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Impact of Agricultural Productivity on Economic Growth and Poverty Alleviation in ECOWAS Countries: An Empirical Analysis

Mouayadi Said Ali Madi, Jiong Gong, & Kokou Wotodjo Tozo

Abstract

Many African countries are still being faced with basic welfare issues such as hunger and extreme poverty, sparking debates among researchers and policy makers on whether the continent can endogenously leverage its agricultural potentials to address these challenges. To contribute to these debates, this study employs a panel data spanning 26 year (1990-2015) and including 13 ECOWAS countries to analyze the impact of production factors on agricultural productivity and examine the question of whether and how agriculture can serve as a tool for growth and poverty alleviation in the region. By linearizing the Cobb-Douglas production function and using fixed effects (FE) with country dummies, we find positive and significant relationship between lands cultivated, physical and financial capitals, as opposed to labor employed on agricultural productivity. Next, by using 2SLS/IV and GMM/IV methods, we show that agricultural productivity can be a pro-growth and counter-poverty tool. Furthermore we find that non-agricultural productivity interacts significantly with agricultural productivity and that agricultural productivity gap (APG) decreases both growth and poverty index. Following these results, we chart the transmission mechanisms for policy makers that will allow them to understand the linkages and pathways through which agricultural productivity affects the entire economy.

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I. Introduction

Agriculture, in simple terms, can be understood as the process –including practice and research – of producing food, feed, fiber and any other desired products by the cultivation of plants and the raising of domesticated animals. In developing countries –especially in sub-Saharan Africa (SSA) and in some Asian countries – active population working primarily in the agricultural sector can go up to 60% of total (Gollin, 2010). Such a sheer size of population making their living from the sector may imply that changes affecting agriculture can have large aggregate effects. More often, practitioners from these countries are faced with unfortunate conditions that lessen their productivity. In the literature, researchers who have discussed agricultural productivity have used various definitions. Some authors refer to it as general output per unit of input, farm yield by crop or total output per hectare, and output per worker. But whatever the measure that has been used, empirical studies support the idea that improvements in agricultural productivity are important for growth (World Bank 2007; Christiansen et al. 2011) and poverty reduction (Datt and Ravallion 1998; Foster and Rosenzweig 2004; Datt and Ravallion 2011; Mellor 1999). Sometimes the greatest concern is how agricultural productivity leads to these outcomes when for instance spatial contexts differ. Economists proposed general perspective, arguing that agricultural productivity growth can catalyze process to economic growth or poverty alleviation when there is efficient inter-sectoral coordination put in place by governments (Thirtle et al. 2003).

Today many Asian countries are far ahead of their counterparts Africans in terms of productivity in agriculture and the gap is certainly worse if compared with developed countries. For Adamopoulos et al. (2017), there are two broad possible explanations for such rich-poor disparities in agricultural productivity. First, due to fragile institutions, poor countries make different economic choices in agriculture than rich countries that affect either the level of inputs and technology used or their allocation across farmers. Second, due to unfortunate endowments, featuring poor land quality, poor countries have a natural disadvantage in agriculture. In the case of Africa, one can cautiously agree with the first while the second argument is very unlikely given that, African continent is home to around 60% of the world arable land suitable for agriculture development. Besides institutional failures such as land management, trade policies and others, some authors suggest that, crucially African states can start with provision of financial capital to farmers which can greatly help them improve their productivity (Diagne 2002; Baffoe et al. 2015; Mwakaje and Girab, 2013; and Owusu 2017). In most of these countries arable land is sufficiently available, so policies that lead to easy access to financial capital should be encouraged. Even earlier, the work of (Miller, 1977) suggests that access to rural credit has the capacity, not only to improve productivity, but also to directly raise the level of farmers' income and indirectly improve the national income distribution. This assertion is informed by the perspective that the bulk of the people in the country are engaged in the area of agricultural and therefore if farmers are able to secure such financial support then it may go a long way to improve their economic contributions to the country, potentially tackling the problem of rural and national poverty.

There are also claims in the literature that agriculturally driven growth is capable of generating a larger welfare effect than non-agriculturally driven growth, especially for the poorest of the population (World Bank 2007). Irz et al. (2001) also pointed out that the most direct contribution of agricultural sector to growth is through generating higher incomes for farmers, and this is an important point for African countries. Through growth in productivity, agricultural sector will play a key role in meeting the food security needs of the residents, in becoming source of income to the producers and major suppliers of raw materials to the mostly agro-based industries in the region. We believe it is imperative to bring out this usefulness of the sector so decision makers give it the focus it needs. In a nutshell, this study is conducted to stress the efficient use of production factors and establish the effect of agriculture on economic growth and poverty reduction among members of the Economic Community of West African States (ECOWAS). Findings will be useful to a number of stakeholders in the agricultural and non-agricultural sectors and too, will help governments in policy development. The remaining part of the paper is organized around six chapters starting with the literature review. Chapter three lays out the methodology and analytics for the research while chapter four describes the data and all the variables. Chapter five presents the results of the regression and the findings are discussed in chapter six. We end the paper with concluding remarks, implications of the findings, policy recommendations and the research limitations.

II. Literature review and Hypotheses development

We review relevant literature to develop hypotheses from general perspective –not limited to Africa – on how production factors affect agricultural productivity, and how this productivity improvement affect growth and poverty.

2.1. Physical capital on agricultural productivity

Use of physical capital in agriculture especially machineries, tractors and the likes, is regarded as sine-qua-non to reduce the human hurdles and enhance the agricultural productivity. Depending on the use of other inputs such as irrigation, high yielding seed varieties, chemical fertilizers, herbicides and pesticides, studies provided evidence that different economies have turned to capital-aided agriculture to reach better outcomes. Verma (2006) found for instance that, in India, many states have embraced agricultural mechanization which has resulted in the agricultural production and productivity to surge. Earlier studies including Singh and Singh (1972) and IETS, Madras (1975) on crops production concluded that tractor farms gave higher yields of wheat, paddy and sugarcane and produced a higher overall gross output per hectare than non-tractor farms. From a recent study conducted on South Asian countries, Anik et al. (2017) assessed agricultural sustainability in Bangladesh, Pakistan, India and Nepal by computing multi-lateral multi-temporal Total Factor Productivity (TFP) indices and their six components –including technical change, technical-, scale- and mix-efficiency changes, residual scale and residual mix-efficiency changes – to analyze the importance of capital in driving TFP growth over a 34-year period (1980–2013). The authors found that all countries sustained agricultural productivity growth at variable rates with Bangladesh experiencing highest rate estimated at 1.05% per annum followed by India (0.52%), Pakistan (0.38%) and Nepal (0.06%). All these findings amongst others confirm that physical capital can play a significant role in agricultural development and this leads us to formulate the following hypothesis.
H1a: Increase in use of physical capital contributes positively to agricultural productivity in ECOWAS countries

2.2. Financial capital on agricultural productivity

Financial capital in the form of private credits to farmers has usually helped them to purchase physical capital. As in the case of physical capital, a number of empirical studies have been conducted to study the relationship between access to credit and agricultural productivity. In their studies to establish the relationship between access to credit and agricultural productivity in Ghana, Baffoe et al. (2015) analyzed responses from 109 farm households of borrowers and non-borrowers to conclude that the difference in productivity of borrowers and non-borrowers was statistically significant. In another study conducted by Kinkingninhoun et al. (2010) to determine the effect of agricultural credit participation on farmers' productivity, results revealed that agricultural credit has a positive significant effect on rice yield, especially confirming that credit users had 157.2 kg per hectare of paddy more than non-credit users. A similar conclusion was drawn by Diagne (2002) in his analysis of the impact of agricultural credit on farmers' output and agricultural yield. Others, including Nosiru (2010), Munturi and Nzomo (2004), Mwakaje (2013) and Owusu (2017), undertook separate studies on different African countries to determine the relationship between microcredit program participation and productivity of small holder farmers. Their findings similarly revealed a significant difference between productivity of the participating farmers and nonparticipating farmers. Following their results, it seems clear that the participation of farmers in credit and micro credit programs could improve agricultural yields. Based on this, the following hypothesis is put forward:

H1b: Financial capital has positive and significant impact on agricultural productivity in ECOWAS countries

2.3. Labor employed on agricultural productivity

In earlier literature, a number of empirical studies of human capital impact on productivity have been conducted. For example, Djomo (2012), using the Stochastic Production Function (SPF) model, measures the effect of human capital on agricultural productivity and income of farm managers in Cameroon. He showed that an additional year of study and experience significantly increases agricultural productivity. In other empirical studies, the impact of human capital on productivity is zero or even negative. Danquah and Ouattara (2014), using a time series (1960-2003) on the economies of African countries south of the Sahara, show that human capital has no effect on productivity. Aurojo et al. (1999) on their side find a negative effect when they have integrated the average level of education of farmers in the production function (see also Ndour 2017 and Gollin 2010). With no indication on the level of education, Sen (1962) is one of the rare authors who suggested that, of two spaces allocated for agriculture, the smaller sized is more productive when identical number of family labors is allocated. In light of these findings, we propose the following:

H1c: Agricultural employed labor has mixed effect on agricultural productivity in ECOWAS countries

2.4. Land or farm size on agricultural productivity

Other things being equal, when there is no land, there is no agriculture. Land is the primary input that enables agriculture to take place. Intuitively, one can assume that access to larger portion of land might be associated with higher output. The debate on farm size and productivity relationship intensified, when Sen (1962) observed inverse relationship between farm size and output per hectare in Indian agriculture, suggesting that small farms are more productive compared to large ones. Many other authors found similar results (e.g. Feder 1985; Berry and Cline 1979 amongst others). Despite a number of studies favoring the inverse relationship, there are different research results which did not find inverse, but rather positive relationship between farm size and productivity (Rao, 1966; Roy, 1981). Moreover, Cornia (1985) analyzed the relationship between factor inputs, yields, and labor productivity for farms of different sizes in 15 developing countries. These results showed a positive relationship between farm size and productivity in Bangladesh, Peru, and Thailand.

