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Assessing the impact of human capital development on economic growth in west African monetary zone: A pooled mean group estimation

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Abstract: This study examines the impact of human capital development on economic growth in the West African Monetary Zone (WAMZ) from 1990 to 2023, focusing on government expenditure on education and health. Grounded in the augmented Solow human capital growth model, the study applies the Autoregressive Distributed Lag (ARDL) estimation technique with the Pooled Mean Group (PMG) estimator to assess both short-run and long-run relationships. The findings indicate a positive and statistically significant long-run impact of education and health expenditure on economic growth, reinforcing the critical role of sustained human capital investments. However, short-run effects vary, with education expenditure contributing modestly to growth, while health expenditure shows a negative short-term impact, likely due to inefficiencies in resource allocation. The Error Correction Term (ECT) suggests that while some WAMZ economies adjust to equilibrium after economic shocks, others exhibit weak correction mechanisms. The causality analysis confirms that economic growth influences education expenditure, but the reverse relationship is not significant. These findings underscore the need for strategic, long-term investments in education and health and institutional reforms to maximize the economic benefits of human capital development in WAMZ countries.

Keywords: *Economic growth, Educational expenditure, Health expenditure, Human capital development, West African monetary zone.*

1. Introduction

Human capital development is widely recognised as a key driver of economic growth, particularly in developing economies. Traditional economic growth models, such as Solow [1] neoclassical model, primarily emphasised physical capital accumulation and labour force expansion as fundamental determinants of economic growth. However, subsequent extensions of the model, such as the augmented Solow model by Mankiw, et al. [2] incorporated human capital as a critical factor influencing long-term productivity and economic performance. Human capital, which includes education, skills, health, and abilities acquired by individuals, is crucial in enhancing labour productivity, innovation, and overall economic output [3].

Despite various policy initiatives to enhance human capital development, economic growth has been inconsistent in the West African Monetary Zone (WAMZ), which comprises The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone. The region faces significant challenges in achieving sustainable economic growth due to inadequate investments in education and healthcare infrastructure [4]. Given the central role of human capital in economic development, it is necessary to examine the extent to which government expenditure on education and health contributes to economic growth in WAMZ member countries.

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Despite the theoretical and empirical consensus on the importance of human capital development in fostering economic growth, the effectiveness of government expenditure on education and health in driving economic performance in WAMZ remains uncertain. Several studies, such as those by Cleeve, et al. [5] and Rahim, et al. [6] have examined the relationship between human capital and economic growth in broader African contexts but have not specifically focused on WAMZ. Many WAMZ economies continue to experience sluggish economic growth, high unemployment, and low productivity levels, raising concerns about whether government spending on education and healthcare adequately enhances human capital development. Disparities in government policies, weak institutional frameworks, and inefficient budgetary allocations across WAMZ countries further complicate the impact of public expenditure on economic growth [7].

Additionally, while some studies suggest a positive correlation between human capital development and economic growth, others report weak or insignificant effects, implying that governance quality, resource misallocation, and inadequate infrastructure may undermine the expected benefits [8]. Consequently, there is a need for a more comprehensive empirical investigation covering the period from 1990 to 2023 to determine whether government expenditure on education and health significantly influences economic growth in WAMZ.

This study aims to analyse the impact of human capital development, measured through government expenditure on education and health, on economic growth in WAMZ between 1990 and 2023. Specifically, it seeks to examine whether government expenditure on education significantly impacts economic growth in WAMZ member countries, analyse whether government expenditure on health contributes meaningfully to economic growth, and investigate a causal relationship between human capital development and economic growth within the region. By addressing these objectives, the study will provide empirical evidence on the effectiveness of public spending on education and healthcare in stimulating economic performance across WAMZ countries. Understanding these relationships will help policymakers optimise budgetary allocations toward human capital development to foster long-term economic growth.

Despite the extensive literature on human capital and economic growth, several research gaps persist, particularly in the context of WAMZ. Most existing studies, such as those by Teixeira and Queirós [3] and Rahim, et al. [6] examine human capital's role in economic growth using global or sub-Saharan African datasets, often neglecting the specific economic and institutional conditions of WAMZ. Additionally, previous research commonly employs traditional proxies such as literacy rates and school enrollment rather than direct government expenditure on education and health, which are more accurate indicators of policy commitment to human capital development [9]. This study addresses these gaps by incorporating government expenditure data from 1990 to 2023, providing a more policy-relevant analysis. Furthermore, limited empirical research has applied the Pooled Mean Group (PMG) estimator, particularly useful in distinguishing long-run homogeneity from short-run heterogeneity across WAMZ countries. Existing studies often rely on static models that fail to capture the dynamic interactions between human capital investments and economic growth over time [10]. Additionally, while some studies have explored the short-run effects of education and healthcare spending, the long-run impact remains underexplored, making further empirical inquiry necessary.

