International Journal of Innovative Research in Education, Technology & Social Strategies
p-ISSN: 2465-7298 | e-ISSN: 2467-8163
Volume 13, Number 1 September, 2026

IJIRETSS

Impact of Education Expenditures on Manufacturing Sector Output in Selected Sub-Sahara African Countries

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Article DOI: 10.48028/iiprds/ijiretss.v13.i1.13

Abstract

This paper examined the impact of education expenditure on manufacturing sector output in selected Sub-Saharan African countries using panel data analysis. The paper was motivated by the need to determine whether investment in Education contributes to manufacturing sector growth, given the persistent challenges of inefficiencies in the allocation and utilization of resources. Specially, the paper investigated the effect of education expenditure, capital accumulation and labour force participation on manufacturing sector output. Secondary data were obtained from World Bank Development Indicators (WDI), Macro trend, and mundi index for selected Sub-saharan African countries. Descriptive statistics were employed to examine the characteristics of variables, while the Random Effects model was selected based on the Hausman test to estimate the relationship between manufacturing sector output (MSO) and the explanatory variables education expenditure (EDU), capital accumulation (K), and labour force participation (LF). Based on the findings, the paper revealed that education expenditure has a negative and statistically significant effect on manufacturing sector output. On the other hand, capital accumulation was found to have a positive and statistically significant effect on manufacturing output. Furthermore, labour force participation exhibited a negative but statistically insignificant effect on manufacturing sector output. The paper concludes that increased spending on education has not translated into improved industrial performance within the study period. The result points to inefficiencies in the allocation and utilization of educational resources, as well as a possible mismatch between the skills produced by the education system and those required by the manufacturing sector. Therefore, the paper recommends governments should improve the efficiency and targeting of education spending by prioritizing technical, vocational, and industry-relevant skills. Emphasis should be placed on aligning educational outcomes with the needs of the manufacturing sector. Strengthening monitoring mechanisms will also ensure proper utilization of allocated funds.

Keywords: *Education expenditure, Manufacturing sector output, Capital accumulation, Labour force participation.*

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Background of the Study

The manufacturing sector is widely recognized as a key driver of economic growth, industrialization, and structural transformation, particularly in developing regions such as Sub-Saharan Africa (SSA). It plays a crucial role in employment generation, technological advancement, value addition, and export diversification. In countries such as Togo, Niger, Gabon, Ghana, and Nigeria, the manufacturing sector is expected to contribute significantly to economic development and reduce overdependence on primary commodities. However, despite its importance, the sector in these countries continues to experience low productivity, weak competitiveness, and limited contribution to gross domestic product (GDP) (Okpala, 2022).

One of the major determinants of manufacturing sector performance is human capital development, which is largely influenced by education expenditure. Education enhances the skills, knowledge, and innovative capacity of the labour force, thereby improving productivity and efficiency in industrial production. According to endogenous growth theory, investment in education promotes technological progress and long-run economic growth (Wang & Shasha, 2016). In line with this, governments across Sub-Saharan Africa have increased their spending on education with the expectation that it will improve workforce quality and stimulate industrial output (Chidi et al., 2023).

Despite these efforts, the manufacturing sector in many SSA countries continues to underperform. Evidence suggests that increased education expenditure has not sufficiently translated into improved manufacturing productivity due to inefficiencies in resource allocation, poor policy implementation, and weak linkage between educational outcomes and industrial needs (Oduola, 2024). In many cases, there exists a mismatch between the skills produced by the education system and those required in the manufacturing sector, which limits the effectiveness of education in enhancing industrial performance (Aigbedon et al., 2017).

Furthermore, empirical studies on the relationship between education expenditure and economic performance present mixed and inconclusive findings. While studies such as Chidi et al. (2023) and Irughe et al. (2020) report a positive relationship between education spending and economic growth, others such as Ogunjobi (2023) and Jeff-Anyeneh et al. (2019) find insignificant or even negative effects on manufacturing productivity and industrial development. This inconsistency suggests that the impact of education expenditure may vary depending on the efficiency of spending, the structure of the economy, and the methodological approach used.

