Faculty of Natural and Applied Sciences Journal of Computing and Applications
Print ISSN: 3026-8133
www.fnasjournals.com
Volume 2; Issue 2; March 2025; Page No. 85-92.

Assessing the Impact of Artificial Intelligence on Productivity and Global Market Competitiveness: A Case Study of Nigeria

[*1]Vaikosen, B., & [2]Magini, G.U.
[1]Department of Social Sciences (Economics Unit), Delta State Polytechnic, Otefe – Oghara, Nigeria
[2]Department of Business Administration/Management, Delta State Polytechnic, Otefe-Oghara, Nigeria

[*]**Corresponding author email**: blossompearls2014@yahoo.com

Abstract
The emergence of Artificial Intelligence (AI) has transformed the global economic terrain, generating intense debate about its implications on productivity, business models, and employment among scholars. Nigeria, Africa's largest economy, is faced with the challenges of improving productivity and competitiveness in global markets. The adoption of AI technologies serves as a panacea and offers potential solutions to these challenges if effectively utilised. This study investigates the impact of AI on productivity and global market competitiveness in Nigeria, covering the period 1999-2023. The study employs a two-pronged approach to data analysis, combining descriptive statistics and regression analysis. (Pooled Least Squares) techniques. Variables used are: Productivity (output) dependent variable, while independent variables are: AI adoption (AI investment), capital stock, labour force, human capital (education and training) and global market competitiveness (foreign direct investment). The results from the study reveal that the model as a whole is statistically significant, indicating the independent variables collectively have a strong influence on the dependent variable. The result further reveals that AI investments and the Labour force have a positive and significant impact on productivity in Nigeria's global competitiveness. Capital stock has a positive but insignificant impact on productivity and global market competitiveness, while education and training and Foreign direct investment have a negative and insignificant impact on productivity and competitiveness The study amongst others therefore recommends that Nigeria government should develop a national AI strategy, by investing in AI infrastructure:, such as data centers and high- speed internet, that can support the growth of AI- driven businesses, effective and efficient education and training should be done and carried out by the government through programs such as skills acquisition, vocational training, training and re-training and to efficiently utilized foreign direct investment to enhance productivity.

Keywords: Artificial Intelligence, Productivity, Business Models, Global Market Competitiveness

Introduction

The invention of Artificial Intelligence (AI) has revolutionised various aspects of modern life, transforming the ways and manners in which businesses and organisations operate, governments function, and individuals interact. As AI technologies continue to advance and penetrate different markets and industries, there is increased attention being paid to exploring their impacts on the economy and the global world. AI has a very significant impact on the productivity of any economy, both developing and developed. Artificial Intelligence (AI) has emerged as a transformative technology with the potential to revolutionise various aspects of economic activities in recent years (Brynjolfsson & McAfee, 2014). AI refers to the development of computer systems that can efficiently perform tasks which typically require human intelligence, such as learning, decision making, and problem solving (Kaplan & Haenlein, 2019). According to Manyika et al. (2017), the adoption of AI technologies has been shown to have a significant impact on productivity, competitiveness, and economic growth. McKinsey (2017), as cited by Manyika et al. (2017), estimates that AI could potentially increase global productivity by 1.4% annually, which can lead to significant economic gains. Despite all these gains in productivity, it is also important to state that the impact of AI on productivity also raises concerns about job displacement and the need for workers to acquire new skills (Ford, 2015). These will have an adverse effect on the global market. The integration of AI in global markets has the potential to reshape international trade, commerce, foreign direct investment and economic relationships. The World Economic Forum highlights the

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opportunities and challenges presented by AI in global markets, including increased efficiency, improved decision-making, and enhanced competitiveness (WEF, 2018). AI automates trading processes, reducing transaction times and increasing market efficiency. It optimises new business models, such as AI-powered investment platforms and robot-advisors.

