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Leveraging Technology Innovations to Boost Africa's Industrialisation

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Abstract
The study employed using dynamic panel modelling technique to examine the effects of technology innovations on industrialization in Africa using annual panel data from 2011 to 2022. The findings show that per capita income, total national reserves, and remittances positively affect industrialisation processes in Africa. With regards to technology innovations, the findings show that technological innovations positively influence industrialisation in Africa. The major policy implication is that Africa's industrialisation could be realised by targeting technology innovation in the continent. The study therefore recommends that African countries should increase investments in innovation, strengthen and build institutions that support technology innovation.

Keywords: Technology Innovations; Industrialisation

1. Introduction

The African Union Agenda 2063 and the United Nations 2030 Agenda for Sustainable Development recognise the significant role of a robust manufacturing sector in driving socio-economic growth and development in Africa. The importance on industrialisation has gained extra momentum with the establishment of the African Continental Free Trade Area (AfCFTA), which aims to establish a unified market for goods and services across the continent, thereby unlocking manufacturing potential and accelerating industrialisation to promote and fostering sustainable growth and employment opportunities in the African continent. Modern industries provide relatively well-paying jobs, particularly for undereducated but skilled individuals who may not have had access to formal employment in the public sector. Employment in the private sector leads to increased household income, and subsequently, driving domestic demand. Moreover, the industrial development generates extensive backward and forward linkages, creating numerous opportunities for suppliers, distributors, retailers, and business services, thereby fostering a dynamic economic ecosystem.

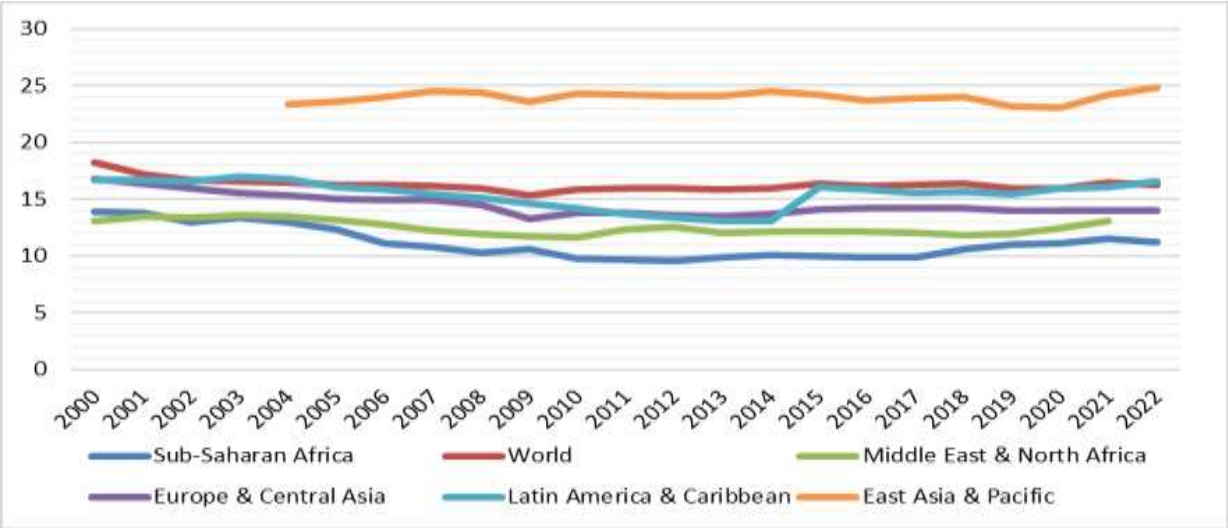
The Agenda 2063 recognises industrialisation as a vital driver for achieving sustainable development, competitiveness, recovery, resilience, and inclusive prosperity in Africa. It seeks to transform Africa's economies from primarily relying on the export of raw materials to value-added production, manufacturing and services. Therefore, by developing a robust industrial sector, the African Union aims to support Member States to create jobs, enhance productivity, increase incomes, and reduce poverty across the continent. Industrialisation would enable African countries to move up the value chain and capture a larger share of the economic benefits associated with processing their natural resources. By

processing raw materials within the African continent, higher value-added products can be generated, leading to increased export revenues, and reduced vulnerability to commodity price fluctuations (Morris and Fessehaie, 2014).