More importantly, most existing studies focus on aggregate economic growth rather than sector-specific outcomes, particularly manufacturing sector output. In addition, many studies are country-specific, with a heavy concentration on Nigeria, thereby limiting the generalization of findings across Sub-Saharan African countries. There is also limited empirical evidence that simultaneously examines the roles of education expenditure, capital

accumulation, and labour force participation in explaining manufacturing sector performance within a panel framework (Ayeni & Omobude, 2018). Given these gaps, there is a need for a comprehensive cross-country analysis that captures both time-series and cross-sectional variations in order to provide more robust and policy-relevant insights.

Therefore, the broad objective of this was to examine the impact of education expenditure on manufacturing sector output in selected Sub-Saharan African countries (Togo, Niger, Gabon, Ghana, and Nigeria), while controlling for capital accumulation and labour force participation, with the objective of determining whether education expenditure significantly influences manufacturing sector output in the region.

The paper is expected to contribute to the existing literature by providing additional empirical evidence that can assist policymakers in designing education–sector policies capable of supporting the manufacturing sector. The paper is structured into five sections namely: introduction, section II reviews literature which include empirical review and theoretical framework. Section III of the paper presents the methodology. Then section IV contains data analysis and results while section V presents conclusion and recommendation.

Literature Review

Education Expenditure

The concept of Education expenditure refers to the financial resources devoted to the provision and development of education systems. Education expenditure entails total financial investment (public, private, and external) allocated to educational systems for the provision of teaching, infrastructure, human resources, and related services aimed at developing human capital**.** In a broader macroeconomic sense, education expenditure is also defined as the total spending on education expressed as a share of GDP, covering government, household, and external funding sources (UNESCO, 2025).

According to the UNESCO Institute for Statistics (UIS)**,** education expenditure is defined as:"all financial resources spent on educational institutions from public, private, and international sources, including both current and capital expenditures." Furthermore, recent OECD (2025) analysis defines education expenditure as the spending on educational goods and services within teaching and non-teaching institutions, including investments in infrastructure, personnel, and educational services

Manufacturing Sector Output

Manufacturing is the process of converting raw materials, components, or parts into finished goods that meet a customer's expectations or specifications. It involves a combination of human labour, machinery, and technology to produce tangible products on a large scale (Daniel *et al.*, 2017). The manufacturing process encompasses a wide range of activities, from design and prototyping to production and quality control. Also, Ebele and Iorember (2017) opined manufacturing sector refers to a broad category of the economy that includes companies and industries involved in the production of goods from raw materials or

components and this sector is a vital part of any economy and often serves as a measure of a nation's economic prowess.

According to the World Bank (2025), manufacturing output is defined as the total value added by manufacturing activities, including the transformation of raw materials into finished or semi-finished goods**.** This value added reflects the sector's contribution to Gross Domestic Product (GDP) and serves as a measure of industrial growth. Similarly, the United Nations Industrial Development Organization (2025) describes manufacturing output as the aggregate production generated by manufacturing industries, encompassing activities such as processing, assembling, and fabrication of goods**.** This definition emphasizes the role of manufacturing in value creation and structural transformation of economies. From a macroeconomic perspective, Organisation for Economic Co-operation and Development (2025) defines manufacturing output as the total production of manufactured goods measured in terms of value added, output volume, or industrial production index. This highlights that MSO can be captured using different indicators depending on data availability.

Manufacturing includes all intermediate processes required for the production and integration of a product's components (Bada, 2017). An element of the industrial sector is manufacturing (processing, quarrying, craft and mining). Therefore, manufacturing entails transforming raw resources into final consumer goods, intermediate goods, or producer goods. Like other industrial operations, manufacturing opens up employment opportunities, supports agriculture, diversifies the economy, and increases the country's foreign exchange, which in turn helps local labour develop skills. It reduces the danger of becoming overly dependent on international trade and promotes resource usage to the maximum (Ogundipe, 2022). A measure of how well the other industrial sector components are employed is the level of production.

