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Interacting Labor Force and Human Capital Development Effects on Manufacturing Sector Productivity

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Abstract

Research Originality: The adoption of technology in the industrial world requires a high-quality workforce. This research provides a novelty by testing human capital development against the output of the manufacturing industry.

Research Objectives: This study analyzes the interactive impact of the industrial labor force and human capital development on manufacturing sector output in the West African Sub-Region from 1989 to 2022.

Research Methods: The study adopted an ex post facto research design. The data used for analysis was sourced from the World Development Indicator (WDI), and the Panel ARDL method was employed to investigate the interactive impact of industrial labor force and human capital development on manufacturing output.

Empirical Results: The results suggest that labor force and human capital had an interactive negative, insignificant impact on manufacturing output in the short run, while in the long run, the interaction of labor force and human capital had a significant favorable influence on the manufacturing sector's output. The composite human capital index had no significant impact on output in the manufacturing sector in both the short run and the long run.

Implications: Policymakers should focus on developing initiatives that will enhance the labor force's skill sets and align them with the needs of the manufacturing sector..

Keywords:

industrial labor force; manufacturing sector; output; autoregressive distribution lag

How to Cite:

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INTRODUCTION

The manufacturing sector plays a crucial role in the development of any nation, improving the standard of living and reducing unemployment and the rate of importation in the country. This is recognized across various sectors, including policymaking, economic planning, and research (Herman, 2020; Mounde, 2017; Su & Yao, 2016), demonstrating this sector's critical role in facilitating structural transformation, creating worthwhile employment opportunities, and fostering sustainable economic growth. The manufacturing sector is, therefore, seen as the engine of economic growth. However, the advantages of this sector appear to elude many African nations despite the continent's abundance of human and natural resources, particularly in West African countries. West African nations significantly lag in manufacturing output, often attributed to widespread illiteracy (Adeyemi & Akode, 2022; Babasanya et al., 2020).

Human capital is paramount in enhancing productivity, fostering growth, and ensuring sustainability in the manufacturing sector. The Labor force in this sector helps quantify the available Labor input for manufacturing production. It provides insights into the potential capacity of the manufacturing sector, while education impacts the quality of the Labor force (Seclen-Luna et al., 2020). The ability of an economy to grow is enhanced by the development of human capabilities (Dudu, 2022; Okunade, 2018). This fact implies that the quantity and quality of the Labor force are crucial in determining the output level in the manufacturing sector. Hence, industrial enterprises adopting the latest production technologies requires a high-quality workforce that matches the complexity and uniqueness of the equipment and materials used.

Therefore, for any enterprise, the urgent task is to manage the quality of the workforce. Successfully addressing this challenge will enable the enterprise to maintain a robust balance between the development of material and personal factors of production (Krasnopevtseva & Krasnopevtsev, 2020). Consequently, the quality of human capital and its development process—influencing Labor force quality—becomes critical for sustaining output growth in this sector (Njoku & Onyegbula, 2017). High Labor productivity can be realized when output improves through enhancing the quality of human capital (Laut et al., 2023).

West African countries have undergone various industrial policies to maximize the potential capacity of the manufacturing sector. Countries like Benin, Nigeria, Togo, Senegal, and Ghana have implemented similar industrial policies, from import substitution to structural adjustment programs (SAP). Additionally, West African countries have introduced several policies to improve human capital, such as Education for All, Universal Primary Education (UPE), Nigeria's Universal Basic Education, Technical and Vocational Education and Training (TVET) embedded in secondary education, Teacher Training and Professional Development, Education for Girls and Women, Science, Technology, Engineering, and Mathematics (STEM) Education, and curriculum reform, among others. West African countries often collaborate through regional organizations like the Economic Community of West African States (ECOWAS), the West African Economic and Monetary Union (WAEMU), and the West Africa Examination Council to harmonize policies, share best practices, and address common challenges related to industrial development and human capital enhancement. Despite these efforts, manufacturing sector output in West

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Africa remains significantly lower compared to other regions on the continent. There is a disconnect between investments in human capital development and their impact on manufacturing sector productivity in these countries.