Furthermore, industrialisation can promote economic diversification, which is crucial for reducing dependence on a narrow range of commodities and building resilience to external shocks. By developing diverse industries, African countries can build local capacity, and create opportunities for entrepreneurship and small and medium-sized enterprises (SMEs). Despite the importance of this sector in the fight against poverty and improving living standards, sub-Saharan Africa (SSA) is the least industrialized region in the world, with the lowest output per capita, highlighting a substantial gap in industrial development. Morris and Fessehaie (2014) postulate the continent has weak industrialization level. In addition, the African Development Bank (African Development Bank, 2019) notes that Africa is at the bottom of the global value chain with its share of global manufacturing at around only 1.9%, this is buttressed in Figure 1.

Figure 1 shows that industrialization in sub-Saharan Africa (SSA) region has been consistently low compared to other regions, it declined from about 14% in 2000 to 9.8% in 2017. Between 2017 and 2022, industrialization rate marginally increased from 9.8% to 11.2%. The low level of industrialisation in Africa is further evident in the continent's import-export dynamics. As of 2022, Africa's total imports reached a value of US$25 billion, surpassing the exported value of US$24 billion highlighting a trade imbalance where Africa leans towards being a net importer rather than an exporter.

Figure 1: Industrialisation (Manufacturing, value added (% of GDP))



Source: World Development Indicators

The African Union High-Level Panel on Emerging Technologies (APET) urges African countries to embrace a bold agenda driven by private sector investments in industrial transformation to unlock their full potential. This requires prioritising domestic manufacturing and embarking on industrialisation process centered around commodities to effectively support inclusive economic transformation while leveraging its resources and capitalising on global shifts in production structures. Thus, to fully utilise Africa's prospects for industrialisation, it is critical to establish strong forward and backward linkages within domestic, regional, and global value chains through technology innovations. Exploiting the opportunities presented by technology innovations is central to enhancing Africa's industrial capabilities and global competitiveness. By adopting these strategies, African countries can seize the opportunities presented by industrialisation, foster economic growth, and promote sustainable development across the continent.

Technology innovation, defined as the economic function through which new technologies are introduced into production and consumption (Scherer, 2001), play a vital role in ensuring quality and precision throughout the production process. Technological innovations are creating opportunities to revolutionize economic and social systems in fundamental ways unparalleled by previous industrial revolutions (Schwab, 2017). Thus, by leveraging technology innovations in manufacturing processes, African countries can enhance productivity, improve product quality, and establish a strong presence in both domestic and international markets, leading to sustainable industrialisation and economic growth. Examples of such technological innovations can include the use of robotics, artificial intelligence, the Internet of Things (IoT), and data analytics to optimise production processes, enhance efficiency, and drive innovations within the manufacturing sector in Africa.

Given the importance of industrialization for African countries and the opportunities created by technology innovations for manufacturing growth, the question is whether leveraging technology innovations can stimulate the much needed industrialization in Africa. This question is especially relevant given that African countries and regional economic communities (RECs) are formulating, adopting and implementing new technology and innovation policies that help them promote industrialisation. Few researchers have identified the determinants of industrialization in Africa (for instance, Gui-Diby and Renard, 2015; Megbowon, Mlambo and Adekunle, 2019, Amoa and Jehu-Appiah, 2022), but it is still empirically unclear what role technology innovation play in industrial development. The empirically analytical void of this makes it difficult to establish a rational industrial policy.

This paper seeks to contribute to policy and empirical literature by providing a quantitative measurement of the influence of technology innovation on industrialisation in Africa. Specifically, the study seeks to answer the following question: What is the effect of innovation on industrialisation.

