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**Sectoral Analysis of Human Capital Investment, Labor
Productivity and Poverty in Nigeria**

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Abstract: This paper is on the analysis of human capital investment and labor productivity in a situation of a rising incidence of poverty in Nigeria on a sectoral basis. The analysis was done using annual time series data between 1986 and 2019. Three sectors were considered in the study: the agricultural, industrial and service sectors. The study used the Autoregressive Distributive Lag (ARDL) technique to estimate each of the stated models. Based on the estimated model, central in the results of the study is in two folds. In the first case, there is a direct positive effect of human capital investment on labor productivity, and a direct negative impact of poverty on labor productivity over time across the three sectors. In the second case, poverty decreases the contribution of human capital investment to labor productivity growth in the agricultural and industrial sectors in the short run only. But there is insufficient evidence on this in the service sector.

Keywords: Human capital investment, labor productivity, poverty, sectors

Introduction

Enhancing factor productivity is a crucial growth-oriented strategy key to the decision on finding the originating of and the means to improve the quantity of output produced. High factor productivity facilitates output growth. It also determines the fraction of the output going to the contributing factor. The larger the share, the better is the development of the factor. The decision-making involving the increment of per capita income or socioeconomic welfare improvement revolves around productivity growth. A further gain to note is its spillover effects on employment, the balance of payment, and inflation. For instance, a policy matching labor productivity to a wage rate increment would prevent the rate of inflation from rising. These benefits underscore the purpose of a search for ways to raise the productivity of the factors.

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Particular productivity of factor in point here is the labor productivity, relevant in the wake of rapid global advancement into the age of a knowledge-based economy. Many factors determine labor productivity growth. Human capital investment is a case in point. Investment in human capital noticeably increases labor skill, efficiency, and capability to perform. Labor productivity level could be adjudged in terms of the level of investment in human capital (Rukumnuaykit & Pholphirul, 2015). Human capital investment in the form of training or skill acquisition, education, nutrition, and health expenditure induce labor productivity. An employee who undergoes school enrolment and participates will advance in knowledge, skill, and capacity to function, and therefore have higher productivity than those without the training.

Some cross-countries and time-series pieces of evidence have been documented on the positive effect of human capital investment on labor productivity (see empirical literature review section). Although human capital investment may have an increasing effect on labor productivity the extent of the strength of the relationship depends critically on the degree of poverty ravaging the economy. Observably, countries with low income or high poverty rate tend to have low or no incentive to invest in human capital and have low labor productivity. On the other hand, rich countries invest more in human capital thereby having high labor productivity. Poverty stimulates nutritional deficiency and poor health conditions and reduces individual's motivation to invest in human capital which adversely affects labor productivity (Strauss, 1986; Dalton, Jimenez & Noussair, 2017; and Duflo 2001). If the poor are to choose between receiving a peanut pay in the current period and investing in human capital to earn higher earnings in the future, the little pay in the present period would be preferred. Whilst poverty controls human capital investment to influence labor productivity, it also affects labor productivity in the absence of the intermediating role of human capital investment such as increasing workers' stress and worries (Mullainathan & Shafir, 2013; and Chemin de Laet & Haushofer, 2013). Thus, poverty has a dual-channel of impact on labor productivity: first, through its direct impact on labor productivity. Second, through its effect on human capital investment that in turn affects labor productivity over time. In the second case, human capital investment assumes an impact transmission channel between labor productivity and poverty.

At this juncture, what is not clear in the second case is whether the shock absorption capacity of human capital investment is strong enough to cushion the harmful impact of poverty on labor productivity or if the increasing rate of poverty is consistent with a growing effect of human capital investment on labor productivity. This is of interest in Nigeria following a continuous rise in the incidence of poverty amidst year-on-year government investment efforts on human capital development to accelerate output per worker. For instance, government expenditure on education in 2000 was roughly ₦57.96 billion which increased to ₦82.80 billion in 2005 and rose further to ₦170.80 billion in 2010, ₦325.19 billion in 2015 and ₦593.37 billion in 2019. Government expenditure on health showed a similar upward trend. In 2000, about ₦15.22 billion was allocated for health which improved to ₦55.66 billion in 2005, ₦99.10 billion in 2010, ₦257.70 billion in 2015 and ₦388.37 billion in 2019. External aid on human capital (education, health, skill, etc.) development from international donors also abounds increasingly to raise human capital investment in Nigeria. Correspondingly, although it reduced from approximately 64.4% in 2000 to about 53.02% in 2005, the incidence of poverty increased continuously between 53.02% in 2005 and 58.64% in 2019 (CBN, 2020; Index Mundi online database). Yet, statistics computed from the World Bank database showed an increase in the total labor productivity from about 6.15 million in 2000 to roughly 8.30 million in 2005 with a marginal decline from approximately 12.79 million in 2015 to roughly 12.04 million in 2019.