The specific interactive effect of the industrial Labor force and human capital development on manufacturing sector output in West Africa has largely been unexplored. Although several studies have emphasized the positive correlation between an educated Labor force and increased productivity—particularly evident within the manufacturing sector—this relationship is relevant to this study (Ojike et al., 2022; Andy et al., 2022). Using secondary and tertiary enrollment data, studies that interacted with the efficiency of human capital development with the Labor force revealed that intermediate-skilled workers have no significant effect on Labor productivity in manufacturing. In contrast, highly skilled workers significantly impact productivity in this sector. This condition suggests that a better-educated Labor force has a significant positive tendency to improve productivity in manufacturing (Loening, 2004; Rukumnuaykit & Pholphirul, 2015). Ewane and Ewane (2024) indicate that government expenditure on education has a negative effect on industrial sector growth in the short run. The results further indicate a long-run asymmetry nexus between human capital and industrial sector growth. This finding implies that human capital and industrial growth are complex.

Previous studies have not explored the diffusion effects of the Labor force and human capital on manufacturing sector productivity in the West African sub-region. Instead, the focus of most studies has been on the effects of human capital development. Despite the extensive studies on the role of human capital on economic growth and manufacturing sector productivity, there is still little or no literature specifically examining the interactive impact of the industrial labor force and human capital development on the manufacturing sector output in the West African Sub-Region. The existing literature has primarily focused on human capital development and labor productivity or economic growth, neglecting the interplay between human capital and the industrial labor force.

Therefore, this study examines the interactive impact of the industrial Labor force and human capital development on manufacturing sector output in the West African sub-region, both in the short and long run, from 1989 to 2022. This addresses the critical gap through empirical analysis of the interactive impact of the labor force and human capital development, using education as a proxy by establishing the short-run and the long-run effects. The study clarifies how labor force education and industrial labor force capacity jointly influence the manufacturing sector's output in the West African Sub-Region.

METHODS

This study employs an ex post facto research design, also known as post-event research design, to investigate the relationship between human capital development and manufacturing sector output in the West African sub-region. The data used for this study are secondary data sourced from World Development Indicators (WDI) and the International Labor Organization (ILOSTAT).

This study is anchored on endogenous growth theory in line with the Cobb-Douglas production function as established in the work of Mukhtar and Enebeli-Uzor (2023), which assumes that a firm produces net output with a Cobb-Douglas production function that uses units of physical capital and units of labor, and has a given efficiency parameter and output elasticities and for capital and labor, respectively.

$$Y_i = AK_i^{\alpha} L_i^{\beta} \quad (1)$$

Table 1. Variable Definition, Measurements, and Data Sources

Variable	Description	*Unit of Measurement*	Source
MSO	Manufacturing sector contribution to GDP	$' Billion	World Development Indicators (WDI)
GPE		Percent	World Development Indicators (WDI)
GSE	Gross secondary enrolments	Percent	World Development Indicators (WDI)
GTE	Gross tertiary enrolments	Percent	World Development Indicators (WDI)
AYS	average year of school	Years	World Development Indicators (WDI)
LFPR	Labor force participation rate	Percent	International Labor Organization (ILOSTAT)
PCAPITAL	Physical capital formation (gross capital formation)	Percent	World Development Indicators (WDI)

Source: Author's Compilation, 2024

The dependent variable, MSO, represents the manufacturing sector's contribution to GDP, measured in billions of dollars (constant 2010 prices). The independent variables used to proxy human capital development include gross primary enrollment (GPE), gross secondary enrollment (GSE), gross tertiary enrollment (GTE) ratios, average years of schooling, industrial labor force rate, and a control variable. The gross fixed capital formation rate measures physical capital. The choice of these variables in this study is informed by economic theories and existing literature related to the subject, as specified in Table 1.

