However, as surplus labour is gradually absorbed, labour becomes scarcer, and wages begin to rise, marking what Lewis (1954) describes as the turning point. The Lewis model therefore explains how industrialisation promotes structural transformation and economic growth through labour reallocation from low-productivity agriculture to higher-productivity manufacturing. This transition can enhance aggregate productivity, employment, income, capital accumulation, technological development, urbanisation, and supporting services. Consequently, the model provides a theoretical foundation for examining the contribution of industrialisation to economic growth in developing economies, particularly African countries.

2.2 Empirical Literature

Industrialisation promotes economic growth through value addition, employment creation, productivity improvement, and economic diversification. However, its growth effects may vary across African economies depending on their industrial structures and economic conditions. Previous empirical studies have employed different measures, datasets, and econometric techniques, producing mixed findings. This section reviews relevant panel and non-panel studies to identify existing research gaps and establish the contribution of the present study.

Fanwell (2022), using panel data for six Southern African countries from 1978 to 2019, found that manufacturing value added (MVA) positively influenced economic growth in both the short and long run. The study highlighted industrialisation as an important driver of structural transformation and sustainable development. In contrast, Bakari et al. (2018), examining Tunisia using annual data from 1969 to 2015 and employing Johansen cointegration, a Vector Error Correction Model (VECM), and Granger causality tests, found a negative long-run relationship between industrial exports and economic growth, with no evidence of short-run causality. The authors attributed the findings partly to structural weaknesses and inadequate economic planning. These contrasting results suggest that the growth effects of industrialisation vary across economic contexts, warranting further investigation into the conditions under which industrialisation promotes economic growth in African countries.

Evidence from Nigeria also reveals mixed effects of industrialisation on economic development. Victor (2022), examining industrialisation and rural development in Akamkpa Local Government Area using survey data from 200 employees, found both positive and negative effects on rural development. The study emphasised effective policies and human-capital development to improve technology adoption and productivity. Similarly, Bennett et al. (2015), using Nigerian annual data from 1973 to 2013, found that industrial output had a positive but statistically insignificant relationship with economic growth. In contrast, savings and net foreign direct investment significantly promoted growth, while inflation had a negative effect. The study recommended political stability and investment-friendly policies to strengthen industrial development and economic growth. In Ethiopia, Endawek (2024), analysing data from 1983 to 2021, found a negative and statistically significant relationship between manufacturing output and economic growth, attributing the result to constraints on manufacturing productivity and competitiveness. The study recommended immediate measures to improve manufacturing performance alongside long-term industrial policy reforms. Likewise, Kezia and Monametsi (2021), examining industrialisation strategies in Tanzania and Botswana through documentary analysis, identified weak policy implementation, poor institutional coordination, inadequate human-capital development, and limited investment in research and development as major constraints. They advocated stronger institutional coordination and greater investment in human resources and R&D. Collectively, these studies suggest that industrialisation does not automatically

translate into economic growth; its contribution depends on productivity, competitiveness, policy effectiveness, and institutional capacity. This reinforces the need to investigate how institutional quality shapes the growth effects of industrialisation across African economies.

Despite the strategic importance of industrialisation to Africa's development, existing empirical evidence is fragmented across individual countries and regional blocs and varies considerably in the measurement of industrialisation and econometric approaches employed. In particular, relatively limited attention has been given to highly industrialised African countries as a distinct group. This creates an important empirical gap concerning whether industrialisation continues to generate significant economic growth effects in economies that have achieved comparatively higher levels of industrial development. This study addresses this gap by examining the relationship between industrialisation and economic growth in 20 highly industrialised African countries using panel data sets from 2002 to 2024. The study therefore contributes to the ongoing debate on whether industrialisation remains an important driver of economic growth in relatively advanced African economies.

3. Methodology

3.1 Data Source and Technique of Analysis

This study employs secondary annual panel data covering 20 highly industrialised African countries for the period 2002–2024, which was sourced from the World Development Indicators and World Governance Indicators. The countries are: South Africa, Morocco, Egypt, Mauritius, Algeria, Kenya, Senegal, Botswana, Nigeria, Ghana, Gabon, Namibia, Cabo Verde, Uganda, Tanzania, Rwanda, Burkina Faso, Eswatini, Ethiopia, and Angola. The selection of countries and the classification into groups are based on the African Development Bank (AfDB, 2022) classification and the extent of industrial development and investment efforts recorded for the respective countries. The use of panel data provides the advantage of exploiting both the cross-country and time-series dimensions of the data, thereby allowing for a more comprehensive assessment of the relationship between industrialisation, institutional quality, and economic growth. The dependent variable of the study is economic growth, measured by the annual growth rate of real gross domestic product (GDP). The major explanatory variable is industrial output (IND). Foreign direct investment (FDI) and value of manufactured exports as a percentage of merchandise (VME) are included as additional explanatory variables to account for the role of foreign capital in promoting investment, technology transfer, and industrial development, while the official exchange rate (EXR) captures movements in the domestic currency relative to the US dollar.

