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Public Health Investment, Human Capital Accumulation, and Labour Productivity: Evidence from West Africa

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Abstract: *The study of public health investment, human capital accumulation, and labour productivity are essential in formulating policies that drive economic development. This study examines the individual and interactive effects of public health investment and human capital accumulation and the interactive effect of human capital accumulation and financial opportunity on labour productivity in West Africa from 1992 to 2020, respectively. The interactive effect of human capital accumulation and financial opportunity has not been given any attention in the literature. The following findings are apparent in the study: One, public health Investment and human capital accumulation positively affect labour productivity in the short and long run. Two, the interactive effect of human capital accumulation and public Health Investment positively and significantly affect labour productivity in the short and long run. Lastly, the interactive effect of human capital accumulation and financial opportunity positively and significantly affects labour productivity in the short and long run. Hence, we suggest that economic policy be formulated to ensure that affordable healthcare and financial opportunity are available, together with human capital accumulation, to fast-track the normalization of the economy.*

Keywords: Interactive effect; human capital accumulation; financial opportunities; public Investment; West Africa; Augmented Solow Model

JEL Classification: C23, C87, H51, H52, J08

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Introduction

The proliferation of studies examining the relationship between human capital accumulation, public health investment, labour productivity, and economic growth is evidence of the keen interest among researchers and policymakers in understanding the relationship and the growth impact of health expenditure and human capital accumulation. Public health investment and human capital accumulation (through public Investment in Education) have gained the interest of policymakers and development economists for several reasons. First, human capital accumulation via public Investment in Education and public health expenditure are the key determinants of economic growth and development (see De La Fuente, 2011; Todaro & Smith, 2012 Anowor et al., 2020). Human capital accumulation through expenditure on Education is theoretically adjudged as the primary driver of socio-economic development. Furthermore, experts see public health investment as an essential determinant that accounts for the differences in health outcomes and economic growth (see Bloom et al., 2018; Anowor et al., 2020). Second, a sound health system, a product of heavy public Investment in health, is the critical determinant of labour quality and the necessary factor that stimulates economic growth and facilitates economic development (see Anowor et al., 2020). Also, human capital accumulation can minimize the skill mismatch in the labour market in developing countries, like countries in the West African Region (Abdychev et al., 2015).

Theoretically, the relationship between human capital accumulation and productivity growth can be viewed from two perspectives. That is the micro and macro perspective. The micro effect is perceived from the improvement in productivity at the firm level, while the macro effects are reflected in the overall economy in the form of economic growth (see Lucas, 1988; De La Funeta, 2011). Motivated by the observed inconsistency in the Solow growth model, Mankiw et al. (1995) adjusted the Solow growth model to incorporate and account for the impact of human capital accumulation on output per worker. That is, the study proposed an augmented form of the Solow growth model that accounts for the effect of human capital accumulation on the growth of output per worker. The general insight from the augmented Solow growth model, Solow growth model, and endogenous growth theory suggests that increasing Education or Knowledge is necessary to grow output per worker and equally explains why there is a difference in economic growth across countries. Another important insight from these theories is that increasing Education or Knowledge increases a country's ability to adopt new technology that will boost total output.

The analysis of the relationship between human capital accumulation, public health investment, labour productivity, and economic growth is not new (see, e.g., Freire-Serén, 2001; Gyimah-Brempong et al., 2006; Jajri & Ismail, 2010; De La Fuente 2011; Asafu-Adjaye 2012; Muktdair-Al-Mukit, 2012; Eneji, Dickson & Onabe 2013; Umoru & Yaqub 2013; Auzina- Emsina, 2014; Oni 2014; Ali et al., 2015; Eggoh, et al., 2015;

Ibe & Olulu-Briggs, 2015; Ogunleye, 2015; Omitogun et al., 2016; Tabar et al., 2017; Awotunde 2018; Erçelik, 2018; Israel et al., 2019; Kelani et al. 2019; Anowor et al., 2020). However, there are inconsistencies in the conclusions of previous studies that make it difficult to pursue a particular policy measure. Some studies found that policies targeted toward increasing public health investment and human capital accumulation eventually increase labour productivity and economic growth, while others found otherwise. For instance, De La Fuente (2011) found that Investment in Education positively and significantly affects productivity growth. Bloom et al. (2018) found that health is essential in explaining cross-country differences in income per worker.

Contrary to the above findings, Bexheti and Mustafi (2015) found a negative relationship between public spending on Education and economic growth. Also, recent studies like Bokana and Akinola (2017) found that human capital accumulation (captured with higher education enrolment and higher Education output) could affect productivity positively or negatively, depending on the estimation method employed. On the one hand, using the Fixed effect model, the study found that human capital accumulation has a positive but not statistically significant effect on productivity. Implying that human capital accumulation is not an essential driver of productivity growth, such a policy promoting human capital accumulation may not bring a significantly favourable change in productivity. On the other hand, the study found a negative relationship using the generalized method of moment (GMM). These inconsistencies in the empirical literature findings have raised many concerns for researchers and policymakers on how the ideal policy authorities should aggressively pursue its implementation.

In the quest to find an explanation for the observed inconsistency in empirical studies, we found that previous studies have focused too much attention on the individual role of Investment on health and human capital accumulation (through Investment in Education) in promoting labour productivity or economic growth (see Okubal, 2005; Muktdair-Al-Mukit, 2012; Eneji et al.2013; Ibe and Olulu-Briggs, 2015; Eneji and Onabe, 2013; Boussalem, Boussalem & Taiba, 2014; Danquaha and Ouattara, 2014; Oni 2014; Onisanwa, 2014; Bedir, 2016; Ibrahim, 2016; Bokana & Akinola, 2017; Bloom, Canning, Prettner, & Schünemann2018; Isreal, Kaliappan & Hamzah, 2019; Kelani et al., 2019; Okowa &Vincent, 2019; Anowor et al., 2020; Remi, Daniel & Efegbere, 2020; Pasara, Mutambirwa, & Diko, 2020**),** While the impact of the connection between public spending on health and human capital accumulation (through Investment in Education) and the compelling connections between human capital accumulation and financial opportunity on labour productivity has not been given much attention in the literature, particularly in West Africa region. Notable exceptions are the studies of Ali et al. (2015), Eggoh et al. (2015), and Omitogun et al. (2016). They examined the interactive effect of Education and health on economic growth but failed to consider the interactive effect of human capital accumulation and financial opportunity on labour productivity.