Empirical Review

Ogunjobi *et al*. (2026) examined the effect of public education expenditure on manufacturing productivity in Nigeria using annual time-series data covering 1981–2024. The data were obtained from the Central Bank of Nigeria and the World Development Indicators, while the Autoregressive Distributed Lag (ARDL) bounds-testing technique was employed to investigate short-run and long-run relationships. The findings revealed that changes in public education expenditure did not have an immediate statistically significant effect on manufacturing output in the short run. However, the first lag of education expenditure had a positive and statistically significant effect, suggesting that the benefits of government investment in education may take time to influence manufacturing productivity. In the long run, the study found that public education spending had not translated into meaningful improvements in manufacturing productivity, which the authors associated with possible inefficiencies in expenditure allocation and the weak connection between public spending and manufacturing-sector needs. The study therefore emphasized the need to align educational funding with the skills and productivity requirements of the manufacturing sector.

Nyeche *et al.* (2026) investigated the effect of human capital investment on industrial sector output in Nigeria using annual time-series data covering 1990–2024. The study used data from the Central Bank of Nigeria Statistical Bulletin and the World Development Indicators. Human capital investment was represented by investment in education, research and development, and health, while industrial-sector gross domestic product served as the dependent variable. The researchers employed the ARDL technique to estimate the short-run and long-run relationships. The results showed that investment in education had a positive and statistically significant effect on industrial-sector output in both the short run and long run. Investment in research and development also had a positive and significant long-run effect, whereas investment in health had a positive but statistically insignificant effect in both periods. The study concluded that human capital investment contributes to industrial-sector performance and recommended stronger collaboration between universities, research institutions, and industry to promote innovation and productivity.

Adamu *et al.* (2025) examined the relationship between human capital development and manufacturing sector output in Nigeria over the period 1980–2023. The study investigated whether human capital indicators, including government expenditure on education and health, contributed to manufacturing sector performance. Annual secondary data obtained from the Central Bank of Nigeria's Statistical Bulletin were analysed using the Autoregressive Distributed Lag (ARDL) technique to establish the short-run and long-run relationships among the variables. The findings revealed that government expenditure on education had a positive but statistically insignificant relationship with manufacturing sector output. Similarly, primary school enrolment exhibited a negative and statistically insignificant effect on manufacturing output, suggesting that educational outcomes may not have been adequately aligned with the technical and professional skills required by the manufacturing sector. The study concluded that increasing educational access and public expenditure alone might not be sufficient to improve industrial productivity unless such investments enhance the quality and relevance of human capital. They recommended education reforms that align learning outcomes with industrial skills requirements, alongside more efficient public expenditure on human capital development.

Oduola (2024) examine the effect of public educational expenditure on the efficiency of resources used in the Nigerian manufacturing sector over the period 1981-2019. The Data Envelopment Analysis is used to estimate the efficiency scores for the years under examination. The results show that, within the DEA estimation of efficiency, public educational capital expenditure does not result in the efficient use of resources for the majority of years under investigation except for the year 2019; only 16 years on public educational recurrence expenditure showed constant returns, and no years showed a decreasing return to scale, compared to the year 1982. The inefficiencies in utilising resources are linked to scale inefficiencies, and the government should target public spending policy to increase the size of capital projects in the education sector.

Chidi *et al.* (2023) investigated the impact of education spending on the economic growth of Nigeria. The study applied annual time-series data from 1980 to 2019 and an Autor Regressive Distributed Lag (ARDL) methodology to examine the effect of education spending on economic growth in Nigeria. The empirical findings established that health, capital expenditure on education, recurrent expenditure on education, positively affected GDP growth rate in the long-run and short-run whereas, inflation rate, gross capital formation, and exchange rate retarded economic growth rate in long-run. Contrariwise, inflation rate, gross capital formation and exchange rate retard the economic growth in the short run. The findings proposed that improved capital and recurrent expenditure on education, stabilized inflation and exchange rate, gross national investment would enhance economic growth, improve living standard, and increase government revenue in the long-term.