However, existing studies on the cause of labor productivity growth in relation to either poverty or human capital assumed a direct linkage. Intuitively, income level determines the extent to

which people can invest in knowledge to boost their productivity. Thus, labor productivity will not increase with an increase in human investment if poverty increases. Consequently, assuming a direct relationship is rather a costly assumption because the relationship is more complex than assumed. This is particularly of interest in Nigeria following a continuous rise in the incidence of poverty, growth in government investment on human capital development and the resultant low output per worker growth rate in the country. In general, what happened to labor productivity if the rate of poverty increases over time? Will a poverty-driven country like Nigeria be motivated to invest in human capital leading to better labor productivity? Is the impact of human capital investment on labor productivity affected by a rise in poverty?

This paper aims to investigate empirically the a fore mentioned questions in the purview of Nigeria’s economy. To achieve this, the interactions of human capital investment and poverty as a determinant of labor productivity, in addition to the individual direct effects, were examined using a three-sectoral labor productivity analysis in Nigeria. These concerns form the basis for achieving good social and economic welfare through labor productivity-enhancing policy development particularly in Nigeria where the incidence of poverty is on a rise.

Literature Review

In the classical theory, labor productivity is an exogenous factor that depends on the ratio between physical capital and labor force, in addition to technical progress. As a result, the classical theory ignored the effect of human capital accumulation on the growth of productivity. However, the new growth theories that came up particularly in the 80s addressed this shortcoming by incorporating the importance of human capital formation in the labor productivity determination. The Lucas (1988) endogenous growth model rooted in the neoclassical theory is agoodinstance of some of these models relating human capital formationtolabor productivity.Knowledge, developed through schooling and learning-by-doing, occupies an important position in the Lucas endogenous growth model. In the model, training and investment in schooling (human capital accumulation) improve labor productivity. Both productivity and human capital are directly linked. The model of Lucas (1988) where output is produced vis-à-vis a production function of a Cobb-Douglas type is as illustrated in equation (1).

$$Q = \rho K^\beta (\vartheta hL)^{(1-\beta)} \tag{1}$$

Where Q , ρ , and K are output, technology, or efficiency parameter, and the physical capital stock. ϑ represents the fraction of the overall labor time utilized on working. h and L are the stock of human capital and labor force. If equation (1) is deflated by the available quantity of the labor force, a re-specification of equation (1) results in a per capita production function type represented in equation (2).

$$q = \rho K^\beta (\vartheta h_{pc})^{(1-\beta)} \tag{2}$$

Note in equation (2), h_{pc} stands for the quantity of per capita human capital determining labor productivity(q).in addition to the direct link between labor productivity and human capital, indirect linkage also exists through the external effect that induces endogenous growth. In the Lucas (1988) endogenous growth model, human capital investment in the form of schooling resultsintwo types of effect: the static and dynamic effects. The former implies that schooling leads to increased productivity of workers undertake to invest in schooling. The latter indicated that schooling enhances the productivity of the entire workforce because of the positive externality or spillover effectof schooling by one employee on the others. On the contrary,the

quality ladders model of Aghion and Howitts (1992) and Grossman and Helpman (1991) emphasize innovations and research and development capital stock as the determinants of productivity and output. Besides, the efficiency theory of wage links the productivity of labor to worker's paid (wage). The theory suggests that the rate of wage paid determines the worker's performance. Of recent, variables like import share, business cycle, institution, trade openness, foreign direct investment, access to export markets, financial depth, income inequality, inflation, exposure to poverty, and urbanization (see, Edmond, 2001; Eaton & Kortum, 2002; Dalton, Jimenez & Noussair, 2017; Loko & Diouf, 2009) have been used in addition to human capital, innovations and research and development in modeling labor productivity.

Previous Empirical Study

Although empirical study on human capital – labor productivity determination is vast, what is fairly common in the findings is the positive effect of human capital (school enrolment (education) and investment in health) on labor productivity. This is not without a few exemptions where a negative or statistically insignificant impact of human capital development on labor productivity is recorded. On the other side, a very small number of studies are on the impact of poverty on the productivity of labor and are usually micro-studies. Other studies rather concentrate on the effect of labor productivity on poverty. There is, however, no single existing study on the interactive effect of poverty and human capital investment on labor productivity. Studies reviewed here are those that directly relate to poverty, human capital investment, and labor productivity. Małysiak, Śniukieniec and Matuzevičiūtė (2018) investigate the effect of increasing human capital development on labor productivity in the European Union (EU) member states. They found a positive and significant impact of human capital on labor productivity. A similar result was obtained by Belorgey, Lecat, and Maury (2006), Fleisher, Hu, Li, and Kim (2011), and Chansarn (2010) in their cross-country studies.

Rukumnuaykit and Pholphirul (2015) study human capital as a determinant of labor productivity among Thai manufacturers using a firm-level dataset. The study reveals a positive and significant effect of human capital on labor productivity. Baharin, Aji, Yussof, and Saukani (2020) examine the effect of human capital resources on labor productivity in Indonesia. The findings showed a short-run positive impact of human capital on labor productivity. But in the long run, the health component of human capital has an insignificant positive impact on labor productivity. Umoru and Yaqub (2013) found a positive impact of health (human capital) on labor productivity in Nigeria. Okowa and Owede (2016) evaluated the impact of human capital development on labor productivity in Nigeria, the study found a short-run positive impact of human capital development (tertiary school enrolment) on labor productivity. Conversely, researchers like Yunus, Said, and Hook (2014) revealed a non-significant impact of education on labor productivity. In the case of poverty, Dalton, Jimenez, and Noussair (2017), in a laboratory experiment, research the effect of exposure to poverty on labor productivity. Included in the findings of the study is the negative effect of exposure to poverty on labor productivity through its impact on the individuals' psychological state. Bandiera et al (2017) found that transfer of income to the poor, among others, and improves productivity.