In addressing the inconsistencies of the empirical literature, this study aims to examine the individual and interactive effects of government health expenditure and human capital accumulation on labour productivity in West Africa. To further bridge the gaps in the literature, the study aims to examine the interactive effect of human capital accumulation and financial opportunity on labour productivity among West African countries. To the best of our knowledge, no study has examined the interactive effect of human capital accumulation and public Investment on health and the interactive effect of human capital accumulation and financial opportunities on labour productivity in West Africa. The interaction between public spending on health and human capital accumulation and the connection between human capital accumulation and financial opportunities carries significant implications for understanding the growth impact of labour productivity and the policy that affects labour quality (Bloom, 2007). It is equally important to note that the positive effect of the Investment on health on labour productivity may be undermined by a lack of human capital accumulation or Education to complement it. Eggoh et al. (2015) suggest that health investments and human capital accumulation should be jointly improved to expect improvement in productivity or economic growth since both are complementary.

Also, the positive effect of human capital accumulation may be limited by the lack of financial opportunity that creates investment firms (to generate job opportunities) or business opportunities. Historical evidence suggests that the contribution of human capital accumulation to productivity and economic growth can only be significant when the labour force that acquires more Knowledge (either by public Investment in Education) is gainfully employed in the production process. Factors like the prevalence of mass unemployment, high-interest rate, restricted credit facility, and high inflation can stifle the impact of human capital accumulation on the growth of output per worker (see Ali et al., 2015). Implying that human capital accumulation can stimulate productivity growth if accompanied by financial or employment opportunities (also introduced by available financial opportunities). When the government and its agencies spend on Education, it should ensure the availability of financial opportunities like credit facilities or low-interest rates for Investment for the educated to ensure the Knowledge is employed in the production process. The educated minds (labour force) will create jobs (or employment for itself), assuming financial opportunities are available in the face of massive unemployment arising from economic shocks or crises like Covid-19 and financial crisis.

West Africa is one of the world's fastest-growing regions. Each country in the region is blessed with diverse resources. Trade and Investment in the region can bring about socio-economic development for millions of people (United States Agency For International Development, 2021). The region comprises 15 countries, including Nigeria, the largest economy in Africa. However, it is essential to note that this region is populated mainly by countries with a low Human development index (in line with United Nations Development Programme Ranking) and are still struggling to recover from the Covid-19 pandemic shock. In addition, global economic activities were suspended for significant periods due to the health crisis caused by the Covid-19 pandemic, which has led to an abnormality in economic outcomes (Fagbemi, 2021). The Covid-19 crisis led to the loss of many human lives and severely affected market confidence and economic activities (Song & Zhou, 2020). Empirical studies reveal that companies and entrepreneurs were severely affected by the Covid-19 shock (see Brown & Rocha, 2020), leading to massive layoffs of workers. It was also revealed that Africa, particularly West Africa, took the lion's share of the global economic contraction resulting from the pandemic's emergence, which has forced millions of people into extreme poverty (Dzigbede & Pathak, 2020; Fagbemi, 2021). Empirically, different estimation techniques have been employed by previous studies to explore the relationship between human capital accumulation, public health investment, labour productivity, and economic growth. For instance, some studies conducted a time-series analysis using the Autoregressive Distributional Lag (ARDL) model (see Okowa & Vincent, 2019; Anowor et al., 2020), the Error Correction model (ECM) (see Jajri & Ismail 2010), the vector error correction model (VECM) (see Remi et al. 2020), and the vector autoregressive model (see Remi et al. 2020). In contrast, some others employed the Generalized method of moment (GMM) (see Bokana & Akinola, 2017), and other studies used the fixed effect estimator for cross-country evidence (see Jajri & Ismail, 2010; Ali et al., 2015; Alimi, 2018).

Motivated by the inconsistency in the findings in the empirical literature due to methodological differences, this study employs a more robust (i.e., panel ARDL) estimation approach that has just begun to be applied in studies of productivity and economic growth (Mensah et al., 2019). We employed the panel ARDL for several reasons. First, the panel ARDL estimation approach can account for cross-sectional heterogeneity, leading to spurious estimation output if ignored in a data set. Secondly, panel ARDL can be used even with variables with different orders of integration, regardless of whether the variables under study are I (0) or I (1) (Pesaran & Shin 1999). Lastly, a model's short-run and long-run coefficients can be estimated concurrently from a data set with large cross-section and time dimensions using the panel ARDL estimation approach. The rest of this paper is organized as follows: section two describes the data and methodology. Section three presents empirical results, and section four concludes the study and provides policy recommendations.

Data and Model

Data

This study used annual panel data of 15 West African countries from 1992 to 2020. The selected period was based on data availability. The variables adopted in this study are Labour productivity (measure division of gross domestic product divided by total labour force), Government expenditure on health (captured with domestic government expenditure on health), human capital accumulation(captured with government spending on Education), Investment in physical capital (captured with gross fixed capital formation), Money supply (captured with broad money), inflation (captured with Consumer price index) and Financial opportunity (proxy with domestic credit to the private sector by banks. The data was sourced from the Central Bank of Nigeria and the World Development Indicator database**.**

Model

In line with the study objectives, the augmented Solow growth model was adopted to serve as the theoretical base for the empirical analysis. Hence, the theoretical model is specified as:

$$Y = K^{\alpha} H^{\beta} (AL)^{1-\alpha-\beta} \quad (1)$$

Y is aggregate output, K is physical capital, H is human capital, L is labour, and A is technical efficiency. α and β are output elasticity parameters. Like the Solow growth model, *A* and *L* are assumed to grow at a constant rate *g* and *n*, respectively, and they are subject to diminishing return to scale given by 1> α + β.