A Principal Component Analysis (PCA) was conducted using four distinct proxies: gross primary school enrollment (GPE), gross secondary school enrollment (GSE), gross tertiary school enrollment (GTE), and average years of schooling (AYS). Principal component analysis is a statistical technique employed to reduce dimensionality and capture the underlying patterns in correlated variables (Fukao & Makino, 2021; Jolliffe & Cadima, 2016). In this instance, the PCA facilitated the transformation of the original variables into a new composite variable, denoted as 'HC.' The principal components were derived based on the eigenvalues and eigenvectors of the correlation matrix, allowing for the extraction of a linear combination of the input variables that maximizes variance in the data. The resulting 'HC' variable serves as a consolidated indicator of human capital, offering a more succinct representation of the information embedded in the initial educational metrics. This study utilizes annual panel time-series data for 12 West African countries, covering the period from 1989 to 2022.

The study examines the moderating effect of the industrial labor force and human capital development on manufacturing sector output in the West African sub-region,

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both in the short and long run. The relationship between the variables, as established in Equation 1, drawn from the Cobb-Douglas production function, is represented and expanded into econometric Equation 2, adapting it from Hena et al. (2019). Hence, the interactive effect of the industrial labor force and human capital development on manufacturing sector output in the West African sub-region is to be determined:

$$\Delta Ln(MSO_{it}) = \alpha 0i + \beta_{1i}MSO_{t-1} + \beta_{2i}HC_{t-1} + \beta_{3i}LF_{t-1} + \beta_{4i}LF * HC_{t-1} + \beta_{5i}PC_{t-1} + \sum_{i=1}^{p}\alpha_{1i}\,\Delta MSO_{t-1} + \sum_{i=1}^{q}\alpha_{2ij}\,\Delta HC_{t-1} + \sum_{i=1}^{q}\alpha_{3ij}\,\Delta LF_{t-1} + \sum_{i=1}^{q}\alpha_{4ij}\,\Delta LF * HC_{t-1} + \sum_{i=1}^{q}\alpha_{5ij}\,\Delta Ln(PC_{t-1}) + \varepsilon_{it} \quad (2)$$

Where: = α_{0i}, β_{1i}, β_{3i}, β_{4i}, and β_{5i} are the long-run coefficients for the intercept and the slope respectively, while the α_{1ij}, α_{2ij}, α_{3ij}, α_{4ij}, *and* α_{5ij}, are the short run coefficients, p, q is the optimal lags on the first differenced variables. The Schwarz Information Criterion (SIC) is the preferred information criterion for lag selection because it penalizes an excessive number of parameters. Adding the multiplicative interaction term captures the moderating impact of LF in the nexus between human capital development and manufacturing sector output.

The HC is a composite function of human capital development which was determined using Principal Component Analysis (PCA), LF is the industrial labor force's direct effect on the manufacturing sector output, while LF* HC is the interaction term that captures the moderating effect. It represents the interaction between the variables "HC" and "LF". Hence, the coefficient β_{4i} of the interaction term HC*LF helps to understand the moderating effect in the long run. If β_{4i} is statistically significant, it indicates that the relationship between HC and MSO is moderated by LF. The sign and magnitude of β_4 tell how the effect of HC on MSO changes as LF varies in the long run. This is also applicable to α_{4ij}, in the short run.