Following these findings and based on the importance of land tenure in Africa, we posit the following hypothesis:
H1d: Farm size or land cultivated has positive and significant impact on agricultural productivity in ECOWAS countries

2.5. *Agricultural productivity on economic growth*

In general, the theoretical literature offers a number of perspectives on the role of agricultural productivity as a source of modern economic growth. Many argue that growth can follow from agriculture when countries are invested with large-scale famers (Reardon and Berdegue, 2006; Maxwell, 2004; Collier and Dercon, 2009). As such, the extent to which poor small-holding farmers would contribute to growth, or first, gain from a pro-agriculture strategy become questionable. For others, they may instead benefit indirectly through the labor market and employment expansion in non-traditional agro export sectors (Anriquez and Lopez, 2007; Maertens and Swinnen, 2009). Gollin (2010) also shared his view on the sector's role in nationwide growth explaining that the large size of the agricultural sector does not necessarily imply that it must be a leading sector for economic growth. In fact, the agricultural sector in most developing countries has very low productivity relative to the rest of the economy. For him, expanding a low-productivity sector might not be good for growth. In order words, only productivity can turn agriculture to a growth-driven sector in developing countries like in the SSA. This leads to our next hypothesis framed as:
H2a: Agricultural productivity has a positive and significant impact on the overall economic growth in ECOWAS countries

2.6. *Agricultural productivity on poverty reduction*

Several studies illustrate the variety of approaches contributing to the consistent finding that agricultural productivity is important for poverty reduction. Datt and Ravallion (1998) found output per unit of land (land productivity) to be statistically significant as a determinant of the squared poverty gap (using national, annual Indian data). Timmer (1997) uses output per worker as the productivity measure, which Mellor (1999) agrees is a better measure of productivity to identify linkages to non-agricultural growth since it encapsulates the additional ways through which farm households earn income. Byerlee, Diao and Jackson (2009) review 12 country case studies and use bivariate analysis to compare agricultural growth per worker across countries. They show that the countries with the highest agricultural growth per worker experienced the greatest rate of rural poverty reduction (Byerlee, Diao, and Jackson 2009). Based on all these finding we formulate the following hypothesis:
H3a: Higher agricultural productivity significantly contributes to poverty reduction in ECOWAS countries

2.7. *On agricultural productivity gap (APG)*

The other problem, lively discussed in the literature is the incidence in cross-sector productivity gap on growth and on poverty. The debate often focuses on what is known as "agricultural productivity gap (APG)", and dated back to several decades. Lewis (1954), for example, noted that in developing countries "there is usually a marked difference between incomes per head in agriculture and in industry." These differences in sectoral productivity were viewed as critical by early development economists. Rosenstein-Rodan (1943), Lewis (1954), and Rostow (1960) viewed the development process as fundamentally linked to the reallocation of workers out of agriculture and into "modern" economic activities. More recently, the work of Caselli (2005), Restuccia, Yang, and Zhu (2008) has shown that the

apparent misallocation of workers across agriculture and non-agriculture can account for domestic and even for the bulk of international income and productivity differences. McMillan and Rodrik (2011) argue that reallocations of workers to the most productive sectors would raise income dramatically in many developing countries and will result in consistent growth. Given that the variation in the APG seems to be much of concern for researchers, and taking the issue to a national level, we formulate the following hypothesis:
H2b: Agricultural productivity gap (APG) has a negative and significant impact on the overall economic growth in ECOWAS countries.
The similar intuition goes to the poverty index, but it should be a converse effect as opposed to the case of growth. The point is when this factor has a negative impact on growth at national level; it is more likely to worsen the poverty level in the same context, leading to the following hypothesis:
H3b: The higher the agricultural productivity gap (APG) the poorer the populations in ECOWAS countries

III. Methodology and models design

In this chapter we focus on the description of models and scientific approaches that help answer the research questions and validate the hypotheses earlier formulated.

3.1. Determinants of agricultural productivity

The model to estimate is derived from a Cobb-Douglas (C-D) production function by taking agricultural productivity as the dependent variable. The basic Cobb-Douglas function is expressed as:

$$Y_{jt} = AK_{jt}^{\alpha}L_{jt}^{\beta}M_{jt}^{\theta}e^{U_{jt}} \qquad (1)$$

where $Y_{jt}$is the agricultural productivity proxied by the "Agricultural value added per worker" in country *j* and year *t*, A is a constant term, $M_{jt}$is the land area for agricultural production in country *j* and year *t*, L_{jt} is the labour input for agricultural production in country *j* and year *t*, K_{jt} is the capital used in agricultural production in country *j* and year *t* and U_{jt} is a disturbance in country *j* and year *t*. α, β and θ are respectively the land, labour and capital elasticity with respect to agricultural productivity. There are 13 countries and therefore j = 1, 2…13 and a total of 26 years, with t = 1, 2… 26.
Taking logarithms on both sides of the equation (1), we have:

$$lnY_{jt} = C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + U_{0jt} \qquad (2)$$

Regression is done using fixed effects (FE) with country and year dummies. Before deciding the estimation method, we conduct the Breusch–Pagan test to examine the presence of heteroskedasticity. This test (LM test) is based on models of type:

$$\sigma_i^2 = h(z_i^{'}\gamma)$$

where $z_i = (1, z_{2i}, \ldots z_{pi})$ explains the difference in the variances. The null hypothesis is $\gamma_2 = \cdots = \gamma_{p-1} = \gamma_p = 0$. To find this out, we follow a simple three-step procedure:
Step 1: Apply OLS in the model:

$$\phi = X\beta + \varepsilon$$

And compute the residuals
Step 2: perform the auxiliary regression

$$e_i^2 = \gamma_1 + \gamma_2 z_{2i} + \cdots + \gamma_p z_{pi} + \eta_i$$

Step 3: The test statistic is the result of the coefficient of determination of the auxiliary regression in Step 2 and sample size n with $LM = nR^2$ and $P(nR^2) = P(\chi^2_{p-1})$ under the null hypothesis of homoscedasticity. It is important to note that the LM test helps us decide between a random effects regression and a simple OLS regression.

There is also a need to perform an F-test to decide between simple OLS and the fixed effects regression by simply calculating

$$F = \frac{R^2/k}{(1-R^2)/(n-k-1)}$$

Where k is the number of restricted parameters, n number of observations and R^2 is from the unrestricted model (pooled OLS). F-test is a Wald test and is performed under the null hypothesis that FE does not provide a significantly better fit than OLS.

Our last test performed is the Hausman test. To make things simple we rewrite the original model in two different ways

$$[\phi_{jt}]_{RE} = X_{jt}\beta_{RE} + a + u_{jt} + [\varepsilon_{jt}]_{RE} \; and \; [\phi_{jt}]_{FE} = X_{jt}\beta_{FE} + a_j + [\varepsilon_{jt}]_{FE}$$

The Hausman test helps us to choose between fixed effects model and random effects model. The null hypothesis is that the preferred model is random effects; the alternate hypothesis is that the model is fixed effects. To carry out the test, we compute $\beta_{RE} - \beta_{FE}$ and its covariance. If the covariance is not significantly difference from zero, then we should use FE instead of RE.

3.2. Effect of agricultural productivity on economic growth

In this section we focus on panel method to study the first of the second hypothesis (H2a) with the growth equation which can be expressed as:

$$G_{jt} = C_1 + \alpha_{1,i}\sum_i X_{jt,i} + \beta_1 Y_{jt} + U_{1jt}, lnY_{jt} = C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + U_{0jt} \quad (3)$$

To handle this case, as productivity is already confirmed to be a linear combination of factor variables, we use a two-stage least squares (2SLS/IV) model and a generalized method of moments (GMM/IV) where the exogenous variables to agricultural productivity Y_{jt} are used as instrumental variables (IVs).