2. Literature Review

Several strands of empirical literatures exist on the factors that influence industrialization. Khan and Ssnhadji (2001) make a contribution to the discussion on the response of industrialization to macroeconomic variables with inflation as the predictor variable. They observed that the differential in threshold levels for the effects of inflation on growth between industrial and developing countries could be due to the former's higher level of conventional taxation than the latter. Similarly, Kaldor (1976) also found that inflation has a dampening effect on developing and industrial activities but the effect is much lower for industrial economies.

Shafaeddin (2006) investigated whether a free-trade regime would aid or hinder the process of developing-country industrialization. To do so, he evaluated the validity of the "trade liberalization hypothesis" (TLH). He found a two-channel approach to answer his question: on the one hand, continued protection would result in inefficiency and a lack of ability to compete in the global market. Premature, universal, and all-encompassing trade liberalization, on the other hand, would result in de-industrialization, concentration in production and exports of primary commodities, resource-based products, simple labor-intensive industries, or assembly operations, and little ability to catch up and upgrade.

Umoh and Effiong (2013) used ARDL to establish the relationship between openness to trade and industry (manufacturing performance) in Nigeria for the period 1970-2008 and found that trade openness has a significant positive short- and long-term impact on manufacturing productivity in Nigeria. As a result, the researchers proposed that the manufacturing sector's policy direction in Nigeria should be based on open policies and trade liberalization as a long-term strategy. Again, they established that reducing trade

restrictions and implementing appropriate incentives are critical to reviving the manufacturing sector's performance.

Amiri et al. (2019) used a panel analysis of 28 countries analyse the effect of natural resource rents and institutional quality on the performance of tradable and non-tradable sectors in resource-rich countries from 2000 to 2016. The panel estimates found evidence that improving institutional efficiency in natural resource-based countries improves the performance of these economies' manufacturing sectors by eradicating or removing the consequences of the natural resource curse phenomenon. Further research found that in natural resource-dependent countries, the ratio of value-added to manufacturing rises unless institutional quality is high. In support of the argument, Ben-Salha et al. (2018) used the Pooled Mean Group (PMG) estimation framework to evaluate the causal association between increased natural resource rents and economic growth in a sample of top resource-abundant countries from 1970 to 2013. They discovered a long-term positive effect of natural resource rent on economic growth.

Megbowon et al. (2019) on the evaluation of the causal relationship between foreign direct investment (FDI) and industrialization from 26 SSAs found that China's FDI outflow to SSAs is not enough to foster industrialization in Africa. Arguing further, they submit that African economies could however benefit from China's outflow of FDI by optimising and, where necessary, amending future agreements in order to encourage or prioritize Chinese investment in sectors with positive linkages. Adegboye et al. (2016), contributing to the discourse on the relationship between FDI and industrialization for 46 African countries, postulate that the inflow of FDI is anticipated to boost domestic firms' investment, technological capabilities, and overall industrial performance.

Das and Drine (2020) investigate the link between Africa's technological gap, educational quality, and growth. Their findings suggest that the ability to absorb new technology is critical for economic growth and development success. Markedly, they found that the most significant barrier to industrial advancement and technological catch-up is Africa's poor human capital development and deteriorated infrastructure. Poor human capital development and very low health expenditure, according to a study by Oyinlola et al. (2020), are the challenges of Sub-Saharan Africa's industrial development. Thus, from the works above, evidence is clearly adduced to suggest that inadequate human capital supply to meet an economy's industrial demand is sufficient to cause industrial failure. As proffered by Shim et al. (2020), the ability of any country or region to progress its human capacity is of great help in promoting and maintaining industrial development.

In another perspective, authors have mentioned that the unflinching importance of natural resource availability to many nations has direct and indirect implications on economic growth. Oyinlola et al. (2020) submit that the availability of natural resources can play a crucial role in a nation's or a continent's industrial development. Udi et al. (2020) found, in South Africa, that total natural resource (TNR) which represents the natural endowments significantly and positively correlates with industrial development. The relationship observed, however, was classified as moderate. To this end, TNR has been suggested to positively influence overall economic growth. OECD (2011) points out that most advanced economies have built their extractive industries on the back of natural resources, thus, fostering an avalanche of economic benefits.