Agum and Babayo (2023) empirically examine the impact of education infrastructure on industrial sector performance in Nigeria. In that vein, an annual time series dataset was generated from Central Bank Statistical Bulletin and World Development Indicators (WDI) for the period, 1980 to 2022. The study employed Autoregressive Distributed Lag Model to analyse the parameters. Ex-post facto research design was also adopted. The descriptive results suggest that all the variables have positive mean. The implication of the positive mean is that all the variables in the model recorded positive average growth rate during the period under review. The inferential analysis began with estimation of unit roots tests and the results revealed that variables were stationary at different orders of integration. Furthermore, the cointegration test shows that there is an evidence of cointegration among the variables. Based on the cointegration result, this study applied ARDL approach to generate the estimated shortrun and long-run results. Based on the short-run estimate, this study reveals that there is positive but statistically significant relationship between education infrastructure and industrial sector performance.

Chukwudi (2023) evaluated the expenditures on education in Nigeria and other West African Countries. The data for this study were gotten from a secondary source obtained from World Bank Annual Report. The data were analyzed using one way ANOVA with the aid of SPSS version 20, and the result showed that there is no significant difference in the expenditures on education between Nigeria and other West African countries at 5% level of significance. We therefore, recommend that Governments of West African Countries should allocate a higher percentage of their budgets to education as to ensure adequate funding for infrastructural development, teacher training, and curriculum enhancement, enhance improvement of budget and monitoring and for overall improvement of the education sector.

Okpala (2022) Government Capital Expenditure and Manufacturing Sector Output in Nigeria using time series data from 1981 to 2018.The government capital expenditure was disaggregated into two functional expenses as capital expenditures on the road and Agriculture. The annual time series data employed were analysed for unit roots using the augmented Dickey Fuller (ADF), and regression techniques based on the Autoregressive

Distributive Lag (ARDL) to determine the relationships. The findings revealed that capital expenditure on road infrastructure has a short-run positive significant effect on manufacturing sector output, but an-insignificant adverse impact on manufacturing sector output in Nigeria; capital expenditure on agriculture has significant impacts on the manufacturing sector output in Nigeria driving at negative in the short run and then positive in the long run. The study hence recommended increased for growth and productivity.

Sannoh (2021) investigated the relationship between general government education expenditure and economic growth in two anglophone West African countries, Gambia and Ghana through cross-country comparison. Econometric tools such as Augmented Dickey Fuller test (ADF), Johansson Cointegration Test, Error Correction Model (ECM) and Granger Causality Test Analysis. The data collected for Gambia and Ghana ranges from 1968 to 2015. After carefully running an individual test on all the variables, we observed a short-run economic meaningful relationship between education expenditure and economic growth in both countries based on the result revealed from ECM. The Granger Causality test result suggests a unidirectional causality that run from Gross Domestic Product (GDP) to Government Education Expenditure (Edu) for Ghana but the study was unable to significantly determine a causal direction for the Gambia. However, the study concluded that Education Expenditure has statistically significant short run impact on economic growth in both countries. The study recommends Governments persistent increase in the spending for education in both countries order to witness massive change in the economy.

Jeff-Anyeneh*et al.* (2019) used the Autoregressive Distributed Lag (ARDL) model to evaluate the long-run and short-run dynamics of government investment on manufacturing development in Nigeria from 1981 to 2016. The findings show that, despite a constant increase in government spending and different government efforts aimed at boosting industrial efficiency in Nigeria, government spending had no long-term or short-term positive impact on the country's industrial development. Government should target spending in ways that favour manufacturing industry growth, this is very important because in Nigeria people tend to be biased towards finding jobs in this sector of the economy. This can be corrected by some re-orientation and establishment of vocational centres and specialized schools that would impart skills that are readily applicable in the manufacturing industry.