The speed of adjustment is also included in the long-run model among the variables. Hence the model is thus

$$\Delta MSO_{it} = \alpha_{0i} + \sum_{i=1}^{p}\alpha_{1i}\,\Delta MSO_{t-1} + \sum_{i=1}^{q}\alpha_{2i}\,\Delta HC_{t-1} + \sum_{i=1}^{q}\alpha_{3i}\,\Delta LF_{t-1} + \sum_{i=1}^{q}\alpha_{4i}\,\Delta \mathrm{HC} * \mathrm{LF}_{t-1} + \sum_{i=1}^{q}\alpha_{5i}\,\Delta PC_{t-1} + \lambda ECT_{t-1} + \varepsilon_{it} \quad (3)$$

Where α_{0i} is the intercept of the model's constant, *i* represents the number of variables, and p and q are optimal lag order. p denoted the lag order of the dependent variable. At the same time, q represents the lag order of regressors, λ is the speed of adjustment parameter (or the coefficient of ECT), ECT is the error correction term, ε_{it} is a vector of the error terms, and $\alpha_{1i,}$ $\alpha_{2i,}$ α_{3i} are the short-run dynamic coefficient of the model.

RESULT AND DISCUSSION

Table 2 presents the summary statistics of the datasets, providing a descriptive overview of the nature of the data obtained on all the variables employed in the study. The results show that, on average, the manufacturing sector contributed approximately $3.5 billion to West African GDP between 1989 and 2022. During the same period, the average years of schooling stood at 3.1 years, compared to the global average of 8.7 years. The gross primary school enrollment averaged 83.2%, indicating that the enrollment

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level in primary schools is low in the West African sub-region. Furthermore, it was revealed that the gross secondary school enrollment averaged 34.8%, while gross tertiary enrollment stood at 5.8%. The average industrial labor force participation rate is 13.9%, and the average physical capital, measured by fixed capital formation, stands at 23.1%. This value indicates that human capital development in the West African sub-region is very low compared to other developed and developing regions during the study period.

Specifically, Cabo Verde has the highest manufacturing sector output in West Africa, with a mean value of $73,325,620. In contrast, Togo has the lowest contribution of the manufacturing sector to GDP. Cabo Verde leads in improved human capital development, demonstrating strong skills in manufacturing activities, with mean values of 112.4% for primary school enrollment, 64.1% for secondary school enrollment, and 9.8% for tertiary school enrollment. In contrast, the Niger Republic has the poorest human capital development, with mean values of 45.9% for primary school enrollment, 11.6% for secondary school enrollment, and 1.54% for tertiary school enrollment. The highest level of physical capital (41.3%) is identified in Cabo Verde, while the lowest (13.9%) is in The Gambia. The West African average years of schooling of 3.13 years, compared to the global average of 8.7 years, highlights the region's low literacy level of the human capital stock.

The skewness of all the variables indicates that almost all had a positive skewness, except for manufacturing sector output and physical capital, which skewed negatively (see Table 2). The kurtosis statistics, a measure of the relative peakedness of a distribution, reveal that all the variables are platykurtic, as their kurtosis statistics were less than 3. This result means their distribution is flatter than normal, with shorter tails. Additionally, the Jarque-Bera statistics showed that all the variables have probability values greater than 0.05, indicating that these variables are normally distributed at the 5% significance level.

Table 2. The Descriptive Statistics

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
MSO	3.46e+09	1.10e+10	-0.127	1.613	2.569	0.277
AYS	3.132	1.735	0.444	1.942	2.466	0.291
GPE	83.247	25.601	0.873	2.403	4.399	0.111
GSE	34.785	21.682	0.702	2.048	3.721	0.156
GTE	5.834	5.284	0.454553	1.635	3.473	0.176
LFPR	13.912	5.682	0.483	2.221	1.986	0.371
PCAPITAL	23.117	9.816	-0.071	2.342	0.585	0.746

Source: Author's Computation, 2024

Moreover, the assessment of the correlation between the variables and the outcomes is detailed in Table 3. The correlation matrix table demonstrates the presence of minimal associations among all the variables and the manufacturing sector output (MSO). This value suggests a limited impact of all the variables on the manufacturing sector output (MSO). Despite anticipating heightened impacts crucial for enhancing manufacturing sector output, the fundamental elements of human capital development stand out as pivotal for propelling the manufacturing sector forward, being inherently determined.