Given the persistent economic challenges WAMZ countries face, including low human capital investment, high poverty rates, and underdeveloped healthcare systems, this study provides empirical evidence to guide policy decisions. By analysing the impact of government expenditure on education and health using the augmented [1] human capital growth model, this research offers a comprehensive understanding of how human capital development influences economic growth in WAMZ between 1990 and 2023. Furthermore, by incorporating macroeconomic variables such as trade openness, foreign direct investment, labour force participation, and gross fixed capital formation, this study presents a more holistic perspective on the key drivers of economic performance in WAMZ. The findings will provide policymakers with valuable insights to optimise government spending on education and healthcare, ensuring that human capital investments contribute effectively to long-term economic

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development. Moreover, this research will enrich the empirical literature on human capital development in developing economies by employing robust econometric techniques, such as log-linear modelling and the PMG estimator. Ultimately, this study aims to bridge the knowledge gap by offering a region-specific analysis that can inform better policymaking in WAMZ and contribute to the broader discourse on the role of human capital in economic growth.

2. Literature Review

The relationship between human capital development and economic growth has been extensively analysed across different economic contexts. Cleeve, et al. [5] explored how human capital influences foreign direct investment (FDI) inflows in sub-Saharan Africa, highlighting that while human capital significantly affects FDI, its role has not increased over time, likely due to the type of investments flowing into the region. Teixeira and Queirós [3] provided further insight by incorporating supply and demand-side determinants, demonstrating that human capital and structural changes in high-knowledge industries significantly influence economic growth. Similarly, Rahim, et al. [6] found that human capital development moderates the adverse effects of natural resource dependence in the Next Eleven countries, mitigating the resource curse and enhancing economic growth. Jemiluyi and Jeke [4] reinforced these findings in the Nigerian context by showing that human capital plays a crucial role in transforming urbanisation into an economic growth driver. These studies collectively suggest that while human capital is a key determinant of economic growth, its effectiveness depends on how well it integrates with other macroeconomic factors such as FDI, industrial structure, and natural resource utilisation.

Further empirical evidence emphasises the interaction between financial development, human capital, and economic growth. Abubakar, et al. [8] investigated the role of financial development in the ECOWAS region, showing that private-sector credit significantly influences economic growth through human capital accumulation. Sarwar, et al. [11] extended this discussion by examining the role of human capital in emerging economies, finding that financial development and human capital interactively contribute to economic growth. Additionally, Jie and Lan [7] highlighted the complex interplay between human capital, natural resources, and economic growth, revealing an inverse U-shaped relationship, where financial sector expansion initially enhances human capital's contribution to growth but later limits sustainable development. These findings indicate that while human capital investments are crucial, their effectiveness is contingent on complementary financial and economic policies.

Other studies have examined the role of human capital composition and investment in shaping long-term economic outcomes. Ma, et al. [9] demonstrated that higher education investment significantly enhances economic development, particularly in regions with strong human capital accumulation. Carillo [12] further emphasised that the balance between highly educated individuals driving innovation and lower-skilled workers adopting technology determines the speed of economic progress. Zhang, et al. [10] provided evidence from China, showing that improvements in human capital quality led to regional economic convergence, further reinforcing the importance of targeted education investments. Similarly, Bekele, et al. [13] found that despite efforts to enhance education in Sub-Saharan Africa, human capital development negatively impacted economic sustainability due to insufficient focus on quality education. These studies highlight that while investment in human capital is necessary, the composition and quality of human capital are equally crucial for fostering sustained economic growth.

Lastly, the impact of government policies and international cooperation on human capital development has been explored in various contexts. Guo, et al. [14] investigated the role of government health investment in China, showing that increased spending on healthcare enhances economic resilience by strengthening human capital. Fahimi, et al. [15] examined the link between tourism and human capital development, finding that tourism-led human capital investment contributes to economic growth. Boachie and Adu-Darko [16] demonstrated how financial inclusion fosters economic growth in Sub-Saharan Africa through human capital development, while Sofilda, et al. [17]

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highlighted the role of fiscal decentralisation in Indonesia, showing that localised human capital investments influence regional economic growth. These findings underscore the importance of well-structured policies, international cooperation, and sustainable financing mechanisms in ensuring that human capital investments translate into long-term economic growth.

Despite extensive research on the relationship between human capital development and economic growth, significant gaps persist, particularly in the West African Monetary Zone (WAMZ) from 1990 to 2023. While studies such as Cleeve, et al. [5] and Teixeira and Queirós [3] have examined human capital's role in economic growth, they often adopt a broader regional or global perspective, neglecting the unique economic, institutional, and structural challenges of WAMZ nations. Furthermore, although several studies, including Rahim, et al. [6] and Jemiluyi and Jeke [4] have explored the impact of human capital on growth, few have specifically analysed government expenditure on education and health as key measures of human capital development within WAMZ countries. Additionally, while the Pooled Mean Group (PMG) estimator is well-suited to capture both the homogenous long-run effects and heterogeneous short-run dynamics across countries, limited empirical research has applied this approach to WAMZ economies, where disparities in policy implementation and institutional capacity may influence short-run variations. Moreover, previous research, such as Abubakar, et al. [8] and Ma, et al. [9] has primarily focused on financial development and education investment in broader contexts without isolating the direct effects of government expenditure on education and health within WAMZ economies. Given these gaps, there is a need for an in-depth empirical study that specifically examines the long-term and short-term effects of government spending on education and health in driving economic growth within WAMZ countries, using robust methodologies such as the PMG estimator to account for regional heterogeneity.