Ayeni and Omobude (2018) investigated educational expenditure and economic growth nexus in Nigeria using secondary and times series data from 1987 to 2016, sourced from the Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS) and other agencies and sources. Relevant statistical tools were employed in exploring the relationships between these variables. The random characteristics of the variables were tested using the Augmented Dickey Fuller (ADF) technique. The links among educational expenditure, education sector output and economic growth were tested via the Autoregressive Distributed Lag (ARDL) and bound test approach developed by Pesaran and Shin. Four research hypotheses were tested. The literature reviewed guided the interpretation of the results. The population for the

study was Nigeria. The findings show that educational expenditure was inconsistent with education sectoral output. On the other hand, while recurrent educational expenditure exhibited significant relationship with real gross domestic product (economic growth), in contrast, capital expenditure on education was insignificant. Generally, the study concluded that the impact of educational expenditure on real GDP is mainly a function of the expenditure type in Nigeria. This is premised on the fact that only recurrent educational expenditure had both positive and significant long-run impact on economic growth within the period of study. The study attributed these findings to the fact that educational expenditure within the period of study was distorted by extraneous factors such as policy mismatch, inadequate funding, less priority placed on capital expenditure, fund misappropriation, etc. The study recommends that in line with international standards, the educational system of Nigeria requires an institutional transformation in terms of policy formulation, implementation and monitoring as well as funding. Also, priority must be given to capital expenditures to translate to economic growth.

Aigbedon *et al.* (2017) examined the impact of the education sector on economic growth in Nigeria. Time series data was used and the study employed ordinary least squares analysis in investigation of the impact and relationships among the economic variables, multiple regression model was also used and the data was estimated. The results revealed that the education sector has a positive impact on economic growth in Nigeria. This implies that economic growth can be improved by increasing education investment in Nigeria. But government expenditure on education is negatively related to the real gross domestic product in Nigeria and statistically significant at a 5% level of significance in explaining the variation in the real gross domestic product in Nigeria, this may be because education funds are not fully or properly utilized in Nigeria. The study concluded that the education sector has a positive impact on economic growth, suggesting that increasing investment in education can improve economic growth in Nigeria. However, they also found that government expenditure on education was negatively related to the Gross Domestic Product (GDP), potentially due to inefficient utilization of funds.

Theoretical Framework

Human Capital Theory

This study is anchored on the Human Capital Theory**,** developed by Theodore Schultz (1961) and later expanded by Gary Becker (1964). The theory posits that investment in education and training enhances the productive capacity of individuals, thereby improving overall economic performance and sectoral output.

Human capital theory views education expenditure as a deliberate investment that increases the knowledge, skills, and competencies of the labour force. According to the theory, a more educated workforce is better equipped to perform complex tasks, adapt to technological changes, and improve efficiency in production processes. These attributes are particularly important in the manufacturing sector, which relies heavily on skilled labour, technical expertise, and innovation.

Methodology

The study utilized secondary data obtained from reputable international databases to ensure reliability and comparability across countries. Specifically, data were sourced from the World Bank (World Development Indicators), Macro-trend and Mundi index was employed for the study. The data cover selected Sub-Saharan African countries: Togo, Niger, Gabon, Ghana, and Nigeria spanning from 1999 to 2025. The variables include: Manufacturing Sector Output (MSO) – proxy: manufacturing value added (% of GDP), Education Expenditure (EDU) – proxy: government education expenditure (% of GDP), Capital Accumulation (K) – proxy: gross capital formation (% of GDP) and Labour Force Participation (LF) – proxy: labour force participation rate (%)

Model Specification

The study model for the paper emanated from the Cobb–Douglas framework which assumes that output is a function of key inputs such as:

$$Y=AK^{\alpha}L^{\beta}$$

Where:
Y = Manufacturing sector output
A = Total factor productivity
K = Capital stock
L = Labour force
α, β = Output elasticities

The paper took the log form of the variables to transform the data into manageable size for the analysis. According to Changyong, *et al.* (2014), log transformations are beneficial for stabilizing variance and reducing the impact of outliers noting that datasets with extreme values or heteroscedasticity (non-constant variance), the logarithmic transformations make the variance more uniform across observations, improving model accuracy and robustness. Therefore, the model is written as:

$$lnMSO_{it}=\beta_0+\beta_1 lnEDU_{it}+\beta_2 lnK_{it}+\beta_3 lnLF_{it}+\mu i+\lambda_t+\epsilon_{it}$$

Where:
$lnMSO_{it}$=Log of manufacturing sector output
$lnEDU_{it}$=Log of education expenditure (as % of GDP or real spending)
lnK_{it}= Log of capital formation
$lnLF_{it}$ = Log of labor force in manufacturing
μ_i= Country fixed
λ_t= Time effects
ε_{it}= Error term
β_0- β_3 = coefficient of education expenditure, capital formation, and labour force.