Methods

Data Collection

A brief description of the data for the analysis is highlighted in Table 1. The sample period is between 1986 and 2019.

Table 1. **Data Used**

Variable	Acronym	Description/Measurement	Source
Human Capital Investment	HI	Measured by the secondary school enrolment (as a percentage of all the eligible candidates) ratio	UNESCO
Labor Productivity	L_p	A ratio of aggregate output to the total labor force. The ratio of output produced per sector divide by the number of workforce in that particular sector determines the labor productivity in that sector. Labor productivity measures the efficiency of labor.	NBS, CBN Annual Statistical Bulletin
Poverty	PTY	Measured in terms of poverty headcount ratio at \$3.20 a day	Index Mundi
Gross Fixed Capital Formation	GFCF	Gross fixed capital formation at constant basic price	World Bank database
Trade Openness	OPN	A ratio of the sum of imports and exports to GDP. It serves as a gauge to which an economy is opened to external trade.	World Bank database

Model Specification

To empirically examine the relationship involving human capital investment, poverty, and labor productivity, a simple linear 3-sector model as in equation (3) is assumed.

$$\ln L_p = \omega_0 + \alpha Pty_t + \delta HI_t + \gamma X_t + \mu_t \tag{3}$$

Where $\ln L_p$ is a log of the index of labor productivity in the industrial, service, and agricultural sectors in Nigeria. Pty represents poverty, HI is the human capital investment (measured by secondary school enrolment (gross) as a percentage of all eligible candidates), X consists of trade openness and a log of gross fixed capital formation ($\ln gfcf$), t is time. ω_0 , α , δ and γ are the model's parameters. Dollar and Kraay (2004) stressed that trade openness stimulates technology diffusion and enhances productivity gains. A regression model for each of the independent variables of interest (poverty and human capital investment) and the two variables combined on labor productivity are systematically estimated without the influence of other control variables. This provides evidence of the reliability of the respective effect of these variables on labor productivity in each of the sectors. Equation (3) is a model of the direct impact of poverty and human capital investment on labor productivity. As a result, in Equations (4) and (5) the indirect impact of poverty and human capital investment is analyzed by introducing an interactive term in the models.

$$\ln L_p = \omega_1 + \alpha_1 Pty_t + \delta_1 HI_t + \pi (HI_t * Pty_t) + \mu_{t1} \tag{4}$$

In equations (7) and (8), $(HI_t * Pty_t)$ is the interactive term and π and π_1 are the coefficients of the interactive term.

$$lnL_p = \omega_2 + \alpha_2 Pty_t + \delta_2 HI_t + \pi_1 (HI_t * Pty_t) + \gamma_1 X_t + \mu_{t2} \tag{5}$$

The study hypothesized that, in all the models, the coefficient of human capital investment is positive but a negative coefficient for poverty. Then, it follows that the coefficient of the interactive term is expected to be positive if an increase in human capital investment can absorb the negative effect of poverty on labor productivity or if a high rate of poverty is consistent with a positive effect of human capital on labor productivity; but negative, if an increase in poverty reduces the effect of human capital investment on labor productivity.

The Autoregressive Distributive Lag (ARDL) approach suggested by Pesaran, Shin, and Smith (2001) and Narayan (2004) is used in the estimations. The approach is suitable for handling variables of the same or different orders of integration. The impact of lagged values can equally be assessed. It also permits a test of co-integration or long-run relationship among the underlying variables through its embedded ARDL Bound co-integration method. The critical values for the ARDL Bound co-integration test are taken from Narayan (2004). To accept (reject) the existence of co-integration among the variables, the computed Wald or F-statistic must lie above (below) a chosen level of the critical value. An F-statistic value falling in-between the upper and lower limit is an indication of an inclusive test. Both the Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) were employed in the unit root test. Also, the study conducted a diagnostic test like heteroskedasticity and autocorrelation test to certify the robustness of the model.

Empirical Results

Table 2 summarizes the descriptive statistic of each of the variables employed. On average, all the variables exhibit a rising trend over the sample period as suggested by the positive mean value of each of the variables. The standard error of human capital investment suggests wide dispersion around its mean value relative to poverty and trade openness. This signifies that poverty and trade openness are likely more stable compared to human capital investment. A reason could be the proliferation of privately-owned schools and subsequent irregularity and unsteadiness of candidate enrollment. Also, the productivity of labor in the service sector (Lp_{ser}) has the least level of dispersion among the sectors as indicated by its standard deviation. The reported Jarque-Bera statistic and its associated p-value showed that all the variables are normally distributed at a level of 5 percent.