3.3. Effect of agricultural productivity on poverty reduction

The method used in this part is also similar to the previous one as the hypothesis formulated are exactly pointing to the same independent variables and the model is framed in this case as:

$$H_{jt} = C_2 + \alpha_{2,i}\sum_i X_{jt,i} + \beta_2 Y_{jt} + U_{2jt}, lnY_{jt} = C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + U_{0jt} \quad (4)$$

To confirm instruments validity, in each case we perform the Sargan-Hansen test of overidentifying restrictions, the underidentification test and finally, the weak identification test.

3.4. Agricultural productivity gap and growth

Here we follow Gollin, Lagakos and Waugh (2012) to have a theoretical understanding of the concept of the agricultural productivity gap (AGP), how it is measured and what are its effects on growth and poverty reduction. To do so, let's consider the standard neoclassical two-sector model featuring constant returns to scale in the production of agriculture and non-agriculture, along with free labor mobility across sectors and competitive labor markets. Free labor mobility implies that the equilibrium wage for labor across the two sectors is the same.

The assumption of competitive labor markets implies that firms hire labor up to the point where the marginal value product of labor equals the wage. Since wages w are equalized across sectors, this implies that marginal value products are also equalized:

$$p_a \times \frac{\partial F_a(I)}{\partial L} = \frac{\partial F_n(I)}{\partial L} = w \qquad (5)$$

where subscripts a and n denote agriculture and non-agriculture. Units are chosen here such that the non-agricultural good is the numeraire, p_a is the relative price of the agricultural good, and I is a vector of inputs used in production.

If the production function F displays constant returns to scale, then marginal products are proportional to average products with the degree of proportionality depending on that factors share in production. Defining $1 - \gamma_a$ and $1 - \gamma_n$ as the shares of labor in production, the constant returns production functions imply:

$$(1 - \gamma_a) \times \frac{p_a y_a}{L_a} = (1 - \gamma_n) \times \frac{y_n}{L_n} \qquad (6)$$

Taking $p_a y_a$ and y_n as value added (VA) in the agriculture and non-agriculture sector respectively, equation (6) says that value added per worker across the two sectors should be equated. Assuming that labor shares are the same across sectors will mean that:

$$\frac{y_n/L_n}{p_a y_a/L_a} \equiv \frac{VA_n/L_n}{VA_a/L_a} = 1 \qquad (7)$$

If the condition in (7) is not met, then this suggests that workers are misallocated relative to the competitive benchmark. For example, if the ratio of value added per worker between non-agriculture and agriculture is larger than one, we should see workers move from agriculture to non-agriculture, simultaneously pushing up the marginal product of labor in agriculture and pushing down the marginal product of labor in non-agriculture. This process should tend to move the sectoral average products towards equality.

Equation (7) without the condition of "unity" is simply the ratio obtained by dividing the labor productivity in non-agricultural sector by the labor productivity in the agricultural sector (also vice versa possible) and can be expressed as:

$$APG = \frac{NA\,Prod}{A\,Prod} \; or \; \frac{A\,Prod}{NA\,Prod} \qquad (7')$$

Having explained and found a proxy for the APG, we can frame our model following the hypothesis (H2b) earlier formulated as:

$$G_{jt} = C_3 + \alpha_{3,i} \sum_i X_{jt,i} + \beta_3 APG_{jt}(K, L, M) + U_{3jt} \qquad (8)$$

3.5. *Agricultural productivity gap and poverty alleviation*

The dependent variable here is the human poverty index, which according to the UNDP refers to deprivation in three essential elements of human life that are already reflected in the HDI, that is, longevity, knowledge and decent standard of living. The analysis in this part is also similar to the previous section on the APG and growth. This is basically testing the last hypothesis (H3b) and the model can be expressed as:

$$H_{jt} = C_4 + \alpha_{4,i} \sum_i X_{jt,i} + \beta_4 APG_{jt}(K, L, M) + U_{4jt} \qquad (9)$$

IV. Data and variables description

Here we give detailed information about our data, their source and the variables that are used in the regressions.

4.1. Data and sources

All the data has been taken from the World Bank and World Development Indicators (WDI) except that on Human Poverty index (HPI) which has been obtained from the African Development Bank and credit to agriculture (financial capital) from FAOSTAT. All the data spans the period 1990 to 2015 except the data on Human Poverty index which spans the period 1997 to 2007 as those for the other years could not be found. Out of the fifteen ECOWAS member states, thirteen were included in the study as two did not have sufficient data available. The countries in the study include Benin, Burkina Faso, Cabo Verde, Cote D'Ivoire, Ghana, Guinea, Guinea Bissau, Niger, Nigeria, Senegal, The Gambia, Togo and Sierra Leone.

4.2. Variable description

In this section we describe the variables used in the regressions for the validation of the hypotheses formulated. All these variables are summarized in the following table.

Table 1: Variable specification

	Variable	Variable description	Anticipated sign
Dependent Variables (Model 1)	Y/A Prod	Agricultural productivity proxied by agriculture, forestry, and fishing value added per worker	
Independent Variables	Physical K /K	Capital proxied by Agricultural machinery, tractors	+
	Financial K / CPS	Domestic credit to private sector (constant 2010 US$)	+
	Labor / L	Agriculture Labor	+/-
	Land / M	Agriculture Land (square meters)	+
	NA Prod (interaction*Y)	Non-agricultural productivity proxied by industry (incl. construction) value added per workers	+
	TOP (interaction*Y)	Trade openness (% [Import + Export/GDP])	+
	FDI (interaction*Y)	Inflows of Foreign direct investment (% GDP)	+
Dependent Variables (Model 2&4)	Economic growth / G	GDP growth rate (Y-on-Y %)	
Independent Variables	Y/A Prod	Agricultural productivity proxied by agriculture, forestry, and fishing value added per worker	+
	NA Prod	Non-agricultural productivity proxied by industry (incl. construction) value added per workers	+
	APG	Agricultural productivity gap	-
	Agri. VA	Agricultural value added(constant 2010 US$)	+
	Manuf. VA	Manufacturing value added (constant 2010 US$)	+
	Serv. VA	Services, value added (constant 2010 US$)	+
	WomenInW	Percentage of women in work (% of total labour force)	+

	Infl. R	Inflation rate	-
Dependent Variables (Model 3&5)	HPI	Human Poverty Index	
Independent Variables	Y/A Prod	Agricultural productivity proxied by agriculture, forestry, and fishing value added per worker	-
	NA Prod	Non-agricultural productivity proxied by industry (incl. construction) value added per workers	-
	APG	Agricultural productivity gap	-
	Agri. VA	Agriculture value added (constant 2010 US$)	
	Manuf. VA	Manufacturing value added (constant 2010 US$)	-
	Serv. VA	Services, value added (constant 2010 US$)	-
	WomenInW	Number of women in work	-
	Infl. R	Inflation rate	+

4.3. Descriptive statistics

The following table gives an account of the variables to be used and their descriptive statistics at level.

Table 2: Descriptive statistics

Variable	Observation	Mean	Std. Deviation	Minimum	Maximum
A Prod (Y)	338	1555.611	1132.233	344.1939	5418.445
Growth rate (G)	338	4.014057	4.902115	-28.09998	26.41732
HPI (H)	143	44.12028	11.42294	14.5	65.5
NA Prod	338	5318.813	4790.594	449.6122	21430.24
APG	338	.5324586	.5507256	.0315819	2.474952
TOP	338	64.20531	20.00562	21.33265	131.4854
FDI	338	8.79e+11	4.18e+12	-1.02e+09	3.45e+13
Infl. R	338	8.704355	12.74576	-7.796642	72.8355
Agri. VA	338	7.16e+09	1.95e+10	3.99e+07	1.25e+11
Manuf. VA	338	3.32e+09	9.15e+09	1.60e+07	5.05e+10
Serv. VA	338	1.46e+10	4.61e+10	3.47e+07	3.21e+11
Physical K (K)	338	111.2409	305.797	.001232	3020.45
Financial K (CPS)	338	4.04e+09	1.32e+10	2774892	1.31e+11
Land (M)	337	145909.2	191042.7	680	737000
Labor (L)	338	3.46e+08	5.25e+08	9218474	2.46e+09
WomenInW	338	2.79e+08	4.67e+08	4296800	2.53e+09

V. Regression Results

This section simply report the findings, and in some cases, if necessary, with short notes or interpretation.