To determine the most appropriate panel estimation technique for the paper, the Hausman test was employed as a diagnostic tool to assess whether the individual country effects were correlated with the explanatory variables. This test was crucial in guiding the selection between the fixed effects and random effects models. This approach ensued consistent and efficient parameter estimation in analysisng the impact of education expenditures on manufacturing sector output in selected Sub-saharan African countries.
H= Hausman test statistic

Under the null hypothesis $H_{0:}$ the preferred model is Random Effects (no correlation between regressors and individual effects); Under the alternative hypothesis $H_{1:\text{ the fixed Effects}}$ model is more appropriate (correlation exists). If the computed H- statistic is significant (p-value<0.05), the null hypothesis is rejected, and the fixed Effect model kis preferred.

Table 1: Variables Description and Measurement

Variable	Acronym	Description	Measurement/Proxy
Manufacturing Sector Output	MSO	Total value of goods produced in the manufacturing sector within the economy	Manufacturing value added (% of GDP) or total manufacturing output (constant USD)
Education Expenditure	EDU	Government spending on the education sector aimed at human capital development	Education expenditure (% of GDP) or total government spending on education
Capital Accumulation	K	Stock of physical assets used in production such as machinery and infrastructure	Gross capital formation (% of GDP)
Labour Force Participation	LF	Proportion of the working-age population actively engaged in economic activities	Labour force participation rate (% of population aged 15–64)

Source: Author's Plotting, 2026.

Results and Discussion
Descriptive Statistics Results
Descriptive statistics provide a preliminary overview of nature, distribution, and characteristics of variables used in paper. They summarize key attributes such as central tendency (mean), dispersion (Standard deviation), and distribution shpe (skewness and kurtosis), as well as indicate normality through tests like the Jaque-Bera statistic. The result is captured in Table 2.

Table 2: Summary Statistics Result

	MSO	EDU	K	LF
Mean	11.5537	5.023333	22.7097	65.5363
Maximum	21.65	16.82	51.3	84.6
Minimum	2.54	1.9	8.3	46.46
Std. Dev.	4.466564	3.276747	7.451578	11.07146
Obervation	135	135	135	135

Source: Author's Plotting Using Stata version 17 (2026)

The descriptive statistics presented in Table 2 provide an overview of the characteristics of the variables used in this study across selected Sub-Saharan African countries. Manufacturing Sector Output (MSO) has a mean value of 11.5537, with a maximum of 21.65 and a minimum of 2.54, indicating significant variation in manufacturing performance across countries and over time. The standard deviation of 4.4666 further confirms the presence of volatility in the manufacturing sector within the region.

Education Expenditure (EDU) records a relatively low mean value of 5.0233, suggesting inadequate investment in human capital development across the selected countries. The wide range between its minimum (1.90) and maximum (16.82) values indicates disparities in education spending policies. Capital Accumulation (K) has a higher mean value of 22.7097, reflecting its importance in driving production activities, although its high standard deviation (7.4516) suggests uneven investment distribution. Labour Force Participation (LF) shows a high mean of 65.5363, indicating a relatively large workforce across the region. However, the standard deviation of 11.0715 points to variability in labour market participation. Overall, the descriptive statistics reveal that fluctuations and disparities in education expenditure, capital accumulation, and labour force participation may significantly influence manufacturing sector output in Sub-Saharan African countries.

Table 3: Hausman Test Result

	Chi-Sq		
Test Summary	Statistic	Chi-Sq. d.f	Prob.
Cross-section random	1.00	3	0.8004

Source: Author's Plotting Using Stata version 17 (2026)

The Hausman test was conducted to determine the most appropriate model between the Fixed Effects and Random Effects estimators. The result shows a Chi-square statistic of 1.00

with 3 degrees of freedom and a probability value of 0.8004. Since the p-value is greater than the 0.05 level of significance, the null hypothesis cannot be rejected. This indicates that the Random Effects model is more appropriate for the analysis.