The dependent variable, economic growth (GDP), is measured by the annual percentage growth rate of real GDP. Industrial output (IND) is measured by industry value added, including construction, expressed as an annual percentage growth rate; foreign direct investment (FDI) is measured by net FDI inflows as a percentage of GDP; value of manufacture exports (VME) is measured as value of manufacture exports as a percentage of merchandise, measuring the contribution of goods exports to economic activity and external-sector performance, while the official exchange rate (EXR) is measured in local currency units per US dollar (LCU/US\$) and captures movements in the domestic currency relative to the US dollar. The empirical analysis is carried out using the fixed-effects dynamic Driscoll–Kraay standard errors estimator, which is appropriate for estimating the models of the study while accounting for heteroskedasticity, autocorrelation and general forms of cross-sectional dependence, making it particularly suitable for macro-panel data involving African countries that may be exposed to common regional and global shocks. An interaction term between industrial output and institutional quality is included to examine the moderating effect of institutional quality. The

hypotheses are tested at the 5 per cent level of significance using appropriate econometric software. Econometric software such as STATA 17 was used in analysing the models of the study.

3.2 Model Specification

The empirical analysis for this study is based on a dynamic fixed-effects (DFE) panel-data model estimated with Driscoll–Kraay (1998) robust standard errors. The model is dynamic because it includes the lagged dependent variable (or lagged level of economic activity, depending on the empirical specification) to capture persistence in economic growth over time. The fixed-effects estimator controls for unobserved country-specific heterogeneity that is constant over time, while the Driscoll–Kraay covariance estimator provides robust statistical inference in the presence of heteroskedasticity, serial correlation and cross-sectional dependence. Following Baltagi (2021) and Wooldridge (2020), the general dynamic fixed-effects model is specified as:

$$Y_{it} = \alpha_i + \delta_t + \rho Y_{i,t-1} + X_{it}'\beta + \varepsilon_{it}, \quad I = 1, \dots, N; t = 1, \dots, T \quad (1)$$

where:

Y_{it} = dependent variable for country at time t ;

$Y_{i,t-1}$ = one-period lag of the dependent variable, capturing the dynamic nature of the model;

X_{it} = vector of explanatory variables;

β = vector of parameters to be estimated;

α_i = unobserved country-specific fixed effects;

δ_t = time-specific effects that capture common shocks affecting all countries;

ε_{it} = error term.

The parameter measures the persistence of the dependent variable over time, while the vector captures the effects of the explanatory variables on economic growth after controlling for unobserved country heterogeneity and common time effects. The inclusion of the time-invariant country-specific characteristics removes the influence of all time-invariant country-specific characteristics, whereas the time effects account for shocks that are common to all countries in a given period, such as global financial crises or commodity price fluctuations (Baltagi, 2021; Wooldridge, 2020).

Following Oyebanji et al. (2022), who incorporated industrial output, foreign direct investment, exchange rate, and other macroeconomic variables in examining industrialisation and economic growth, the present study extends the specification by explicitly incorporating institutional quality. This extension is also consistent with the New Institutional Economics perspective, which emphasises the role of institutions in shaping economic incentives, investment decisions, productivity, and economic performance. The basic model for Oyebanji et al. (2022) was specified as:

$$RGDP = f(IND, FDI, INT, EXCH) \quad (2)$$

Where RGDP represents the real GDP (%), IND stands for industrial output, FDI is foreign direct investment, INT is the interest rate, and EXCH is the exchange rate.