5.1. Result 1: Production factors and agricultural productivity

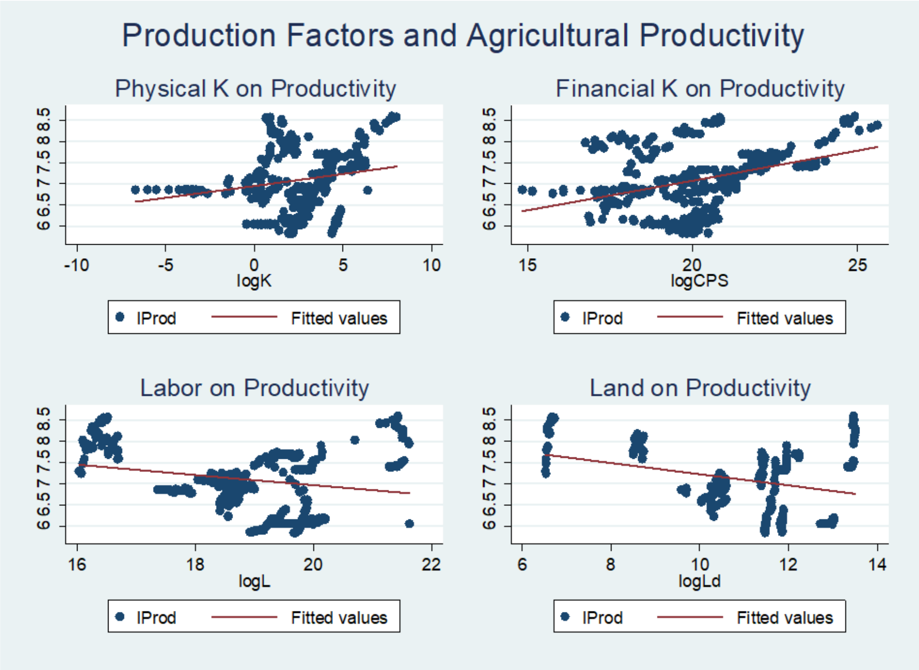

Figure 1: Scatter plots and fitted lines of mains factors on productivity

A first look at the graph shows that the use of capital inputs might in fact be positively correlated with agricultural productivity as suggested by our first two hypotheses. The downward slopes on labor input and land cultivated were, for the first expected, but not for the second. All this highlights can be confirmed in our next steps.

Table 3: Benchmark results

	Dependent is Log of Agricultural Productivity		
VARIABLES	Pooled OLS	RE	FE
Log (Physical K)	0.0446***	0.0502***	0.0354**
	(0.0135)	(0.0144)	(0.0145)
Log (Financial K)	0.310***	0.180***	0.142***
	(0.0190)	(0.0175)	(0.0185)
Log (Labor)	-0.235***	-0.0595	-0.0628
	(0.0537)	(0.0400)	(0.0389)
Log (Land)	-0.186***	-0.112	0.612***
	(0.0372)	(0.0742)	(0.166)
Intercept	7.190***	5.684***	-1.318
	(0.592)	(0.840)	(1.671)
LM Test	No	Yes	---
F-Test	No	---	Yes
Hausman Test	---	No	Yes
Observations	337	337	337
R-squared	0.629	---	0.361
Number of ID	---	13	13

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

By performing the LM test, the F test and the Hausman test on these results, we can notice that the fixed effects model appears appropriate to obtaining more reliable estimates. In what follows, we control for cross-sector productivity and cross-country factors in order to confirm the benchmark figures. Adding the interaction terms, the new model looks like the following:

$$lnY_{jt} = C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + \zeta_1[lnY_{jt} * ln(NA\,Prod)_{jt}] + \zeta_2[lnY_{jt} * ln\,FDI_{jt}] + \zeta_3[lnY_{jt} * ln\,TOP_{jt}] + \lambda_j \sum_{j=1}^{13} d_j + \lambda_t \sum_{t=1990}^{2015} d_t + U_{0jt}$$

With NA Prod standing for non-agricultural productivity, FDI for (%GDP) of foreign direct investment inflow, TOP for trade openness, d_j and d_t for country and year dummies respectively and lastly $\zeta_1, \zeta_2, \zeta_3, \lambda_j, \lambda_t$ the parameters to estimate for the control variables.

Table 4: Production factors and productivity, robust model

VARIABLES	Dependent is Log of Agricultural Productivity					
	[1]	[2]	[3]	[4]	[5]	[6]
	Capital effect	Labor effect	Land effect	Log-linearized C-D model [Basic]	Cross-sector control	Cross-country control
Log (Physical K)	0.0500***			0.0354**	0.0272***	0.0294***
	(0.0143)			(0.0145)	(0.0104)	(0.0105)
Log (Financial K)	0.168***			0.142***	0.0437***	0.0364**
	(0.0169)			(0.0185)	(0.0145)	(0.0148)
Log (Labor)		0.0886*		-0.0628	-0.108***	-0.128***
		(0.0462)		(0.0389)	(0.0282)	(0.0298)
Log (Land)			1.361***	0.612***	0.377***	0.276**
			(0.147)	(0.166)	(0.121)	(0.126)
*Y*NA Prod*					0.0654***	0.0622***
					(0.00378)	(0.00400)
*Y*FDI*						0.0690*
						(0.0360)
*Y*TOP*						0.0146
						(0.0100)
Constant	3.278***	5.149***	-7.267***	-1.306	0.478	2.064
	(0.333)	(0.868)	(1.523)	(1.592)	(1.151)	(1.303)
Control	No	No	No	No	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No
Observations	337	338	338	337	337	337
Number of countries	13	13	13	13	13	13

Standard errors in parentheses and each term in interaction terms are in log
*** p<0.01, ** p<0.05, * p<0.1

5.2. *Result 2: Effect of agricultural productivity on economic growth*

This part provides evidence to the first of our second hypothesis (H2a). For regression, we employ the 2SLS and GMM with instruments as described in the method section. In both cases, equation (3) can be rewritten as follows:

- Closed economy

$$G_{jt} = C_1 + \alpha_{1,i} \sum_i X_{jt,i} + \beta_1 Y_{jt} + U_{1jt}$$

$$Y_{jt} \equiv C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + \zeta_1[lnY_{jt} * ln(NA\,Prod)_{jt}] + U_{0jt}$$

- Open Economy

$$G_{jt} = C_1 + \alpha_{1,i}\sum_i X_{jt,i} + \beta_1 Y_{jt} + U_{1jt}$$

$$Y_{jt} \equiv C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + \zeta_1[lnY_{jt} * ln(NA\,Prod)_{jt}] + \zeta_2[lnY_{jt} * ln\,FDI_{jt}] + \zeta_3[lnY_{jt} * ln\,TOP_{jt}] + U_{0jt}$$

- In both cases (closed and open), we set:

$$\sum_i X_{jt,i} = ln(NA\,Prod)_{jt}$$

Table 5: Productivity and growth, robust model

VARIABLES	Dependent is Growth Rate				
	FE/country dummies	Closed Economy		Open Economy	
		2SLS/IV	GMM/IV	2SLS/IV	GMM/IV
Log (A Prod)	1.600	2.927*	1.294***	3.661**	1.437***
	(1.010)	(1.663)	(0.497)	(1.644)	(0.492)
Log (NA Prod)	3.493***	3.959***	0.324	4.057***	0.101
	(1.130)	(1.154)	(0.304)	(1.158)	(0.273)
Intercept	-33.86***		-7.923**		-7.008*
	(12.01)		(4.021)		(3.984)
Country FE	Yes				
Year FE	No				
Sargan stat $chi^2(q)P-val$		0.2921>0.05		0.0591>0.05	
CD Wald F stat		47.361>19.28		32.976>19.28	
Anderson LM stat $chi^2(q)P-val$		0.0000<0.05		0.0000<0.05	
Instruments		Yes	Yes	Yes	Yes
Observations	338	337	337	337	337
R-squared		0.029	0.021	0.003	---
Number of countries	13	13		13	

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

Results appear to be well in line with our predictions i.e. agricultural productivity does affect positively economic growth. The use of robust models with instruments gives more significant estimates in both cases with the elasticities slightly higher in open economy. The control variable, the non-agricultural productivity is also robust, having positive and significant effect on growth when the 2SLS/IV is employed.

5.3. Result 3: Effect of agricultural productivity on poverty reduction

This part provides evidence to the first of our third hypothesis (H3a). For regression, we employ the GMM with instruments as described in the method section.

$$HPI_{jt} = C_2 + \alpha_{2,i}\sum_i X_{jt,i} + \beta_2 Y_{jt} + U_{2jt}$$

$$Y_{jt} \equiv C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + \zeta_1[lnY_{jt} * ln(NA\,Prod)_{jt}] + \zeta_2[lnY_{jt} * ln\,FDI_{jt}] + \zeta_3[lnY_{jt} * ln\,TOP_{jt}] + U_{0jt}$$

$$\sum_i X_{jt,i} = ln(NA\,Prod)_{jt} + lnAgri.VA_{jt} + lnManuf.VA_{jt} + lnServ.VA_{jt} + lnWomenInW_{jt} + Infl.R_{jt}$$

Table 6: Regression results for agricultural productivity and poverty reduction

	Dependent is log of HPI				
VARIABLES	GMM/IV				
	[1]	[2]	[3]	[4]	[5]
Log (A Prod)	-15.73***	-16.13***	-15.21***	-15.86***	-15.93***
	(1.004)	(1.127)	(1.217)	(1.043)	(1.070)
Log (NA Prod)		0.518	0.538	0.0762	2.983***
		(0.707)	(0.780)	(0.729)	(0.669)
Intercept	155.1***	153.7***	146.5***	148.8***	137.6***
	(6.926)	(7.189)	(11.20)	(11.00)	(11.83)
Control			Yes	Yes	Yes
Instrument	Yes	Yes	Yes	Yes	Yes
Observations	142	142	142	142	142
R-squared	0.504	0.492	0.514	0.500	0.575

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

Estimates from this regression appear very robust. One can remark the consistency of the estimated elasticities of agricultural productivity on poverty index (HPI). As we add more controlling variables, the coefficients stay stable between -15% and -16% with 1% percent increase in agricultural productivity.

