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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE Human capital, capital goods import and economic growth in West Africa

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Abstract: This research paper investigates interactions of human capital, capital goods import and economic growth with a panel of 13 West African countries comprises of 7 low income and 6 low-middle income countries over the period of 1980-2018. The study adopts the Panel Auto-Regressive Distributed Lag (ARDL) cointegration techniques to establish a short and long-run relationship existing among the variables. Panel ARDL (Fixed effect) result revealed that the returns to equipment investment are moderately high on the average. Findings do not support the hypothesis that human capital makes production inputs more effective and helps countries gain from equipment investment and other imported investment for all the countries. This is due to inadequate knowhow and skill arising from the low levels of human capital in these countries. Determining the threshold of human capital development at which countries benefit from equipment investment, findings indicates that countries of the low-middle Income that exhibit a comparatively higher human capital (1.45 on the average) benefited more from imported capital stock and other importations than countries of the low income with very low human capital (1.27 on the average). Thus, we conclude that investment in human capital, innovation, and knowledge are significant contributors to economic growth and should be the priority of developing economies.

Subjects: African Studies; Economics and Development; Regional Development; Economics

Keywords: human capital; capital stock import; economic growth; panel auto-regressive distributed lag model; low income countries; low-middle income countries

1. Introduction

After peaking at 4.7% in 2010 to 2014, Africa's real GDP growth slowed to 2.1% in 2016, with improvement reaching an estimated 3.5% in 2018 (ADB, 2019). Economic growth is crucial to the development of African states, especially West Africa where the importation of capital goods, which represents channel for the diffusion of technology to promote growth remains huge. Africa Development Bank (2020) outlook indicates that West Africa economic growth picked up to an estimated 3.7% in 2019 with growth majorly driven from Ghana, Côte d'Ivoire, and Nigeria. Drivers of economic growth are strongly linked to labour force mobilization, human capital, total factor productivity and capital goods.

Growth in developing economies can be attributed to the use of imported machinery by industrial sectors in manufacturing firms, mining and the industrial sectors at large (Habiyaremye, 2013). How sustainable is such growth is a major question. Developing countries generally require the import of capital goods which they cannot produce but found necessary to





© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent. enhance productivity (Harvey & Sedegah, 2011). Across Africa especially in West Africa, human capital contributes less to the growth of labour productivity than in other developing countries despite its huge import of capital goods in form of machinery from frontier nations such as China, USA, UK, Germany, etc., this has been attributed in ADB (2020) economic outlook, to the low educational quality, inadequate physical capital, mismatches in education, skills and poor technological know-how in the sub-region.

The import of capital goods has increased tremendously in developing countries over the past decade with West Africa countries concentrating largely on machinery which improves the technology. Yet increased growth commensurate with such import has not been witnessed in the sub-region probably due to low human capital development. The empirical literature on growth has established the effect of investment in human capital and that of equipment on economic growth in developing economies. Lee (1995) indicated that investment in capital equipment and goods by low-income countries from high income has been found to increase the efficiency of capital thereby increasing their growth rate of capital. Mazumder (2001) also extends the work of Lee (1995) stating that developing countries with a comparative disadvantage in machinery production tends to benefit from other countries through trading in cheap machineries importation with better quality. To delve deeply into our discussion, it is essential to look into some stylized facts about the three major variables for this study in West Africa.

1.1. West Africa economic growth

Despite gains in the economic growth of West African countries, it remains a marginal player in the alobal economy due to its weak production base and low integration in the alobal value chain (World Bank, 2018). Variations abound across countries on the strength and quality of growth. Nigeria, Cape Verde, Burkina Faso, Ghana, and Mali saw strong per capita GDP growth, ranging from 2 to 3 percent per annum between 1980 and 2009; other countries stagnated in growth per capita. Nigeria annual GDP growth rate estimated as 8% in 2010 dropped to an estimated value of 2.3% in 2019, Ghana had 7.8% in 2010 and stood at 7.3% in 2019, Côte d'Ivoire recorded 2.02% in 2010 and was estimated to grow at 7% in 2019, while Sierra Leone with 5.3% in 2010 had estimated record of 5.8% in 2019 (ADB, 2019; World Bank, 2018). ADB (2020) reported that the West African real GDP growth rate was estimated at 3.4% in 2018, slightly above the continental average of 3.1% and far below 5.7% estimated of East Africa, which has been Africa most dynamic region, and 4.3% of North Africa. Within the African region, West Africa economy remains vibrant and strong with Six West African countries, namely: Côte d'Ivoire (3rd), Senegal (5th), Burkina Faso (6th), Ghana (8th), Benin (9th) and Guinea (10th) ranked in the top 10 in Africa in 2018 in terms of real GDP growth. Nigeria being the largest in West Africa with about 70% of West Africa's regional performance and has pulled down West Africa's average growth rate.