This result suggests that the individual country-specific effects are not correlated with the explanatory variables included in the model. Therefore, the Random Effects estimator is preferred as it provides more efficient and consistent estimates. Consequently, the study adopts the Random Effects model in analyzing the impact of education expenditure, capital accumulation, and labour force participation on manufacturing sector output in selected Sub-Saharan African countries. Based on the Hausman test result, the paper adopts the random effects models, as it provides efficient and consistent parameter estimates in the context.

Random Effect Regression Result

The paper established that there is no significant correlation between the regressors and the individual country effects, as indicated by the Hausman test result. Accordingly, the analysis proceeds with the estimation using Random Effects model. This approach is appropriate as it exploits both within–country and between country variations over the paper period, enhancing efficiency in parameter estimation. By accommodating country-specific unobserved heterogeneneity while assuming it is uncorrelated with the explanatory variables. The Random effects model offers robust framework for examining the impact of education expenditure on manufacturing sector output, as presented in Table 4.

Table 4: Random Effect Regression Result
Dependent Variable: MSO
Method: Panel EGLS (Cross-section random effects)

Variable	Coefficient	Std.Error	t-Statistic	Prob.
EDU	-0.4109	0 .1197	-3.43	0.001
k	0.1033	0.0424	2.44	0.015
LF	-0.1006	0.0714	-1.41	0.159
C	17.8654	4.9840	3.58	0.000

Effects Specification

	S.D	**Rho**
Cross-section random	0.1691	0.3635
Idiosyncratic random	0.0258	0.2811

Weighted Statistics

Root MSE	3.7243	R-square	0.3203
Mean dependent var	0.0200	Adjusted R-square	0.3047
Sum Square resid	0.0490	F-statistic	20.58
Durbin- Watson Stat	1.8898	Prob(F-statistic)	0.0000

Source: Author's plotting using Stata (2026)

From table 4, the regression results show that education expenditure (EDU) has a negative and statistically significant effect on manufacturing sector output (MSO), with a coefficient of -0.4109 and a probability value of 0.001. This implies that increases in education spending are associated with a decrease in manufacturing output during the study period. This unexpected result may be due to inefficiencies in educational spending or a mismatch between acquired skills and industrial needs.

Capital accumulation (K) has a positive and statistically significant effect on MSO, with a coefficient of 0.1033 and a p-value of 0.015. This indicates that increased capital investment significantly enhances manufacturing output, confirming the critical role of capital in industrial development. Labour force participation (LF) shows a negative but statistically insignificant relationship with MSO, with a coefficient of -0.1006 and a p-value of 0.159. This suggests that labour does not significantly influence manufacturing output, possibly due to low productivity or inadequate skills.

The model's overall goodness of fit and explanatory power is evaluated using the R-square, adjusted R-square, and F-statistics values. An R-square of 0.3203 indicates that approximately 32% of the variation in manufacturing sector output (MS0) across the selected Sub-saharan African countries is explained by the combined influence of the three independent variables: Education expenditure (EDU), Capital accumulation (K), and Labour force participation (LF). While this level of explanatory power is moderate, it is reasonable given the multidimensional nature of MSO, which is influenced by a wide range of social, political, and economic factors beyond education expenditure alone.

The Adjusted R-square of 0.3047 further supports this interpretation by adjusting for the number of predictions in the model. It reflects the model's ability to explain variability while penalizing for potential over fitting. This suggests that the model retains validity and relevance even when accounting for model differences. The F-statistic of 20.58 ($p = 0.0000$) confirms that the model is statistically significant overall. Additionally, the Durbin-Watson statistic of 1.8898 suggests the absence of autocorrelation, indicating reliable estimates. This implies that the independent variables jointly have a significant effect on MSO, and the likelihood of the observed results occurring by chance is very low.