5.4. Result 4: Agricultural productivity gap and growth

Here we provide evidence to the second of our second hypothesis (H2b). For regression, we employ the GMM as in the previous case.

$$G_{jt} = C_3 + \alpha_{3,i} \sum_i X_{jt,i} + \beta_3 APG_{jt} + U_{3jt}$$

$$APG_{jt} \equiv C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + \zeta_1\left[lnY_{jt} * ln(NA\,Prod)_{jt}\right] + \zeta_2\left[lnY_{jt} * ln\,FDI_{jt}\right] + \zeta_3\left[lnY_{jt} * ln\,TOP_{jt}\right] + U_{0jt}$$

$$\sum_i X_{jt,i} = ln(NA\,Prod)_{jt} + lnAgri.VA_{jt} + lnManuf.VA_{jt} + lnServ.VA_{jt} + lnWomenInW_{jt} + Infl.R_{jt}$$

Table 7: Regression results for APG and growth rate

VARIABLES	Dependent is Growth Rate				
	FE	P-OLS	GMM/IV		
APG	-2.171	-0.713	-1.077	0.412	-0.100
	(1.319)	(0.484)	(0.854)	(0.639)	(0.696)
Intercept	5.170***	4.394***	4.676***	0.554	1.467
	(0.749)	(0.371)	(0.461)	(5.103)	(4.975)
Country FE	No				
Year FE	No				
Control				Yes	Yes
Instruments				Yes	Yes

Observations	338	338	337	337	337
R-squared	0.008	0.006	0.005	0.011	0.046
Number of country	13				

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results are unstable but most outcomes from the table suggest that the relationship between APG and growth is negative although not significant.

5.5. Result 5: Agricultural productivity gap and poverty alleviation

Here we provide evidence to the second of our third hypothesis (H3b). The model used for regression as follows:

$$HPI_{jt} = C_4 + \alpha_{4,i} \sum_i X_{jt,i} + \beta_4 APG_{jt} + U_{4jt}$$

$$APG_{jt} \equiv C_0 + \alpha_0 lnK_{jt} + \beta_0 lnL_{jt} + \theta_0 lnM_{jt} + \zeta_1[lnY_{jt} * ln(NA\,Prod)_{jt}] + \zeta_2[lnY_{jt} * ln\,FDI_{jt}] + \zeta_3[lnY_{jt} * ln\,TOP_{jt}] + U_{0jt}$$

$$\sum_i X_{jt,i} = ln(NA\,Prod)_{jt} + lnAgri.VA_{jt} + lnManuf.VA_{jt} + lnServ.VA_{jt} + lnWomenInW_{jt} + Infl.R_{jt}$$

Table 8: Regression results for APG and HPI

VARIABLES	Dependent is HPI				
	FE	P-OLS	GMM/IV		
APG	-0.474	-4.360***	-7.068***	-7.094***	-7.056***
	(3.798)	(1.571)	(2.577)	(0.879)	(1.033)
Intercept	44.38***	46.49***	50.29***	46.21***	60.37***
	(2.084)	(1.265)	(1.679)	(11.21)	(13.87)
Country FE	No				
Year FE	No				
Control				Yes	Yes
Instruments				Yes	Yes
Observations	143	143	142	142	142
R-squared	0.000	0.052			0.263
Number of country	13				

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results show that, holding all other things else constant, agricultural value added itself does have a negative but insignificant effect on HPI. Other interesting estimates show a positive effect of women labor force and the decreasing effect of inflation rate on poverty.

VI. Discussions

Here we interpret, explain our results, and discuss possible implications. We also highlight and discuss the pathways through which productivity contribute to growth and poverty reduction.

6.1. What truly determine improvement in agricultural productivity and how?

The results (Table 3) suggest that access to financial capitals in the form of private credits, and the use of physical capitals such as fertilizers, tractors and other essential machinery equipment are associated with higher productivity. In the meantime, other things else held constant, a percentage increase in farm land also results in nearly 0.3% in agricultural productivity whilst labor input has a significantly negative impact on this outcome. These findings interestingly show some consistency with the literature and confirm our hypotheses. In a further step, we also check for cross-sectoral and cross-country effects on the agricultural productivity. Using interaction terms by factoring agricultural productivity with non-agricultural productivity, results show that productivity in other sectors also has positive and significant impact agricultural productivity. Similar procedures applied to FDI and trade openness show positive impacts although not significant.

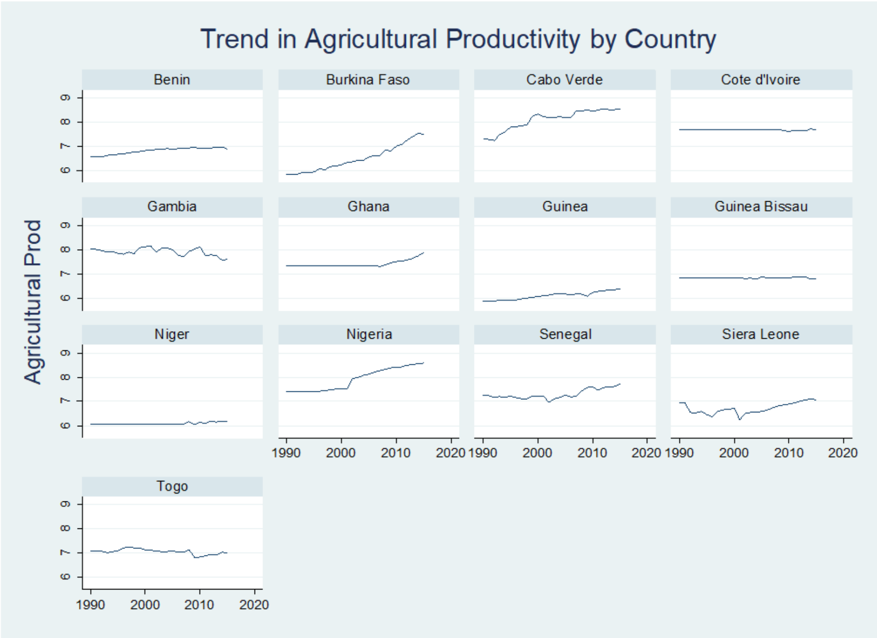

Figure 2: Trend in Agricultural Productivity by country

Many countries appear to have had upward sloping trends in agricultural productivity over the past decades. Countries like Nigeria and Cabo Verde dominate as top nations in the list with very high value added per worker at the end of period (2015). Others have maintained an incredible momentum over the same period. These mainly include Burkina-Faso with a growth rate of over 446% in 25 years followed by Cabo Verde, 259.72% and Nigeria.

The case of Burkina-Faso is particularly eye-catching and can be a learning ground for other countries. According to a World Bank report, Burkina-Faso is still dominated by subsistence production and characterized by low crop and livestock productivity, low but increasing diversification. To address its challenges, the Agriculture Diversification and Market Development Project (PAFASP) is now set up to promote businesses in its rural areas, where access to credit from commercial banks and microfinance institutions was limited. Through the provision of matching grants, this project tries to provide incentives for small and medium enterprises to embark on investment. Through both initial and additional financing, the project (2006–2017) has benefitted more than 385,000 people, of whom 30 percent are women, and has significantly contributed to the development of four, targeted value-chains (meat/livestock, poultry, onion, and mango) whose professional organizations are now well-structured and fully operational. The key impacts of the project include a rise in rural incomes for the project's beneficiaries and a significant increase in agricultural exports (World Bank, 2017).

Another example is Cabo Verde. This country and FAO have partnered since 1976, when early interventions were focused on emergency agricultural assistance. Since then, there has been a shift towards longer-term development interventions, with a greater concentration on food and nutrition security, agricultural productivity and value chain development and food safety (FAO, 2019). Looking at the graph, Cabo Verde appears one of the highest performers in the agricultural sector in the region. According to a report by UNCTAD (2006), the agricultural sector, excluding agribusiness, represents more than 20% of regional gross national product (GNP) for the Economic Community of West African States (ECOWAS) countries, employing 44% of its population. The total expenditure on agricultural policies has stayed steady during the period 2006–2013 (available period), around 6% of the total Cape Verde national budget in all years except 2011, in which it was 11%. Thus, for example, the agricultural policy of the last planning period (2004–2015) focused on organization of rural areas in general and water basin management in particular, as an opportunity to exploit the potential of the agricultural sector to achieve a reduction in poverty (Governo de Cabo Verde, 2011). Corral et al. (2017) studied agricultural and rural improvement in the country and concluded that "this improvement was due to both interventions in agricultural policies and other policies (related to the strengthening of human, social and physical capital) that generated several positive impacts in the areas with interventions".