3. Methodological Notes

This study employs the augmented Solow human capital growth model, grounded in the human capital theory and an extensive theoretical and empirical review of the impact of human capital development on productivity and economic growth. The model, which builds upon Solow's original framework, was extended by Mankiw, et al. [2] to incorporate human capital as a crucial factor in economic growth. The augmented Solow model is expressed as follows:

$$Y = AK^{\alpha}(HL)^{\beta} \quad 1$$

Where Y represents economic growth (output level), K denotes the stock of physical capital, H represents the level of human capital, L is labour, measured by the number of workers, A is Total Factor Productivity, α and β denote the elasticities of capital and labour input with respect to output, respectively.

In its econometric form, the model can be rewritten as:

$$Y = AK^{\alpha}(HL)^{\beta}e^{\mu t} \quad 2$$

Taking the log-linear transformation for empirical estimation, we obtain:

$$logY = \alpha_0 + \alpha_1 logK_i + \beta_1 \log(H + L) + W \quad 3$$

Where α_0 represent the constant term, $\alpha_1 = logA$, $W = logU$ accounts for stochastic disturbances.

To enhance the model's applicability within the WAMZ context, this study modifies the augmented Solow human capital-growth model by incorporating government expenditure on education and health as explicit measures of human capital development. These additional variables, encompassing recurrent and capital expenditures, are included based on the premise that education and healthcare investments are fundamental drivers of human capital accumulation. The expanded model takes the form:

$$logY_{it} = \alpha_0 + \alpha_1 GEH_{it} + \beta_1 GEE_{it} + \beta_2 TOP_{it} + \beta_3 GFC_{it} + \beta_4 LAB_{it} + \beta_5 FDI_{it} + \mu_{it} \quad (4)$$

Where Y_{it} (economic growth) is proxied by real Gross Domestic Product (GDP), GEH_{it} denotes government expenditure on health, GEE_{it} represents government expenditure on education, GFC_{it} is gross fixed capital formation, TOP_{it} indicates trade openness, LAB_{it} represents labour force participation rate, FDI_{it} stands for Foreign Direct Investment, i denotes the cross-section of the six

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WAMZ countries, t represents the time dimension, μ_{it} is the error term capturing unobserved heterogeneity. This modified framework allows for a comprehensive assessment of human capital development's long-run and short-run effects on economic growth in WAMZ, incorporating key macroeconomic variables that influence the region's economic dynamics.

The augmented Solow human capital growth model is the most suitable framework for this study as it integrates human capital as a key determinant of economic growth, aligning with the focus on government expenditure on education and health in the West African Monetary Zone (WAMZ). Unlike the traditional [1] model, which emphasises physical capital and labour, the Mankiw, et al. [2] extension explicitly incorporates human capital, allowing for a better understanding of how education and healthcare investments drive economic development. Given WAMZ's structural challenges, such as low human capital development and weak healthcare infrastructure, this model comprehensively analyses their impact on growth. Its flexibility in accommodating trade openness, foreign direct investment (FDI), and labour force participation make it well-suited for WAMZ's economic complexities. By employing the Pooled Mean Group (PMG) estimator, this study captures both long-run equilibrium effects and short-run variations across WAMZ economies.

This study adopts an ex post facto research design, which uses historical panel data to examine the relationship between human capital development—measured by government expenditure on education and health—and economic growth in WAMZ countries from 1990 to 2023. Since the variables under investigation have already occurred and cannot be manipulated, the ex post facto design is appropriate for identifying causal inferences based on observed data. This design enables the researcher to analyse existing economic trends and policy outcomes using statistical techniques without influencing the data environment.

Table 1.
Data Sources and Expected Signs of Coefficients

Economic Growth (ΔY_{it})	**Dependent**	**WDI**
Government Expenditure on Health (GEH_{it})	Positive (+)	WDI
Government Expenditure on Education (GEE_{it})	Positive (+)	WDI
Gross Fixed Capital Formation (GFC_{it})	Positive (+)	WDI
Trade Openness (TOP_{it})	Positive (+)	UNCTAD
Labour Force Participation Rate (LAB_{it})	Positive (+)	WDI
Foreign Direct Investment (FDI_{it})	Positive (+)	UNCTAD

Note: WDI-World Development Indicator; UNCTAD-United Nations Conference on Trade and Development.

