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Financial Deepening and Agricultural Labour Productivity in ECOWAS: A Threshold Analysis

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Abstract
This study examines the threshold effect of financial deepening on agricultural labour productivity using a panel of 15 Economic Community of West African States (ECOWAS). We adopt a battery of econometric models including the Hansen threshold model and a polynomial model within a Feasible Generalised Least Square (FGLS) setting. The results reveal that there exists no threshold effect of financial deepening on agricultural labour productivity. Results further show that financial deepening is not a significant driver of agricultural labour productivity in ECOWAS but life expectancy at birth and agricultural gross fixed capital formation per worker are significant drivers. This implies that financial depth is not a potent strategy in boosting agricultural labour productivity. As a result, paying attention to the significant determinants is rather recommended.

Keywords: Financial Deepening, Agricultural Labour Productivity, Hansen Threshold model, Polynomial Model, Feasible Generalised Least Square, ECOWAS

JEL Classification: E24, J24, O47

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1. Introduction

The agriculture industry is essential to the economic development of West Africa. According to the Economic Community of West African States' (ECOWAS) national accounts, the agricultural industry employed more than half of the region's populace and contributed, on average, roughly 20 percent to the region's overall GDP between 2014 and 2016 (see ECOWAS National Accounts, 2008). Evidence also suggests that, in terms of employment, more than 40 percent of the population in this region is employed in agriculture (see World Development Indicators, 2022). The value chains in West Africa that can help with the achievement of the Sustainable Development Goals were highlighted by Fessehaie (2016). The seven value chains cited by Fessehaie (2016) are upstream connections to extractive industries, cashew nuts, seafood, processed foods, apparel/textiles, and cocoa. Thus, it is obvious that two or three of these value chains fall under the agriculture sector. These are all indications of how significant agriculture is in West Africa. As a result, it is important to pay attention to the agricultural sector's production since it affects the rewards that stakeholders in the sector receive (Obasaju et al., 2016; Oladipo et al., 2019).

The Centre for Study of Living Standards (CSLS) observed that, as detailed in De Avillez (2011), the use of labour productivity as a partial measure of productivity and overall living standards is warranted. The emphasis of this study is agricultural labour productivity since it might give an indication of the living conditions of people in this region and because it is crucial to ECOWAS. This is due to the fact that the level of labour productivity is easier to use as a basis for comparison across subsectors, regions, and countries and more intuitive for single-input or partial productivity measures as they provide evidence of variations in the productivity of input (Global Strategy for Agricultural and Rural Statistics, 2017). In terms of hours worked, for example, production (or GDP) or value added per hour, or in terms of labour employed, for example, output per person or per worker, labour productivity may be quantified (Organisation for Economic Cooperation and Development, 2001).

According to economic development models like the endogenous growth model, finance can support the expansion of the real sector. For instance, King and Levine (1993) have written about the impact of finance on economic development and productivity. Capital per worker, or the ratio of capital to labour, and human capital per worker are considered the fundamental inputs to labour productivity according to the growth accounting framework and the Augmented Solow growth model. Endogenous growth theories and other financial theories, however, also emphasize the crucial contributions that finance makes to raising productivity. Given the significant role that finance may play in raising productivity, including labour productivity, it follows that the depth of financing warrants consideration (Ganti & Acharya, 2017; Noreen et al., 2017). Financial deepening is just a rise in the nation's supply of financial assets. It is a word used by economists to describe the expansion of financial service offerings, while it may also be used to describe a wider range of services. Financial deepening also means expanding the reach of financial services into all spheres of society, whether this is done formally through the banking industry or informally through other channels. Its effects might be enormous in scope, such as those on a nation, or local, affecting businesses and households. In other words, financial deepening refers to the extent of the availability of the supply of money or credit, and productivity is anticipated to increase with access to credit.

There are emerging theoretical and empirical evidences positing the prospect of "too much finance" notwithstanding the significance of financial development in stimulating the performance of the real sector. This is because it is thought that financial development only

helps productivity and economic growth up to a certain degree, after which more funding becomes risky for the actual economy. Recent works in this field include (Adeniyi et al., 2015; Law & Singh, 2014). Investigating the 'too much finance' phenomena is necessary given the need to improve rather than reduce labor productivity in the ECOWAS agriculture sector. In other words, does the ECOWAS region's agricultural labour productivity suffer from an excess of finance? What is the financial deepening threshold beyond which more finance becomes harmful to agricultural labour productivity in ECOWAS, assuming "too much finance" is indeed a problem? Threshold modeling was used in a related research by Adeniyi et al. (2015) to evaluate the effect of financial development on economic growth in Nigeria. However, rather than agricultural labour productivity, their main concern was economic expansion. In contrast to the current study, which has a regional focus and uses panel data to its advantage, their study's scope was restricted to Nigeria.

2. A Review of Literature

Despite the fact that the issue of agricultural labour productivity seems to be limited in the available studies, research on financial deepening and agricultural productivity is developing internationally. The measurements of agricultural productivity (sales per worker, yield per acre, and value added per worker) represent agricultural labour productivity in the bulk of the earlier studies examined since the volume of agricultural output is a direct consequence of the labor engaged in the process. Both agricultural productivity and agricultural labour productivity have been studied using comparable metrics (Diao et al., 2018; Zhang et al., 2020).