By transforming Equation (1) through mathematical manipulation, we obtain;

$$Ln\left(\frac{Y}{L}\right) = LnA + g_t - \left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)Ln\left(n+g+\delta\right) + \frac{\alpha}{1-\alpha-\beta}Ln\left(s_k\right) + \frac{\beta}{1-\alpha-\beta}Ln\left(s_h\right) \quad (2)$$

(s_k) and (s_h) are the Investment or savings devoted to physical capital accumulation and human capital accumulation, and δ is the depreciation rate for physical and human capital.

$$LnA = \alpha_0, \frac{\alpha}{1-\alpha-\beta} = \alpha_1, \frac{\alpha}{1-\alpha-\beta} = \alpha_{2,} \frac{Y}{L} = y, g = 0 \text{ and } \left(n+g+\delta\right) = 0$$

since the labour force, technology, and depreciation grow at a constant rate over time and GDP per worker or output per worker.

The model becomes;

$$\mathbf{Lny = \alpha_0 + \alpha_1 lns_k + \alpha_2 lns_h} \quad (3)$$

Let Lny = LnLP, $\alpha_2 \mathbf{lns_h} = b_1 LnGEH + b_2 LnHCA$ and $\mathbf{lns_k} = lnIVP$

Therefore,

$$LnLP = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_1} lnIVP + b_1 LnGEH + b_2 LnHCA \quad (4)$$

By adding the interactive terms, the functional specification in mathematical form is given as

$$LnLP = \alpha_o + \alpha_1 LnIVP + Lnb_1 GEHit + b_2 LnHCA + + b_3 Ln(HCA*GEH) + b_4 ln(HCA*FO) \quad (5)$$

Due to multicollinearity problem, three econometric models were specified with control variables.

Model 1

$$lnLP_{it} = \phi_0 + \phi_1 LnFO_{it} + \phi_2 LnHCA_{it} + \phi_3 INF_{it} + \eta_t \quad (6)$$

Model 2

$$lnLP_{it} = \theta_0 + \theta_1 LnFO_{it} + \theta_2 LnMS_{it} + \theta_3 Ln\left(HCA*GEH\right)_{it} + \mu_t \quad (7)$$

Model 3

$$LnLP_{it} = \gamma_0 + \gamma_1 LnIVP_{it} + \gamma_2 LnGEH_{it} + \gamma_3 Ln\left(HCA*FO\right)_{it} + \varepsilon_t \quad (8)$$

Where subscript i = 1,….., N represents each country's identity in the Panel while t= 1,…..T denotes time, and the elasticity of output per effective labour with respect to each exogenous variable in the three models are given by the θs, ϕs, and γs. However, θ_0, $\phi_{0,}$ and γ_0 are the country-specific fixed effects in the three models, while η, ε and μ are normally distributed error terms. LP is Labour productivity, GEH is Government expenditure on health per worker, HCA is human capital accumulation, IVP is Investment in physical capital per worker, MS is Money supply per worker, and FO is financial opportunity per worker.

Panel Estimation Technique

To fully comprehend the justification for employing the Panel ARDL to estimate the parameters of the models specified, it is important to briefly discuss the general framework of panel data analysis (see Samargandi, Fidrmuc & Ghosh, 2013).

<u>Static models</u>

The prominent static model in panel data analysis is the pooled ordinary least square (pooled OLS0), fixed effects, and random-effects models. However, there are lots of problems associated with the use of the traditional panel models (that is, pooled OLS, fixed effects, and random-effects models). Among these problems is the issue relating to the inability of these estimators to capture the dynamic nature of the data employed. The model's dynamism is an important area that cannot be neglected in the empirical literature (see Samargandi et al., 2013). Another issue is that these estimators assume that the slope coefficients of the countries that make up the group are the same. Hence, they impose homogeneity in the model's slope coefficients across countries, even when there may be significant differences between them.

Dynamic panel model

The generalized method of moment (GMM) and panel ARDL are the most common dynamic estimators used in a panel data analysis. The GMM estimators (However, many empirical studies have applied the GMM techniques in analyzing macro panel analysis (Samargandi et al., 2013). According to Roodman (2006), the GMM estimators are likely to produce spurious results for two reasons: small N and significant T. First, a small N may result in an unreliable autocorrelation test. Second, as the period of the data increases, so will the number of instruments. It impacts the validity of the Sargan test of over-identification restriction and leads to the rejection of the null hypothesis of instrument homogeneity (see Samargandi et al., 2013). As a result, we doubt the dependability and consistency of the GMM results.

Panel Autoregressive Distributed Lag (Panel ARDL)

Pesaran and Smith (1995), Pesaran (1997), and Pesaran and Shin (1999) present the autoregressive distributed lag (ARDL) model in error correction form. The emphasis here focuses on the significance of having consistent and efficient estimates of the parameters in a long-run relationship (see Samargandi et al., 2013). According to Pesaran and Shin (1999), panel ARDL can be used even with variables with different orders of integration, regardless of whether the variables under study are I (0) or I (1). Also, the coefficients of static and dynamic models (the short-run and long-run coefficients) can be estimated concurrently from a data set with large cross-section and time dimensions. According to Pesaran et al. (1999), the dynamic heterogeneous panel regression can be incorporated into the error correction model using the autoregressive distributed lag ARDL (p,q) technique and stated as follows:

$$\Delta(LnLP_{it}) = \varphi_i[(LnLP_{i,t-j}) - \{\beta_i^{'}(y_{it})\}] + \sum_{j=1}^{p-1}\rho_j^{i}\Delta(LnLP_{i,t-j}) + \sum_{j=1}^{q-1}\phi_j^{'}\Delta(y_i)_{t-j} + \theta_i + \varepsilon_{it} \quad (9)$$

Where $LnLP$ is labour productivity, "y" is the set of independent variables in the three models. ρ and ϕ represent the short-run coefficients of lagged dependent and independent variables, respectively. θ is a country-specific fixed effect, θ is the long-run coefficients, and φ is the coefficient of the speed of adjustment to the long-run equilibrium. The subscripts “I” and “t” represent country and time, respectively. The long-run growth regression is contained in the term enclosed in square brackets. The mean group (MG) model of Pesaran and Smith (1995), the pooled mean group (PMG) estimator developed by Pesaran et al. (1999), and the dynamic fixed effects estimator can all be used to estimate Equation (9) (DFE). Maximum likelihood is used to compute all three estimators, which consider the long-run equilibrium and the heterogeneity of the dynamic adjustment process (see Samargandi et al., 2013).