1.2. Human capital in West Africa

Human capital which accounts for the largest share of countries wealth globally remains low among West African states. Human capital is determined by the sum of population health, knowledge, skills and experience. The new human capital index ranked on a 0–100 scale with 0 being the worst, while 100 stands for the best based on indexes of Development, Deployment, Capacity, and Know-how and result indicated that only Ghana with a score of 61.01 (72nd) out of 130 countries in 2017 came close to the world average of 61.5 with rationale attributed to the progress recorded by Ghana on the reduction in gender inequality and women empowerment. Low educational attainment, primary and secondary school enrolment rates and literacy across all age groups are tremendously challenging the development of human capital in West Africa.

1.3. Imports of capital goods in West Africa

Capital goods import from developed countries is a common transfer channel on technology that promotes African economic growth where many countries capital goods are almost imported and paid for in foreign rates or led to incurred debt. West Africa's largest imports include Vehicles, Computer (IT products), Pharmaceuticals and Electronics from China, Korea, Belgium, and the United Kingdom. West Africa trade exports have not kept up with their imports, thus leading to a trade deficit. Report indicates that West Africa imports of Chinese goods in 2012 were about US \$18.1 billion with only about US\$4.3 billion goods on exported goods to China (Pigato & Gourdon, 2014). The composition of West African imports showcases the exogenous influence of international trade in the region.

From the global perspective, the United Nations 2030 Agenda for Sustainable Development itemized 17 Sustainable Development Goals (SDG) towards ending poverty and other deprivations in the world. Major strategies at the heart of these goals are strategies that improve health and education, reduce inequality, and spur economic growth. Given this requirement of human capital development to achieve sustainable development in the future, do West African countries have such level of human capital to achieve the projected development? Another major role of human capital is in absorbing technology diffused through equipment and machinery in production processes which is crucial for economic growth.

2. Goal of the study

Given the foregoing, it is therefore pertinent to ask what level of education, skills and strength does the labour force within the industrial sectors across West Africa states are endowed with? This paper therefore places focus on the importance of human capital on a country's strength to absorb the capital goods import and make judicious use of them. We proxy capital equipment investment in developing nations with imports of machinery from OECD countries and examine the human capital impact on the growth of such imports. Consideration is also given to the level of interaction between equipment investment and human capital for the selected samples of 13 West Africa countries over the period 1980–2018. A major question answered by this study is how effective are the imported equipment in the West African sub-region, that is, what is the interaction between education and skill acquisition measured by the human capital index and stock on imported equipment? This is a major gap identified in previous studies on this subject.

A major contribution to existing literature by this study is to determine the threshold of human capital development at which countries benefit from equipment investment. Do countries of the Low-Middle Income that exhibit a comparatively higher human capital benefit more from imported capital stock and other importations than countries of the Low Income with very low human capital?

3. Literature review

Empirical research on economic growth, human capital, and capital imports mostly consider import demand effect on growth and that of capital import on growth. Empirical studies on the linkages among the three variables in developing countries remain few. Lagares (2013) paper focussed on the growth effects of imported and domestic capital on the economic growth of 32 Latin American countries with time-series data from 1960 to 2010. The result showed growth exhibited a positive relationship with capital imports and domestic capital. In like manner, Habiyaremye (2013) study on developing countries found that the use of imported machinery in developing economies promotes growth. The study revealed that investment in domestic equipment products often slow down growth rates, while imported equipment investment with adequate know-how of them raises growth through improved productivity.