It is undeniable that strong credit markets may help small farmers obtain the capital they need to enhance their businesses and increase yields (Binswanger-Mkhize & Savastano, 2017). Demirgüç-Kunt and Klapper (2018) assert that, despite the importance of other institutional and policy factors like property rights, legal frameworks, and so forth, financial inclusion can also have a positive impact on agricultural productivity as a transmission channel for achieving inclusive growth. This study thinks it's reasonable to examine financial deepening and agricultural labour productivity in several continents throughout the world.

Data from the World Bank's Enterprise Surveys, performed between 2006 and 2014, were used in a fixed-effects regression analysis by D'Antoni and Mishra (2020) to investigate the relationship between financial deepening and agricultural production in 18 countries in Latin America and the Caribbean. The research used sales per worker to quantify agricultural output while access to credit, insurance, and savings were used to measure financial depth. It was discovered that having access to finance significantly increased agricultural output, while the impacts of other services were less obvious. The relationship between financial deepening and agricultural production in Pakistan, a country in Asia's southern sub-region, was examined by Chandio et al. (2019). Access to credit, savings, and insurance were utilized as markers of financial maturity in a regression analysis that used data from a survey of 500 rural Pakistani families conducted in 2017, while yield per acre represented agricultural output. The study found that having access to funding improved productivity and increased production per acre by 15 percent. Insurance and other financial services like savings accounts have little effects.

The impacts of financial deepening on agricultural output and the decline in poverty in sub-Saharan Africa were examined by Balde and Traoré in 2019. The study used panel data from 28 sub-Saharan African countries for the years 2004 to 2015 in a fixed-effects regression analysis to capture financial deepening via credit to the private sector, agricultural productivity via value added per worker, and poverty reduction via the poverty headcount

ratio. The results of the study show that financial deepening increases agricultural output in sub-Saharan Africa (which grew by 0.03 percent) and reduces poverty (which reduced by 0.09 percent). Alene et al. (2018) investigated the relationship between financial depth and agricultural production in rural Uganda, an East African nation. With the help of access to credit, savings, and insurance, data from a survey of 1,500 rural Ugandan families conducted in 2015 demonstrated financial depth, and yield per acre was used to calculate agricultural production. The study found that access to credit and other financial services led to an average 22 percent improvement in agricultural production.

In order to explore its effects on income inequality in Africa, Okafor et al. (2023) employed the generalized method of moment estimate approach on many dimensions of financial development (access, depth, efficiency, and stability). The study found that while financial depth promotes inequality in Africa, financial access, efficiency, and stability help to lessen it. In order to further analyze the connection between financial depth and economic growth, Okafor et al. (2021) use the Johansen Cointegration, error correction, and Granger causality techniques. The findings imply that when financial deepening rises, it supports Nigeria's economic expansion. The causal link between financial deepening and agricultural output in Nigeria was explored by Camillus (2019), employing the financial development theory. The data indicate a causal association between agricultural production and financial deepening in Nigeria, with agricultural output increasing the likelihood of this relationship. However, causality was not proven. Additionally, the model's long-run cointegrating link was developed utilizing the Engle-Granger cointegration technique. Therefore, the research promoted improving the agricultural sector in order to further extend Nigeria's financial development.

Tabash et al. (2022) undertook a research to look at the effects of financial deepening on two important sectors of the Nigerian economy: manufacturing and agriculture, on a much larger scale than the agricultural sector. The results showed that, while the industrial sector is not much affected, financial deepening has a favourable and statistically significant influence on Nigeria's agriculture sector growth. Based on this conclusion, the report suggests decreasing loan interest rates to assist generate finances that will support the agricultural sector's expansion. The report also contends that creating industrial banks will further advance economic development by encouraging credit flow into the manufacturing sector.

Adeniyi et al. (2015) used threshold modeling inside the Autoregressive Distributed Lag (ARDL) framework to examine the effect of financial development on economic growth from 1960 to 2010. They added the squared term of private sector credit as a proportion of GDP to the ARDL equation, which already had the level term of private sector credit as a percentage of GDP, to account for threshold. The equation containing the level term of total liquid liabilities also contained the squared term of total liquid liabilities (M3 money supply) as a percentage of GDP. Their findings demonstrated that economic growth in Nigeria was favourably impacted by squared terms but adversely impacted by the level form of the selected financial development indicators. Their findings suggested a U-shaped relationship in that the level of financial development was growth-retarding while the squared term was growth-enhancing during the study period, though they did not specify the precise threshold at which financial development supports (or slows) growth.

Fowowe (2020), who corresponds to the secondary goal of the present study, did not analyze thresholds but rather the effects of financial inclusion on agricultural output in Nigeria. In three years, the author employed land productivity to assess household agricultural productivity in Nigeria. In order to quantify agricultural production specifically, crop revenue

per hectare was used in the study. As for financial inclusion, the study used financial access and saving (using either formal or semi-formal financial institutions to save) as metrics. The estimating method employed was the instrumental variable methodology. The study discovered, among other things, that financial inclusion significantly and favourably affected Nigeria's agricultural productivity. However, there are other ways in which the study of Fowowe (2020) is different from the current study. The former, instead of ECOWAS, concentrates on Nigeria. Second, the dependent variable differs because it deals with land/crop production rather than labour productivity.