3.1. Estimation Technique

This study employs panel data covering six WAMZ countries over 33 years (1990–2023), making the panel Autoregressive Distributed Lag (ARDL) model an appropriate estimation technique. Following Pesaran and Smith [18] and Pesaran, et al. [19] and Pesaran, et al. [20] the panel ARDL model is suitable when variables are a mix of I(0) and I(1) but not I(2), necessitating stationarity tests to confirm integration orders. This study utilises the Im-Pesaran-Shin (IPS) unit root test, which accommodates heterogeneity across cross-sectional units and assumes interdependence among them. The IPS test is advantageous as it relaxes the restrictive assumption of a uniform autoregressive parameter, allowing for a combination of stationary and non-stationary series within the panel. Given the economic diversity of WAMZ countries, this approach enables country-specific variations in human capital investments and economic growth trends, ensuring robust short-run and long-run estimates.

The panel ARDL model effectively estimates both short-run and long-run coefficients while addressing heterogeneity biases in dynamic panels. Pesaran and Smith [18] propose the Mean Group (MG) estimator, which averages individual country-specific ARDL parameters but becomes inefficient when slope homogeneity holds. Conversely, Pesaran, et al. [19] and Pesaran, et al. [20] introduce the Pooled Mean Group (PMG) estimator, which assumes long-run coefficient homogeneity while allowing short-run dynamics to vary across countries, making it more efficient under long-run equilibrium

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convergence. This study conducts a Hausman [21] to determine the appropriate estimator, where PMG is preferred if p > 0.05. A re-parameterised panel ARDL error correction model is adopted, with the Error Correction Term (ECT) capturing the speed of adjustment toward long-run equilibrium. The re-parameterised panel ARDL (p, q, q…, q) error correction model can be demonstrated thus;

$$\Delta Y_{it} = \pi_i ECT_{it} + \sum_{j=1}^{p-1} \omega_{ij} \Delta(\Delta Y)_{it-j} + \sum_{j=0}^{q-1} \emptyset'_{ij} \Delta X_{i,t-j} + \alpha_i + \varepsilon_{it} \quad (4)$$

Notes: $\pi_i = -(1-\gamma_i)$, the coefficient of the speed of adjustment for the group is expected to be negative and statistically significant. $ECT = \left[Y_{i,t-1} - \varphi'_i X_{i,t}\right]$, the error correction term. ω_{ij}, $\emptyset'_{ij}$ signifies the short-run dynamic coefficients and φ'_i = vector of long-run relationships.

4. Results and Discussions

4.1. Pre-Estimation Tests

The summary statistics provide valuable insights into the distribution and characteristics of the variables used in analysing the impact of human capital development on economic growth in the West African Monetary Zone (WAMZ). The average GDP growth rate of 3.87% indicates modest economic expansion across the region, while government expenditure on education and health, at 2.38% and 5.27% of GDP, respectively, suggests relatively low investments in human capital. Other key economic indicators include gross fixed capital formation (14.88%), labour force participation (67.76%), foreign direct investment (FDI) (6.76%), and trade openness (0.54), reflecting moderate international economic engagement. The standard deviations show substantial variability in economic performance, with GDP growth exhibiting a high deviation of 10.99%, indicating fluctuations in economic stability. Similarly, FDI, with a standard deviation of 25.20%, highlights significant fluctuations in foreign investment inflows, while government expenditure on education (1.78%) and health (3.56%) display more moderate variation across WAMZ countries.

Table 2.
Summary Statistics.

Variable	GDPG	EDU	HLT	GFC	LAB	FDI	OPN
Obs	204	204	204	204	204	204	204
Mean	3.872	2.3847	5.2662	14.878	67.7596	6.7553	0.5418
Std. dev.	10.989	1.7767	3.5568	7.3412	11.9238	25.1980	0.6951
Min	-51.031	0.1081	2.0012	-2.4244	48.642	-202.824	0.0956
Max	106.28	9.4422	26.2949	52.4183	84.301	167.329	6.3636

The minimum and maximum values further emphasise economic volatility in the region. GDP growth ranges from -51.03% to 106.28%, illustrating periods of economic contraction and rapid expansion, while FDI swings between -202.82 and 167.33, indicating significant capital inflows and outflows. Trade openness varies from 0.10 to 6.36, reflecting differences in economic integration among member states. These extreme values suggest that WAMZ economies experience periods of instability, with large fluctuations in key economic indicators. Despite positive trends in GDP growth and FDI, the low average education and health expenditures highlight potential challenges in human capital development, which could hinder long-term economic growth prospects. The findings underscore the need for more stable and strategic investments in education and healthcare to enhance the region's economic resilience and sustainable development.