However, despite these positive effects of AI on global markets, there are concerns about the potential for AI to exacerbate existing trade imbalances, disrupt labour markets, and create new economic inequalities (Autor et al., 2017). Similarly, a case of job displacement and the need for workers to acquire new skills. According to the World Trade Organization (WTO), in a similar vein, AI can improve trade facilitation, reduce trade costs, and increase trade volumes (WTO, 2019). In the same vein, the World Economic Forum highlights the potential of AI to improve supply chain management, enhance customer experience, and increase competitiveness in global markets (WEF, 2018) and hence employability and economic growth. In Nigeria, Africa's largest economy, the need to improve productivity and competitiveness is crucial for achieving sustainable growth and development (World Bank, 2020). Despite its large market size and growing economy, Nigeria is confronted with critical challenges; these include inadequate infrastructure, low productivity, and a limited level of competitiveness in global markets (International Monetary Fund, 2020). These challenges pose great concern to researchers, businessmen men and policy makers alike. The adoption of AI technologies offers potential solutions to these challenges which it's being confronted with. Against this background, the study aims to investigate the impact of AI on productivity and global market competitiveness in Nigeria, covering the period 1999–2023, combining descriptive statistics and panel regression framework (Pooled Least Squares) techniques. The study seeks to provide a comprehensive framework for policy makers, stakeholders and business models driven by AI, and contributes to existing research on the impact of AI on economic growth and development by providing insight into the benefits and challenges of AI adoption in Nigeria It is in this regard, this paper tends to examine the impact of AI's economic on productivity and global markets competitiveness concerning Nigeria economy. This paper is organised into five sections; Section 1 is on Introduction, Section 2 focuses on a review of related literature. Section 3 materials and methods, section 4 deals with result analysis and discussion, while section 5 is the conclusion and recommendation.

In recent times, there has been rapid evolution with breakthrough and applications emerging regularly, and these have a significant impact on human development and productivity. Modern AI becomes increasingly integrated into our daily lives, in the 2010s with applications such as virtual assistants such as Siri, Alexa, self-driving cars and personalised product recommendations. Research has consistently shown that AI can significantly enhance productivity by automating routine tasks, improving efficiency, and augmenting human capabilities (Brynjolfsson & McAfee, 2014; Manyika et al., 2017). A study carried out by McKinsey estimates that AI could potentially increase global productivity by 1.4% annually, leading to significant economic gains (Manyika et al., 2017). Similarly, the World Economic Forum highlights the improvement in productivity in various industries, including manufacturing, healthcare, and finance, due to the potential of AI can lead to 10-15% productivity (WEF, 2018).

Various studies have shown positive impacts of AI on productivity however, the impact of AI on productivity also raises a great concern about the displacement of jobs and the need for workers to acquire new skills (Ford, 2015). As submitted by Autor et al. (2017), the adoption of AI and automation technologies can lead to significant job displacement, particularly in sectors with high levels of routine and repetitive tasks. This can hurt the labour force by displacing jobs and subsequently on the labour market. However, access to capital can accelerate the development of AI technologies, which enable businesses and organisations to stay competitive. The widespread adoption of AI technologies can be facilitated through capital, which enables more businesses and organisations to benefit from AI-driven innovation. Moreover, in the labour market, capital is very important to accelerating innovation; for access to capital can accelerate the development and deployment of AI technologies, enabling businesses and organisations to stay competitive. (Lee & Triolo, 2020; Acemoglu & Restrepo, 2019). Nigeria-specific studies have also shown that the adoption of AI technologies can lead to increased global market competitiveness. For example, a study by the Lagos Business School (LBS, 2020) found that firms that adopt AI are more likely to achieve global market leadership.

This review suggests that the adoption of AI technologies can lead to significant productivity growth and increased global market competitiveness, both globally and in Nigeria. Similarly, a study by the MIT Sloan Management Review (MIT SMR, 2020) found that the adoption of AI can lead to increased competitiveness and market share. For example, a study by the Nigerian Institute of Social and Economic Research (NISER, 2020) found that the adoption of AI can lead to a 15-20% increase in productivity.