From the foregoing, different threshold analysis has been conducted, yet there remains some lacuna in the literature in respect of whether or not there exists threshold for financial deepening beyond which financial deepening hazards agricultural labour productivity in ECOWAS. In addition, the recent state of literature shows the scarcity (or even lack) of empirical literature assessing the impact of financial deepening on agricultural labour productivity in ECOWAS. The contribution of this study thus lies in filling these gaps in literature.

3. Materials and methods

3.1. Methodology

Finding the financial deepening threshold is of importance. In order to do this, the threshold variable—agricultural credit as a percentage of agricultural GDP (AGCD)—is employed as a stand-in for financial depth in the agricultural sector. Except in situations when such sector-specific variables are not accessible, the variables to be included are particular to the agricultural sector. The neoclassical and endogenous growth models provide hints. According to the neoclassical approach, an economy's output may be described as a function of labour and capital as factor inputs, with technical advancement evolving through time. A typical production function of the Cobb-Douglas type may be written as follows:

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

where Y = output (or value added); A = Solow residual or Hicks neutral technological change (also referred to as total factor productivity); K and L are physical capital and labour units respectively; α and β are the shares of capital and labour (also known as elasticities) respectively. Holding the A (Hicks neutral technological change) constant, to obtain labour productivity from (1), (1) is divided through by the labour units (L):

$$Y/L=A(K/L)^{\alpha}.(L/L)^{\beta} \quad \text{or} \quad Y/L=A(K/L)^{\alpha} \quad (2)$$

The left hand side variable is output (or value added) per unit of labour–a measure of labour productivity. To linearise (2), we apply a logarithmic transformation and obtain:

$$Log(Y/L) = \beta_0 + \log(K/L) \quad (3)$$

where $\beta_0 = \log A$

With a sector-specific outlook, Y/L is the agricultural labour productivity which will be denoted subsequently as ALP and K/L (capital per worker) is denoted subsequently as agriculture gross fixed capital formation per worker–AGFCFpw. Hence, equation (3) could be re-written as:

$$Log(ALP) = \beta_0 + \log(AGFCFpw) \quad (3)$$

Equation (3') will be augmented to incorporate the variable of interest, which is financial deepening in the agricultural sector (AGCD), in line with the endogenous growth model, which posits that finance is important to the real sector. In addition, we factor in selected covariates. The baseline regression may be adapted, in line with the Hansen threshold estimation technique, to include two-regime threshold models entrenched in a single equation of the form:

$$\begin{aligned} Log(ALP_i) = \{&\beta_{01} + \beta_{11}Log(AGFCFpw_i) + \\ &\beta_{21}Log(AGCD_i) + \beta_{31}Log(AGTRDO_i) + \beta_{41}Log(HCI_i) \\ &+\beta_{51}Log(FER_i) + \beta_{61}Log(LEB_i) + \beta_{71}Log(INF_i)\}d_i(AGCD_i \leq \gamma) + \{\beta_{02} \\ &+ \beta_{12}Log(AGFCFpw_i) + \beta_{22}Log(AGCD_i) + \beta_{32}Log(AGTRDO_i) + \beta_{42}Log(HCI_i) \\ &+ \beta_{52}Log(FER_i) + \beta_{62}Log(LEB_i) + \beta_{72}Log(INF_i)\}d_i(AGCD_i > \gamma) + \varepsilon_i \end{aligned} \quad (4)$$

where *AGCD* (the independent variable of interest) is agricultural credit deepening calculated as the agricultural credit as a percentage of agriculture GDP. It is the indicator function of a dummy variable that assumes the value 1 if the condition is met and 0 otherwise. It is the threshold variable that separates all observations into two groups. Its unknown value must be approximated by the least squares approach. If the coefficients for the 'potential' two regimes are noticeably different, then there are in fact two distinct regimes, and the dataset may be divided into two portions, the first and second of which represent the first and second regimes, respectively. Additionally, the dataset can show a U-shaped curve or an inverted U-shaped curve at that point. Simply put, a non-linear equation (two regimes/existence of a threshold) is compared to a linear equation (one regime/no threshold). Another comparable measure of financial deepening relating to the private sector will be used as a form of sensitivity check; credit given by the banking sector as a proportion of GDP. Another often used measure of financial deepening is the money supply to GDP ratio, but its applicability to the agriculture sector is probably somewhat restricted. Real agricultural labour productivity (ALP) is the dependent variable; it is calculated here as agricultural value added per (agriculture) worker. It is in US dollars of constant 2010 value.