Pesaran and Smith (1995) proposed the Mean Group (MG) estimator, which calls for estimating separate regressions for each country and calculating the coefficients as weighted means of the estimated coefficients for the individual countries. The Pooled Mean Group (PMG) estimator’s main feature is that it allows short-run coefficients, such as intercepts, the speed of adjustment to long-run equilibrium values, and error variances, to be heterogeneous across countries (see Samargandi et al., 2013). In contrast, long-run slope coefficients are restricted to being homogeneous across countries. This does not impose any constraints. It allows all coefficients to vary and be heterogeneous both in the short and long run. However, a sufficiently sizeable time-series dimension of the data is required for the consistency and validity of this approach.

The cross-country dimension should be significant as well. Finally, the dynamic fixed effects estimator (D.F.E.) is very similar to the PMG estimator. It imposes constraints on the slope coefficient and error variances to ensure that they are equal across all countries in the long run. The DFE model also requires the adjustment coefficient’s speed and the short-run coefficient to be identical. The model, however, includes country-specific intercepts. DFE consists of a cluster option for estimating intra-group correlation with standard error.

However, it is essential to ascertain the order of integration of the series before estimating the Panel ARDL model. There are two generations of panel unit root tests: the first generation unit root test and the second generation unit root test. There are two groups of tests in the first generation. One group assumes a standard unit root process across the individual’s cross-section unit (such as Levin et al., 2002), and the other group allows for heterogeneity in the unit root process for each individual in the Panel (such as Im, Pesaran, and Shin (IPS), 2003). However, the first-generation unit root tests fail to account for cross-sectional dependence across the Panel. It assumes that the individual time series in the Panel are cross-sectionally independently distributed (see Nusair, 2019; Pesaran, 2007). Hence, we must test for unit roots before estimating any of the Panel ARDL models.

Cross-Sectional Dependence (CD)

Ignorance about the existence of cross-sectional dependence may cause distortion, leading to the estimation of spurious regression results (Pesaran, 2007). On the other hand, the second generation (such as Pesaran et al., 2008) panel unit root tests recognize and address the issue of cross-sectional dependence (CD). Pesaran et al., 2008 reported the conventional ADF regression with a cross-sectional average and its first difference to get the cross-sectionally Augmented Dickey-Fuller (CADF). In the existence of CD, the CADF test gives more consistent and accurate results than the first-generation unit root test (see Azam et al., 2021). Hence, this study employs the Pesaran (2004) cross-sectional dependence CD) test to test for cross-sectional dependence for each variable and then test for unit root using the "first generation" IPS test of Im et al. (2003) and the "second generation" CADF test Pesaran et al., 2008 as well to avoid the spurious result.

Panel Causality

It is conventional to test for causality to ascertain the direction of causality among the variables of interest. The direction causality helps the policymaker design the appropriate policy to rescue an economy from a particular crisis or achieve a target goal (Azam et al., 2021). Hence, the study employed Dumitrescu-Hurlin heterogenous Granger Causality technique that presumes short-run and long-run causality (see Lopez & Weber, 2017; Azam et al., 2021). Dumitrescu-Hurlin possesses two features that make it superior to other traditional panel causality tests; (i) it can be employed to ascertain causal relation in a situation where the data is unbalanced and the Panel is heterogeneous; (ii) it also takes cognizance of cross-sectional dependency (see Azam et al., 2021). Based on Dumitrescu-Hurlin, short-run causality among the variables of interest is obtained. The long-run causation is analyzed by the statistical significance of the error correction terms (ECTM) obtained from the three models specified above. Also, according to Apostolidou et al. (2014), long-run causality is informed by the statistical significance of the negative coefficient of the error correction term. Hence, Dumitrescu-Hurlin heterogeneous causality model can be specified as:

$$Z_{it} = \beta_i + \sum_{j=1}^{j} \phi_i^j Z_{i,t-j} + \sum_{j=1}^{j} \theta_i^j Y_{i,t-j} + \varphi_{it} \tag{10}$$

Where subscript i is the individual cross-sectional unit, and t is time. β_i is the country-specific effect, j is the optimum lag interval for all cross-sections, Y and Z represent the series in which causality will be assessed.

Empirical Analysis

This section presents results generated by estimation techniques adopted to estimate the parameters of the models specified in the previous section. The empirical results are reported in three subsections. The first section reports the preliminary results, including the homogeneity test, cross-sectional dependence test, and unit root test results. The following section reports the regression results of West African countries and the results of the Panel of 5 countries selected based on the United Nations Development Program human development ranking. This means that the sub-sample comprises countries with the highest Human development index (HDI). The last section reports the results of the Dumestricu-Hurlin causality test.

Homogeneity, Cross-Sectional Dependence, and Unit root Tests.