Discussion of Findings

Findings from the paper showed that education expenditure (EDU) had a negative but statistically significant impact on manufacturing sector output across the selected Sub-saharan African countries, the negative and significant effect of education expenditure contradicts theoretical expectation. This implies that increased spending on education does not translate into improved manufacturing performance within the study period. This may reflect inefficiencies in the education system, poor alignment between educational outcomes and industrial needs, or the delayed impact of education on productivity. This findings align with that of Oduola (2024), who found that public educational expenditure does not lead to efficient resource utilization in Nigeria's manufacturing sector, largely due to scale

inefficiencies, Also The finding further agrees with Ayeni and Omobude (2018), who concluded that the effectiveness of educational expenditure depends on its composition, with distortions arising from poor policy implementation and misallocation of funds. However, the result contradicts: Chidi *et al.* (2023) and Sannoh (2021) studies reported that education expenditure positively affects economic growth.

The study finds that capital accumulation has a positive and statistically significant effect on manufacturing sector output. This indicates that increased investment in physical capital enhances industrial productivity. This result is consistent with Okpala (2022) and Chidi *et al.* (2023) who found that capital expenditure (especially on infrastructure) positively influences manufacturing output, particularly in the short run. Also, the finding is in line with general economic theory, which emphasizes capital as a critical factor of production. The result confirms that manufacturing growth in Sub-Saharan Africa is largely capital-driven, meaning that investments in machinery, infrastructure, and technology are essential for improving industrial output.

The findings show that labour force participation has a negative but statistically insignificant effect on manufacturing sector output. This suggests that labour does not play a significant role in driving industrial productivity in the region. This result aligns with Ogunjobi *et al.* (2026) found that government expenditure (including education) had an insignificant impact on productivity, highlighting a disconnect between resource input and output. However, it contradicts Agum and Babayo (2023) reported a positive relationship between education infrastructure and industrial performance, implying that labour quality enhances productivity. The insignificance of labour force participation suggests that labour in Sub-Saharan Africa may be abundant but not productive, due to low skill levels Poor training systems and weak linkage between education and industry.

Conclusion and Recommendations

This paper examined the impact of education expenditure on manufacturing sector output in selected Sub-Saharan African countries using panel data analysis. The Random Effects model, selected based on the Hausman test, was employed to estimate the relationship between manufacturing sector output (MSO) and the explanatory variables education expenditure (EDU), capital accumulation (K), and labour force participation (LF). Based on the findings the study revealed that education expenditure has a negative and statistically significant effect on manufacturing sector output. This suggests that increased spending on education has not translated into improved industrial performance within the study period. The result points to inefficiencies in the allocation and utilization of educational resources, as well as a possible mismatch between the skills produced by the education system and those required by the manufacturing sector. On the other hand, capital accumulation was found to have a positive and statistically significant effect on manufacturing output, confirming that investment in physical capital remains a major driver of industrial growth in Sub-Saharan Africa. This highlights the importance of infrastructure development, machinery acquisition, and technological investment in enhancing production capacity.

Furthermore, labour force participation exhibited a negative but statistically insignificant effect on manufacturing sector output. This implies that the availability of labour alone does not guarantee increased productivity, likely due to low skill levels, inadequate training, and inefficiencies in labour utilization. Overall, the study concludes that while capital plays a critical role in driving manufacturing output, the effectiveness of education expenditure in promoting industrial growth in Sub-Saharan Africa is limited by structural and institutional challenges. Additionally, the contribution of labour to manufacturing output is constrained by issues related to quality rather than quantity.

Based on the findings of the study, the following recommendations were made:

i. Governments should improve the efficiency and targeting of education spending by prioritizing technical, vocational, and industry-relevant skills. Emphasis should be placed on aligning educational outcomes with the needs of the manufacturing sector. Strengthening monitoring mechanisms will also ensure proper utilization of allocated funds.
ii. Policy efforts should focus on increasing investment in critical infrastructure and industrial capital such as machinery, power supply, and technology. Governments should also create an enabling environment to attract private and foreign investment. This will enhance production capacity and sustain manufacturing sector growth.
iii. There is a need to improve the quality and productivity of labour through continuous skill development and training programs. Governments should promote capacity building and encourage collaboration between industries and training institutions. This will ensure that the labour force is equipped with relevant and practical skills for manufacturing activities.

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