Real agricultural gross fixed capital formation per agricultural worker is referred to as AGFCFpw. A beneficial influence on agricultural labour productivity is anticipated from improvements in the available stock of agricultural gross fixed capital creation per agricultural worker. For instance, increased accessibility to physical capital like tractors and other agricultural machinery is anticipated to increase agriculturalists' production. AGFCFpw is determined by dividing agricultural gross fixed capital formation by the labour force employed in the industry. The labour force engaged in the agriculture industry is determined using an indirect technique. It is determined by dividing the agricultural value added (expressed in constant 2010 US dollars) by the agricultural value contributed per worker. It is determined by dividing the total of agricultural imports and exports by the GDP of agriculture. The agricultural sector is predicted to benefit from increased access to high-quality agricultural inputs that may not be sufficient or not be present in the local economy, which will increase agricultural labour productivity. Improved seedlings, fertilizer, agricultural equipment, etc. are a few examples of these inputs. If the economy-wide openness to trade indicator, or the traditional measure of trade openness (sum of imports minus exports divided by GDP), produces different results, it will also be confirmed. This parameter has a percentage value. It is a measure of human capital that takes into account educational returns and years of schooling. It is included in accordance with the endogenous growth theory, which among other things emphasizes the importance of human capital in enhancing the real sector's performance. Implicitly, it is thought that the number of years

spent in education correlates with higher levels of knowledge and skills needed to increase production. The a priori anticipation is also that this variable will increase agricultural labour productivity in a favourable way. In the absence of national data on education specifically related to the agriculture sector, it is used as a measure of education. Each acre of arable land is fertilizer. As plant nutrients, fertilizers serve to augment essential components that naturally occur in the soil. Thus, the availability of fertilizer is expected to enhance agricultural labour productivity. LEB is life expectancy at birth (average number of years) which is expected to be reflective of the quality of health of the populace. Only healthy individuals can meaningfully engage and produce in any venture, agriculture inclusive. In essence, higher levels of this variable are expected to have a positive relationship with the dependent variable. φ_i and γ_t are respectively country and time dummy variables included in order to account for variables not included in the model but which are specific to some countries (cross-section) and those that vary over time. Country-specific variables may include the quality of land, weather, etc. and time-varying variables include such factors as the level of development (say proxy by gross domestic product per capita), amount of rainfall, etc. These dummies assume the value one for a given country or time and zero otherwise. ε_{it} is the idiosyncratic error term. Note that we use the constant term to proxy for total factor productivity/technical change[i].

All the variables are expected to have a positive relationship with the dependent variable. To express (4) compactly, matrix notation is useful. This is expressed as:

$$Log(ALP_i) = \beta' x_i + \delta_n' x_i(\gamma) + \varepsilon_i \quad (5)$$

where $\delta_n = \beta_{i2} - \beta_{i1}$ while $\beta = \beta_{i2}$

A supplementary regression will be done as a robustness test. The auxiliary regression is a linear equation that includes the financial deepening squared term (AGCD). In order to determine if there is a substantial difference between the coefficients of the level term and the squared term of the indicator of financial deepening, the squared term of AGCD is added. If they are considerably different, this supports the presence of distinct regimes and a barrier for financial deepening. The auxiliary regression's details are as follows:

$$\begin{aligned} Log(ALP_{it}) &= \beta_0 + \beta_1 Log(AGFCFpw_{it}) + \\ &+ \beta_2 Log(AGCD_{it}) + \beta_3 Log(AGCD_{it})^2 + \\ &+ \beta_4 Log(AGTRDO_{it}) + \beta_5 Log(HCI_{it}) + \\ &+ \beta_6 Log(FER_{it}) + \beta_7 Log(LEB_{it}) + \varphi_i + \gamma_t + \varepsilon_{it} \end{aligned} \quad (6)$$

Based on the secondary objective which concerns the impact of financial deepening on agricultural labour productivity, the model is stated as:

$$\begin{aligned} Log(ALP_{it}) &= \beta_0 + \beta_1 Log(AGFCFpw_{it}) + \\ &+ \beta_2 Log(AGCD_{it}) + \beta_3 Log(AGTRDO_{it}) + \\ &+ \beta_4 Log(HCI_{it}) + \beta_5 Log(FER_{it}) + \\ &+ \beta_6 Log(LEB_{it}) + \varphi_i + \gamma_t + \varepsilon_{it} \end{aligned} \quad (7)$$

3.2. Estimation Technique

In order to determine whether or not there is a threshold for financial depth, the Hansen threshold approach is prioritized for the baseline regression (equation 4). This method's formulation is straightforward, yet it has clear consequences for policy and is simple to use in empirical research (Hansen, 2000). Least squares are used to compute the regression parameters. The threshold value γ in (4) is not identified under the null hypothesis of no threshold effect; hence the *p*-values are calculated using a bootstrap analogue as Hansen (2000) already showed that the bootstrap analogue yields asymptotically correct *p*-values. When a threshold parameter is significant under one regime but becomes negligible under a different regime, this shows that the sample has split, which suggests the presence of nonlinearities. Investigation will be how sensitive the outcome is to the financial deepening indicator used. In the literature, private sector credit as a percentage of GDP is frequently utilized; although not unique to the agriculture sector, we use it as a sensitivity test.

For the auxiliary regression (equation 6), different techniques will be used. First, the Feasible Generalised Least Square (FGLS) technique will be employed to obtain estimates for equation (6). This follows from the excess of the time series dimension (18 years, i.e. 2000 to 2017) over the cross-section dimension (15 ECOWAS countries). The choice of FGLS when the time series dimension exceeds the cross-section dimension is in line with Ashley (2012). For FGLS, three different assumptions in respect of the error process are first made in order to choose the appropriate structure for the error in the data. The assumptions are: (i) the existence of contemporaneous correlation in the cross sections; (ii) serial correlation; and (iii) heteroskedasticity. (i) will be tested using the LM test of Breusch and Pagan (1980), (ii) will be tested with the serial correlation test of Wooldridge (2002) and (iii) will be tested using the Modified Wald test proposed by (Greene, 2008). The null hypotheses respectively are no contemporaneous correlation, no serial correlation and no heteroskedasticity. These three assumptions will be tested.