4.1.1. Correlation Analysis

The correlation matrix provides insights into the relationships between key economic variables in studying human capital development and economic growth in the West African Monetary Zone (WAMZ). Foreign direct investment (FDI) exhibits the highest positive correlation with GDP growth (0.1851), suggesting that increased FDI inflows are associated with economic expansion. However, government expenditure on education (0.0532) and gross fixed capital formation (0.0351) show only

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weak positive correlations with GDP growth, indicating a minimal direct impact. Conversely, health expenditure (-0.0088) and trade openness (-0.0616) display weak negative correlations with GDP growth, implying that these factors may not contribute significantly to economic expansion in the short run. These findings suggest that while FDI drives growth, human capital investments and trade openness might require a longer-term perspective to yield substantial economic benefits.

Table 3.
Correlation Matrix.

Variables	GDPG	EDU	HLT	GFC	LAB	FDI	OPN
GDPG	1						
EDU	0.0532	1					
HLT	-0.0088	0.1712	1				
GFC	0.0351	0.3037	0.0293	1			
LAB	0.0036	-0.2509	-0.0894	-0.1736	1		
FDI	0.1851	-0.0329	0.0764	0.1092	0.1	1	
OPN	-0.0616	-0.0538	-0.0581	0.0149	0.1939	0.1906	1

Examining the relationship between human capital indicators and other economic factors, education expenditure (EDU) shows a positive correlation with health expenditure (0.1712) and gross fixed capital formation (0.3037), indicating that higher investment in education is linked to improvements in health and capital formation. However, EDU negatively correlates with labour force participation (-0.2509) and trade openness (-0.0538), suggesting that increased education expenditure does not immediately translate into higher workforce participation or trade benefits. Similarly, labour force participation (LAB) has weak negative correlations with capital formation (-0.1736) and health expenditure (-0.0894) while showing slight positive correlations with FDI (0.1) and trade openness (0.1939). Finally, trade openness has mixed relationships with economic variables, displaying a weak negative correlation with GDP growth (-0.0616) and education expenditure (-0.0538) but a positive association with FDI (0.1906) and labour force participation (0.1939), suggesting that trade openness may support workforce engagement and foreign investment inflows, which could drive long-term economic benefits.

4.1.2. Unit Root Test

The IPS unit root test results provide crucial insights into the stationarity properties of the variables used in the study, ensuring that appropriate econometric techniques are applied to avoid spurious regression results. The findings indicate that GDP growth (GDPG) and Foreign Direct Investment (FDI) are stationary at level form (I(0)), as their test statistics are highly significant at the 1% level, suggesting that these variables do not exhibit unit root behaviour and remain stable over time. Conversely, government expenditure on education (EDU), health expenditure (HLT), gross fixed capital formation (GFC), labour force participation (LAB), and trade openness (OPN) are non-stationary at the level form but become stationary after first differencing (I(1)), indicating that these variables follow long-term trends and require transformation for proper econometric modelling. While trade openness (OPN) presents mixed results at level form, its first-differenced values confirm that it is also I(1), implying that external shocks significantly influence trade activity in WAMZ countries.

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Table 4.
IPS Unit Root Test.

	Level		1st Difference		
Variable		**Trend**		**Trend**	**Remark**
Y	-4.6380***	-3.4154***	-11.4464***	-10.1338 ***	I0
EDU	-1.8558	-0.4042	-6.4425***	-4.9202***	I1
HLT	0.4976	0.3148	-6.4182***	-5.1963***	I1
GFC	0.9609	-1.0511	-8.2043***	-8.1232***	I1
LAB	1.7732	1.0624	-3.4450***	-1.3536*	I1
FDI	-3.5786***	-3.1169***	-11.204***	-9.8966***	I0
OPN	-0.1702	-2.5823***	-8.9677***	-7.8216 ***	I1

These results highlight the necessity of employing econometric techniques that accommodate both I(0) and I(1) variables. Given the mixed integration orders, the Autoregressive Distributed Lag (ARDL) bounds testing approach is well-suited for analysing the short-run and long-run relationships between human capital development and economic growth. Additionally, the presence of I(1) variables suggests the need for cointegration tests to determine whether stable long-term relationships exist among the variables. If cointegration is confirmed, an Error Correction Model (ECM) can be used to assess the speed of adjustment toward equilibrium in response to short-term fluctuations. These findings provide a strong empirical foundation for investigating how human capital investment influences economic performance in WAMZ, ensuring that the study's methodological approach effectively captures both short-run dynamics and long-run economic trends.

4.2. Data Analyses

4.2.1. Testing of the Hypotheses

The results presented in Table 5 provide insights into the short-run and long-run dynamics between human capital development indicators and economic growth in the West African Monetary Zone. The error correction term (ECT) is statistically significant with a coefficient of -0.564, suggesting that deviations from the long-run equilibrium are corrected at a speed of 56.4% per period. This implies that the model adjusts relatively quickly to restore equilibrium whenever shocks disrupt economic growth. The significance of ECT confirms the presence of a stable long-run relationship among the variables, reinforcing the importance of human capital development in influencing economic growth over time.

Table 5.
Short Run and Long Run Analysis.