Like Mensah et al. (2019), we begin the analysis by first investigating whether the slope coefficients are heterogenous or homogenous. Employing the Pesaran and Yamagata (2008) homogeneity test, it is clear from Table 1a. that the null hypothesis of slope homogeneity in both the full sample and the sub-sample analysis is strongly rejected at a 10% as well as 1% level of significance. This implies that heterogeneity exists for slope coefficients of all variables interests in both samples; thus, heterogeneous panel methods in which parameters differ across individual cross-sections within the panels must be adopted. Hence, a justification for employing the Panel ARDL to estimate the models' parameters. In addition to the homogeneity test, we further investigate the degree of cross-sectional dependence in data via the Pesaran (2004) cross-sectional dependence test. Table 1b presents the results of the cross-sectional dependence test and the unit root tests. From table 1, it is clear and justified that the null hypothesis of no cross-sectional dependence is strongly rejected at a 10% significant level. This means that the cross-sectional dependence exit and due consideration will be given to its presence. First, we ignore the presence of cross-sectional dependence to examine the order integration with the IPS unit root test, and we employ the CADF afterward. The first and second-generation unit root tests indicate mixed order integration among the series.

The IPS suggests that LnLP, LnHCA, LnMS, LnGEH, and LnIVP are stationary at first, while LnFO and INF are stationary at level. The CADF, on the other hand, suggests that LnLP, LnHCA, LnMS, LnGEH, LnIVP, and LnFO are stationary at first difference while only INF is stationary at level. Given the presence of cross dependence, we ignore the result of IPS and conclude with CADF that only INF is stationary at a level. At the same time, the remaining series are stationary at first difference. However, this further justifies using the Panel ARDL model, which can handle series with mixed order of integration, provided that none is integrated at the second difference.

Table 1a: Pesaran-Yamagata's homogeneity test Result

Group	Δ	adj. Δ
Full Sample	6.862***	8.687***
Sub-Sample	6.467***	8.244***

Source: Author's Compilation

{*}, {**}, {***} represents significant at 10%, 5%, and 1% respectively. "Δ" and "adj. Δ" represent the Pesaran and Yamagata (2008) calculated delta and adjusted delta, respectively.

Table 1b: Cross-Sectional Dependence (CD) and Unit root Test result.

		1st Generation (IPS)			2nd Generation (CADF)		
Variable	**CD-test**	Level	1st diff	I(d)	Level	1st diff	I(d)
LnLP	40.30***	0.74	-6.57***	I(1)	-0.94	-6.21***	I(1)
LnHCA	20.51***	3.91	-2.32**	I(1)	4.55	-2.03**	I(1)
LnFO	45.03***	2.45***	-	I(0)	-0.81	-8.563 ***	I(1)
LnMS	42.68***	4.2	-3.52***	I(1)	3.96	-11.09***	I(1)
LnGEH	44.17***	2.19	-7.23***	I(1)	-1.25	-2.37*	I(1)
LnIVP	31.54***	-1.1	-13.39***	I(1)	-5.165***	-	I(1)
INF	46.76***	-3.99***	-	I(0)	2.36	-4.04***	I(0)

Source: Author's Compilation

{*}, {**}, {***} represents significant at 10%, 5%, and 1% respectively.

Estimation

We estimated the parameters of the three different models with two sets of data. The first set of data contains the data for 15 West African countries (the full sample), while the second set contains data for 5 West African countries (the Subsample). The models' estimation results using the full sample data set are reported in Table 2, while the results of the Sub-sample data set are reported in Table 3. The Hausman test is required to select a particular estimator in the Panel ARDL framework. The Hausman test result provides a clear insight into the appropriate Panel ARDL estimator for a specific panel data analysis. Hence, the Hausman test results are reported together with estimated parameters.

Estimation results (Full sample)

Table 2. presents the estimation results of the Panel ARDL model and traditional panel estimators for the full sample. Based on the outcome of the Hausman test, model 1 and 2 were estimated with pooled mean group estimator, while model 3 was estimated using the mean group estimator. Conventionally, the existence of a long-run relationship requires that the coefficient of the error correction term be negative (but not lower than -2) and statistically significant (Samargandi et al., 2013). From Table 1, the panel ARDL results indicate that the error correction terms for the three models are negative and statistically significant. Implying that a long-run relationship exists between the variables in each model and labour productivity (LP).

From Table 2, model 1, it can be said that human capital accumulation per worker (HCA) and financial opportunity per worker (FO) positively affect labour productivity (LP) in the short run and long run. At the same time, Inflation (INF) negatively affects labour productivity in the short run, while it has a positive effect in the long run. Further, the lagged LP has a positive effect on the current LB, while the lagged HCA, FO, and INF have a negative impact on the current LP. The positive relationship between HCA and Labour productivity implies that workers become more skillful as they acquire more Knowledge and are less wasteful.

A 1% increase in HCA will lead to a 13.6% and a 21.6% significant increase in LP in the short and long run, respectively. However, workers become discouraged and reduce productivity after a year of knowledge accumulation. Meaning, a 1% increase in the one period lagged HCA will result in a 10.3% decrease in LP, but this does not significantly affect LP even at the 10% significance level. In addition, an increase in FO by 1% will lead to a 125.8% and 10.2% increase in LP in the short and long run, respectively. However, only the short-run effect significantly drives LP. Also, a 1% increase in 1 period lagged FO will lead to a 23.7% decrease in LP, but this negative effect is not statistically significant at the 10% significance level. INF and lagged INF are negative, but these effects do not significantly affect LP at the 10% significance level in the short run. A 1% increase in INF and lagged INF will lead to a 0.3% and 1.4% decrease in LP in the short run, respectively. However, a 1% increase in INF will lead to a 1.9% significant increase in LP in the long run.

The estimation result of model 2 indicates that FO, Money supply per worker (MS), and the interaction of HCA and public Investment in Health per worker (HCA* GEH) affect LP positively both in the short run and in the long run, respectively. A 1% increase in FO, MS, and HCA* GEH will lead to a 47.8%, 12.8%, and 1% increase in LP in the short run, respectively. 1% increase in FO, MS, and HCA* GEH will also lead to a 91.5%, 6.1%, and 1.6% increase in LP in the long run, respectively. In addition, FO and MS significantly affect LP both in the long and short run. However, only the short-run effect of HCA* GEH on LP is not significant at the 10% level of significance, but the long-run effect has a statistically significant impact on LP even at the 1% significance level.