But the scenario looks different in countries like Togo, Guinea and Niger. These three countries (Figure 2) have something in common: low or declining agricultural productivity. In Niger for instance, according to a 2018's World Bank report, agricultural contribution to the economy represents around 40% of the national GDP and occupies nearly 90% of the active population. This can explain the extremely low level of agricultural productivity as only 10% of active population are working in the non-agricultural industry and responsible for a whopping share up to 60% of national GDP. Currently, the performance of the agricultural sector is unstable from one year to another because of its high exposure to agronomic, climatic, health, and more recently security risks (World Bank, 2018). Besides programs such as FAO's IPPM in Niger which seeks to promote balanced fertilization for healthy crop growth, reduce the use of harmful pesticides and help farmers adapt production to a changing climate, the government can also strive to incentivize or promote facilitative measures in order to attract foreign capitals in the country. Foreign investors can also be attracted to do business in the downstream such setting leather processing or shoes factories as the country has advantage in livestock industry.

6.2. What is the influence of agricultural productivity on economic growth?

Using all three models (FE, 2SLS and GMM), results in Table 6 confirm that GDP growth is positively affected by agricultural and non-agricultural productivity. In the 2SLS model, closed economy's coefficients suggest that a 1% increase in agricultural productivity is associated with 2.927% in GDP growth rate and 3.661% when open economy's controlling instruments are added. In the GMM model, although the magnitude of estimates decreases, the impact remains unchanged and statistically significant (1.294% and 1.437%, respectively in closed and open economy. These findings point out the importance of economic liberalization as a facilitating factor in agricultural role for economic growth. To advance the debate in the context of our sample, we are first going to take a look at how each country has been performing in terms of growth over the studied period, then to discuss the detailed mechanism underlying the role of agricultural productivity in growth.

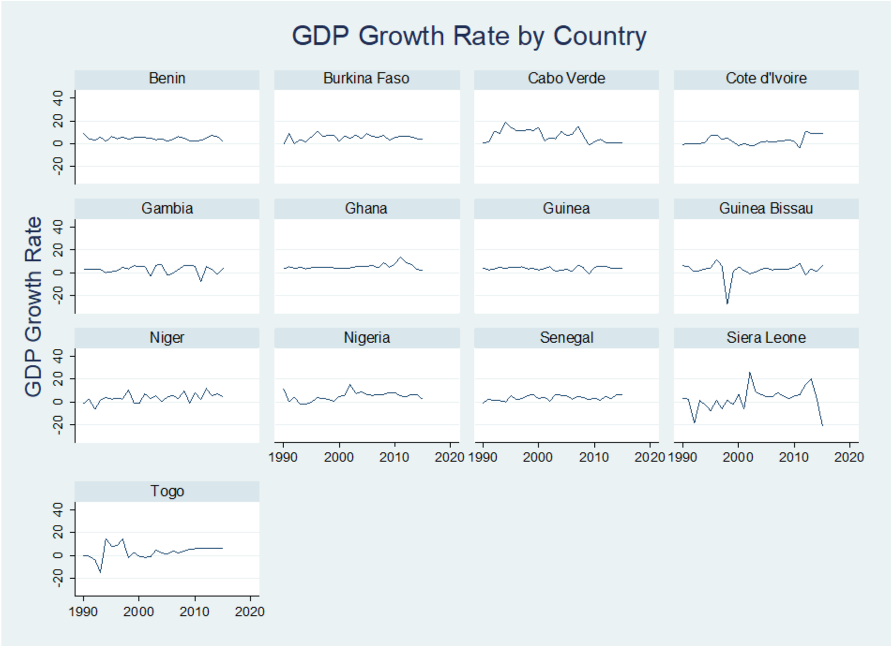

Figure 3: Trends in GDP Growth Rate by Country

The figure shows that only few countries were able to maintain positive and somewhat consistent growth rate over the study period. These countries include Benin with an average rate of around 4.52%; Ghana, 5.38%; Guinea, 3.75% and Senegal, 3.58%. High but unstable growth countries include Sierra Leonne (between -20.60% and 26.42%), Cabo Verde (between -1.27% and 19.18%) and similarly Togo, Guinea Bissau and the Gambia.

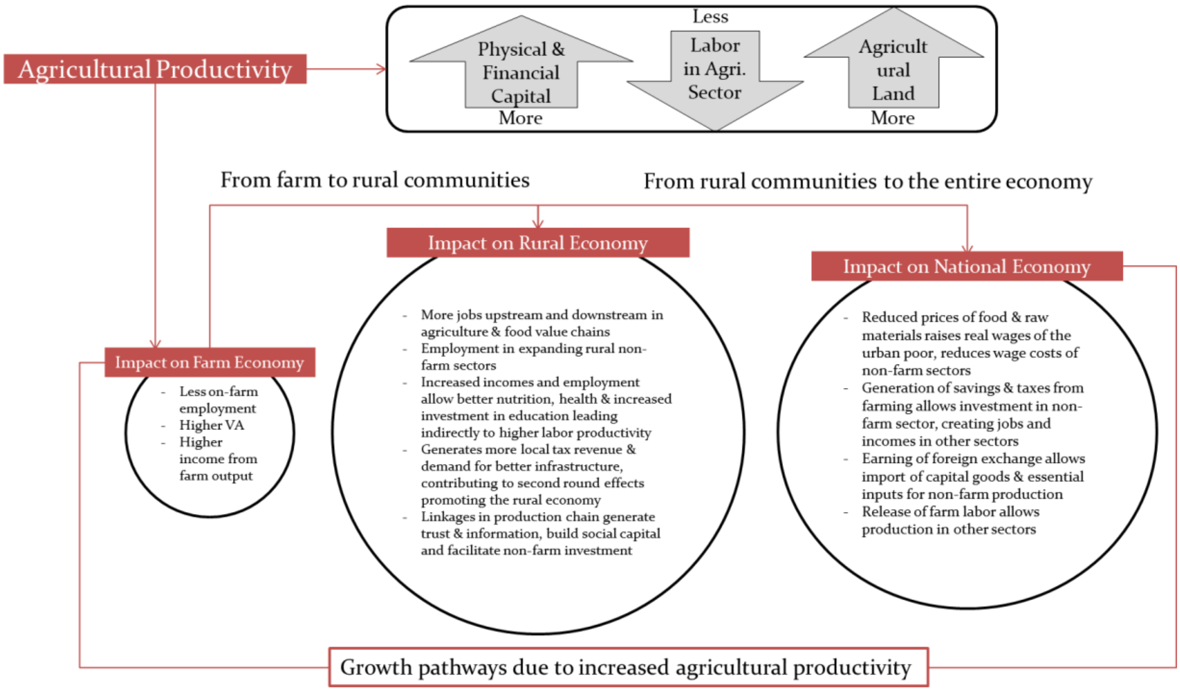

Figure 4: Growth pathways following increased agricultural productivity

Source: Authors' compilation based on own findings and following Irz et al. (2001)

The chart is drawn by combining our findings to the work by Irz et al. (2001). A close look at the figure suggests that productivity does increase the well-being of the people at national level but following an indirect path. Here we are going to discuss some details in order to draw significant implications based on the chart. The starting point is very important: increased capital inputs (financial capital is made available to purchase physical capitals), decreased labor employed in the agricultural sector (the ones who work in the sectors must be equipped with needed financial and physical capitals) and finally allocate more cultivable lands to the few endowed labor working in the agriculture. If this is done, it will automatically trigger productivity in the agricultural sector and the whole chart will make full sense.

6.2.1. Impact on farm economy

With an increased agricultural productivity, labor employed in the sector declines and because the few workforces in agriculture can produce higher output, the surplus agricultural labor will migrate to other stages of the value chains. With few people being able to produce more with less cost, the most direct contribution to workers is the generation of higher incomes for farmers. This is possible only if primarily governments and financial institutions incentivize credits access to farmers and these farmers are assisted and followed up in effective utilization of physical capitals acquired with loans. Furthermore the increased effect of land does not necessarily mean to expand cultivated area. Efficient use of capitals by farmers implies that same area can bear higher yield with less labor input.

6.2.2. Impact on the rural economy

Increased agricultural production will affect other sectors in the rural economy through a series of linkages. These include production links, both 'upstream' from the farm in demand for inputs and services for agriculture, as well as 'downstream' from the farm in the demand for processing, storage, and transport. There are also consumption links as farmers and farm laborers spend their increased incomes on goods and services in the local rural economy. According to Irz et al. (2001), there are other possible links. For example, there may be gains both to welfare and to rural human capital as increased food production and farming incomes allow better nutrition of rural workers and investment in health and education (Timmer, 1995). Increased agricultural output may generate more tax revenues, allowing more public investment in infrastructure, the demand for which may be stimulated by the growth of the farm sector. A final linkage may run from a more dynamic farm sector to social capital formation, as increased interactions between farmers, input suppliers, processors and banks generate the confidence and trust needed to mount new non-agricultural businesses.