Saka and Olanipekun (2021) examined the role of human capital in the relationship between the industrialization process and growth in Nigeria from 1980 to 2016. Based on the new growth theory attributed to Lucas (1988), and having employed the Two-Stage Least Square technique, firstly, they assert that industrialization is significantly important for economic growth. Secondly, they established that

human capital growth can help to boost economic growth through industrialization. Their findings seem to appreciate the assumption that human capital is a significant predictor of industrialization. In the words of Raheem et al. (2018), human capital is considered to be the main driver of industrial development in the African region.

Kothakapa et al. (2021) observed, between 1970 and 2014, the relationship between financial development and industrialization in low- and middle-income countries using a dynamic panel model. Their results indicate that there is a non-linear relationship between the two variables. More precisely, the findings indicate that financial development harms industrial development until a certain point, at which point the effect reverses. This evidence of a "U-shaped" relationship highlights the critical role of financial development in the industrialization process of developing economies but also highlights the relationship's complexity. Similarly, Folarin (2019) found a significant positive effect of financial reforms on industrialization in Nigeria.

3. Data and Methodology

3.1 Methodology

The aim of this study is to investigate the role of technology innovation in industrialization process in Africa. To achieve that, the study employed a panel model for 31 African countries over the period 2011-2022, describing the relationship between an industrialization indicator and different regressors which include technology innovations proxied by Global Innovation Index (GII) and a variety of socio-economic indicators (GDP per capita (GDPC), remittances (REMIT), degree of openness to trade (TRADE), inflation (INFL) and total natural resources (TNR)).

The model for regression estimated is hereby specified as follows:

$$INDUSTRY_{it} = \beta_0 + \beta_1 IDUSTRY_{it-1} + \beta_2 GDPC_{it} + \beta_3 TNR_{it} + \beta_4 TRADE_{it} + \beta_5 REMIT + \beta_6 INFL_{it} + \beta_7 INNOVATION_{it} + U_{it} \quad (1)$$

With: $U_{it} = \mu_i + \varepsilon_t + \nu_{it}$ where $\nu_{it} \rightarrow N(0, \sigma_v^2)$

Baltagi et al. (2009) posit that the inclusion of the lagged dependent variable in the empirical model implies that there is correlation between the regressors and the error term since lagged INDUSTRY depends on U_{it-1} which is a function of the μ_i, the country specific effect. Because of this correlation, dynamic panel data estimation of model (1) suffers from the Nickell (1981) bias, which disappears only if *t* tends to infinity. The preferred estimator in this case is system Generalized Method of Moments (GMM) suggested by Arellano and Bond (1991), which basically differences the model to get rid of country specific effects or any time-invariant country specific variable1.

For a better use of the system GMM, Roodman (2006) suggests the introduction of time dummies variables. Moreover, for the endogenous variables, only their lagged values of at least 2 periods are considered as valid instruments. The number of instruments should not exceed the number of groups, so, the p-value of the Sargan test of over-identifying restrictions as well as the Arellano-Bond test for serial correlation in the second-differenced errors should be above 0.12.

3.2 Data

This study used secondary panel data covering 31 African countries[2] from 2011 to 2022. The variables that were covered in this study were industrialization (INDUSTRY) as the outcome variable, total natural resource (TNR), trade openness (TRADE), GDPC per capita, inflation (INFL) and Global Innovation Index (GII) as predictor variables. The study period was chosen because of data availability. Table 1 pre-

sents the summary of the description of data.

Table 1. Data, Sources, Measurement and Empirical Justification of Variables

Variable	Measurement	Source	Empirical Support
Industrialisation (INDUSTRY)	Competitive Industrial Performance Index (0-1)	UNIDO	
Total Natural Resources (TNR)	Total Natural Resources Rents (% of GDP)	WDI	Amoah and Jehu-Appiah, 2022; Amiri et al., 2019; Haveranek et al., 2016
Trade Openness (TRADE)	Trade (Exports + Imports) % of GDP	WDI	Amoah and Jehu-Appiah, 2022; Ngo et al., 2020
GDP per Capita (GDPC)	GDP per capita in current dollar		
Inflation (INFL)	Consumer Prices (Annual %)	IFS	Sabir et al., 2019; Erdogan and Unver, 2015
Global Innovation Index (GII)	Innovations index (0-100)	WIPO	Shinyekwa et al., 2022