Long Run		**Short Run**	
		ECT	-0.564**
			(2.25)
L2.EDU	70.067**	D.EDU	3.052**
	(0.91)		(1.75)
L2.HLT	19.917**	D.HLT	-0.556**
	(0.7)		(0.73)
L.GFC	1.397	D.GFC	-0.34
	(0.08)		(0.73)
L2.LAB	20.196*	D.LAB	-1.391
	(0.43)		(0.19)
L2.FDI	19.432	D.FDI	-0.056*
	(0.91)		(0.2)
L2.OPN	-416.617	D.OPN	-3.186
	(1.18)		(0.62)
		_cons	-379.826
			(0.95)
		N	198

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

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In the long run, government expenditure on education exhibits a strong positive and statistically significant relationship with economic growth, with a coefficient of 70.067. This result suggests that increased spending on education plays a crucial role in fostering economic expansion over time. Education contributes to human capital development by enhancing the skills and knowledge base of the workforce, which in turn improves productivity, fosters innovation, and boosts competitiveness. In the context of WAMZ countries, this finding underscores the importance of sustained investments in education to support long-term economic growth. As the level of education rises, the workforce becomes more skilled, leading to higher efficiency in production and the ability to adapt to technological advancements. In the long run, the strong significance of education expenditure highlights its transformative role in shaping the economic future of WAMZ nations, making it a critical area for policy focus.

In the short run, the impact of government education expenditure on economic growth is positive but much smaller, with a coefficient of 3.052, though still statistically significant. This indicates that while increased spending on education contributes to economic growth in the short term, its effects are less immediate than the long-term impact. The modest short-run effect can be attributed to the time lag required for educational investments to yield tangible economic benefits. Enhancing educational infrastructure, improving teacher quality, and reforming curricula take time before they translate into an improved labour force. Additionally, short-term economic conditions and competing budgetary demands may influence the immediate impact of educational spending, making its short-term effect less pronounced. Nevertheless, the positive correlation in both timeframes underscores the necessity for consistent and strategic investments in education, ensuring that both short-term and long-term economic goals are met.

Similarly, in the long run, government expenditure on health demonstrates a positive and statistically significant impact on economic growth, with a coefficient of 19.917. This suggests that higher investment in healthcare contributes to economic expansion by ensuring a healthier, more productive workforce. A population with better access to healthcare services experiences fewer work absences due to illness, enjoys increased life expectancy, and contributes more effectively to economic activities. In WAMZ countries, this finding highlights the need for stronger healthcare systems and increased investments in medical infrastructure, preventive care, and healthcare accessibility to promote economic stability and growth. However, in the short run, health expenditure has a negative and significant coefficient of -0.556, indicating that health investments may not yield immediate positive economic returns. This could be due to resource allocation inefficiencies, infrastructure development delays, and the time required for health improvements to reflect in economic performance. While short-term challenges may arise, the long-term benefits of health expenditure reinforce the necessity for sustained policy focus on improving healthcare systems. By addressing inefficiencies and ensuring targeted health interventions, WAMZ countries can maximise the economic benefits of health investments, ultimately supporting broader economic development.

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Table 6.
Short Run Results for Individual Countries

	Gambia	Ghana	Guinea	Liberia	Nigeria	Sierra Leone
ECT	0.001	0.005	-0.033**	-0.405**	-0.238**	0.007
	(0.06)	(0.44)	(1.57)	(4.76)	(2.29)	(0.09)
D.EDU	0.583**	0.77*	-2.059	3.052*	21.795**	1.496*
	(0.76)	(1.56)	(1.91)	(0.2)	(1.7)	(0.52)
D.HLT	-2.225	1.593	-0.041	-1.215**	-3.441**	-0.921*
	(1.81)	(1.42)	(0.05)	(1.23)	(3.87)	(0.93)
D.GFC	0.065	-0.065	0.172	-1.725*	-1.178	0.14
	(0.51)	(0.62)	(1.88)	(2.42)	(0.89)	(0.25)
D.LAB	-27.725**	0.494	2.008	8.585	-3.219	1.2
	(6.12)	(0.27)	(1.75)	(0.71)	(1.59)	(0.31)
D.FDI	0.477	0.516	0.007	0.215**	-1.019	-0.346
	(1.38)	(1.37)	(0.06)	(9.90)	(1.36)	(0.52)
D.OPN	3.992	-0.062	6.623	-2.167	4.023	26.477
	(0.47)	(0.01)	(1.84)	(0.75)	(0.51)	(0.74)
_cons	-0.559	2.343	-10.216	-159.827	-80.797	2.019
	(0.15)	(0.43)	(1.42)	(1.84)	(1.52)	(0.08)
N	198	198	198	198	198	198

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The Error Correction Term (ECT) measures the speed at which short-run deviations from equilibrium are corrected in the long run. The results indicate that Guinea (-0.033**), Liberia (-0.405**), and Nigeria (-0.238**) have negative and statistically significant ECT values, implying that deviations from equilibrium in these countries are corrected over time. Among them, Liberia has the fastest adjustment rate (-0.405), suggesting that its economy is more responsive to restoring long-term equilibrium after short-term shocks. Nigeria's adjustment process (-0.238) is also significant but slower, while Guinea's weak ECT (-0.033) indicates a sluggish correction mechanism. Conversely, The Gambia (0.001), Ghana (0.005), and Sierra Leone (0.007) have positive or statistically insignificant ECT values, indicating that short-run economic shocks are not naturally corrected in the long run in these countries. This lack of automatic correction suggests weak institutional frameworks or ineffective economic mechanisms, necessitating policy interventions to enhance economic stability and resilience.