Aramowo (2014) on the nexus between capital goods import and economic growth in West Africa Monetary Zone based on Panel ARDL Model found that capital goods import play important role in promoting sub-regional economic growth. This paper found that the imports of capital goods exhibit a positive and highly significant impact on economic growth in the short and longrun with the magnitude of coefficient higher in the long run. It was also recorded that domestic investment has a negative but non-significant effect on economic growth with a significant effect manifesting in the long-run. Fawehinmi et al. (2019) considered the impacts of human capital and capital goods import on the economic growth of 30 countries in Sub-Sahara Africa using the Panel ARDL analysis. The group found that imports of capital goods have a positive and significant impact on economic growth, while human capital failed to exhibit a positive significant impact on the economic growth in the observed 30 countries of Sub-Sahara Africa. Further analysis by the study revealed the presence of a weak correlation between capital goods import and human capital in the countries; thus signifying that the management and utilization of imports of capital goods for growth in the sub-Sahara Africa region lie heavily on the human capital.

Rehman et al. (2022 *with the* aim to determine the contribution of exports of communication technology, goods and services, food, and manufacturing exports and foreign investments to economic growth in Pakistan, found out that exports of goods and services and food exports have a negative relationship with economic growth in Pakistan economy. By using time-series data and the non-linear ARDL technique to assess the linkages of the variables through positive and negative shocks, they discovered that foreign investment exposed a constructive and negative linkage to economic growth during positive and negative shocks. Exports of goods and services and food exports were found to exhibit an adversative association with economic development in Pakistan. The paper failed to adduce an economic reason for such adversative effect which may come from poor or unskilled human capital managing the exports.

4. Methodology

4.1. Theoretical framework

This study focuses on three major variables. These are human capital, import of capital goods, and economic growth. The impacts of human capital on economic growth have been explained by many economists. For example, the endogenous growth models of Romer (1986) and Lucas (1988) identified human capital as a major cause of divergence in economic growth of developed and developing countries. Romer (1990) again, Rebelo (1991), and Stokey (1991) all tried to extend this gospel of endogenous growth further to a more refined form.

What endogeneity theory preaches is quite different from the classical theory that relies more on external forces to achieve growth. Growth, according to endogeneity theory, is a function of internal forces, such as human capital, knowledge capital and innovations. It considers positive externalities and the spillover effect from an economy that is knowledge and technological based which will spur economic development. The endogenous theory postulates that in the long-run, the rate of growth of any country depends on policy measures like research and development promotion through subsidies, research innovation and improved education. These tend to impact positively on growth rate through increase incentive for innovation in an endogenous growth models.

Nelson and Phelps (1966) indicated that imported goods and economic growth can be affected by human capital strength and level. To establish this point, Benhabib and Spiegel (1994), built on the model of Nelson and Phelps (1966) which defined the association between output growth and human capital in two different channels. Firstly, it tends to improve on the ability of a country to shoulder domestic innovation. Secondly, it has the ability to facilitate technology adoption in that country. This is the approach adopted by Benhabib and Spiegel (1994) while Lucas (1988) classify human capital as a mere endogenous variable in the production function.

This study combines these two approaches of Nelson and Phelps (1966) and Lucas (1988) to model the interaction between imported goods and human capital as it affects economic growth in the West African sub-region.

To describe the interaction, we start with a standard nonlinear production function with the assumption of constant returns to scale.

$$Y_{it} = A_{it} K_{it}^{0\alpha} K_{it}^{E\beta} L_{it}^{1-\alpha-\beta} \varepsilon_{it}$$

Where:

 Y_{it} = Output in country i in period t,

A = technology level (TFP)

 $K_{it}^{E\beta}$ = Equipment Stock

 $K_{it}^{0\alpha}$ = Other capital stock (imports of non-equipment investment (denoted as M)).

L = Labor force

 ϵ = error term.

Note that stock of capital is split into two in Equation 1. Existing literature and study on equipment investment make distinguishing clarity between equipment investment and that of investment in structures. This study chose not to make this distinction, reason being that some of the variables termed "Other capital stock" like the non-equipment investment, are imported.