Secondly, in respect of the secondary objective which deals with assessing the impact of financial deepening on agricultural labour productivity in ECOWAS, for equation (7), we use techniques that produce consistent estimates in the case of endogeneity of any variable(s). In this wise, instrumental variable (IV) techniques come handy. We compare the results from IV/two-stage least squares (IV/2SLS) robust to arbitrary patterns of heteroskedasticity and those from IV-generalized method of moments (IV-GMM), specifically two-step GMM of Arellano and Bond (1991) using xtabond2 syntax in Stata. A static model is used here rather than a dynamic model in order to reduce the number of instruments needed for the GMM model[ii]. Instrumental variable regressions require that three conditions be satisfied: (1) The instrumental variable must be strongly correlated with the potentially endogenous variable as indicated by a significant t-statistic and significant F statistic in the first stage regression; an F statistic which should be greater than 10 going by the rule of thumb. The F test indicates whether the coefficients on the instruments are jointly equal to zero in the first stage regression. (2) The instrument must be excludable from the second-stage regression; Sargan (or Hansen) statistic of over-identifying restriction is needed here and this is available if the equation is over-identified. (3) There must be at least as many instruments as potentially endogenous variables for the model to be identified. Internal instruments (lag of potential endogenous variables), in line with Roodman (2009) are considered as instrumenting variables[iii].

With a time-series dimension of 18, there is the possibility of non-stationarity. Linear dependence of regressors may also induce multicollinearity into the model. In the subsection

that deals with presentation and discussion of results, the summary statistics of variables, coupled with correlation and time-series analyses, are first presented.

3.3. Sources and Scope of Data

The data used for this study is panel in nature (Eluyela *et al.*, 2019; Eluyela *et al.,* 2020). It covers 15 countries in the Economic Community of West African States (ECOWAS)–Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The data spans 2000 through 2020.

Agricultural labour productivity was sourced from World Development Indicators (WDI). Agric gross fixed capital formation was sourced from Food and Agriculture Organisation (FAO) whereas both agricultural value added and agricultural value added per worker were obtained from WDI; these were used in calculating agricultural gross fixed capital formation per worker. Agricultural credit data was obtained from FAO while agricultural GDP data was obtained from ECOWAS national accounts; these were used in calculating agricultural credit deepening. Agricultural trade openness was calculated using data obtained from FAO. Human capital index was obtained from Penn World Table. Data on fertilizer and life expectancy at birth were both sourced from WDI.

4. Presentation and Discussion of Results

4.1. Summary Statistics

Table 1 presents the summary statistics from 2000 to 2020. The values are presented in their raw/untransformed forms in order to get insights from the original data. Attention is paid to the dependent variable (agricultural labour productivity) and the independent variable of interest– financial deepening (agricultural credit deepening). The minimum value for agricultural labour productivity (agricultural value added per worker) within the study period is about $393 which is a value specifically for Guinea in year 2009 whose value rose to $561.46 in 2017. Nigeria had the maximum value in the region, amounting to $6057.86 which was a value attained in 2010. The average value stood at $1282.58 with a somewhat high standard deviation of $971.02 showing some reasonably high disparity in labour productivity within ECOWAS. In terms of agricultural credit deepening, the minimum value of 0.01% was attained by Guinea Bissau in 2015 while the maximum of 21.07% was attained by Mali in 2009. The mean value of 2.22% ensued and a 2.75% standard deviation shows that not much disparity exist in terms of agricultural credit deepening within ECOWAS.

4.2. Correlation Statistics

Next, Table 2 presents the correlation statistics in order to understand the nature of correlation amongst the independent variables and circumvent possible collinearities. Table 2 shows that there are no strong correlations amongst the independent variables as most of the values are much below 0.7. Hence the fear of multicollinearity is allayed.

4.3. Panel Unit Root Tests

In Table 3, the result of the panel unit root test is presented. The Maddala and Wu (1999) panel unit root test is reported. Since the panel unit root test is sensitive to lag order, and since the panel tends to be micro in nature (with time series just 18), lags 0 and 1 are reported. The Pesaran (2007) test is used to validate the results when necessary. The panel unit root tests provide evidence in support of the stationarity of all the variables.

4.4. Threshold Analysis

a. Baseline regression

Next, the result for the baseline regression using the Hansen threshold technique is presented in Table 4a. From Table 4a, only the values for one regime are reported. This follows from the finding that the null hypothesis of a linear model cannot be rejected. In other words, if the sample is split into two, the coefficients are not statistically different for the two regimes. With agric credit deepening as the threshold variable of interest, the threshold estimate is 5.41% lying within 90% confidence intervals with values 4.91% and 8.02%. The associated bootstrap p-value is 0.465. The bootstrap p-values are asymptotically correct (Hansen, 1996). An insignificant bootstrap-value (given that the bootstrap p-value of 0.465 is greater than 0.1) suggests that there is no need for a sample split, that is, the null hypothesis of a linear model cannot be rejected. Thus, there exists no threshold and consequently only one regime exists. Hence, there is no evidence that the level or increasing values of agricultural credit depth in ECOWAS negatively affects agricultural labour productivity. Importantly, since the bootstrap p-value is insignificant, the threshold estimate is unimportant and should not be taken seriously. This result contradicts the finding of Adeniyi *el al*. (2015) who found threshold effect of financial development on economic growth in Nigeria.