Table 2. Descriptive Statistics

Variable	Mean	Std.Dev	Min	Max	Jarque-Bera (Prob.)
HI (%)	22.172	18.783	0.000	56.205	3.011(0.222)
PTY (%)	55.648	5.372	45.300	66.900	0.466 (0.792)
OPN (%)	34.400	11.026	9.136	53.278	1.290 (0.525)
GFCF (Billion)	8.14E+12	1.39E+12	5.67E+12	1.06E+13	0.935 (0.626)
Lp_{agr} (million)	180904.9	77988.27	77988.27	302289.0	3.982 (0.137)
Lp_{ind} (million)	254494.7	24387.78	24387.78	311820.6	0.847 (0.655)
Lp_{ser} (million)	357922.7	177874.1	177874.1	672755.8	4.834(0.089)

Table 3 showed the results of the ADF and PP unit root test. In the result, the human capital investment indicator, poverty rate, agricultural and industrial sector labor productivity index are first-difference stationary variables at a level of 5 percent as suggested by ADF and PP test. Both

the ADF and PP indicated that trade openness is a level stationary variable by 5 percent level. The gross fixed capital formation, as shown by the PP test, is a trend and a level stationary variable at a level of 5 percent. Additionally, the ADF test indicated labor productivity in the service sector as a trend and level stationary series. Therefore, the variable of the model combined level and first-difference series.

Table 3. Summary Result of the Stationary Test

Variables	ADF				PP			
	Level		First Difference		Level		First Difference	
	C	C &T	C	C &T	C	C &T	C	C &T
HI	-2.141 (0.231)	-2.222 (0.463)	-7.154 (0.000)	-7.076 (0.000)	-2.147 (0.229)	-2.266 (0.440)	-7.183 (0.000)	-7.107 (0.000)
PTY	-2.294 (0.180)	-2.125 (0.514)	-6.378 (0.000)	-6.390 (0.000)	-2.294 (0.180)	-2.125 (0.514)	-6.378 (0.000)	-6.398 (0.000)
OPN	-3.119 (0.035)	-2.881 (0.181)	-7.168 (0.000)	-3.635 (0.047)	-3.040 (0.041)	-2.712 (0.238)	-7.541 (0.000)	-11.244 (0.000)
LnGFCF	-1.558 (0.491)	-2.661 (0.258)	-9.691 (0.000)	-9.626 (0.000)	-1.747 (0.399)	-4.908 (0.002)	-9.678 (0.000)	-9.682 (0.000)
<i>LnLp_{agr}</i>	-0.491 (0.881)	-1.761 (0.701)	-5.645 (0.000)	-5.560 (0.000)	-0.492 (0.881)	-1.845 (0.660)	-5.645 (0.000)	-5.560 (0.000)
<i>LnLp_{ser}</i>	-0.949 (0.759)	-4.660 (0.005)	-1.596 (0.473)	-1.462 (0.822)	-0.122 (0.939)	-1.612 (0.767)	-3.019 (0.043)	-2.968 (0.156)
<i>LnLp_{ind}</i>	-1.974 (0.296)	-3.431 (0.066)	-4.939 (0.000)	-4.915 (0.002)	-1.974 (0.296)	-2.268 (0.439)	-4.941 (0.000)	-4.905 (0.002)

Note: C = constant, C&T = constant and trend. Statistics significant level = 5 percent
 Source: Compiled by the Author

Table 4 presents the ARDL co-integration results estimated for each of the models of labor productivity in the agricultural, service, and industrial sectors in Nigeria. The results portend a rejection of a no co-integration hypothesis.

Table 4. ARDL Co-integration Results

Models	F-Statistic					
	<i>LnLp_{agr}</i>			3.7375**		
	<i>LnLp_{ser}</i>			6.5722*		
	<i>LnLp_{ind}</i>			6.9262*		
Critical Values	Lower Limit (l(0))			Upper Limit (l(1))		
Level (%)	<i>LnLp_{agr}</i>	<i>LnLp_{ser}</i>	<i>LnLp_{ind}</i>	<i>LnLp_{agr}</i>	<i>LnLp_{ser}</i>	<i>LnLp_{ind}</i>
10	2.254	2.300	2.300	3.388	3.606	3.606
5	2.685	2.753	2.753	3.960	4.209	4.209
1	3.713	3.841	3.841	5.326	5.686	5.686

Note: ** and * indicate Prob. > 0.5 < 0.1 and Prob. < 0.01, 0.05 & 0.1
 Source: Compiled by the Authors

The parsimonious long-run and short-run estimates on the analysis of whether growth in poverty dampens down the impact of human capital investment on labor productivity and the individual (direct) impacts are presented on a sectoral basis as in Table 4 through 6. In each of the tables, 5 models (columns 2 – 6) were presented. Column 2, model 1, is on the direct impact of human capital investment on labor productivity excluding other variables. Column 3 added the poverty rate to model 1. Included in column 4 are trade openness and gross fixed capital

formation variables. Columns 5 and 6 are for the interaction effect of poverty and human capital investment on output per worker.

Labor Productivity Determinants in the Service Sector

Table 3 reports the long-run and short-run regression results on labor productivity, poverty, and human capital investment relationship in the service sector with and without the interaction effect in Nigeria.