To consider the effectiveness of these exogenous variables on the output of the economy, the study used the growth rate of output per labour. This is derived by dividing Y_{it} by L and taking the log-difference of the equation as shown in Equation 2.

$$\Delta \mathbf{y}_{it} = \Delta \mathbf{A}_{it} + \alpha \Delta M_{it} + \beta \Delta K_{it}^{\sharp} - (\alpha + \beta) \Delta L_{it} + \Delta \varepsilon_{it} \tag{2}$$

The major challenge is securing data for total factor productivity growth for the West African countries. While some countries' data were not available others were incomplete for the period covered by this study. To solve this problem, we look at a better definition of technological growth. Nelson and Phelps (1966) defined technological growth variable (ΔA_{it}) as follows:

$$\Delta A_{it} = \gamma_1 + \gamma_2 H_{it} + \gamma_3 H_{it} \Delta K_{ti}^{\mathcal{E}} \tag{3}$$

 γ_1 in Equation 3 represents exogenous technological progress. H_{it} accounts for domestic innovation, while $H_{it}\Delta K_{ti}^E$ is the excess realized from investment in imported capital goods. This is assumed to be controlled by the level of education or any development that directly affect human capital in the workforce. This was termed effective capital by Lucas (1988).

4.2. Model specification

By substituting for ΔA_{it} in Equation 2, we generate the model for analysis in this study. This is presented in Equation 4.

$$\Delta \mathbf{y}_{it} = \gamma_1 + \gamma_2 \mathbf{H} \mathbf{c}_{it} + \gamma_3 \mathbf{H} \mathbf{c}_{it} \Delta K_{ti}^{\mathsf{E}} + \alpha \Delta M_{it} + \beta \Delta K_{it}^{\mathsf{E}} - (\alpha + \beta) \Delta L_{it} + \Delta \varepsilon_{it}$$
(4)

Equation 4 therefore, has per worker GDP growth rate as the dependent variable. This is modelled as function of human capital, human capital—capital stock interaction, growth in non-equipment goods, capital stock growth and the growth in labor force.

4.3. Variable description and measurement

Per Worker GDP (y): This is the dependent variable. This study used the output-side real GDP at current PPPs (in mil. 2011US\$), divided by labor.

(1)

labor (L) is measured by number of persons engaged (in millions), **Hc is human capital index per person** based on years of schooling and returns to school: It is calculated based on average years of education and an estimated rate of return to education from the Mincer equation. (Sourced from PWT 9.1)

Capital stock (K^{ϵ}) is capital equipment at current PPPs (in mil. 2011US\$). This study chose not to make a distinction between capital equipment and other capital imported since the latter falls within the imports of non-equipment investment.

Imports of non-equipment goods and services (M): This is proxied by import of goods and services as percentage of GDP. The imports of goods and services are the worth of all the goods and services received from other countries. These goods includes all imported non-equipment and services involving freight cost, merchandise value, etc. It excludes factor services known as employees and investment income compensation and transfer payments.

Effective Capital (**HcKe**): This is a proxy for knowledge-based economy. It is the product of human capital index and capital stock. Its parameter captures interaction between human capital investment and investment in equipment; this tells how effective capital can be, given changing levels of knowledge and skill.

A priori expectations of the variables on GDP are summarized in Table 1.

4.4. Descriptive analysis of data

Equation 4 is the primary model for this study. Due to some reasons, especially data availability in the region under study, some of the variables were proxied. Panel data analysis is best suited for this study due to insufficient variables. It also reduces the noise coming from individual series; therefore, heteroscedasticity is not an issue. The main interest of this study is the group, but the use of the panel estimation technique also takes heterogeneity into account by allowing for subject-specific variables. Data were sourced from the Penn World Table 9.1. Out of the 16 countries in the West Africa sub-region, 13 countries were used based on data availability for the period 1980 to 2018. This is a heterogeneous panel where N (the countries) is large, and T (time in years) is equally large, but N < T.