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Correlation analysis also helps detect multicollinearity among independent variables. High correlations between predictors may signal multicollinearity issues, which can affect the reliability. Adhering to Kim's (2019) correlation standards, it can be inferred that no multicollinearity exists among the exogenous variables since the correlation values among the independent variables are less than 0.70 (70%).

Table 3. Correlation Matrix

Correlation	MSO	GPE	GSE	GTE	LFPR	PCAPITAL	AYS
MSO	1						
GPE	0.022	1					
GSE	0.012	0.688	1				
GTE	0.158	0.516	0.649	1			
LFPR	0.096	0.511	0.429	0.246	1		
PCAPITAL	0.088	0.378	0.331	0.235	0.186	1	
AYS	0.293	0.582	0.618	0.575	0.343	0.336	1

Source: Author's Computation, 2024

Table 4 reveals that all the tests fail to reject the null hypothesis of no cross-sectional dependence. This result suggests that the individual entities within the sample exhibit some degree of interdependence, which is an important factor to consider in econometric analyses. Given the presence of cross-sectional dependence, it becomes imperative to employ first-generation panel-based tests to ensure the robustness of our results. These tests, including the Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), Fisher-type tests (both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests), Breitung test, and Hadri test, are specifically designed to account for potential cross-sectional dependencies among panel data.

Table 4. The Cross-Sectional Dependence Test results

Tests	Statistics	P-Value
Bruesch Pegan LM	578.45	0.39
Pesaran-scaled LM	21.70	0.48
Pesaran CD	18.46	0.54

Source: Authors' computation (2024)

Each of these tests has its strengths and is suited to different data characteristics and assumptions regarding the underlying processes. For instance, while the LLC and IPS tests generally assume homogeneity across cross-sections, the Fisher-type tests allow for heterogeneity, making them suitable for diverse panel datasets. Based on the findings presented in Table 4, it is crucial to adopt first-generation panel-based tests, which will enhance the credibility of the empirical findings and provide a better understanding of the dynamics in the dataset. After confirming cross-sectional dependence between the variables, we employed different PURTs such as LLC, IPS, Fisher Type (ADF and PP), Breitung, and Hadri. Table 5 shows that many variables are non-stationary at a level while becoming stationary at first differences $I(1)$. Meanwhile, the manufacturing sector output and physical capital are stationary at this level. Since there is a combination of $I(0)$ and $I(1)$, ARDL-bound cointegration tests were conducted to look for a long-run relationship among the variables.

Table 5. Panel Unit Root Test Results for the West African Region in 1989–2022

Variable	LLC		IPS		ADF-FISHER		PP	
	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
MSO	-3.45349 (0.000)	-	-2.54836 (1.000)	-	43.1333 (0.0096)	-	50.6885 (0.0062)	-
GPE	0.528 (0.299)	-10.463 (0.000)	1.925 (0.973)	-10.273 (0.000)	18.705 (0.768)	148.526 (0.000)	15.321 (0.911)	151.278 (0. 000)
GSE	6.857 (1.000)	-9.875 (0.000)	9.279 (1.000)	-9.864 (0.000)	4.052 (1.000)	143.767 (0.000)	4.778 (1.000)	181.456 (0.000)
GTE	3.868 (1.000)	-13.091 (0.000)	5.736 (1.000)	-14.263 (0.000)	20.904 (0.644)	206.694 (0.000)	17.180 (0.841)	220.376 (0.000)
AYS	-5.216 (0.100)	-12.485 (0.000)	0.700 (0.758)	-13.122 (0.000)	35.608 (0.060)	181.928 (0.000)	54.248 (0.061)	238.446 (0.0000)
LFPRIN	0.152 (0.560)	-19.622 (0.000)	1.494 (0.933)	-18.783 (0.000)	24.602 (0.428)	150.193 (0.000)	34.654 (0.074)	166.933 (0.0000)
PCAPIT	-1.731 (0.042)	-	-1.876 (0.0418)	-	45.905 (0.050)	-	71.186 (0.000)	-