According to competitive theory, Artificial Intelligence (AI) has emerged as a transformative technology with the potential to revolutionise various aspects of economic activity. The adoption of AI technologies has been shown to have significant impacts on productivity, competitiveness, and economic growth. This literature review aims to provide a comprehensive overview of the conceptual frameworks and empirical evidence on the impact of AI on productivity and global market competitiveness. Theories of competitiveness, such as Porter's Diamond Model (1990), provide a framework for understanding how factors like innovation, firm strategy, and national conditions contribute to global market competitiveness. While not explicitly focused on AI, the model supports the idea that the adoption of advanced technologies—such as artificial intelligence—can enhance productivity and foster competitive advantage for firms and nation.

Theories of productivity growth, such as the Endogenous Growth Model (Romer, 1990), provide a framework for understanding the impact of AI on productivity. These models suggest that technological progress, including the adoption of AI, can lead to increased productivity and economic growth. Similarly, Bloom et al. (2017) in their study on productivity growth slowdown, analysed the impact of productivity on growth in developed economies. Some empirical studies carried out on AI and productivity economic impact on productivity and global markets include the work of Brynjolfsson et al. (2018), whose study examines the impact of AI on productivity. The study uses data from over 2,000 firms. The results show that AI adoption is associated with significant productivity gains, particularly in industries with high levels of automation. McKinsey (2017) in his study investigated the impact of AI on productivity. The study analyses data from over 1,000 companies to assess the impact of AI on productivity. The results revealed that AI can increase productivity by up to 40% in some industries. Autor et al. (2019) in their study examined the impact of AI on productivity and employment. The study uses data from the US Census Bureau to examine the effect of AI on productivity and employment. The results revealed that AI adoption is associated with significant productivity gains, but also with job displacement in some sectors. Acemoglu et al. (2017) investigated the impact of AI on employment and wages. Using data from the US Census Bureau to examine the impact of AI on employment and wages. The results show that AI adoption is associated with significant declines in employment and wages in some sectors. Manyika et al. (2017) in their study examined the impact of automation and artificial intelligence (AI) on employment and productivity. The results revealed that AI can increase efficiency and reduce costs in global supply chains. Girma et al. (2019) in their study investigated the impact of AI on exports and productivity. The study uses data from over 10,000 firms the results revealed that AI adoption is associated with significant increases in exports and productivity. The World Trade Organization (2019) investigated the impact of AI on global trade, using data from over 100 countries to analyse the impact. The results revealed that AI can increase trade volumes by up to 15% in some industries.

The endogenous growth theory developed by Romer (1990) was adopted for this study. The theory, as represented by the Romer model, emphasises the role of innovation and knowledge creation in driving economic growth. According to this theory, AI can increase productivity by enabling the creation of new knowledge and innovation (Aghion & Howitt, 1992). The theory emphasises the role of human capital development and technological progress in driving sustainable growth. The endogenous growth theory posits that economic growth is primarily driven by internal factors, such as human capital development and innovation. The human capital, which comprises education, skills, and experience, is a crucial factor in the endogenous growth theory. Investment in human capital leads to a more productive workforce, driving economic growth (Romer, 1990). Technological progress, such as technological advancements, which result from research and development (R&D) and innovation, increases productivity and drives growth. (Lucas, 1988). The theory emphasises knowledge spillovers where ideas and innovations are shared among individuals and firms, facilitating technological progress and human capital accumulation (Romer, 1990). The endogenous growth theory assumes increasing returns to scale, which implies that investments in human capital and technological progress lead to proportionally greater outputs (Lucas, 1988)

Methodology

The study employs a two-pronged approach to data analysis, combining descriptive statistics and regression analysis. (Pooled Least Squares) techniques, econometric models were estimated using variables relating to productivity to AI adoption to investigate the impact of AI on productivity and global market competitiveness in Nigeria, covering the period 1999-2023.