Long-run Model

Beginning with column 2 (model 1) in Table 4, the estimated long-run coefficient of human capital investment turns out positive. It means that increasing investment in human capital could push up labor productivity growth in the service sector in the long run. Given the associated p-value, the positive relationship between human capital investment and labor productivity is statistically significant at a level of 5 percent. This finding conforms to the result reported by Belorgey, Lecat, and Maury (2006) and in line with Lucas (1988) static model of the endogenous model that school enrollment facilitates productivity. In model 2, human capital investment has a positive effect but the impact of poverty is negative, as anticipated, on labor productivity in the long run. Therefore, as an increment in human capital investment leads to increased labor productivity, so is a reduction in labor productivity owing to a rising rate of poverty. The estimated negative effect of poverty is similar to the finding of Dalton, Jimenez, and Noussair (2017). However, the magnitude of the impact of human capital investment on labor productivity is lower than the negative effect of an increased poverty rate in the long run, and both are statistically significant at a level of 5 percent.

Additionally, in column 4, the estimated coefficients of human capital investment and trade openness are positive and poverty is negative. All except trade openness are statistically significant at 5 percent. Unfortunately, the estimated coefficients of the interactive terms in columns 5 and 6 are contrary to the study's expectation. It is positive with the implication that the positive effect of an increased human capital investment on labor productivity would not decrease in the service sector should the poverty rate increase. Since the coefficient is not statistically significant at 5 percent, the long-run positive interactive effect of poverty and human capital investment on labor productivity is rejected in the service sector in Nigeria.

Short-run Model

In the short run, the impact of the current rate of human capital investment on labor productivity is positive and significant at 5 percent. But there is no evidence that growth in human capital investment had contributed positively to labor productivity growth in the last two years as shown in column 2. Since human capital investment is represented by school enrollment, then the non-positive and insignificant impact of human capital investment on labor productivity in the service sector could be as a result of the withdrawal of some enrollees without completing schooling or training and skills acquisition but unskillfully join the workforce. In column 3, the short-run impact of human capital investment is also positive and significant at 5 percent. The coefficient of poverty is also significant at 5 percent and negative. The same result is obtained in column 4. A reason is that poverty reduces people's capacity to engage in productivity-enhancing activities such as attending seminars, conferences and workshops. Nonetheless, both trade openness and gross fixed capital formation came out with a wrong sign and are not statistically significant at a level of 5 percent. The spillover effect of poverty in the model accounts for the ineffectiveness of trade openness and gross fixed capital

formation in the short run. The effects gradually fade away over time; hence, a positive effect of trade openness, and gross fixed capital formation in the long run.

In column 5 and 6, the current value of the coefficient of the poverty and human capital interaction is not statistically significant and are positive. But, the immediate past period of the coefficients showed a negative and a 10 percent level of significance of the impact of poverty and human capital interaction on labor productivity. Therefore, there is no strong statistical evidence that poverty reduces the positive impact of human capital investment on labor productivity in the short run. This is not amazing since economic agents are rational and will lean on experience to augment future events. Hence, a reduced impact of poverty on the relationship between human capital and labor productivity. The p-values of the estimated error correction mechanism in columns 2 through 6 suggested that labor productivity in each of the models converges to its equilibrium or steady-state at a rate of about 17 percent, 27 percent, 26 percent, 28 percent, and 28 percent per annual for model 1 through 5.

Table 5. Estimates on Labor productivity Determinants in Service Sector

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Long-run					
HI	0.017 (0.000)*	0.007 (0.000)*	0.005 (0.009)*	0.002 (0.912)	-0.001 (0.909)
PTY		-0.024 (0.00)*	-0.027 (0.00)*	-0.025(0.04)*	-0.029 (0.00)*
OPN			0.005 (0.096)**		0.005 (0.118)
LnGFCF			-0.732 (0.112)		-0.762 (0.173)
HI*PTY				0.0001 (0.780)	0.0001 (0.606)
C	11.955 (0.000)	13.184 (0.000)	34.768 (0.015)	13.285 (0.00)	35.774 (0.038)
@trend	0.030 (0.000)*	0.044 (0.000)*	0.056 (0.000)*	0.044 (0.00)*	0.056 (0.000)*
Short-run					
HI	0.002 (0.000)*	0.001 (0.000)*	0.001 (0.015)*	0.001 (0.912)	-0.0004 (0.906)
HI(-1)	-0.001 (0.115)	-0.001 (0.006)*	-0.001 (0.04)*		
HI(-2)	-0.001 (0.178)				
PTY		-0.001 (0.152)	-0.0001 (0.947)	-0.002 (0.323)	-0.0003 (0.873)
PTY(-1)			0.003 (0.139)		0.003 (0.15)
OPN			-0.001 (0.100)		-0.001 (0.189)
OPN(-1)			-0.001 (0.230)		-0.001 (0.167)
LnGFCF			-0.048 (0.386)		-0.047 (0.313)
LnGFCF(-1)			0.094 (0.173)		0.100 (0.714)
HI*PTY				0.0002 (0.84)	0.0002 (0.714)
HI*PTY(-1)				-0.0001 (0.05)**	-0.0002 (0.05)**
@trend	0.005 (0.021)	0.012 (0.000)	0.016 (0.000)	0.012 (0.00)	0.016 (0.000)