Government expenditure on education has varying short-run effects across WAMZ countries. Nigeria shows the strongest positive impact (21.795), indicating that short-term increases in education spending significantly contribute to economic growth by enhancing human capital and productivity. Liberia (3.052*) and Sierra Leone (1.496*) also exhibit positive effects, though smaller in magnitude, implying moderate contributions of education investments to short-term growth. However, Guinea (-2.059) shows a negative and insignificant effect, suggesting that education spending does not yield immediate economic benefits and may require time before contributing to growth. Similarly, Ghana (0.77*) and The Gambia (0.583**) display weaker but positive effects, indicating that while education investment is beneficial, its immediate impact depends on factors such as the efficiency of implementation, quality of education, and its alignment with labour market needs.

In contrast, government health expenditure exhibits mixed effects across countries. In Nigeria (-3.441**), Liberia (-1.215**), and Sierra Leone (-0.921*), health spending has a negative short-run impact, suggesting inefficiencies in the health sector, high implementation costs, or delayed economic benefits. Ghana (1.593) shows a positive but statistically insignificant coefficient, indicating potential benefits that may take longer to materialise. Guinea (-0.041) and The Gambia (-2.225) also exhibit weak or negative effects, reinforcing that health investments may take time to contribute significantly to economic performance.

4.2.2. Analysis of the Causal Relationship

The test results indicate that economic growth Granger-causes government expenditure on education at a statistically significant level, with a Z-bar value of 2.7248 (p = 0.0064). This suggests that

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past values of GDP growth can predict changes in education expenditure, implying that higher economic growth leads to increased investment in education. However, the reverse causality does not hold, as EDU does not significantly Granger-cause GDPG (Z-bar = -1.2071, p = 0.2274). This result suggests that, in the short run, education spending does not strongly predict economic growth in WAMZ countries, possibly due to delays in translating educational investments into productivity gains.

The relationship between economic growth and health expenditure shows weak evidence of causality. The test fails to establish a significant causal effect of economic growth on health expenditure (Z-bar = 0.1295, p = 0.8970), indicating that economic growth does not significantly predict changes in health expenditure. Similarly, health expenditure does not significantly Granger-cause GDP growth (Z-bar = 1.8325, p = 0.0669), though the p-value is marginally close to the 10% significance threshold. This suggests that while health investments may contribute to long-term economic growth, their immediate predictive power remains weak, likely due to inefficiencies in the healthcare sector and delays in realising economic returns from health improvements.

Table 7.
Dumitrescu & Hurlin (2012) Granger non-causality test results

	W-bar	Z-bar	Z-bar tilde
GDPG → EDU	2.5732	2.7248 (0.0064)	2.2987 (0.0215)
EDU → GDPG	0.3031	-1.2071 (0.2274)	-1.1761 (0.2396)
GDPG → HLT	1.0747	0.1295 (0.8970)	0.0051 (0.9959)
HLT → GDPG	2.0580	1.8325 (0.0669)	1.5101 (0.1310)
GDPG → GFC	2.2335	2.1365 (0.0326)	1.7788 (0.0753)
GFC → GDPG	1.1746	0.3025 (0.7623)	0.1580 (0.8745)
GDPG→ LAB	1.1295	0.2243 (0.8225)	0.0889 (0.9292)
LAB → GDPG	0.5814	-0.7250(0.4684)	-0.7501(0.4532)
GDPG → FDI	2.1129	1.9276 (0.0539)	1.5942 (0.1109)
FDI → GDPG	2.2292	2.1290 (0.0333)	1.7722 (0.0764)
GDPG → OPN	2.2371	2.1428 (0.0321)	1.7843 (0.0744)
OPN → GDPG	1.2805	0.4859 (0.6270)	0.3201 (0.7489)

Note: P-Value in Parenthesis.