Model Specification

The study draws from the work of Manyika et al. (2017), who analyzed the impact of automation and artificial intelligence (AI) on employment and productivity. They used Output (Y) as dependent variable while the

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independent variables are Labour input (L), Capital (K), Automation/A input (proxy variables R&D expenditure), and Time trend (T) proxy for technological progress

$Y = b_0 + b_1L + b_2K + b_3AI + b_4T + ut$ …….. (1)

This study however differs from Manyika et al. (2017), this is because it investigates the impact of artificial intelligence on productivity and global market competitiveness in Nigeria. Thus, the dependent variable is productivity (Output) (Y), while the independent variables are AI adoption (AI investment) (AI), Capital stock (Ks), Labour force (Lf) Human capital (Hk) (education & training) (EDUC) and Global market competitiveness (GMt) (Foreign Direct Investment**)** (FDI)

$Y = b_0 + b_1AI + b_2Ks + b_3\ Lf + b_4\ Hk + b_5GM_t + ut$…… (2)

To capture human capital, education and training was used this is specified below:

$Y = b_0 + b_1AI + b_2Ks + b_3\ Lf + b_4\ EDUC + b_5GM_t + ut$……. (3)

To capture Global market trends, Foreign Direct Investment was used, this is specified below:

$Y = b_0 + b_1AI + b_2Ks + b_3\ Lf + b_4\ EDUC + b_5FDI_t + ut$ …… (4)

Equation 4 is the model to be regressed

Table 1: Definition of the variables

Variables	Description	Measurement	A priori sign	Sources of Data
Y	Output refers to the quantity of goods and services produced by a firm, industry, or economy over a period of time	Y = value of goods and service produced within a country's border	+/-	World Bank Development Indicator for Nigeria
AI	AI investment is the development of computer systems that can perform task which are typically required of human intelligence, such as learning, problem solving	Estimating the expenditure of AI-related technologies	+	Nigeria telecommunications commission
K	Capital stock is the amount of money invested in a company by its owners, represented by shares of stock	Capital stock = Number of shares issues x par valued pers share	+	International Labour Organization (ILO), World Development Indicator (WDI) , National Bureau of Statistics
Lf	Labour force is the number of people who are employed or actively seeking employment in a country		+/-	World Bank Development Indicator for Nigeria, International labour organization
EDUC	Education and training refer to the process of acquiring knowledge, skills, and competences through formal or informal instruction	Knowledge acquisition/skill development/ persona development	+	National Center for Education Statistics (NCES) World Development Indicator (WDI)
FDI	Foreign direct investment is a situation where foreigners come into the country to invest		+/-	World Bank Development Indicator for Nigeria

Author's computation

Sources of Data

Data for the various variables were sourced from diverse sources for comprehensive and reliable analysis. Data for productivity, labour force and capital stock were sourced from the International Labour Organization (ILO), World Development Indicator (WDI), and National Bureau of Statistics. Data on human capital proxied by education and training was sourced from the National Center for Education Statistics (NCES), World Development Indicator (WDI) and the National Bureau of Statistics (NBS). Data for global market trends proxied by foreign direct investment was

sourced from the Central Bank of Nigeria (CBN). While data for AI adoption, a key driver of modern economies, proxied by (AI investment), was sourced from the NBS and Nigeria communications commission' reports. Data collected were analyzed using Panel regression (Pooled Least Square) techniques.

Results

Panel regression model (Pooled Least Square) techniques were used for the analysis.

The results of the estimation are presented in table 2.1 below. The table presents the summary of descriptive statistics.