Figure 1 presents the descriptive analysis of human capital at the mean level across the West African countries in ascending order. The average HC index is least in Burkina Faso (BFA) and highest in Ghana (GHA). The bar chart shows that human capital across this sub-region is lower than 2% on the average. This implies that an additional year of education will produce an individual rate of return to schooling that is less than 2% per annum in this sub-region. The implication of this result is that the region may rely more on imported capital service to operate equipment and technological devices.

Table 1. A priori expectations on exogenous variables					
Variable	Indicator	Sign	References		
Нс	Human capital index per person	positive	Nelson and Phelps (1966)		
K ^E	capital equipment at current PPPs	positive	Lucas (1988).		
М	Import of goods and services as percentage of GDP.	positive	Lagares (2013), Aramowo (2014)		
(НсКе)	Product of human capital index and capital stock	positive	Lucas (1988).		

Figure 1. Mean of human capital across West African countries.



Further analysis of human capital by income group is presented in Figure 2. World economies are categorized into four income groups, namely, high income, upper middle income, lower middle income, and low-income groups. West African sub-region of the Sub-Sahara African region fall into two major income groups, which are lower-middle-income (LminC) and lower-income (LincC). Figure 2 shows that countries in the lower-income group in West Africa have the lowest human capital index (1.271 on the average). These countries are; Burkina Faso, The Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger Republic, Sierra Leone, and Togo.

However, countries in the lower middle-income group have a slightly better performance in times of human capital development (1.45 on the average). These countries are: Benin Republic, Cape Verde, Ghana, Ivory Coast, Mauritania, Nigeria and Senegal.



Figure 2. Mean of human capital by income group.

Mean of HC by CROSS_SECTION

across West African countries.





Figure 3 shows the average value of capital stock (measured in million USD) imported by the West African countries between 1980 and 2018. Nigeria had the highest capital stock importation, while The Gambia has the least. Out of the 13 countries, only Nigeria and Ghana can be classified among countries with growing capital investments, the rest have less than 100,000USD investment in capital equipment.

Figure 4 is the interaction between human capital rate and capital stock importation. It shows that low rate of HC development across West African sub-region culminates to low effectiveness on capital in the sub-region. When a country is lacking in trained skills to operate machineries and equipment, the importation of human resources is inevitable. Only Nigeria and Ghana have a larger proportion of train skills to operate capital equipment among the 13 countries selected in West Africa. These descriptive statistics help us to establish heterogeneity across the West African countries. The assumption of heterogeneity holds in this study.

4.5. Estimation technique

This study employed Panel Cointegration technique. A useful starting point of the technique is to study the association between the variables. We conducted a correlation test of association

Table 2. Correlation analysis of variables					
	Y	L	м	KE	НС
Υ	1				
L	0.4	1			
	0				
М	-0.08	-0.31	1		
	0.0973	0			
KE	0.59	0.78	-0.18	1	
	0	0	0.0001	_	
НС	0.32	0.22	0.27	0.43	1
	0	0	0	0	

Probability values in italics

among the variables, necessary to avoid the problem of multicollinearity. The correlation result is shown in Table 2. The probability values of the correlation coefficients are all significant at 1% except the correlation between output per worker and imported goods and services which is significant at 10%. Our major concern is the pairwise correlation of the exogenous variables. From Table 3, only the correlation between capital stock (KE) and labor (L) is high (0.78) all others are very low. This can be explained in the direction of the input substitution theory of production. Labor can easily be substituted for capital and vice versa in the production process.

4.6. Panel Unit Root Test

The appropriate model specification can be determined by looking at the cointegration properties of the model, unit root especially. If the series cointegrates, it means our model portrays a long-run equilibrium, with deviations that are mean-reverting. This study employed two different Panel Unit root methods to test the non-stationarity of the variables in the models with the aim of knowing the best and appropriate estimation technique. Fisher-ADF and Im, Peseran and Shin (IPS), Unit root tests which both have heterogeneity hypothesis were used at the individual country level. This study focused on the group that is sub-region, therefore Levin, Lin & Chu Panel Unit Root Test was used to test for a common unit at the group level

Summary of the Panel Unit root tests for common unit root and individual unit root are presented in Tables 3 and 4 respectively