The updated version of the model for this study emphasises the value of manufactured exports as a percentage of merchandise (VME) and the official exchange rate (EXR), which captures movements in the domestic currency relative to the US dollar. These were added to other proxies of industrialisation in order to delve further into the effects of industrialisation on economic growth. The

lagged value of GDP (L_GDP) was also included to capture the dynamic effects of the dependent variable; the new modified implicit model is now specified as:

$$GDP_{it} = f(L_{GDP_{it}}, IND_{it}, VME_{it}, FDI_{it}, EXR_{it}) \quad (3)$$

However, this study used the GDP growth rate rather than the level of real GDP as the dependent variable because the objective is to assess the effect of industrialisation on economic growth. GDP growth, measured as the annual percentage change in GDP at constant prices, directly captures changes in real economic output over time (World Bank, n.d.; OECD, 2026). Unlike the level of real GDP, which primarily reflects the absolute size of an economy, GDP growth measures the rate at which economic activity expands or contracts. This distinction is particularly important for cross-country analysis because African economies differ considerably in economic size. Using GDP growth therefore facilitates comparison of economic performance across countries while reducing the possibility of conflating economic size with the rate of economic expansion. Accordingly, GDP growth rate provides a conceptually appropriate measure of the dependent variable for examining the growth effects of industrialisation in highly industrialised African countries.

For the purpose of this study, the empirical model is specified as follows:

$$GDP_{it} = \alpha_0 + \rho GDP_{i,t-1} + \alpha_1 IND_{it} + \alpha_2 VME_{it} + \alpha_3 FDI_{it} + \alpha_4 EXR_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

4. Results and Discussions

4.1 Descriptive Statistics

Descriptive statistics in panel data analysis provide a preliminary summary of the characteristics, distribution, and variation of the variables across countries and over time. It typically reports the mean, standard deviation, minimum, maximum, and number of observations. This helps identify differences in economic performance among countries, assess the extent of variability in the data, and detect unusual or extreme observations before conducting econometric analysis.

Table 1: Descriptive statistics estimation results

Variables	Mean	Std. dev.	Min	Max	Obs
GDP	4.517794	3.815519	-20.80528	15.84368	460
IND	4.338365	7.136563	-31.7484	54.91892	460
FDI	2.810803	3.046712	-8.766964	18.4907	460
VME	30.15774	25.64531	0.6581227	96.22484	460
EXR	389.1875	717.0957	0.7924171	3757.262	460

Source: Author's computation, 2026 using STATA 17.

Table 1 presents the descriptive statistics for the highly industrialised African countries. GDP growth averages 4.52%, while industrial output averages 4.34%, indicating relatively strong average growth in both economic activity and industrial production, although substantial variation exists across countries and over time. FDI averages 2.81% of GDP, while manufactured exports account for approximately 30.16% of merchandise exports, suggesting considerable differences in export structures across the sampled economies. The exchange rate records a mean of 389.19 local currency units per US dollar, with substantial dispersion. However, the wide ranges and standard deviations

across the variables indicate considerable cross-country and temporal heterogeneity. The analysis is based on 460 observations from 20 countries, providing an adequate panel for the subsequent econometric analysis.

4.2 Pesaran's cross-sectional dependence

Testing for cross-sectional dependence is essential in panel data analysis to determine whether error terms across countries are correlated and to guide the selection of appropriate estimation techniques. This is particularly important in multi-country studies, where economic shocks may spill across countries through trade, investment, financial markets, regional integration, and common global events. Pesaran's (2004) CD test evaluates the null hypothesis of cross-sectional independence against the alternative of cross-sectional dependence. The test can be applied to both fixed-effects and random-effects specifications to assess whether cross-country error dependence may affect the reliability of the estimation results.

Table 2: Pesaran's cross-sectional dependence test results

Test	Statistic		p-value	Decision
Pesaran CD test	F. e	8.404	0.0000	Reject the null
Pesaran CD test	R. e	9.028	0.0000	Reject the null

Source: Author's computation, 2026, using STATA 17.

Table 2 reports the results of Pesaran's cross-sectional dependence (CD) test for the study's model. The results showed that the null hypothesis is rejected for both the fixed-effects and random-effects specifications in the model, as all reported p-values are 0.0000, which is statistically significant at the 1% level. These results provide strong evidence of cross-sectional dependence among the highly industrialised African countries. This means that economic developments in one country are not completely isolated from developments in other countries in the sample. For example, changes in industrial output, GDP growth, foreign direct investment, and exchange rates in one country may be transmitted to other countries through regional and international economic linkages.

4.3 Panel Unit Root Test for Stationarity (second generation)

The stationarity of the variables is tested before regression estimation to avoid spurious relationships and unreliable statistical inference that may arise from non-stationary data (Granger & Newbold, 1974). Given the potential for cross-sectional dependence, the study employs the Breitung (2000) and Pesaran (2007) CADF/CIPS panel unit-root tests. Variables stationary at level are classified as integrated of order zero, $I(0)I(0)I(0)$, while those that become stationary after first differencing are classified as $I(1)I(1)I(1)$. The Breitung test is used to assess stationarity under cross-sectional independence, whereas the Pesaran test accounts for cross-sectional dependence among panel units.