The estimation results of model 3, given the Hausman test outcome, indicate that the slope, intercept, and error correction varies across West African countries. This means that model 3 parameters were estimated using the Mean group estimator (MG). The MG results suggest that Investment in physical capital (IVP), GEH, and the interaction of HCA and FO affect LP positively in the short and long run. IVP, GEH, and HCA* FO significantly affect LP at the 10% significance level in the long run. However, only IVP and HCA* FO significantly affect LP in the short run, while the effect of GEH does not significantly affect LP in the short run, even at the 10% level. The result also shows that a 1% increase in IVP, GEH, and HCA* FO will lead to 11.7%, 11.1%, and 2.3% increase in labour productivity in the short-run, respectively, but in the long run, a 1% increase in IVP, GEH, and HCA* FO will lead 28.6%, 24.1% and 3.7% significant increase in LP.

Table 2: Estimation Result

Variable	Model 1		Model 2		Model 3	
	Panel ARDL	Static Estimator	Panel ARDL	Static Estimator	Panel ARDL	Static Estimator
long-run						
LnFO	0.102	0.044***	0.915***	-0.261***		
LnGEH					0.286***	0.823***
LnHCA	0.216***	0.922***				
INF	0.019***	0.003***				
LnIVP					0.286**	-0.176
LnMS			0.061**	0.010***		
LnHCA*LnGEH			0.016***	0.090*		
LnHCA*LnFO					0.037***	0.008***
C_b		4.244***		4.924***		4.958***
Short-Run						
ECT_{-1}	-0.286***		-0.262***		-0.352**	
D(LnFO)	1.258***		0.478***			
D($LnFO_{-1}$)	-0.237					
D(LnHCA)	0.136**					
D($LnHCA_{-1}$)	-0.103					
D(LnGEH)					0.111	
D(INF)	-0.003					
D(INF_{-1})	-0.014					
D(LnIVP)					0.117*	
D($LnLP_{-1}$)	0.157					
D(LnMS)			0.128***			
D(LnHCA*LnGEH)			0.01			
D(LnHCA*LnFO)					0.023***	
C_a	2.631***		1.500***		2.442***	
Hausman	4.14	0.25	3	56.29	33.100***	3
P-Value	0.246	0.968	0.392	0	0	0.392
Model	PMG	Random Effect	PMG	Fixed Effect	MG	Random Effect
N	15	15	15	15	15	15
NT	396	410	399	414	399	414

Source: Author's Compilation

{*}, {**}, {***} represents significant at 10%, 5%, and 1% respectively. N is the number of Countries, NT is the number of observations, Ca is the dynamic estimator, and Cb is the intercept for static estimator.

Estimation results (Sub-sample)

Table 3 presents the estimation result of the three models using the sub-sample data set. In model 1, the effect of HCA and FO on LP long run are positive and are statistically significant even at the 10% level. In the short run, only the effect of HCA on LP is positive, while the effect of FO on LP is negative. However, both effects are not statistically significantly different from zero. On the other hand, the long-run effect of INF on LP is negative and statistically significant. In contrast, the short-run effect of INF on LP is positive it is not significant at the 10% level of significance. In addition, the lagged LP has a negative but not significant impact on the current LP, while the lagged HCA and FO have a negative effect on the current LP, the effect lagged HCA on LP is considered to be significant at the 10% significance level. Also, the lagged INF has a positive but not significant effect on LP.

In the long run, a 1% increase in HCA and FO will lead to a 26% and 146.6% significant increase in LP, while a 1% increase in INF will lead to a 0.4% significant decrease in LP. In the short run, a 1% increase in HCA and INF will lead to a 4.9% and 0.8% increase in LP, but Meaning, a 1% increase in the one period lagged HCA will result in a 10.3% decrease in LP, but a 1% increase in FO will lead to a 39.5% decrease LP. Also, a 1% increase in 1 period lagged HCA and FO will lead to a 6.9% decrease in LP, but the negative effect of lagged FO on LP is not statistically significant even at the 10% significance level. On the other hand, a 1% increase in lagged INF will lead to a 0.2% increase in LP, but this effect is not significant even at the 10% significance level. The estimation result of model 2 indicates that FO, MS and the interaction of HCA and GEH (HCA* GEH) affect LP positively both in the short and long run, respectively. 1% increase in FO, MS, and HCA* GEH will lead to a 44.3%, 17.1%, and 9% statistically significant increase in LP in the short run, respectively. 1% increase in FO, MS, and HCA* GEH will also lead to a 70.4%, 8.5%, and 1.9% statistically significant increase in LP in the long run, respectively.

Table 3: Estimation Result

Variable	Model 1		Model 2		Model 3	
	Panel ARDL	**Static Estimator**	**Panel ARDL**	**Static Estimator**	**Panel ARDL**	**Static Estimator**
long-run						
LnFO	1.466***	1.134***	0.704***	0.944***		
LnGEH					0.403**	0.650***
LnHCA	0.260***	0.071***				
INF	-0.004**	0.003***				
LnIVP					0.274	0.111*
LnMS			0.061**	0.245***		
LnHCA*LnGEH			0.019***	0.001		
LnHCA*LnFO					0.030**	0.026***
C_b		6.160***		1.508**		3.707***
Short-Run						
ECT_{-1}	-0.383***		-0.376		-0.446***	
D(LnFO)	-0.395		0.443***			
D($LnFO_{-1}$)	-0.069					
D(LnHCA)	0.049					
D($LnHCA_{-1}$)	-0.084**					
D(LnGEH)					0.201	
D(INF)	0.008					
D(INF_{-1})	0.002					
D(LnIVP)					0.058	
D($LnLP_{-1}$)	-0.006					
D(LnMS)			0.171**			
D(LnHCA*LnGEH)			0.009*			
D(LnHCA*LnFO)					0.024**	
C_a	1.622***		1.500***		2.264***	
Hausman	7.06*	0.25	0.56	11.41**	33.100***	220.480***
P-value	0.07	0.968	0.905	0.01	0	0
Model [redacted]	MG	Random Effect	PMG	Fixed Effect	MG	Fixed Effect
N	5	5	5	5	5	5
NT	139	145	139	145	125	130

Source: Author's Compilation

{*}, {**}, {***} represents significant at 10%, 5%, and 1% respectively. N is the number of Countries, NT is the number of observations, Ca is intercepted for the dynamic estimator, and C_b is the intercept for the static estimator.