From Table 3, the hypothesis of common unit root process in the variables can be rejected at levels for import variable (M) and human capital variable (HC) implying that the two variables are integrated of order zero I(0). However, other variables are integrated at order 1. The result suggests that the most appropriate cointegration technique is Panel ARDL. For the optimal lag

Table 3. Levin, Lin & chu unit root test							
Null :	Commoi	Common unit root process in the group					
Variable	Statistic	Statistic Prob.** Integration					
D(Y)	-8.6248	0.0000	I(1)				
М	-1.3265	0.0923	I(0)				
D(KE)	-3.1569	0.0008	I(1)				
D(L)	-2.966	0.0015	I(1)				
НС	-3.3199	0.0005	I(0)				

Table 4. Panel unit root test (individual process)				
Unit root assumes individual unit root process				
Method	Statistic	Prob.**		
Im, Pesaran and Shin W-stat	-9.81283	0.0000		
ADF - Fisher Chi-square 167.987		0.0000		
PP - Fisher Chi-square	412.442	0.0000		
Im, Pesaran and Shin W-stat	-3.04375	0.0012		
ADF - Fisher Chi-square	62.411	0.0010		
PP - Fisher Chi-square	74.3298	0.0000		
ADF - Fisher Chi-square	54.493	0.0079		
PP - Fisher Chi-square	50.0046	0.0223		
Im, Pesaran and Shin W-stat	-6.72372	0.0000		
ADF - Fisher Chi-square	142.57	0.0000		
PP - Fisher Chi-square	216.501	0.0000		
Im, Pesaran and Shin W-stat	1.7	0.9554		
ADF - Fisher Chi-square	23.6267	0.5973		
PP - Fisher Chi-square	7.52166	0.9998		
	Nest Unit root a Unit root a Method Im, Pesaran and Shin W-stat ADF - Fisher Chi-square PP - Fisher Chi-square Im, Pesaran and Shin W-stat ADF - Fisher Chi-square Im, Pesaran and Shin W-stat ADF - Fisher Chi-square PP - Fisher Chi-square PP - Fisher Chi-square Im, Pesaran and Shin W-stat ADF - Fisher Chi-square PP - Fisher Chi-square PP - Fisher Chi-square Im, Pesaran and Shin W-stat ADF - Fisher Chi-square PP - Fisher Chi-square	Unit root assumes individual unit inMethodStatisticIm, Pesaran and Shin W-stat-9.81283ADF - Fisher Chi-square167.987PP - Fisher Chi-square412.442Im, Pesaran and Shin W-stat-3.04375ADF - Fisher Chi-square62.411PP - Fisher Chi-square74.3298ADF - Fisher Chi-square54.493PP - Fisher Chi-square50.0046Im, Pesaran and Shin W-stat-6.72372ADF - Fisher Chi-square142.57PP - Fisher Chi-square142.57PP - Fisher Chi-square216.501Im, Pesaran and Shin W-stat1.7ADF - Fisher Chi-square23.6267PP - Fisher Chi-square7.52166		

selection, the study used the Schwarz Information Criterion (SIC) and Akaike Information Criterion, with each suggesting ARDL (2,1,1,1,1,1) as optimal lag.

The next step is to conduct a homogeneity test comparing the random effect and fixed effects models or whether to use the Mean Group or the Pooled Mean Group (PMG) models.

The study conducted the Hausman Test which has a null hypothesis of Random effects, that is individual effects are independent of explanatory variables. A rejection of this hypothesis support the choice of fixed effect as the most appropriate for the specification. The results of the Hausman Test are summarized in Table 5.

The probability of the Hausman test statistics is 0.0419, which is lower than 0.05, we reject the null hypothesis. The fixed effect model is most appropriate as the random effect correlates with the explanatory variables. This result also implies homogeneity across the West African countries. Factors not included in our model represented as constant terms differ across the sub-region. Factors such as technological development, governance, infrastructural facilities, and so on are not the same across the sub-region.

Table 5. Hausman homogeneity test					
Correlated Random Effects - Hausman Test					
Test Summary Chi-Sq. Statistic Chi-Sq. d.f. Prob.					
Cross-section random	9.913159	4	0.0419		

5. Results

5.1. Human capital and investment in capital stock

The results of the Pool Mean Group/ARDL test showing both the long run and short run growth function for West African countries are presented in Table 6.