6.2.3. Impact on national growth

For this effect to truly materialize there needs to be a healthy agricultural value chain within ECOWAS countries and the end products should be highly tradable. According to Goedde et al. (2019), supply chains for agriculture in sub-Saharan Africa are fragmented. In analyzing major agricultural-input chains in eight countries, the authors found that inputs changed hands at least three times before they reached the farmer, moving from national importers to regional distributors to "agro-dealers" (which are typically small, rural shops). The value chains need to be consistent. On the other hand, agricultural products should be regionally if not globally tradable. Tradable goods contribute to export expansion which leads to increased export revenues for a country. These exports revenues come in form of foreign exchanges. In fact, earning of foreign exchange allows import of capital goods and essential inputs for farm and non-farm production. In general, it is rational to argue that an increase in national output tends to drive down the price of food, hence benefiting consumers and all net purchasers of food. Growth of agricultural productivity per labour unit at a rate higher than agricultural production can allow the release of labour to other sectors where there are higher productivity jobs. This transfer, central to Lewis's theories of development, has been an important element in the very high rates of growth experienced in East Asian economies since the 1980s. Some studies (e.g. Verma, 2006) on farm mechanization indicated that net human labour displacement in agricultural operations may not be so significant and should be more than compensated by increased demand for human labour due to multiple cropping, greater intensity of cultivation and higher yields. On the other hand, the demand for non-farm labour for manufacture, services, distribution, repair and maintenance as well as other complementary functions can increase substantially and will help in relieving rural unemployment to some extent. Mechanization in agriculture provided indirect employment to skilled and unskilled persons engaged in operation, repair and maintenance of prime movers and farm.

6.3. What is the influence of agricultural productivity on poverty reduction?

As hypothesized, our findings confirm that agricultural productivity has a negative and significant impact on the level of poverty in ECOWAS countries. A percentage increase in the overall agricultural productivity is associated with 15.93% in poverty reduction. In the literature, several studies have also provided evidence for the poverty reducing potential of agricultural productivity growth in the past. For instance, in Ethiopia, Diao and Pratt (2007) conducted a study on staple crop production and found that growth in staple crop productivity has greater potential for poverty reduction in not only agricultural but also in non-agricultural sector in their model. Minten and Barrett (2008) also found similar evidence for Madagascar with regard to rice, a largely nontradable due to high marketing and transport costs. Other works include those of Jayne et al. (2010) who found that maize is the single most important crop in most smallholder farm incomes Kenya, Malawi, Zambia, and Mozambique, suggesting that productivity increases could result in poverty alleviation. Earlier works suggest that in sub-Saharan Africa and some parts of Asia, as much as 60% of the economically active population works primarily in agriculture, and approximately the same fraction resides in rural areas. Many of the people living in the rural areas of the developing world are poor, and conversely, most of the world's poor people inhabit rural areas—as much as 70–75%, according to Ravallion et al. (2007). Agriculture also accounts for a significant fraction of the economic activity in the developing world, with some 25% of value added in poor countries coming from this sector (World Development Indicators, 2009). In Africa, the performance in poverty reduction as a consequence of development policies occupies great part of researchers and policymakers discussion. We take a look at how HPI evolves over time in the selected countries for our study.

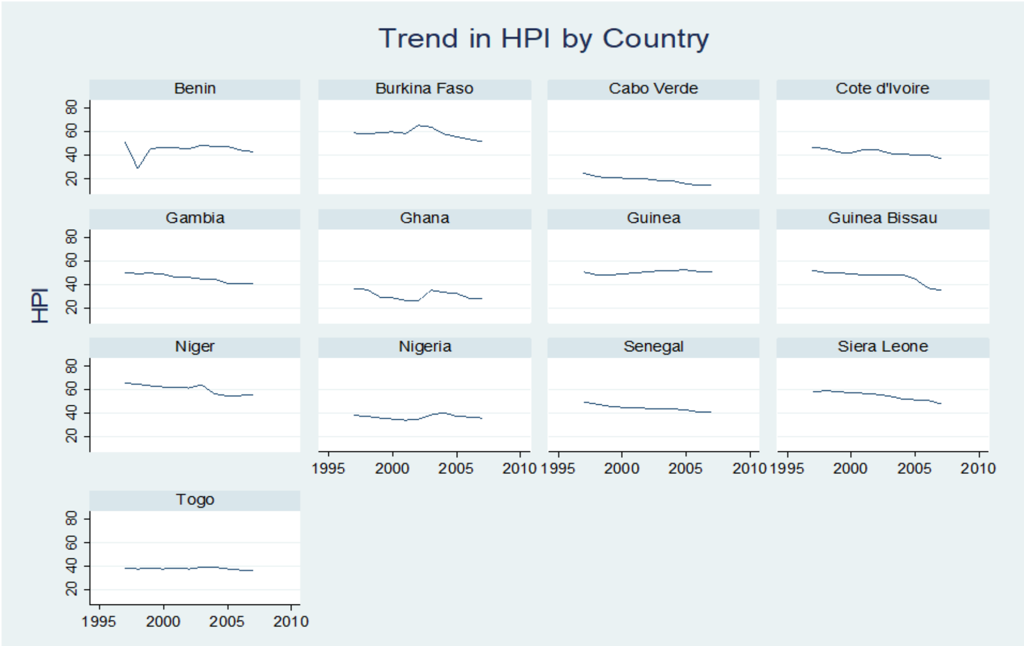

Figure 5: Trend in Poverty Reduction

According to the graph, most countries have had decreasing trends in the HPI. This pattern is clearer for countries like the Gambia, Senegal, Cote d'Ivoire, Sierra Leonne, Guinea Bissau, Cabo Verde and Niger. On the other hand; Benin, Ghana, Guinea, Togo and Nigeria have shown no particular trends leading to our interest to explain how the poverty reduction can be effective in these countries and what mechanism should policy makers need to have a closer look at. Such mechanisms are proposed and discussed based on the following chart.

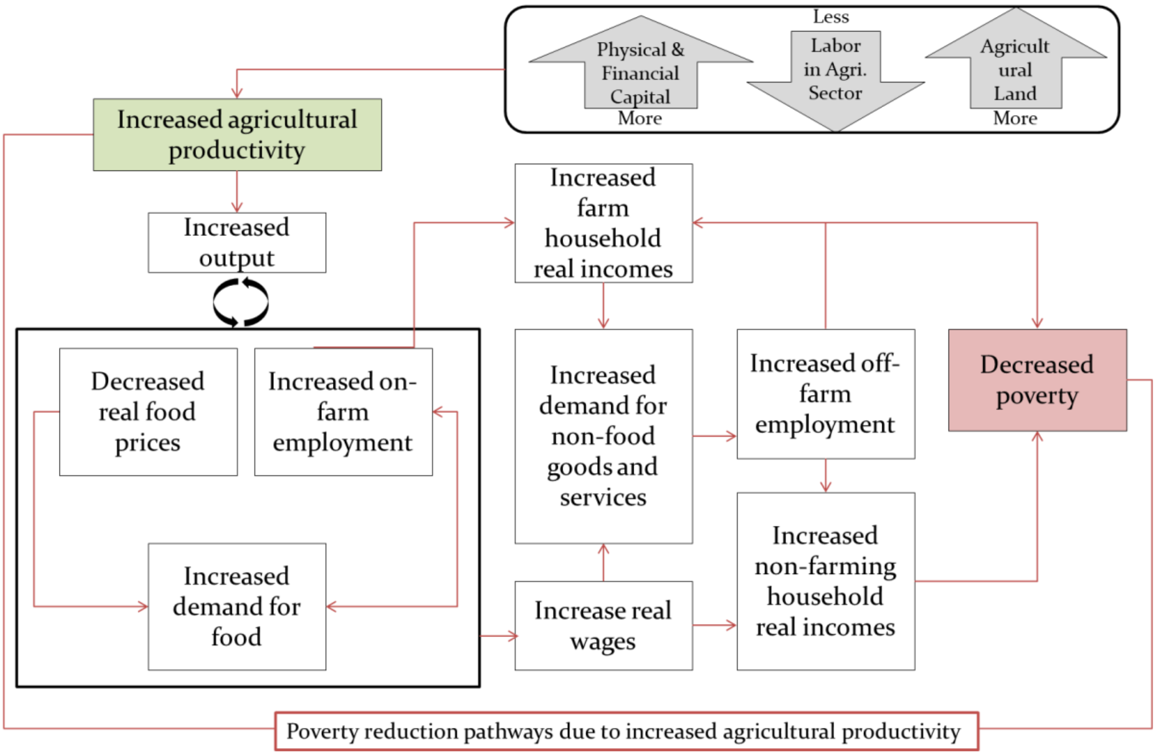

Figure 6: Poverty reduction pathways following increased agricultural productivity
Source: Authors' illustration following Schneider and Gugerty (2011)

The chart is drawn by combining our findings to the work by Schneider and Gugerty (2011). A close attention suggests that productivity does decrease poverty but indirectly. Here we are going to discuss some details in order to draw significant implications based on the chart.