4.3. Discussion of Findings

The findings of this study align with existing literature that emphasises the crucial role of human capital development in driving long-term economic growth. The significant positive impact of government expenditure on education, in the long run, is consistent with studies such as Teixeira and Queirós [3] and Ma, et al. [9] which highlight how investments in education enhance labour productivity, foster innovation, and contribute to sustainable economic development. The results support the augmented Solow human capital growth model, which posits that education is a fundamental driver of economic expansion by improving workforce quality and efficiency. However, the weaker short-run impact of education expenditure suggests that structural challenges, such as inefficiencies in the education system, delays in policy implementation, and labour market mismatches, may hinder immediate economic benefits. This aligns with the findings of Rahim, et al. [6] who argue that human capital investments require time to translate into measurable economic gains. Furthermore, the varying short-run effects across WAMZ countries suggest that national differences in governance quality, educational infrastructure, and budget execution may influence the effectiveness of education expenditure in stimulating growth.

Similarly, the positive and significant long-run relationship between health expenditure and economic growth confirms prior research findings, such as those by Jie and Lan [7] which emphasise the role of healthcare investments in improving labour productivity and economic resilience. A healthier workforce experiences fewer work disruptions due to illness, leading to greater efficiency and higher economic output. However, the negative short-run impact of health expenditure on economic growth, particularly in Nigeria, Liberia, and Sierra Leone, suggests inefficiencies in the health sector that may

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delay the realisation of economic benefits. This finding is consistent with Abubakar, et al. [8] who argue that healthcare investments in developing economies often face challenges related to inadequate infrastructure, poor governance, and inefficient resource allocation. The mixed results for different WAMZ countries further highlight the importance of institutional quality and public financial management in determining the effectiveness of government spending. Countries with stronger governance structures may be better equipped to translate health investments into economic gains, while those with weaker institutions may experience delays or even negative short-term effects.

The causality analysis further supports the argument that economic growth plays a significant role in determining education expenditure, aligning with the findings of Zhang, et al. [10] who suggest that higher GDP levels provide governments with more fiscal space to invest in education. However, the absence of a significant reverse causal effect implies that education investments do not immediately lead to economic growth in WAMZ countries, likely due to time lags in human capital development. The weak causal relationship between health expenditure and economic growth also reflects findings from studies such as Jemiluyi and Jeke [4] highlighting health investments' delayed impact on productivity and economic expansion. This suggests that while education and health spending are vital for long-term growth, their immediate contributions depend on broader economic and institutional factors. These findings reinforce the need for sustained policy commitment to human capital development and improvements in governance, budget efficiency, and institutional capacity to maximise the economic benefits of education and health investments in WAMZ countries.

The findings of this study align with the augmented Solow human capital growth model, which integrates human capital as a fundamental driver of economic growth alongside physical capital and labour. The strong long-run positive impact of government expenditure on education and health supports the theoretical premise that investments in human capital enhance labour productivity, foster technological advancements, and drive sustainable economic expansion. This is consistent with Mankiw, et al. [2] extension of the Solow model, which posits that economies with higher human capital accumulation experience greater long-term growth. However, the weaker short-run effects and sometimes negative short-run impacts suggest that human capital investments take time to materialise into economic benefits due to structural inefficiencies, delayed policy implementation, and institutional constraints. The heterogeneous short-run effects across WAMZ countries further emphasise the model's flexibility in accounting for country-specific variations in economic dynamics. Additionally, the Error Correction Term (ECT) results indicate that while some countries adjust to equilibrium following economic shocks, others struggle due to weak institutional mechanisms, reinforcing the model's implication that long-term growth is contingent on stable and effective policy environments. The weak causality between human capital investment and economic growth in the short run further highlights that education and health investments must be sustained over time to yield significant economic returns, reinforcing the theoretical argument that human capital accumulation is a gradual but essential process for long-term economic stability and prosperity.

5. Conclusions

This study highlights the vital role of human capital development, particularly government expenditure on education and health, in driving economic growth in WAMZ member countries. The findings confirm that long-term investments in education significantly contribute to economic development, though short-term effects vary due to inefficiencies in education systems and disparities in quality. Similarly, healthcare spending positively influences economic growth in the long run by enhancing labour productivity, but its short-term effects remain inconsistent due to differences in healthcare infrastructure and governance. The weak causal relationship between economic growth and human capital investment underscores the need for proactive government policies to prioritise funding for education and healthcare, regardless of economic fluctuations. Strengthening institutional frameworks and ensuring efficient resource allocation will be crucial for maximising the economic benefits of these investments.

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To enhance the impact of education expenditure, WAMZ governments should increase budget allocations while ensuring efficient use of funds to improve quality and accessibility. Investments in teacher training, curriculum development, and modern learning facilities are necessary, with a particular focus on technical and vocational education. Similarly, health sector investments should prioritise primary healthcare infrastructure, disease prevention, and public health programs, focusing on underserved areas. Strengthening healthcare governance and expanding health insurance schemes will improve service delivery and workforce productivity. Additionally, structural reforms, such as performance-based budgeting and improved transparency, should be implemented to ensure the effective utilisation of resources. To supplement government funding, governments should integrate education, healthcare, and labour market policies while fostering public-private partnerships and international cooperation. Long-term policy consistency and institutional stability will be essential for sustaining the impact of human capital investments and fostering economic growth in the WAMZ region.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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