The result in Table 6 can be interpreted in many dimensions. The ECM coefficient (Cointq01) captures the joint causality in the panel as well as the speed of adjustment of per worker GDP in the short run. The negative value (-0.1547) which is significant at 5%, implies that there is disequilibrium in per worker GDP across the West African countries which the set of imported capital stock, labour, and effective labour are trying to restore in the long run. The value of the ECM measures the speed of short-run adjustment of per worker GDP. The speed on the average is about 15.5% per annum. This is a very slow adjustment. It is also observed that none of the individual coefficients significantly impact on growth in the short run. This should be expected as growth is a long-run process; combinations of factors, capital, labour, and technology may not show the immediate effect on growth but are expected to improve on growth in the long-run.

The long-run impact coefficient in Table 6 also implies long-run causality. All the variables are significant at 1% level. This result tests the impact of productive factors, labour, imported capital, and other imported investments, on per worker growth, when human capital makes imported capital more effective. It is observed that labour negatively impacts per worker GDP. On average, it indicates a diminishing return to growth per worker as labour increases. Imported capital stocks also exhibit a diminishing return to growth across the sub-region. This can be explained as due to human capital across the West African countries that is considerably low among other regions of the world. Low human capital indicates low education and skill acquisition, and low returns to education. The interaction coefficient confirms this in Table 6 that is negative. The coefficient measures effectiveness of capital. The results indicate an inverse relationship between equipment investment interaction with human capital and growth for countries of West Africa due to their low

Table 6. PMG/ARDL of human capital and the impact of imported capital stock on growth Dependent Variable: $D\ell n$ (Y)

Selected Model: AKDL(2, 1, 1, 1, 1)						
Variable	Coefficient	Std. Error	t-Statistic	Prob.*		
Long Run Equation						
HC	4.026977	0.553855	7.270812	0.0000		
HC*ℓn(KE)	-0.191465	0.05106	-3.74981	0.0002		
ℓn(M)	0.271777	0.062651	4.337938	0.0000		
ℓn(KE)	0.522037	0.042735	12.21578	0.0000		
ℓn(L)	-0.368461	0.067674	-5.44463	0.0000		
Short Run Equation						
COINTEQ01	-0.154736	0.042686	-3.62498	0.0003		
Dℓn(Y(-1))	-0.091922	0.056722	-1.62057	0.1059		
D(HC)	13.72636	7.91561	1.734087	0.0837		
D(HC*ℓn(KE))	-1.458541	0.803578	-1.81506	0.0703		
Dℓn(KO)	0.021384	0.044245	0.483313	0.6291		
Dℓn(KE)	1.839443	1.207079	1.52388	0.1283		
Dℓn(L)	-0.601691	0.341247	-1.76321	0.0786		

Selected Model: ARDL(2, 1, 1, 1, 1, 1)

Table 7. Human capital and the impact of other investment on growth				
	PMG/ARDL		ROBU	ST OLS
Variable	Coefficient	Prob.*	Coefficient	Prob.*
НС	3.75284	0.0000	3.427087	0.0000
LOG(KE)	0.331895	0.0000	0.382711	0.0000
LOG(M)	1.347523	0.0000	1.424229	0.0000
LOG(L)	-0.522187	0.0000	-0.423712	0.0000
HC*LOG(M)	-0.953443	0.0000	-0.977685	0.0000

levels of human capital. The results also suggest a diminishing returns to equipment investment given an increase in human capital. The coefficient of other imported goods and services is positive (0.2717) and significant. This implies a positive effect of other investment on economic growth in the West African sub-region, even though it exhibits diminishing returns to scale.

5.2. Human capital and other investments

Some questions that came to mind form the results above are:

- (i) What could be driving the relationship observed between human capital and investment in equipment in the sub-region?; and
- (ii) Is it possible that the impact of good and services (a measure of other investment) is driven by the level of human capital in each country?