ECM	-0.166 (0.00)*	-0.267 (0.00)*	-0.283 (0.00)*	-0.261 (0.00)*	-0.282 (0.00)*
R²	0.997	0.998	0.999	0.998	0.999
S.E	0.030	0.023	0.019	0.023	0.020
$X^2_{(Wht)}$	6.114(0.411)	6.035(0.536)	10.437(0.730)	10.590(0.226)	14.935(0.456)
$X^2_{(BG-LM)}$	4.451(0.108)	2.106(0.349)	2.460 (0.292)	2.420 (0.298)	1.963(0.375)

Note: ** and * means Prob. > 0.5 < 0.1 and Prob. < 0.01, 0.05 & 0.1

$X^2_{(BG-LM)}$ represents the Chi-Square statistic of Breusch-Godfrey autocorrelation LM test, $X^2_{(Wht)}$ is the Chi-Square statistic of the White Heteroskedasticity test. The p-values are in the bracket

Source: Author’s compilation

Labor Productivity Determinants in the Agricultural Sector

Table 5 is a summary report of parsimonious short-run and long direct and the interactive effects of poverty and human capital investment on labor productivity in the agricultural sector in Nigeria.

Long-run Model

In column 2 of Table 5, the estimated long-run coefficient of human capital investment is positive as theoretically predicted and statistically significant at a level of 5 percent. This presages a growth in labor productivity follows growth in human capital investment. The rate of adjustment of output per worker in the agricultural sector to a change in human capital investment is roughly 1 percent in the long run. In column 3, the marginal effect of human capital investment on labor productivity is as well positive and statistically significant at 5 percent when poverty was added in the model. The positive effect of human capital investment on labor productivity reflects the claim by Zepeda (2001) that human capital development drives agricultural productivity over time. Also, as expected, the long-run effect of poverty on labor productivity is negative and significant at a 5 percent level. This implies an inverse relationship between labor productivity and the poverty rate. The higher the poverty rate the more is the reduction in the level of the output per worker in the agricultural sector. Specifically, a high rate of labor productivity implies a lower rate of poverty, vice-versa. This reasonable because poverty creates nutritional deficiency and poor health conditions that adversely affect labor productivity according to Dalton, Jimenez and Noussair (2017).

In column 4, the estimated long-run coefficient of human capital investment is equally positive and significant at 5 percent. There is no statistical proof that gross fixed capital formation and trade openness have positive effects on labor productivity in the agricultural sector as suggested in column 4. The long-run coefficients of the interactive terms in columns 5 and 6 are positive, predicting that an increase in the investment in human capital absorbs the negative impact of poverty on labor productivity in the long run. Regrettably, the coefficient is not statistically significant. Therefore, there is no statistical evidence that the interaction of poverty and human capital investment produces a positive impact on output per worker in the long run. Intuitively, agricultural activities in Nigeria require a lower level of educational attainment and are mostly done by poor rural dwellers. Under that circumstance, poverty will have no serious intermediating role in the relationship between human capital investment and productivity nor can human capital investment have the advantage of absorbing the effect of poverty on labor productivity in the long run. The positivity and statistical significance (at 5 percent) of the coefficient of the trend included in all the models is an indication of a positive effect of time on the impact of human capital investment and poverty on labor productivity in the agricultural sector.

Short-run Model

Supported by the study of Yenus, Said, and Hook (2004), the results in section (b) of column 2 indicated that the current rate of human capital investment has a positive, but statistically insignificant effect on labor productivity at 5 percent in the short run. The lagged values of human capital investment are also not statistically significant and negative. Thus, in the short run, there is a lack of convincing empirical evidence that improvement in human capital investment raises labor productivity in the agricultural sector. A justification is likely that a large fraction of the workforce in the agricultural sector in Nigeria does not recognize the vitality of human capital investment in accelerating agricultural output. As a result, the human capital investment may not affect labor productivity in the agricultural sector in the short run. In column 3, the impact of human capital investment on labor productivity is also positive but marginally significant at 10 percent. The coefficient of immediate and two years lagged value of the human capital investment on labor productivity is negative and insignificant at 5 percent. The coefficient of poverty rate is negative and statistically significant at 5 percent. That is, poverty reduction increases labor productivity in the short run. This is mostly because people will have enough nutrients and required health to work more and can still afford to hire more labor as poverty went down. In column 4, there is no sufficient statistical evidence of a short-run positive impact of human capital investment on labor productivity; the same applies to poverty. Both trade openness and gross fixed capital formation are not statistically significant in the model.

In columns 5 and 6, the coefficients of the current and the immediate past values of poverty and human capital investment interaction in the agricultural sector are not statistically significant in the short run. However, a twice lagged value of the coefficient is statistically significant at 5 percent and negative. Consequently, it is an indication of a mounting poverty rate, in the past, reducing labor productivity through its negative impact on human capital investment in the sector. That is, the spillover effect of poverty on human capital investment has a negative consequence on the growth of labor productivity in the agricultural sector in the short run in Nigeria. Furthermore, it implies that the rate of adjustment of labor productivity owing to the negative shock of poverty on human capital investment is not instantaneous; it will take some time to adjust. The coefficient indicating the speed of adjustment of each of the models is significant at 5 percent, less than one, and negative. Thus, none of the convergence paths of the models is explosive or overheated. The long-run convergence rate for model 1 is roughly 47 percent per year, about 73 and 28 percent per year for models 2 and 3, and roughly 98 percent annually for model 5.