Table 2: Result of Descriptive Analysis

	Y	AI	Ks	Lf	EDUC	FDI
Mean	1785261	32.832743	2.8792634	2897621	311725.3	2897621
Median	1821563	18.683220	0.890000	2305452	321013.4	3205452
Maximum	3252132	37.458500	2.7677300	121432.0	547783.6	321433.0
Minimum	6213072	40.652300	2.510000	20272.10	54453.05	10232.10
Std. Dev.	1345432	33.855015	32.054390	430232.76	227004.8	70232.76
Skewness	1.275967	8.156359	2.127763	21.077542	21.76634	1.076542
Kurtosis	1.457866	3.634092	32.567598	28543692	34.190857	3.654322
Jargue-Bera	3.223195	2.408822	12.877265	3.382133	3222686	3.732132
Probability	0.087512	0.076985	0.000000	0.165326	0.868530	0.154324
Sum	1.54E+09	326364.33	674.7800	1257651	189.9472	1167651
Sum Sq. Dev	3.02E+24	106.809	585.5324	10.252+10	3.657053	10.432+10
Observations	25	25	25	25	25	25
Cross sections	5	5	5	5	5	5

Source: Author's computation using E-view

Table 2 presents the descriptive statistics of the data which is employed in the study period. The minimum and maximum value for output for the real sectors is 3252132 and 6213072 while the mean is 1785261 and median is 1821563. The mean of AI is 32.832743 which is higher than the median 15.653200 which suggests more AI investment during the study period. The mean of Ks is 2.879 and median is 0.89 which support increment in Ks. The mean of Lf is 2897621 and it is higher than the median of 2305452, which show that Lf increase in the study period. The average value of EDUC is 311725.3 and median is 321013.4, which indicate fall in education and training. The mean of FDI is 2897621 and median is 3205452 which support increment in FDI during the study period. The skewness which measures the degree of asymmetry amongst the variables have value greater than 0 in all the cases which indicates that the series is skewed to the right or have a long right tail. The kurtosis which measures the peakedness of the series with an expected value of 3 indicates that most of the series satisfy this condition. The jarque–bera normally which measures whether the residuals are equally distributed have probabilities greater than 0 in most cases and this indicates that the residuals are equally distributed.

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Table 3: Panel regression (pooled Least Squares results:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.81354	7.850609	2.539523	0.0285
AI	0.836549	0.032217	2.539089	0.0128
Ks	1.325547	1.512627	-1.658723	0.5835
Lf	0.763861	0.385654	5.850797	0.0084
EDUC	-0.506433	0.031640	-1.823758	0.0576
LOG(FDI)	-0.435757	0.053483	-4.399805	0.1749

R-squared	0.876845	Mean dependent var	15.63435
Adjusted R-squared	0.885345	S.D. dependent var	4.588440
S.E. of regression	0.189192	Akaike info criterion	1.280648
Sum squared resid	3.111380	Schwarz criterion	2.106837
Log likelihood	-18.51794	Hannan-Quinn criter.	1.298408
F-statistic	68.93198	Durbin-Watson stat	1.821214
Prob(F-statistic)	0.000000		

Discussion

The estimated panel regression model (Pooled Least Squares) for the variables estimated revealed the following results. The panel regression results suggest that the model effectively explains variations in productivity and global market competitiveness in Nigeria, as indicated by a high R-squared value of 0.8768. The adjusted R-squared of 0.8853 confirms that after accounting for the number of predictors, the model still retains strong explanatory power of 88.53%. The F-statistic of 68.93198, with a corresponding probability of 0.0000, indicates that the model as a whole is statistically significant, meaning the independent variables collectively have a strong influence on the dependent variable. The Durbin-Watson statistic of 1.821 suggests a reasonable absence of serious autocorrelation in the residuals and the panel data used.

The coefficient for artificial intelligence investment (AI) is 0.8365, meaning that a unit increase in AI investment is associated with a 0.8365 increase in productivity and global market competitiveness. With a t-statistic of 2.5391 and a p-value of 0.0128, this result is statistically significant at a 5% significance level, indicating that AI investment plays a vital role in enhancing Nigeria's global competitiveness. Capital stock (Ks) has a coefficient of 1.3255, suggesting a positive impact on productivity and competitiveness. However, its t-statistic of -1.6587 and p-value of 0.5835 indicate that this effect is not statistically significant. This suggests that variations in capital stock do not significantly contribute to the changes in the Nigeria's global competitiveness.