Table 3: Panel Unit root test for stationarity estimation results

Variables	Pesaran's CADF test			Breitung Lambda Statistic		
	Level	1 st Difference	Order of Integration	Level	1 st Difference	Order of Integration
GDP	-5.587 (0.000)	-10.752 (0.000)	I(0)	-4.4496 (0.0000)	-6.4098 (0.000)	I(0)
IND	-5.272 (0.000)	-12.114 (0.000)	I(0)	-7.0774 (0.0000)	-10.4547 (0.000)	I(0)
FDI	-0.195 (0.423)	-8.156 (0.000)	I(1)	-2.2378 (0.0126)	-3.8101 (0.0001)	I(0)
VME	-2.282 (0.011)	-8.918 (0.000)	I(0)	-0.8427 (0.1997)	-7.0506 (0.0000)	I(1)
EXR	2.533 (0.994)	-2.035 (0.021)	I(1)	2.6262 (0.9957)	-3.0441 (0.0012)	I(1)

Source: Author's computation, 2026, using STATA 17.

Table 3 presents the second-generation panel unit root test results for the highly industrialised African countries using Pesaran's Cross-sectional Augmented Dickey-Fuller (CADF) and Breitung Lambda tests. The results indicated that GDP, industrial output (IND), and, depending on the test employed, the value of merchandise exports (VME) are stationary at level, I(0), while FDI and the exchange rate (EXR) generally become stationary after first differencing, I(1). The differences observed between the two tests, particularly for FDI and VME, reflect differences in their underlying test procedures and assumptions. Nevertheless, the combined evidence indicates that the variables are integrated at either level or first difference, with none exhibiting integration of order two, I(2). This mixed integration order suggested that the variables possess suitable time-series properties for subsequent panel-data estimation. The findings also demonstrate the importance of employing second-generation tests, particularly in a multi-country panel where cross-sectional dependence may arise from common economic shocks and regional linkages.

4.4 Test for multicollinearity (Correlation Matrix and Variance Inflation Factor test)

Multicollinearity was assessed using both the pairwise correlation matrix and the variance inflation factor (VIF). The correlation matrix provides a preliminary diagnostic, with very high pairwise correlations among explanatory variables potentially indicating multicollinearity (Gujarati & Porter, 2009). The VIF provides a more comprehensive assessment by measuring the extent to which the variance of an estimated coefficient is inflated by its linear association with the other regressors. VIF values above 10 are commonly considered indicative of serious multicollinearity, although a more conservative threshold of 5 is sometimes applied (Hair et al., 2019).

Table 4: Correlation Matrix estimation results

Variables	GDP	IND	FDI	VME	EXR
GDP	1				
IND	0.5668	1			
FDI	0.1350	0.1470	1		
VME	-0.1529	-0.1326	0.0485	1	
EXR	0.1009	0.1966	0.0451	-0.2575	1

Source: Author's computation, 2026 using STATA 17.

Table 4 above presents the pairwise correlation coefficients among economic growth (GDP), industrial output (IND), foreign direct investment (FDI), value of merchandise exports (VME), and exchange rate (EXR) for the highly industrialised African countries. The correlation analysis indicates a moderate positive association between GDP and industrial output (IND; $r = 0.5668$), while GDP exhibits weak correlations with FDI, VME, and EXR. The explanatory variables also show generally weak pairwise correlations, with none exceeding 0.20 except the correlation between VME and EXR ($r = -0.2575$). Overall, the results provide no evidence of serious pairwise multicollinearity among the explanatory variables in Model. Nevertheless, the correlation matrix serves only as a preliminary diagnostic; therefore, VIF analysis is subsequently employed to provide a more robust assessment of multicollinearity.

Table 5: Variance Inflation Factor VIF test results

Variables	VIF	Tolerance (1/VIF)
VME	1.08	0.922090
EXR	1.08	0.923911
IND	1.04	0.964275
FDI	1.02	0.978463
Mean VIF	1.06	

Source: Author's computation, 2026 using STATA 17.