Table 6. Estimates on Labor productivity Determinants in the Agricultural Sector

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
	Long-run				
HI	0.010 (0.000)*	0.007 (0.009)*	0.006 (0.023)*	-0.096 (0.485)	0.005 (0.746)
PTY		-0.009 (0.004)*	-0.002 (0.08)**	0.005 (0.913)	-0.004 (0.508)
OPN			0.004 (0.087)**		0.001 (0.611)
LnGFCF			-1.189 (0.055)		-0.202 (0.440)
HI*PTY				0.002 (0.368)	0.0001 (0.788)
C	11.299 (0.000)	11.782 (0.000)	46.357 (0.01)	11.240 (0.000)	17.456 (0.033)
@trend	0.031 (0.000)*	0.036 (0.000)*	0.051 (0.000)*		0.033 (0.000)*

	Short-run				
HI	0.001 (0.428)	0.001 (0.098)**	-0.0001 (0.753)	-0.008 (0.541)	0.011 (0.503)
HI(-1)	-0.001 (0.319)	-0.001 (0.099)	-0.002 (0.06)**	-0.012 (0.375)	-0.002 (0.831)
HI(-2)	-0.002 (0.08)**	-0.002 (0.205)		0.032 (0.027)*	0.018 (0.031)*
PTY		-0.007 (0.003)*	-0.001 (0.817)	0.002 (0.743)	-0.004 (0.341)
PTY(-1)				-0.004 (0.522)	-0.004 (0.568)
PTY(-2)				0.011 (0.129)	
OPN			-0.002 (0.142)		0.001 (0.612)
OPN(-1)			-0.002 (0.196)		
LnGFCF			-0.087 (0.387)		0.116 (0.430)
HI*PTY				0.0002 (0.463)	-0.0002 (0.531)
HI*PTY(-1)				0.0002 (0.422)	-0.00003 (0.83)
HI*PTY(-2)				-0.001 (0.019)*	-0.0004 (0.022)*
@trend	0.015 (0.007)*	0.026 (0.000)*	0.022 (0.029)*		0.033 (0.056)**
ECM	-0.472 (0.002)*	-0.726 (0.000)*	-0.424 (0.047)*	-0.229 (0.017)*	-0.985 (0.036)*
χ^2	0.9811	0.9816	0.9883	0.9870	0.9923
S.E	0.0648	0.0652	0.0571	0.0632	0.0502
$X^2_{(Wht)}$	6.0872(0.460)	10.1329(0.187)	13.4106(0.267)	18.7321(0.132)	11.5574(0.642)
$X^2_{(BG-LM)}$	1.6904(0.430)	1.7587(0.415)	0.2629(0.877)	1.228(0.541)	3.1064(0.212)

Note: ** and * means Prob. > 0.5 < 0.1 and Prob. < 0.01, 0.05 & 0.1

$X^2_{(BG-LM)}$ represents the Chi-Square statistic of Breusch-Godfrey autocorrelation LM test, $X^2_{(Wht)}$ is the Chi-Square statistic of the White Heteroskedasticity test. The p-values are in the bracket

Source: Author's compilation.

Labor Productivity Determinants in the Industrial Sector

Table 6 contained long-run and short-run results estimated on interactive and the direct effect of poverty and human capital investment on the output per worker in the industrial sector.

Long-run Model

In column 2, Table 6, human capital investment and labor productivity have a positive longrun relationship, validating Lucas (1988) endogenous growth model and the findings of Corvers (1997) that both the intermediate and high-skilled workforce has a positive effect on labor productivity in the manufacturing sector of the European Union. The long-run positive effect of human capital investment on the output per worker is statistically significant at a level of 5 percent. Thus, adding to the existing level of human capital investment amounts to increasing labor productivity in the industrial sector. The magnitude of the effect of human capital investment on labor productivity is up to 0.4 percent annually. In column 3, the long-run effect of human capital investment on labor productivity in the sector is equally positive and statistically significant at 5 percent. Surprisingly, poverty has a decreasing but statistically insignificant impact on labor productivity in the long run. This is usually the case where a good

proportion of workers in the industrial sector are at least an average-income people compared to those in the agricultural sector. In column 4, the impact of poverty on labor productivity is negative. The effect of gross fixed capital formation on labor productivity is positive. Both the poverty and gross fixed capital formation are not statistically significant at 5 percent but 10 percent. Trade openness plays no passive role in determining labor productivity in the long run. In the case of the long-run coefficient of the interactive term in columns 5 and 6, both are negative but not statistically significant at any level whatsoever.