Note: The series is at 5% significance levels. The figures in parenthesis () are significant values.
Source: Authors' computation (2024)

Table 6. Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4946.746	NA	2.82e+29	87.67692	87.84587	87.74547
1	-3668.563	2375.385	1.01e+20	65.92146	67.27309*	66.46994
2	-3577.454	158.0289*	4.82e+19*	65.17618*	67.71048	66.20457*
3	-3538.561	62.64151	5.91e+19	65.35507	69.07204	66.86337

* Indicates lag order selected by the criterion
Source: Authors' computation (2024)

Before performing the panel cointegration test, it was essential first to ascertain the optimal number of lags to include in the model. Accurately determining the appropriate lag length is a critical step, as it influences the robustness and reliability of the subsequent analysis. In this study, we employed an unrestricted model to guide our selection process for the lag lengths of each variable under consideration. The findings are presented in Table 6, which illustrates the lag length selections across the various variables. The decision-making criterion adopted here involved identifying the lag length most frequently chosen by most of the established criteria. Based on this, it is evident that a lag length of 2 emerged as the most selected option across the model.

Table 7 result revealed that the value of the F-statistic (7.073549) is greater than the upper bound value of 3.61 at a 5% level of significance. Therefore, the null hypothesis of no long-run relationship is rejected. Hence, there is cointegration among the variables

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in the model. Given this, a long-run relationship exists among the variables. The study proceeds to estimate the short-run and long-run of the cointegrated variables.

Table 7. Cointegration Test: Panel ARDL Bound test

Test Statistics	Value	K
F-statistic	7.073549	6
	Critical value Bounds	
Significance	Lower Bound	Upper Bound
10%	2.12	3.23
5%	2.45	3.61
1%	3.15	4.43

Note: ** denotes statistical significance at the 5% level.
Source: Authors' computation (2024)

The study estimates the interactive effect of the industrial labor force and human capital development on manufacturing sector output in West Africa. The human capital considered here is a composite variable, which serves as a consolidated indicator of human capital development (gross primary school enrolment, gross secondary school enrolment, tertiary school enrolment, and average years of schooling) that provides a more concise representation of the information embedded in the education metrics through principal component analysis (PCA). The results in Table 8 show that human capital does not significantly impact manufacturing sector output in the short run. This result indicates that human capital has an insignificant relationship with manufacturing sector output in West Africa in the short run. The long-run results also reveal that human capital has no significant relationship with manufacturing sector output.

The short-run results further revealed that the current labor force has no significant relationship with manufacturing sector output. In contrast, the labor force's lagged variable (lag 1) positively correlates with manufacturing sector output. This research suggests that the number of industrial laborers in the short run does not yield the immediately required output in the manufacturing sector. Interestingly, the lagged effect of the labor force, represented by the lag one variable, demonstrates a positive relationship with manufacturing sector output. This positive coefficient indicates that changes in the labor force from the previous period positively influence current manufacturing output levels. Although not statistically significant in the short run, this positive lagged effect illustrates the potential dynamic adjustments and time lags in the response of manufacturing output to changes in labor force size. However, in the long run, the labor force has a substantive impact on manufacturing sector productivity, as the capacity of the labor force required in the manufacturing sector reaches its optimal level.

The results further indicate that the interaction of labor force and human capital development has a negative impact on the manufacturing sector output in the short run, both in the current period and lag 1. These findings suggest that, in the short term, increases in the current joint labor force and human capital will retrogress the manufacturing sector output level. The results indicate that the labor force and human capital significantly positively impact manufacturing sector output in the long run. This finding indicates that enhanced human capital development within the labor force has a substantial impact on improving manufacturing sector output in the long run.