Table 1. Summary statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
ALP (constant 2010 $)	250	1282.58	971.02	393.07	6057.86
AGCD (%)	195	2.22	2.75	0.01	21.07
FER (fraction)	151	10.58	10.25	.00	52.04
LEB (years)	270	57.62	6.43	38.70	67.15
HCI (index)	216	1.53	0.30	1.07	2.37
AGTRDO (fraction)	270	0.55	0.38	0.05	1.74
AGFCFpw (constant 2010 $)	196	0.71	0.51	0.11	2.47

Source: Authors' estimations using STATA software, 2023

Table 2. Correlation statistics

	LAGCD	LFER	LLEB	LHCI	LAGTRDO	LAGFCFpw
LAGCD	1.000					
LFER	0.242	1.000				
LLEB	0.310	-0.095	1.000			
LHCI	0.231	0.097	0.220	1.000		
LAGTRDO	0.288	0.056	0.401	0.029	1.000	
LAGFCFpw	0.417	0.461	0.003	0.497	-0.078	1.000

Source: Authors' estimations, 2023

Note: The 'L' prefix (for all the variables) denote logged values

Table 3. Panel unit root test

Maddala and Wu (1999) Test			
	Lags		
Variable	0	1	*Order of Integration*
LALP	61.421 (0.000)***	34.426 (0.187) *87.404 (0.000)***	I(0)
LAGFCFpw	60.481 (0.000)***	47.613 (0.002)***	I(0)
LAGCD	88.831 (0.000)***	31.729 (0.286) *-2.602 (0.001)***	I(0)
LAGTRDO	72.396 (0.000)***	42.546 (0.039)**	I(0)
LHCI	74.532 (0.000)***	47.475 (0.012)***	I(0)
LFER	127.722 (0.000)***	138.656 (0.000)***	I(0)
LLEB	171.353 (0.000)***	145.739 (0.000)***	I(0)

Source: Author's estimations using STATA software, 2023

Note: *, **and *** denote significance at 10%, 5% and 1% respectively. The Pesaran (2007) values (italicized) are presented below the Maddala and Wu (1999) values in the occasion that the lags 0 and 1 of the latter test yield different conclusions.

Table 4a. Hansen threshold technique results

Dependent variable: agric labour productivity (LALP)	Threshold variable: agric credit deepening (LAGCD) and private sector credit (LPCGDP)	
	Financial deepening indicators	
	Agric credit deepening (LAGCD)	Private sector credit (LPCGDP)
Regime 1 Threshold estimate 90% confidence interval Bootstrap p-value	 5.41% 4.91%, 8.02% 0.465	 12.17% 12.12%, 12.37% 0.200

Note: The percentage equivalence of the logged values are the ones reported for ease of interpretation.

Explanatory note: LAGCD is log of agricultural credit deepening; LALP is log of agricultural labour productivity; LPCGDP is log of private credit as a share of GDP.

Table 4b. FGLS technique to investigate threshold

	FGLS
Dep. Variable: LALP	
Panel A	
LAGCD	0.050 (0.034)
LAGCD^2	0.004 (0.003)
LAGFCFpw	0.121*** (0.030)
LAGTRDO	0.012 (0.028)
LHCI	2.579*** (0.554)
LFER	-0.002 (0.004)
LLEB	2.288*** (0.674)
CONSTANT	-3.663 (2.867)
Panel B	
Year FE	Yes
Country FE	Yes
R-Squared	-
Wald chi-squared	2301.62
Chi-squared [p-value]	[0.000]
Wooldridge Auto Correlation Test (F-Stat.) [p-value]	(21.11) [0.001]
Modified Wald Test for Heteroskedasticity Chi-square [p-value]	519.77 [0.000]
Breusch-Pagan LM test of independence/cross-sectional dependence Chi-square [p-value]	397.07 [0.000]

Source: Author's, using STATA software, 2023

Note: Robust standard errors which are consistent in the presence of any pattern of heteroskedasticity and autocorrelation within panels are reported in curly brackets while p-values are presented in square brackets in panel A. In panel B, F statistics are in curly brackets while p-values are in squared brackets. *, ** and ***, respectively, indicate significance at 10%, 5% and 1% levels. – Means the estimates not available or not reported.

Explanatory note: LAGFCFpw is log of agricultural gross fixed capital formation per worker; LAGCD is log of agricultural credit deepening; LAGTRDO is log of agricultural trade openness; LHCI is log of human capital index; LFER is log of fertilizer and LLEB is log of life expectancy at birth.