The VIF results indicate no evidence of problematic multicollinearity among the explanatory variables in Model. The VIF values range from 1.02 for FDI to 1.08 for VME and EXR, with IND recording 1.04 and a mean VIF of 1.06. The corresponding tolerance values are also high, ranging from 0.9221 to 0.9785. These values are substantially below conventional VIF thresholds and well above the minimum tolerance level, indicating that the explanatory variables are not excessively correlated. Thus, multicollinearity is unlikely to bias the precision of the regression estimates, supporting the inclusion of the variables in the subsequent empirical models.

4.5 Hausman test for model selectin

The analysis compares three alternative estimators: pooled ordinary least squares (Pooled OLS), fixed-effects (FE), and random-effects (RE) models. The model selection procedure is conducted sequentially using the F test for individual effects, the Breusch–Pagan Lagrangian multiplier (LM) test, and the Hausman specification test. These tests are important for determining whether unobserved

country-specific effects are present and, if so, whether they should be treated as fixed or random in the estimation process.

Table 6: Hausman test for model selection estimation results

Model comparison	Test	Statistic	Probability
Pooled versus fixed	F test that all $u_i = 0$	$F(19, 436) = 2.30$	$\text{Prob} > F = 0.0015$
Pooled versus random	Breusch and Pagan Lagrangian multiplier test	$\text{Wald } \chi^2(4) = 511.42$	$\text{Prob} > \chi^2 = 0.0000$
Fixed versus random	Hausman Test	$\chi^2(4) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 18.16$	$\text{Prob} > \chi^2 = 0.0012$

Source: Author's computation, 2026 using STATA 17.

Table 6 presents the model-selection tests used to determine the appropriate panel-data estimator for the highly industrialised African countries. The model-selection tests indicate that the fixed-effects estimator is appropriate for the highly industrialised African countries. The F-test rejects the pooled model ($F(19, 436) = 2.30$, $p = 0.0015$), while the Breusch–Pagan LM test also rejects the pooled specification ($\chi^2 = 511.42$, $p < 0.001$). The Hausman test further rejects the random-effects model in favour of fixed effects ($\chi^2(4) = 18.16$, $p = 0.0012$), indicating systematic differences between the fixed- and random-effects estimates. Accordingly, the fixed-effects model is selected for the subsequent empirical analysis.

4.6 Heteroskedasticity Test

Heteroskedasticity occurs when the variance of the error term is not constant across countries or over time. In cross-country panel data, it may arise from differences in economic structures, industrial capacity, institutional quality, and macroeconomic conditions. Although it does not necessarily bias fixed-effects coefficient estimates, it can undermine the reliability of conventional standard errors and statistical inference. The study employs the Breusch–Pagan/Cook–Weisberg test to examine the null hypothesis of constant error variance against the alternative of heteroskedasticity (Breusch & Pagan, 1979). To address potential violations, Driscoll–Kraay standard errors are used to provide robust inference in the presence of heteroskedasticity, serial correlation, and cross-sectional dependence.

Table 7: Heteroskedasticity estimation results

Test	X^2 test statistic	p-value	Decision
Breusch-Pagan/Cook-Weisberg	46.73	0.0000	Rejection of null

Source: Author's computation, 2026, using STATA 17.

The Breusch–Pagan/Cook–Weisberg test rejects the null hypothesis of homoskedasticity ($\chi^2 = 9.71$, $p = 0.0018$), indicating the presence of heteroskedasticity in the panel data. This finding implies that the error variance is not constant across observations and that conventional standard errors may provide unreliable inference. Accordingly, the subsequent fixed-effects estimations employ Driscoll–Kraay standard errors to obtain inference robust to heteroskedasticity, serial correlation, and cross-sectional dependence.

4.7 First-order serial correlation

We used the Wooldridge (2002) test to detect first-order serial correlation in the panel data. The test evaluates the null hypothesis of no serial correlation in the idiosyncratic error terms against the alternative of first-order autocorrelation. A statistically significant result ($p < 0.05$) leads to rejection of the null hypothesis, indicating that errors within a country are correlated across successive periods. Detecting serial correlation is important because it can compromise the reliability of conventional standard errors and statistical inference.

Table 8: First-order serial correlation estimation results

Test	F test statistic	p-value	Decision
Wooldridge	4.637	0.0444	Reject the null

Source: Author's computation, 2026, using STATA 17.

The Wooldridge test indicates the presence of first-order serial correlation in the panel data for low-industrialised African countries ($F = 5.307$, $p = 0.036$). The null hypothesis of no first-order serial correlation is therefore rejected at the 5% significance level. This finding suggests that the error terms are serially correlated across time, potentially rendering conventional standard errors unreliable. Accordingly, the subsequent fixed-effects estimations employ Driscoll–Kraay standard errors, which provide inference that is robust to serial correlation, heteroskedasticity, and cross-sectional dependence.