In addition, FO, MS, and HCA* GEH statistically and significantly affect LP in the long and short run at the 10% significance level. Like the full sample, the parameters of model 3 were estimated using the Mean group estimator (MG). The Hausman test result was the motivation that influenced the decision to use the MG

Like the full sample, the parameters of model 3 were estimated using the Mean group estimator (MG). The Hausman test result was the motivation that influenced the decision to use the MG estimator to estimate the parameters of model 3. Also, like the full sample, the MG results suggest that Investment in physical capital (IVP), GEH, and the interaction of HCA and FO affect LP positively both in the short and long run. GEH and HCA* FO significantly affect LP in the long run at the 10% significance level. However, only HCA* FO significantly affects LP at the 10% level of significance in the short run. The result also shows that a 1% increase in IVP, GEH, and HCA* FO will lead to a 5.8%, 20.1%, and 2.4% increase in LP in the short run, respectively. In the long run, a 1% increase in IVP, GEH, and HCA* FO will lead to a 27.4%, 40.3%, and 3% increase in LP, respectively.

Comparing the findings and conclusions of previous with the results of our full sample and Sub-sample model analysis, we saw that our result is consistent with previous studies. Specifically, the study is consistent with the studies that found positive relationship between HCA, GEH, and LP (see De la Fuente, 2011; Umoru & Yaqub, 2013; Bloom et al., 2018; Isreal et al., 2019; Kelani et al., 2019). Unlike the other studies, the study further saw instances in which human capital accumulation through Government expenditure on Education can have a negative effect on labour productivity. That is, we found that the effect of human capital accumulation will become negative after a period if not accompanied by public health Investment. This is because both policy variables are complementary (Eggoh et al., 2015). Also, the positive effect of the interaction between human capital accumulation and public health investment on labour productivity found in this study is consistent with the findings of Omitogun et al. (2016) and Eggoh et al. (2015). They examined the interactive effect of human capital accumulation and public health investment health but employed different estimation techniques for estimating the parameters of the model their studies adopted.

Figure 1: Summary of Estimation results Full sample

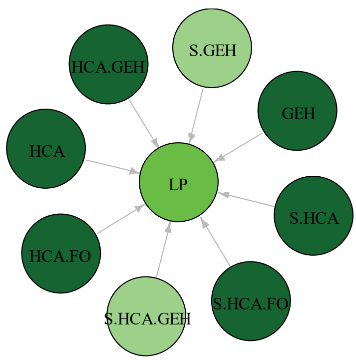
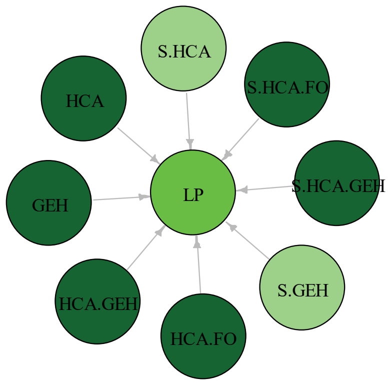


Figure 2: Summary of estimation results Full sub-sample



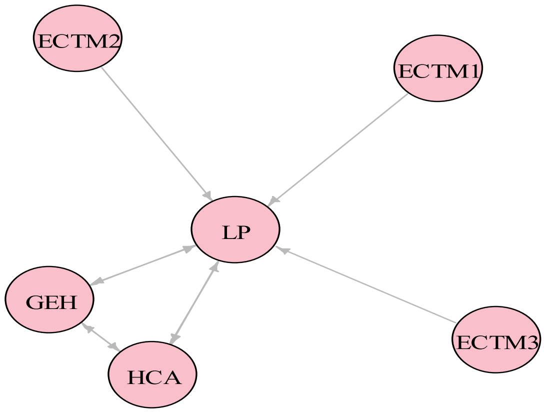
Source: Authors' compilation

Figure 1 and Figure depict the conclusions from the three models in line with the study objective. The colour green (without considering the type of green) used in the Figures implies that all policy variables in the network graph affect the target variable positively. That's is, human capital accumulation per worker (HCA), government expenditure on health per worker (GEH), the interaction of HCA and GEH, and the interaction of HCA and financial opportunity per worker (FO) affect labour productivity positively in the long run and short run, respectively. It is important to note that the "S." represents the short run, and the variable without "S." are long-run variables or effects, as the case may be.

Going by the variation in the colour of the nodes in the Figures, the dark green implies that the variable has a significant positive effect on labour productivity. In contrast, the light green suggests the effect of the variable has no significant effect, all at the 10 % significance level. The arrows in the figures are single-edge arrows, which means that endogeneity issues were relaxed by the theory and estimation methods employed. The endogeneity was not considered, and the estimates were not affected by the endogeneity problem because the estimation technique used in the study is robust to endogeneity-related issues (Menegaki, 2019).

Panel Causality.

Figure 2: Pairwise Dumitrescu Hurlin Panel Causality



Source: Authors' compilation

The double edge arrow indicates bidirectional causality, while the single edge arrow means unidirectional causality.