The FGLS estimates presented in Table 4b also lends credence to this conclusion as it shows that both the level and squared terms of agriculture credit depth (LAGCD and LAGCD^2) are both positively related to agricultural labour productivity, albeit do not statistically

significantly influence agricultural labour productivity in ECOWAS. Stated differently, this current study finds evidence that raising the levels of agricultural credit deepening in ECOWAS by a power of two would not result in a regime change and become deleterious to agricultural labour productivity in this region. These findings go against the results of Adeniyi *el al*. (2015)

If private sector credit (as a percentage of GDP) is used as a proxy for financial deepening, the bootstrap p-value of 0.2 also shows that the null hypothesis of a linear model (existence of only one regime) cannot be rejected, hence the result is in consonance with that used as a proxy for financial deepening in the agricultural sector. These findings also negate the results of Ibrahim and Alagidede (2018) who investigated nonlinearities in the financial development-economic growth nexus using evidence from sub-Saharan Africa between 1980 and 2014 by the use of a sampling splitting and threshold estimation technique. With human capital (proxy by primary pupil to teacher ratio), there existed two regimes. Their evidence supported the existence of two regimes. They found that unlike regime 1, in regime 2, the impact of finance on growth when countries are above the threshold for initial secondary school enrolment was positive and significant irrespective of the measure of finance used. In the whole, some empirical studies found the existence of a threshold while others did not. This current study also does not find any evidence in support of a threshold for financial deepening in relation to agricultural labour productivity in ECOWAS.

4.5. Instrumental Variable Results

Here are the empirical findings from employing IV approaches to examine how financial deepening affects agricultural labour productivity. The sample is limited to include just data from 2008 to 2020 in order to lower the instrument count. The findings meet the prerequisites as outlined in the aforementioned requirements, as shown in Panel B of Table 5. The substantial F statistic indicates that the model is statistically significant and has a strong fit (R squared in Excel of 0.9). The Arellano-Bond test of autocorrelation (using internal instruments, i.e. lagged values) supports the validity of the utilized instruments whereas the Sargan test supports the exogeneity of the instruments. The null hypothesis that the regressors are jointly exogenous is rejected when taking into account the joint test of endogeneity of the regressors, as demonstrated by the 2SLS method, suggesting that the IV approaches should be prioritized. For comparison, OLS data are also shown alongside. The findings for OLS are shown in Column 1 of Table 5, while the results for IV-2SLS and IV-GMM are shown in Columns 2 and 3, respectively.

Except for fertilizer, which is similarly not statistically significant, most of the variables fit the a priori assumption, and the three methodologies mainly provide findings that are identical. The three methodologies are in agreement that financial deepening does not significantly influence agricultural labour productivity in ECOWAS since it is the independent variable of interest. Using the conventional/aggregate metrics of financial deepening, auxiliary regressions were run (not given here). Agriculture credit deepening was specifically replaced by the private sector credit as a percentage of GDP and money supply (M2) as a percentage of GDP, but the findings obtained were the same for both since they had no discernible effect on farm labor productivity. In a summary, empirical data from this study demonstrates that financial deepening was not a significant factor in ECOWAS throughout the study period when determining the productivity of agricultural labour. However, in the case of Adeniyi et al. (2015), they investigated the impact of financial development on economic growth in Nigeria and found that financial development (using the ratio of money supply to GDP) negatively and insignificantly impacted economic growth while private

sector credit as a ratio of GDP negatively and significantly impacted economic growth in Nigeria. This view is supported by D'Antoni and Mishra (2020), Chandio *et al.* (2019), Balde and Traoré (2019), Alene *et al.* (2018) and Fowowe (2020).

Table 5. Empirical results for IV techniques and OLS

	OLS	2SLS	2-STEP GMM
Dep. Variable: Logged Agricultural Labour Productivity (LALP)	PANEL A		
LAGCD	0.007 (0.025)	0.032 (0.096)	0.172 (0.103)
LHCI	0.038 (1.145)	2.095 (1.451)	0.443 (0.321)
LLEB	5.875*** (1.777)	3.854*** (0.899)	1.941*** (0.144)
LFER	-0.005 (0.015)	0.0568 (0.076)	-0.109 (0.094)
LAGFCFpw	0.130** (0.065)	0.323*** (0.081)	0.570*** (0.080)
LAGTRDO	0.057 (0.049)	0.109 (0.109)	-0.281** (0.110)
CONSTANT	-14.388* (7.347)	6.967*** (0.112)	-
	PANEL B		
Year FE	Yes	Yes	Yes
Country FE	Yes	No	No
R-Squared	0.96	0.92	-
F-Stat.	322.57	150.42	11567.20
Instrument count	-	-	14[iv]
Sargan test (pvalue)	-	-	0.251
p-value of F stat.	0.000	0.000	0.000
AR1 AR2	-	-	0.196 0.993
Endogeneity of regressors (chi square p value)	-	0.022	-

Notes:*, ** and *** represent significance at 1, 5 and 10% levels respectively. Robust standard errors[v] are reported in parenthesis. AR1 and AR2 signify Arellano and Bond autocorrelation at orders 1 and 2 respectively.

Some of the other determinants of agricultural labour productivity are significant while some are not. Human capital index (used to proxy education levels and skills in ECOWAS) and fertilizer availability are both insignificant while both life expectancy at birth and agricultural gross fixed capital formation per worker (physical capital per worker in the agricultural

sector) are significant. The first stage F tests (not reported here) are all statistically significant so they are strongly correlated with the potential endogenous variable.