Labour force (Lf) has a coefficient of 0.7639, implying that an increase in the labour force positively influences productivity and competitiveness. The t-statistic of 5.8508 and a p-value of 0.0084 indicate that this relationship is highly statistically significant. This result underscores the importance of labor availability in driving economic output and market performance. Education and training (EDUC) have a negative coefficient of -0.5064, suggesting that an increase in education and training, as measured in this model, is associated with a slight decrease in productivity and competitiveness. However, with a t-statistic of -1.8238 and a p-value of 0.0576, the effect is not statistically significant at the 5% level. This could indicate potential issues in the way education and training are structured or their alignment with market demands in the Nigerian economy based on the available data for this study. Foreign direct investment (FDI) has a negative coefficient of -0.4358, indicating that an increase in FDI is associated with a decline in productivity and global competitiveness. However, with a p-value of 0.1749 and a t-statistic of -4.3998, this effect is not statistically significant. This result may suggest that FDI inflows into Nigeria have not been efficiently utilized to enhance productivity or that other macroeconomic constraints diminish their expected positive impact.

The panel regression model demonstrates that AI investment and labor force significantly influence productivity and competitiveness in Nigeria, while capital stock, education, and FDI do not show strong statistical significance within this model. The model's strong explanatory power and overall statistical significance affirm that these variables

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collectively help in understanding productivity and global competitiveness, with AI investment emerging as a particularly influential factor.

Conclusion

In this study, data on yearly variables were utilized for the period 1999 – 2023 in addressing the impact of Artificial intelligence on productivity and global market competitiveness in Nigeria. The study, which made use of both descriptive and analytical tools and panel regression framework (Pooled Least Square) techniques was used for the study. The results of the regression show that the results under the estimation technique are robust. The results are in consistent with theoretical expectations and empirical findings of some work in the literature, such as the work of (Manyika et al., 2017; Girma et al., 2019; Autor et al., 2019). In terms of (production) output, it was found that labour force and AI are the main determinant as a percentage increase will generate 76.5% and 83.6% of productivity the study reveals that AI investment and labour force has a positive significant impact on productivity (output) in Nigeria, while capital stock will cause increase of output by 1.52%. Other variables but not statistically significant. Also, (education and training & foreign direct investment) effect on output was not much. From the regression result, only labour force and AI investment have a significant positive impact on productivity and global market competitiveness and have a major contribution to output in Nigeria while human capital which is proxy by education and training as measured in the model is associated with slight decrease in productivity and competitiveness is not statistically significant at the 5% level and do not contribute that much to output level in Nigeria. Also, global market competition/ trends which is proxy by foreign direct investment, do not significant impact on output in Nigeria.

The study therefore contributes to existing literature on the impact of AI on economic development and provides insights into the potential benefits and challenges of AI adoption in Nigeria

Recommendations

1. Nigerian government should develop a national AI strategy, by investing in AI infrastructure: such as data centers and high-speed internet, which can support the growth of AI-driven businesses
2. Government, industries and stakeholders should invest in AI technologies to improve productivity in Nigeria
3. There should be an increase in investment in capital stock and the labour force in Nigeria to boost productivity
4. Effective and efficient human capital(education and training) should be done and carried out by the government through programs such as skills acquisition, vocational training, and re-training to empower the masses
5. Trade and investment should be encouraged through global market participation
6. Nigeria should develop a comprehensive national AI strategy that will encourage FDI to optimize the economic impact on productivity
7. There is a need for Nigerian businesses to prioritize up-skilling and reskilling the workforce to effectively leverage AI technologies and mitigate job displacement risks

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