WDI = World Development Indicator (World bank), IFS = International Financial Statistics (IMF); World Intellectual Property Organization (WIPO), UNIDO= United Nations Industrial Development Organization

The Global Innovation Index

The variable of interest in this study is innovation and how it impacts international trade. There were two proxies (patents and the percentage of R&D of GDP) that could have served the purpose. However, these had limitations that led to being discarded. Patents had significant data limitations, especially for African countries, making it impossible to use. Although the proportion of the national budget allocated to R&D is equally a good proxy for innovation, many countries included in the analysis did not have updated data. The best option aside from these two was the Global Innovation Index (GII) whose construction is scientific. Data were available for all the countries and the years of analysis. The GII is an annual ranking of countries by their capacity for and success in innovation. It aims to capture the multi-dimensional facets of innovation and provide the tools that can assist in tailoring industrial policies to promote long-term output growth, improved productivity, and job growth. The GII helps to create an environment in which innovation factors are continually evaluated. The core of the GII consists of a ranking of world economies' innovation capabilities and results. Details about the GII computation are given in Table A1 in Appendices.

4. Results and Discussion

In this section, the empirical analyses are presented and discussed. Firstly, preliminary results consisting of descriptive statistics and test of multi-collinearity are presented and the regression estimates are presented next.

4.1 Preliminary Results

From Table 2, the skewness and kurtosis value, suggest that the data is normally distributed. Byrne (2010) and Hair et al. (2010) assert that for data to be thought of as normal, it must have a skewness value between −2 to +2 and a kurtosis value between −7 to +7.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
INDUSTRY	345	2.330	0.392	1.230	3.679	0.026	3.507
GII	352	3.205	0.216	2.451	3.711	-0.390	3.227
GDPC	341	8.207	0.862	6.525	10.079	0.309	2.070
TNR	341	1.662	1.380	-6.049	3.664	-3.060	16.061
TRADE	353	4.049	0.396	2.794	4.846	-0.267	2.668
REMIT	372	2.909	2.814	0.000	13.611	1.188	3.738
INFL	348	1.600	1.078	-2.001	6.323	-0.201	4.743

Source: Author's own calculations

Also from the correlation matrix (Table 3), in line with Prunier et al. (2015) and Dormann et al. (2013), it bears mentioning that there is no problem of multi-collinearity among the predictor variables since no correlation coefficient of above 0.7 was observed. In the views of Prunier et al. (2015) and Dormann et al. (2013), a case of multi-collinearity can be assumed if the correlation value among the explanatory is 0.7 or more.

Table 3: Correlation matrix

	INDUSTRY	GII	GDPC	TNR	TRADE	REMIT	INFL
INDUSTRY	1.000						
GII	0.190	1.000					
GDPC	0.398	0.526	1.000				
TNR	-0.095	-0.463	-0.514	1.000			
TRADE	0.005	0.249	0.292	-0.266	1.000		
REMIT	0.212	-0.010	-0.108	0.048	-0.075	1.000	
INFL	0.046	-0.105	-0.051	0.036	-0.036	0.122	1.000

Source: Author's own calculations

4.2 Empirical Results

In this section, the empirical results are presented. The estimation results for one-step system GMM with standard deviation in parenthesis are presented in Table 4 below. The results of the second order serial correlation AR(2) and standard Hansen test show that the empirical performance of the system GMM estimation is satisfactory and robust. The test of the second order serial correlation AR(2) shows absence of second order serial correlation problem since the AR(2) test statistic is unable to reject the null hypothesis of no second order serial correlation. The Hansen test for over-identification indicates that the

null hypothesis of exogenous instruments is not rejected, indicating that the instruments used are appropriate. In addition, the total number of instruments is strictly lower than the number of groups.