Table 5: Pairwise Dumitrescu Hurlin Panel Causality Tests Results

Null Hypothesis:	W-Stat.	Zbar-Stat.	Decision
LnGEH does not homogeneously cause LnHCA	5.46	5.19***	Bidirectional between GEH and HCA.
LnHCA does not homogeneously cause LnGEH	4.55	3.74***	
LnLP does not homogeneously cause LnHCA	3.41	1.89*	Bidirectional between LP and HCA.
LnHCA does not homogeneously cause LnLP	7.41	8.21***	
LnLP does not homogeneously cause LnGEH	6.82	7.27***	Bidirectional Between LP and GEH.
LnGEH does not homogeneously cause LnLP	9.78	11.94***	
ECTM1 does not homogeneously cause LnLP	4.01	2.66***	Unidirectional between ECMM1 and LP
LnLP does not homogeneously cause ECTM1	2.42	0.27	
ECTM2 does not homogeneously cause LnLP	3.44	1.80*	Unidirectional between ECMM2 and LP
LnLP does not homogeneously cause ECTM2	2.59	0.51	
LnLP does not homogeneously cause ECTM3	1.97	-0.46	Unidirectional between ECMM3 and LP
ECTM3 does not homogeneously cause LnLP	3.74	1.97**	

Source: Author's Compilation

{*}, {**}, {***} represents significant at 10%, 5%, and 1% respectively. ECTM1, ECTM2, and ECTM3 are the error correction term for Model 1, Model 2, and Model 3, respectively. Moreover, they are obtained from the residuals of the three models (Azam et al., 2021).

Table 5 and Figure 2 depict the outcome of the pairwise Dumitrescu Hurlin panel causality test. Table 5 shows the validity of the decision to reject the null hypothesis of no homogenous causality among a pair of variables of interest. At the same time, the figure gives a clear picture of the information disclosed in Table 5. It can be inferred from the Table that a bidirectional causality exists between human capital accumulation per worker (HCA) and labour productivity (LP), and labour productivity (LP) and government expenditure on health per worker (GEH), human capital accumulation, and government expenditure on health, respectively in the short run. While a unidirectional causality exit in the long run. This means HCA, GEH., HCA. * FO, HCA* GEH, INF, MS, FO, and IVP all-cause labour productivity in the long run.

Robustness Check.

To examine the robustness of the result, we estimated the models using a dataset of 5 West African countries selected based on UNDP ranking. We further estimated a static model for both the full sample and sub-sample to justify and ascertain the consistency and efficiency of the estimates. Table 2 and Table 3 show that Human capital accumulation per worker (HCA) positively affects Labour productivity (LP) in the long and short run, respectively. This result is also consistent with the random effect model for both Tables. The lagged HCA is negative for both samples. The only differences between the main estimation result (full sample estimation result) and the supporting estimation result (sub-sample estimation result) are the long-run and short-run effect of the control variables on Labour Productivity (LP) as well as the effect of the lagged LP on current LP. These differences occurred due to the different Panel ARDL estimators used for estimating the two sample samples, where necessary.

For instance, Model 1 and model 2 for the sub-sample estimates were estimated with the pooled mean group estimator (PMG), while model 3 was estimated with the mean group estimator (MG). Unlike the full sample, models 1 and 3 were estimated with the MG estimator, while model 2 was estimated with the PMG. These estimators have underlying assumptions which can result in estimating different parameter estimates. The financial opportunity estimated parameter (FO) (as seen in Table 2 and Table 3) for both the full and sub-sample positively affects labour productivity in the long run. However, the short-run result of model 1 (in Table3) for the Subsample shows a negative effect. This is because the subsample result is estimated with the MG, allowing heterogeneity in the short run and long. Pesaran, Shin, and Smith (1999) have proven the PMG result superior to the MG result. The long-run coefficient for inflation in Model 1 (in Table 2 and Table 3) was also different. This is also due to the difference in the estimation technique used, which Hausman Test informs. This difference can also be traced to the heterogeneity among the countries in the sub-sample. Recall that the Subsample consists of 5 West African countries with the highest human development index. Also, recall that Education has high-income potential and employment potential for educated labour. Inflation or expected inflation induces educated or skilled workers to reduce productivity while making unskilled workers increase productivity. According to the UNDP ranking, only two West African countries fall within the Middle human development rank. Inflation is likely to reduce the productivity of workers in such countries. Hence, the MG estimator considers this heterogeneity in its estimation process.

Conclusion and Policy Recommendations

The study examines the effect of human capital accumulation and public health investment on labour productivity in West Africa. In addition, the study equally examined the interactive effect of human capital calculation and public health investment and the interactive effect of human capital accumulation and financial opportunity on labour productivity in West Africa using the Panel ARD. It is now clear from the study analysis that human capital accumulation complements financial opportunity positively and significantly affects labour productivity in the short and long run. Also, Human capital accumulation augmented with public spending on health and public Investment in Health has a positive effect in the long run and the short run. However, only the long-run effect is significant at a 10% level of significance.

From the findings of this study, policy aiming at improving labour productivity in the short run and long run should be based on improving the availability of financial opportunity in line with human capital accumulation through public Investment in Health. In order to ascertain the direction of causality, the study further employed the Dumitrescu Hurlin panel causality test. A bidirectional causality was found to exist among human capital accumulation (LNHCA) and labour productivity (LNLP), and labour productivity (LNLP) and government expenditure on Health (LNGEH), human capital accumulation, and government expenditure on health, respectively, in the short run. While a unidirectional causality exit in the long run.

Therefore, the study recommends that economic policy should formulate to guarantee sufficient and simultaneous Investment in Health and Education to ensure that labour productivity is sustained in the long run. As the government invests in health, the same Investment should be extended to human capital to balance the Investment to improve human and economic development. Intuitively, people sacrifice their longer-term economic well-being for health without a publicly-funded health system. Also, the society might be populated with those that will draw more than what they have contributed to the community if there is no publicly sponsored education to stimulate or build the potential of the low-income individuals in the society.

To reduce the unemployment rate, monetary policy should be formulated so that private businesses and students (beneficiaries of public and private expenditure on

Education) will not be financially constrained when they want to explore new ideas or Knowledge. This will create the willingness of wanting to get educated those who have lost hope in Education. This study contributes to Knowledge by presenting and analyzing the three possible models that can be used to formulate economic policy relating to productivity growth in West Africa. The study also suggests the best model improves labour productivity in the long and short run.

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