This suggests that as the labor force's skills, education, and training improve over time, the manufacturing sector output experiences significant growth. Consequently, long-term investments in human capital development can lead to pronounced and sustainable improvements in the performance and efficiency of the manufacturing sector. Hence, the quantity and quality of the industrial labor force can lead to significant improvements in manufacturing output in the West African sub-region.

Table 8. The Interactive Effect of Labor Force and Human Capital Development on Manufacturing Sector Output Results in Output

Short-run Estimates				
Variable	**Coef.**	**Std. Err.**	**t-Statistic**	**Prob.***
C	-1.065	0.353	-3.014	0.003
D(LNHC)	0.248	0.355	0.699	0.485
D(HC(-1))	1.167	1.187	0.984	0.326
D(LNLFPR)	-2.917	4.834	-0.603	0.547
D(LNLFPR(-1))	3.037	3.078	0.990	0.325
D(LNLFPR*HC)	-3.011	3.256	-0.925	0.356
D(LNLFPR*HC(-1))	-3.373	3.360	-1.004	0.316
D(LNPCAP)	-0.189	0.215	-0.878	0.381
D(LNPCAP(-1))	-0.006	0.130	-0.045	0.964
ECT(-1)	-0.292	0.089	-3.271	0.001
Long-run Estimates				
LNHC	0.058	0.077	0.752	0.453
LNLFPR	2.164	0.809	2.676***	0.008
LNLFPR*HC	2.566	0.372	6.893***	0.000
LNPCAP	0.179	0.148	1.215	0.226

Note "*", "**" and "***" represent the probability values of 10%, 5% and 1% respectively
Source: Author's computation (2024)

Examining the interaction between the labor force and human capital in West Africa reveals a dynamic relationship with manufacturing sector output. In the short run, the findings indicate an insignificant negative impact, suggesting that the immediate changes in the labor force and human capital interaction may not substantially influence manufacturing output. However, in the long run, this finding revealed that interacting the labor force with human capital development positively and significantly impacts the manufacturing sector within the West African sub-region. This finding suggests a complex relationship between the labor force, human capital development, and manufacturing sector output. It addresses the complexity that contributes to the existing disagreements in the literature regarding the relationship between human capital development and manufacturing sector output (Dabić et al, 2023; Musiita & Jeke, 2023). The insignificance of negative impact in the short run can be attributed to the absorption of newly entering workers, who possess relatively low skills that give optimal productivity in the sector. Human capital development initiatives, while crucial, may take time to manifest tangible improvements in productivity

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and efficiency within the manufacturing sector, as revealed in the long-run results. This suggests that sustained investments or improvements in human capital development do not have a discernible impact on enhancing manufacturing sector output over an extended period as revealed in the literature that the traditional view of economic success and success in manufacturing primarily draws on the quality values of employees (Dabić et al, 2023; Musiita &Jeke, 2023) but contrary to some other literature (Olarewaju et al., 2021)

A skilled and well-educated labor force is indispensable for enhancing productivity and efficiency in the manufacturing sector. Human capital development, encompassing education and training, plays an essential role in improving the quality of the labor force by providing workers with the necessary skills and knowledge. The findings align with established principles of economic development that emphasize the crucial role of human capital in fostering industrial progress, as revealed in the endogenous growth theory.

CONCLUSION

This study examined the interactive nature of human capital development, using education and the industrial labor force to influence the manufacturing sector output in the West African sub-region. The findings revealed a mixed impact of the interaction between the labor force and human capital development on manufacturing sector output in the West African sub-region within the short-run and long-run periods. In the short run, it was found that interacting labor force and human capital development showed a negative insignificant influence on output in the manufacturing sector. A positive significant influence was revealed in the long run, indicating a decrease in the short run and an increase.

Policymakers in the West African sub-region should focus on developing initiatives that will enhance the labor force's skills and align them with the manufacturing sector's needs. A mere increase in the labor force without appropriate integration and training does not yield immediate benefits. Thus, investment in education, vocational training, and industry-specific skill development are essential to improve output in the manufacturing sector significantly.

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