From Table 4, the empirical results show that coefficients of lagged industrialisation (INDUSTRY), GDP per capita (GDPC), total natural resources (TNR), remittances (REMIT) and Global Innovation Index (GII) are statistically significant suggesting that changes in these indicators of various African economies potentially accounts for the movement in their industrial development. The coefficients of trade openness (TRADE) and inflation (INFL) are negative and statistically insignificant

Income which is proxied by per capita GDP was found to be a significant determinant of industrialization in Africa, thus reflecting the idea that as income increases the probability of industrialization increases as well and which is also in line with the a priori expectation of this study. It implies that an increase in GDP per capita is associated with a corresponding increase in the level of industrial development, and a decline in the GDP per capita leads to a corresponding decline in industrialization. This could be as a result of increasing possibility of fund being freed for manufacturing sector use as income increases could promote industrialization. The result is similar to early studies (Megbowon et al., 2019; Adegboye et al., 2016).

The estimated coefficient of total natural resource positive and statistically significant. The result points out that an increase in the total natural resources rent serves as a breeding platform for enhanced industrialization in Africa. Arguing further, the result gives an indication that the more available the stock of natural resources is in an economy, the more attractive the economy appears for industrial activities. Generally, natural resources serve as a feed (raw material production) for the industrial sector of most economies. To a very large extent, the success rate of most manufacturing industries is dependent on the consistent and reliable availability and provision of raw materials. The result is consistent with Ben-Salha et al. (2018) and Amiri et al. (2019).

Remittances (REMIT) has a positive and statistically significant coefficient suggesting that remittances are a source of external financing that can support the industrialization process in Africa. Remittances can affect industrialization through reduction of liquidity constraints of manufacturing firms (investment effect). In addition, remittances can affect industrialization through recipients' expenditures, that is, they increase the disposable income of recipients which expand the size of the local market and increase demand for manufactured goods.

Table 4: Regression Results

	1	2	3	4	5	6	7	8
	Overall Index	Innovation Input Sub Indexes					Innovation Output Indexes	
INDUSTRY(t-1)	0.756*** (0.0974)	0.755*** (0.0932)	0.759*** (0.0962)	0.748*** (0.0969)	0.750*** (0.0999)	0.767*** (0.1000)	0.763*** (0.1006)	0.760*** (0.0925)
GDPC	0.063** (0.0333)	0.066*** (0.0302)	0.056* (0.0289)	0.074*** (0.0359)	0.071** (0.0330)	0.061* (0.0303)	0.062* (0.0304)	0.058** (0.0295)
TNR	0.011** (0.0108)	0.010* (0.0124)	0.011 (0.0112)	0.009 (0.0118)	0.006 (0.0102)	0.009 (0.0105)	0.011* (0.0111)	0.013** (0.0119)
TRADE	-0.028 (0.0377)	-0.025 (0.0384)	-0.030 (0.0382)	-0.029 (0.0382)	-0.029 (0.0384)	-0.028 (0.0365)	-0.027 (0.0363)	-0.025 (0.0368)

REMIT	0.013*** (0.0038)	0.012*** (0.0037)	0.012*** (0.0036)	0.013*** (0.0037)	0.013*** (0.0040)	0.012*** (0.0041)	0.013*** (0.0037)	0.012*** (0.0028)
INFL	-0.019 (0.0166)	-0.020 (0.0155)	-0.018 (0.0161)	-0.020 (0.0160)	-0.018 (0.0167)	-0.019 (0.0162)	-0.019 (0.0164)	-0.023 (0.0191)
GII	0.016*** (0.0723)							
Institutions		0.054* (0.0932)						
Human Capital			0.029** (0.0208)					
Infrastructure				-0.048 (0.0597)				
Market Sophisticatio n					0.086 (0.0635)			
Business Sophisticatio n						0.031* (0.0568)		
Knowledge Creation							0.051** (0.0380)	
Creativity								0.026** (0.0158)
Observations	280	280	280	280	280	280	280	280
AR(2)	1.22 (0.223)	1.25 (0.226)	1.17 (0.231)	1.22 (0.223)	1.20 (0.226)	1.21 (0.210)	1.25 (0.214)	1.27 (0.203)
Hansen Test	13.47 (0.199)	14.66 (0.145)	13.99 (0.174)	14.29 (0.160)	12.08 (0.279)	13.86 (0.179)	15.50 (0.115)	14.63 (0.167)

Note: Figures in parentheses are robust standard errors, except for Hansen test and autocorrelation errors test of Arellano-Bond (AR2) which are p-values. For AR(2) and Hansen test, null hypotheses is respectively absence of second order autocorrelation and validity of lagged variables as instruments. ***, ** and * denote significant at 1%, 5% and 10%, respectively.