5.8 Regression with Driscoll-Kraay standard errors

Driscoll–Kraay standard errors provide robust statistical inference in panel-data regression when errors may exhibit heteroskedasticity, serial correlation, and cross-sectional dependence. This approach is particularly suitable for macroeconomic and international panel studies, where countries may be affected by common economic shocks and interconnected market conditions. By accounting for these forms of error dependence, Driscoll–Kraay standard errors improve the reliability of statistical inference (Driscoll & Kraay, 1998; Hoechle, 2007).

Table 9: Regression with Driscoll-Kraay error estimation results: Fixed-effects methods

Variables	Coefficients	Std Error	T-stat	P-value
Lagged GDP (L_GDP)	0.1379	0.0474	2.91	0.008**
Industrial Output (IND)	0.1906	0.0202	9.42	0.000***
Foreign Direct Investment (FDI)	0.0213	0.0096	2.23	0.037**
Value of Merchandise Exports (VME)	0.0003	0.0006	0.57	0.575*
Exchange Rate (EXR)	−0.0016	0.000517	−3.04	0.006**
Constant	3.0381	0.0474	18.11	0.000***
Number of observations	440	F(5, 21)	51.22	Within R ² = 0.305
Number of groups	20	p-value	0.000	

Source: Author's computation, 2026, using STATA 17.

Table 9 reports the fixed-effects estimates with Driscoll–Kraay standard errors for the highly industrialised African countries. Industrial output (IND) has a positive and statistically significant effect on economic growth ($\beta = 0.1906$, $p < 0.001$), while FDI is also positive and significant ($\beta = 0.0213$, $p = 0.037$). Lagged GDP has a positive and significant coefficient ($\beta = 0.1379$, $p = 0.008$),

indicating persistence in economic growth. In contrast, the coefficient of VME is positive but statistically insignificant ($\beta = 0.0003$, $p = 0.575$), suggesting no statistically discernible effect on growth in this specification. The exchange rate has a negative and statistically significant coefficient ($\beta = -0.0016$, $p = 0.006$). Generally, the model is jointly significant ($F(5, 21) = 51.22$, $p < 0.001$) and explains 30.5% of the within-country variation in economic growth (within $R^2 = 0.305$).

5. Discussions and Summary of Major Findings

The study finds that industrial output (IND) has a positive and statistically significant relationship with economic growth in highly industrialised African countries. The coefficient remains positive across model specifications, while FDI and VME also exhibit positive coefficients. This consistency reinforces the importance of industrial output as a correlate of economic growth. The finding supports Kaldor's First Law, which identifies industrial activity as an engine of growth through productivity improvements, increasing returns to scale, and the reallocation of resources to higher-productivity activities. It also aligns with Szirmai (2012), who highlights manufacturing's role in structural transformation and aggregate productivity growth. Similarly, McMillan and Zeufack (2022) emphasise manufacturing's contribution to rising living standards, labour productivity, and indirect employment through industrial linkages. These linkages suggest that industrial output can stimulate growth beyond direct production by supporting transport, logistics, finance, trade, and related services.

6. Conclusion and Policy Recommendations

In a nutshell, the study found that industrial output has a positive and statistically significant effect on economic growth among the highly industrialised African countries. The positive relationship remained robust across the model specifications, indicating that industrialisation is an important driver of economic growth irrespective of countries' level of industrial development. This finding supports the view that industrial expansion contributes to structural transformation by increasing productivity, creating employment, promoting technological progress, and strengthening linkages with other sectors of the economy. Thus, the study concluded that industrialisation remains an important factor in promoting economic growth and supporting the structural transformation of highly industrialised African economies. Given the positive and statistically significant effect of industrial output on economic growth among the highly industrialised African countries, the study further recommended that governments should continue to prioritise industrialisation as a central pillar of national development strategies. Public investment should focus on expanding manufacturing capacity, agro-processing, mineral beneficiation and value-added production to reduce dependence on primary commodity exports. Governments should also invest in industrial infrastructure, including reliable electricity, transport networks, logistics systems, industrial parks and digital infrastructure, to reduce production costs and improve industrial competitiveness. Furthermore, policies should encourage technological upgrading, innovation, industrial diversification and greater participation in regional and global value chains through the implementation of the African Continental Free Trade Area (AfCFTA).

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