Coming to the coefficients of the statistically significant variables, with respect to life expectancy at birth (LLEB), the 2 step-GMM reports a value of 1.94. This implies that a percent increase in life expectancy, holding other variables constant, leads to about 1.94 percent increase in agricultural labour productivity in ECOWAS. For physical capital per worker (AGFCFpw), a percent increase in this variable, holding other variables constant, leads to about 0.57 percent increase in agricultural labour productivity. In terms of agricultural trade openness (LAGTRDO), both the OLS and 2SLS yield similar conclusion; it's positively related to agricultural labour productivity but not a statistically significant variable. However, the 2-step GMM suggests that agricultural trade openness is negative and significant thereby contradicting the OLS and 2SLS estimates. In an auxiliary regression not reported here, the aggregate/conventional trade openness was used rather than that specific to the agricultural sector. The result, as is the case with OLS and 2SLS shows that trade openness is a positive but insignificant variable. It should be noted that the use of the aggregate measure of trade openness (in the auxiliary regression) does not alter the conclusion of the other variables. The conclusion reached by Mourao (2015) in terms of the relationship between trade and openness and the agricultural sector is different from that of this current study. The study obtained a positive and significant relationship while analysing the impact of trade openness on the agricultural sector in Belarus from 1990 and 2012. The difference in conclusion is however not surprising for known reasons: This current study focused on the ECOWAS economy unlike Mourao (2015). Furthermore, the dependent variable used here is a measure of labour productivity in the agricultural sector while agricultural as a share of GDP is the dependent variable in Mourao (2015).

5. Conclusion and Policy Recommendation

To investigate whether or not there exists a threshold for financial deepening, the Hansen threshold technique was employed (Hansen, 1996, 2000). The Hansen technique was also corroborated with the use of a polynomial term, specifically the squared term of financial depth, within an FGLS setting. The Hansen threshold result supports the existence of one regime and the FGLS results also show that even the squared term of financial deepening, similar to the outcome of its level form, does not significantly boost agricultural labour productivity in ECOWAS. Thus, it is concluded that this study does not find a threshold beyond which financial deepening would become detrimental to agricultural labour productivity.

In essence, empirical evidences in this study show that ECOWAS region is not close to having excessive financing as an issue to grapple with when it comes to agricultural labour productivity in the region. Rather, given that not even the squared term of financial deepening is able to significantly boost agricultural labour productivity, financial deepening may be de-emphasised. The secondary objective of this study is to investigate the significant determinants of agricultural labour productivity. To achieve this objective, instrumental variable techniques were prioritised. The unanimous decision is that life expectancy at birth, human capital and agricultural gross fixed formation per worker is the significant drivers for agricultural labour productivity in ECOWAS. Financial deepening and other selected determinants are insignificant. Following the findings emanating from this study, the following recommendations are made. One, to boost agricultural labour productivity, governments and policymakers in ECOWAS should increase spending on education and health which are critical to improving human capital and life expectancy at birth. Two,

governments in ECOWAS need to develop and expand their capacity to raise the level of agricultural investment which will spur economic growth and reduce poverty in the region.

5.1 Limitation of the Study and Suggestions for Future Research

This study relied on various measurement of financial depth for financial deepening but ignored financial access. However, it is possible for financial depth not to contribute to economic growth if it is not accessible. Therefore, it will be interesting to see whether the results remain robust when financial depth interacts with financial access to determine agricultural labour productivity.

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CONFLICTS OF INTEREST

The authors declared that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Data for the study are available upon request.

AUTHOR'S CONTRIBUTION

Barnabas Olusegun Obasaju conceived and wrote the paper, sourced for data, analysed and interpreted the data.

Uzoaku Ruth Obasaju conceived and wrote the paper, sourced for data, analysed and interpreted the data.

Akanbi Saad Babatunde wrote the paper, analysed and interpreted the data.

Damilola Felix Eluyela wrote the paper, analysed and interpreted the data. .

Ademola Andrew Onabote wrote the paper, analysed and interpreted the data.

David Eseosa Obadiaru wrote the paper, analysed and interpreted the data.

Endnotes

[1] Note that as obtained from the Penn World Table, this variable does not incorporate health in its calculation

[ii] Data on total factor productivity of ECOWAS countries as contained in Penn World Table is scanty. Hence we allow it to be captured by the constant term.

[iii] Although xtabond2 is designed mainly for dynamic models, it can also be used for static models with the advantage that Arellano and Bond autocorrelation test are provided (See Roodman, 2009).

[iv] In line with the rule of thumb, we ensure that the difference between the sample size and the number of instruments is larger than 40 in respects of the IV regressions (See McFadden, 1999).

[v] Number of instruments is consistently kept lower than number of cross sections by dropping 2 year dummies while also testing the consistency of the estimates when different sets of year dummies are used. This strategy also helps to obtain an over-identified model thus obtaining the Sargan/Hansen statistics otherwise the model will be exactly identified

[vi] One-way and two-way clustering of standard errors (i.e. clustering of the country id or year, or both) didn't yield significantly different estimates

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