The variable of interest in the analysis is the technology innovation, which was proxied by the Global Innovation Index (GII). From Table 4, it could be seen that the variable of interest is positive and statistically significant, suggesting that technological innovations enhance industrialization. The estimations were further disaggregated into 5 Innovation Input Sub Indexes and 2 Innovation Output Indexes to capture the key components of the GII that are crucial for industrial development. Out of the 5 Innovation Input Sub Indexes, institutions, human capital and research and business sophistication emerged as significant predictors of industrialization in Africa, there were positive regression coefficients suggesting that an improvement in the innovative activities in institutions, human capital and research and business sophistication could enhance industrial development. The estimated coefficients for knowledge creation and creativity are positive and statistically significant, implying that the knowledge creation and

creativity are key predictors of industrialisation in Africa. These results suggest that Africa's industrialisation could be realised by targeting technology innovation in the continent.

5. Conclusion and Policy Implications

The study principally sought to investigate the effect of technology innovations industrialization in Africa. With data span from 2011 to 2022, a system GMM approach was employed. Our findings show that total natural resource (TNR), per capita GDP (GDPC) and remittances (REMIT) were significant determinants of industrialization whereas trade openness (TRADE) and inflation (INFL) were observed as insignificant determinants of industrialization. While GDPC, TNR, and REMIT were significantly positively related to industrialization, TRADE and INFL were negatively and insignificantly related to industrialization.

Regarding the variable of interest, the findings show that technology innovations (GII) is positively related to industrialisation. The findings further show that technology inputs including institutions, human capital and research and business sophistication are significant predictors of industrialization in Africa. Knowledge creation and creativity were also found to be key predictors of industrialisation in Africa. From these findings, the study concludes that Africa's industrialisation could be realised by targeting technology innovation in the continent.

The results provide policy directions for African governments and policymakers for enhancing industrial development and subsequently ripping the benefits that imbibe in it. Industrialization has been proven to be an engine of economic development, and promoting the economic welfare of the population through employment and poverty reduction channels. As result, governments of various economies must endeavor to strengthen and intensify the factors that promote industrialization. The following policy implications were suggested:

- Establish a Continental Innovation Fund and increase and target funding of R&D to generate innovative technologies to foster product improvement, development, and diversification;
- Formulate innovation policies to address institutional linkages and collaboration, weak engineering and entrepreneurship capabilities, and limited financial resources for technological innovation;
- Establish science and technology parks; artisanal and industrial clusters for purposes of incubation;
- Create a database of scientists and engineers that can be organized and networked to provide a critical mass of expertise to advance the STI program; and
- Provide legal and institutional frameworks to enhance technology diffusion, adaptation and harness knowledge from the rest of the world.

References

4 Amiri, H., Samadian, F., Yahoo, M., & Jamali, S. J. (2019). Natural Resource Abundance, Institutional Quality and Manufacturing Development: Evidence from Resource-Rich Countries. Resources Policy, 62, 550-560.

5 Amoah, C., & Jehu-Appiah, J. (2022). Factors Driving Industrialization in Africa: A Panel Two-Stage Least Square Approach. Modern Economy, 13, 144-158.

6 Byrne, B. M. (2010). Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming (Multivariate Applications Series) (Vol. 396, p. 7384). Taylor & Francis Group.

7 Ben-Salha, O., Dachraoui, H., & Sebri, M. (2018). Natural Resource Rents and Economic Growth in the Top Resource-Abundant Countries: A PMG Estimation. Resources Policy, 74, Article ID: 101229.