Short-run Model

In column 2 of the short-run estimate reported in Table 7, although human capital investment has a positive coefficient, it is not statistically significant at 5 percent. A similar estimate is depicted in the result reported in column 3. However, the negative coefficient of the poverty rate in column 3 is statistically significant at 5 percent. That is, *ceteris paribus*, poverty directly reduces labor productivity in the short run. The estimated effect of poverty on labor productivity is around 0.6 percent per year. The result in column 4 is consistent with that of column 3 in the case of poverty and human capital investment. Furthermore, in column 4 trade openness positively determined labor productivity in the industrial sector in the short run at a significant level of 5 percent.

Lastly, the coefficient of the interactive effect of poverty and human capital investment on labor productivity in the short run is statistically significant at a level of 5 percent and negative. This implies that as the rate of poverty increases, the impact of human capital investment on output per worker in the industrial sector reduces but applicable only in the short run. The coefficients of the speed of adjustment attached to model 1 in column 2 through model 5 in column 6 indicated that about 27 percent, 23 percent, 38 percent 33 percent, and 71 percent of the error in the short run is corrected annually in the long run in the respective models.

Table 7. Estimates on Labor productivity Determinants in the Industrial Sector

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Long Run					
HI	0.0036 (0.046)*	0.0027 (0.020)*	0.0011 (0.467)	0.013 (0.504)	-0.024 (0.135)
PTY		-0.0037 (0.648)	-0.016 (0.060)**	0.0018 (0.824)	-0.017 (0.026)*
OPN			0.0067 (0.145)		0.002 (0.366)
LnGFCF			0.3342 (0.078)**		0.349 (0.002)*
HI*PTY				-0.0002 (0.606)	0.0004 (0.115)
C	12.3783 (0.000)	12.6205 (0.000)	3.133 (0.590)		2.958 (0.299)
Short Run					
<i>LnLp_{ind}</i> (-1)				0.355 (0.034)*	0.459 (0.028)*
HI	0.00002 (0.976)	0.0006 (0.2228)	0.0004 (0.478)	0.0203 (0.012)*	0.016 (0.054)**
HI(-1)					0.014 (0.092)**
PTY		-0.007 (0.040)*	-0.005 (0.019)*	0.001 (0.826)	0.002 (0.513)
PTY(-1)					0.008 (0.050)**

OPN			0.002 (0.032)*		-0.0003 (0.814)
LnGFCF			0.109 (0.181)		0.248 (0.019)*
HI*PTY				-0.0004 (0.012)*	-0.0003 (0.045)*
HI*PTY(-1)					-0.0002 (0.102)
ECM	-0.267 (0.016)*	-0.229 (0.027)*	-0.326 (0.019)*	-0.385 (0.00)*	-0.712 (0.000)*
R²	0.722	0.747	0.784	0.844	0.909
S.E	0.052	0.050	0.744	0.041	0.038
$X^2_{(Wht)}$	1.453(0.693)	0.913(0.923)	2.185(0.823)	8.695(0.275)	15.562(0.341)
$X^2_{(BG-LM)}$	3.079(0.215)	0.140(0.933)	1.974(0.373)	0.757(0.685)	0.119(0.942)

Note: ** and * means Prob. > 0.5 < 0.1 and Prob. < 0.01, 0.05 & 0.1

$X^2_{(BG-LM)}$ represents the Chi-Square statistic of Breusch-Godfrey autocorrelation LM test, $X^2_{(Wht)}$ is the Chi-Square statistic of the White Heteroskedasticity test. JB Stat. is the Jarque-Bera statistic (normality test). Ramsey F(.) is for the misspecification of a model. The p-values are in the bracket

Source: Author’s compilation.

Policy connotations of Findings

The study’s findings to a large extent imply that intensification of investment in human capital is a necessity to strengthening output per worker across sectors in Nigeria. However, it must be supported by policies that mitigate poverty. Because a mounting rate of poverty has a direct and a hidden negative weight on labor productivity.

Also, the negative effect of an unbridled poverty rate is severe, extending to the damnation of the positive contributions of human capital investment to the growth of labor productivity, for the most part, in the industrial and agricultural sectors in the short run in Nigeria. In other words, the capacity of an increased human capital investment to mitigate the harmful effect of poverty on output per worker is weak and limiting. Therefore, a conscious and adequate poverty cutback procedural must be followed to gain the positive effect of human capital investment on labor productivity among the sectors in Nigeria.

Conclusions

Understanding the behavioral coexistence of human capital investment and poverty is paramount to increasing the output per worker. As a result, the study emphasizes the interactive impact as well as the direct effect of poverty and human capital investment on sectoral labor productivity in Nigeria. The study established colossal evidence of a rising rate of poverty directly reducing labor productivity in the agricultural sector in the short run and long run, in the service sector in the long run, and in the short run in the industrial sector. Human capital investment, on the other hand, has a short-run and long-run direct positive relationship with labor productivity in the service sector. Its positive impact on the agricultural and industrial sectors is limited to the long run. The interactive effect of poverty and human capital investment on labor productivity is negative in the industrial and agricultural sectors in the short run. Consequently, poverty reduction is important not solely as a result of its direct negative effect on labor productivity but its unfavorable impact on human capital investment across different sectors in Nigeria. Therefore, among others, swift poverty cutback policies to gain the positive effect of human capital investment on labor productivity among the sectors must be put in place.

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