To answer these questions, the results were further subjected to robustness tests. The results reported above were subjected to a number of robustness tests. The question here is, does the level of human capital makes imported goods and other capital services more effective as to increase per worker growth? We answer this question by conducting a long-run test using the interaction between human capital and other investments (effective imports investment) as an independent variable. The PMG/ ARDL long-run model was supported by a Robust OLS. This will also ascertain that our model does not violate the regression assumptions. The results are presented in Table 7.

The long-run coefficients in Table 7 are similar to those in Table 6. All coefficients are significant at 1% level. Labor is confirmed by the PMG and the Robust OLS have a negative impact on per worker growth. A situation that strongly supports the low skilled labor that dominates developing economies. Human capital interaction with imported goods and services negatively impacts per worker growth. The implication is that human capital across the West African countries is too low to make importations, both capital stock and other goods and services effective as to increase growth. Two additional inferences can be drawn from the result of the robustness tests:

- (i) Interactions between equipment investment and growth were positive but very low for countries with low human capital development;
- (ii) There is confirmation of diminishing returns to equipment investment as human capital increases.

6. Conclusion

Some literature suggests the presence of a significant and positive causal relationship between equipment investment and growth. This paper examined this assertion, using a panel of 13 low income developing countries in West Africa for the period 1980–2018. These 13 countries were categorized into two income groups. Seven countries belong to the Low-Income Group, while six are Low Middle-Income Group. Two variables were used to proxy investment in importation. The Capital stock is assumed not produced within the country but imported, and imported goods and capital services.

We also examined the impact of human capital on the relationship between equipment investment and growth using the PGM/ARDL regression analysis. That is whether human capital makes capital stocks more effective to increase growth. The study equally examined, as a check, the role played by human capital in the relationship between other imported investments and growth using PMG and Robust regression,

The results suggest that the returns to equipment investment are moderately high on average. Our main hypothesis that human capital makes production inputs more effective and helps countries gain from equipment investment and other imported investment was not supported by the findings for all the countries. This we find out to be probably due to the low levels of human capital in these countries.

The study found an inverse relationship between equipment investment interaction with human capital and growth for countries of West Africa due to their low levels of human capital. This finding supports the claim of Fawehinmi et al. that human capital failed to exhibit a positive significant impact on the economic growth in selected countries of sub-Sahara Africa. Similar to this is Rehman et al. (2022) *for* Pakistan, who discovered that foreign investment exposed a constructive and negative linkage to economic growth during positive and negative shocks. This can be explained in the direction of inadequate knowhow.

The study also found out that countries beyond a certain threshold of human capital benefit from equipment investment to a greater extent than countries below this threshold. Thus, countries of the Low-Middle Income that exhibit a comparatively higher human capital (1.45 on the average) benefited more from imported capital stock and other importations than countries of the low income with very low human capital (1.27 on the average). Thus, there is evidence of a negative relationship between investment in equipment and growth for countries with low levels of human capital.

7. Recommendations

The relationship between effective equipment investment and growth that is negative for countries with low levels of human capital can be explained in two dimensions. It can be argued that increasing equipment investment without a considerable increase in human capital may lead to "enduring growth" and may have "negative developmental" effects arising from increasing inequality. In the alternative, investment in capital stocks that are produced and imported from developed countries may not benefit developing countries significantly and may even generate negative effects if the country lacks the skill to operate such equipment. In such a case, such countries will have to import engineering services from producer countries to operate such equipment.

From the findings of this study, it is obvious that human capital development is very crucial to development in developing economies. Policies to foster improved education and skill acquisition are highly recommended in these countries. The findings also show support for the theory of endogeneity that says that "economic growth is primarily the result of endogenous and not external forces". Investment in human capital, innovation, and knowledge are significant driver of economic growth and should be the priority of developing economies. Considering the endogenous growth theory, an economy in the long-run can observe growth with well-developed economic policy measures. Policies favoring subsidies for research and development on education are highly recommended as it will increase the incentive for innovation.

One limitation witnessed in this study is that these developing countries are highly dependent on importation, making it difficult to distinguish between equipment investment and non-equipment investment structures as does by the endogenous growth theory. This study chose not to make this distinction since most of the non-equipment investment are imported.

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