8 Das, G. G., & Drine, I. (2020). Distance from the Technology Frontier: How Could Africa Catch-Up via Socio-Institutional Factors and Human Capital? Technological Forecasting and Social Change, 150, Article ID: 119755.
9 Dormann, C. F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carré, G., Lautenbach, S. et al. (2013). Collinearity: A Review of Methods to Deal with It and a Simulation Study Evaluating Their Performance. Ecography, 36, 27-46.
10 ECA, 2016. Innovation, Competitiveness and Regional Integration, Economic Commission for Africa (ECA), 146(2), pp. 199-222.
11 Erdogan, M., & Unver, M. (2015). Determinants of Foreign Direct Investments: Dynamic Panel Data Evidence. International Journal of Economics and Finance, 7, 82-95.
12 Folarin, O. E. (2019). Financial Reforms and Industrialization: Evidence from Nigeria. Journal of Social and Economic Development, 21, 166-189.
13 Hair, J., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate Data Analysis (7th ed.). Pearson Educational International.
14 Havranek, T., Horvath, R., & Zeynalov, A. (2016). Natural Resources and Economic Growth: A Meta-Analysis. World Development, 88, 134-151.
15 Kaldor, N. (1976). Inflation and Recession in the World Economy. The Economic Journal, 86, 703-714.
16 Khan, M. S., & Ssnhadji, A. S. (2001). Threshold Effects in the Relationship between Inflation and Growth. IMF Economic Review, 48, 1-21.
17 Kothakapa, G., Bhupatiraju, S., & Sirohi, R. A. (2021). Revisiting the Link between Financial Development and Industrialization: Evidence from Low and Middle Income Countries. Annals of Finance, 17, 215-230.
18 Lucas, R. E. (1988). On the Mechanics of Economic Development. Journal of Monetary Economics, 22, 3-42.
19 Megbowon, E., Mlambo, C. & Adekunle, B. (2019). Impact of China's outward FDI on sub-Saharan Africa's Industrialization: Evidence from 26 countries, Cogent Economics & Finance, 7:1, 1681054.
20 Morris, M., & Fessehaie, J. (2014). The industrialisation challenge for Africa: Towards a commodities based industrialisation path. Journal of African Trade, 1(1), 25–36.
21 Ngo, M. N., Cao, H. H., Nguyen, L. N., & Nguyen, T. N. (2020). Determinants of Foreign Direct Investment: Evidence from Vietnam. The Journal of Asian Finance, Economics, and Business, 7, 173-183.
22 OECD (2011). The Economic Significance of Natural Resources: Key Points for Reformers in Eastern Europe, Caucasus and Central Asia. OECD Publishing. http://www.oecd.org/env/outreach/2011_AB_Economic%20significance%20of%20NR%20in%20EECCA_ENG.pdf
23 Opoku, E. E. O., & Yan, I. K. M. (2019). Industrialization as Driver of Sustainable Economic Growth in Africa. The Journal of International Trade & Economic Development, 28, 30-56.
24 Oyinlola, M. A., Adedeji, A. A., & Bolarinwa, M. O. (2020). Exploring the Nexus among Natural Resource Rents, Human Capital and Industrial Development in the SSA Region. Economic Change and Restructuring, 53, 87-111.
25 Saka, J., & Olanipekun, D. B. (2021). Human Capital Development and Industrialization in Nigeria: Implication for Economic Growth. Religación, 6, 280-295.

26 Shafaeddin, M. (2006). Does Trade Openness Helps or Hinders Industrialization? MPRA Working Paper, 4371

27 Shinyekwa, I., Kiiza, J., Hisali, E., & Obwona, M. (2016). The Evolution of Industry in Uganda. In C. Newman, et al., Eds., Manufacturing Transformation: Comparative Studies of Industrial Development in Africa and Emerging Asia (p. 191). Oxford Scholarship Online.

28 Umoh, O. J., & Effiong, E. L. (2013). Trade Openness and Manufacturing Sector Performance in Nigeria. Margin: The Journal of Applied Economic Research, 7, 147-169.