As discussed in the previous section, the starting point here is also important: increased capital inputs, decreased labor employed in the agricultural sector and allocation of more cultivable lands to the few endowed labor working in the agriculture. All this together has the potential to trigger productivity in the agricultural sector, linking it to poverty reduction for the entire economy. The most important point is that this relationship is not immediate to productivity growth. There is a mechanism. In the literature, only one study (Thirtle et al., 2001 and Irz et al. 2001) models the direct relationship between agricultural productivity and changes in poverty measures at the macroeconomic level across countries. These authors have examined the effect of land and labor productivity (yield and the land-to-labor ratio) as well as total factor productivity (by sing agricultural VA) on the percentage of the population living on less than US$1 per day (the headcount index) using country-level data from the 2000 World Development Report. Thirtle et al.'s (2001) findings suggest that agricultural productivity growth has a robust and consistent impact on poverty for all productivity measures. They calculate that a 1% increase in productivity is associated with a decrease of 0.62% to 1.3% in the percent of the population below the US$1 per day poverty line. In the next stage, when output or specifically when agricultural yields increase at lower production cost compared with a 'benchmark situation' (a result we may also refer to as agricultural productivity), there will be an immediate outcome: the prices will fall compared with the 'benchmark situation'. First, this will benefit all net food buyers in both rural and urban settings. This view is already supported in the literature. The works of Binswanger and Quizon (1989), Otsuka (2000) and Irz et al. (2001) demonstrated that output expansion and the resulting decline in food prices was the primary mechanism through which the green revolution decreased inequality and poverty. We will leave this for later. The following outcome when prices decrease for agricultural products is that people will tend to buy more with the same budget (or the budget of the 'benchmark situation'). Buying more implies an increase in the demand of the same goods. This increased demand for agricultural products leads to an increase in employment in the agricultural sector. Our description means that, indirectly, growth in agricultural productivity can increase real wage rates through the mechanism previous mentioned, which both directly and indirectly will later contribute to poverty alleviation (Datt and Ravallion, 1998).

The remaining part of the puzzle is how the effect snowballs to the other sectors of the economy until a nationwide outcome. This may arise through the multipliers effect in non-farm economy. According to Schneider and Gugerty (2011), increased agricultural production creates demand for products and services both upstream (inputs, services for agriculture) and downstream (processing, storage, transport). The authors pointed out that it also generates consumption links as farmers and farm laborers spend increased incomes on goods and services. However, for Irz et al. (2001), the degree of these multiplier effects depend on several factors including the extent of rural infrastructure, population density, the extent of immediate processing needs for agricultural products, the nature of technological change in farming and the tradability of goods and services both produced and demanded by agricultural communities. Other studies including Haggblade et al. (1989, 1991), Hazell and Ramasamy (1991) and Delgado et al. (1994) have estimated the production and consumption multiplier effects of increased agricultural production in specific regions. Their findings suggest that over 75% of the multiplier effects in rural economies occur through consumption linkages. Some studies find that multiplier effects are stronger in areas with better infrastructure (and therefore rural-urban links).

6.4. On APG, "growth and poverty reduction" in ECOWAS

Based on regression outcomes (Table 7 and 8), the relationship between APG and growth rate on one hand and between APG and HPI on the other hand appears to be negative, but only significant between APG and HPI. The negative sign in the first case portrays a situation where growth seems to be decelerated due to wider gap between productivity in the agricultural and non-agricultural sectors. The estimate of the column 5 of Table 7 for instance suggests that 1% increase in the APG is associated with 0.1% decrease in overall growth rate. But this result is not statistically significant. By contrast, Table 8 displays results with higher significant level. Column 5 of the same table suggests that when APG increases by 1%, the resulting reduction in national poverty level is as high as 7.056% which is quite impressive. Based on how we have computed APG, these results mean for the first that productivity in agriculture does not contribute as much as productivity in the non-agricultural sector to economic growth and for the second that, poverty reduction is mainly driven by agricultural productivity in the ECOWAS countries. So the question, for those reasons is: "Should these countries keep non-agricultural productivity high to drive growth or should they improve agricultural productivity at the expense of non-agricultural sector in order reduce poverty?" This is an interesting point that we shall not be able to fully address in this study. However, given the significance of the second result, it may be advisable to the ECOWAS countries to improve productivity in the agricultural sectors. And as discuss in previous section, this can have a snowball effect on the other sectors, and by the mechanisms discussed from figure 4 and figure 6, will lead to overall growth and poverty alleviation. That being said, we want to look at how the APG is truly a subject of discussion on the sampled countries.

In the literature, studies found, based on national accounts data for developing countries that, value added per worker is on average four times higher in the non-agriculture sector than in agriculture. Taken at face value this "agricultural productivity gap" suggests that labor is greatly misallocated across sectors in the developing world (Gollin et al. 2012). In SSA, up to 60% or more of labor force is employed in the agricultural sector which unfortunately remains the least productive sector of all, thus sparking the concern over it proper effect on growth and poverty reduction in the region. Let us take a look at the severity of the average APG in the ECOWAS countries.

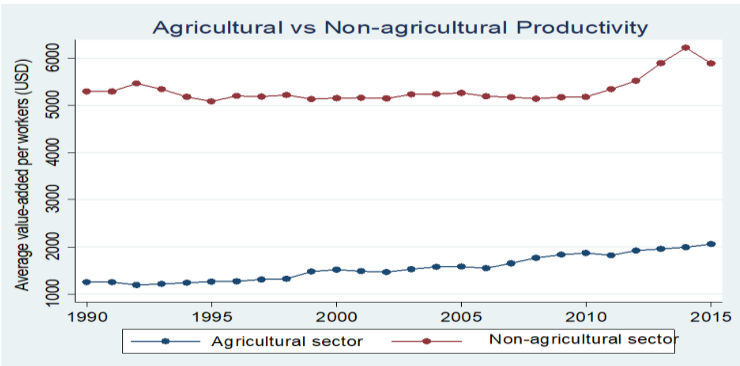

Figure 7: Agricultural vs. Non-agricultural Productivity

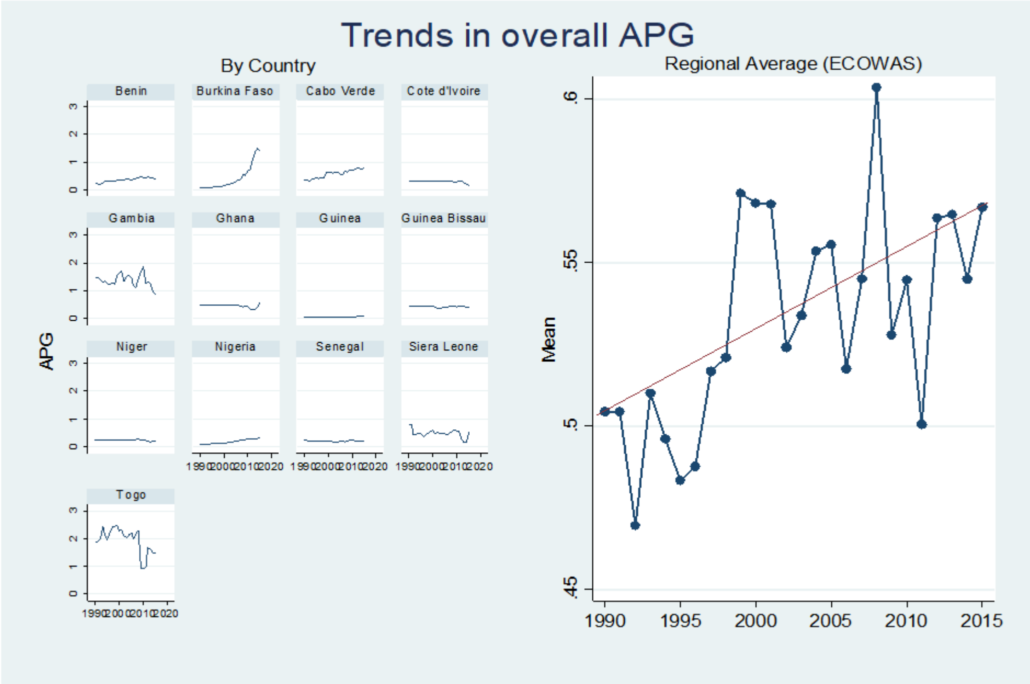

Figure 8: Trend in overall average APG

The two figures taken in general suggest a growing gap between productivity in agriculture and non-agricultural sectors in the ECOWAS. Figure 7 particularly shows that non-agricultural productivity has been very high and away from that of agriculture. One thing important to mention is the large amount of workforce pooled in agricultural activities in Africa. Up to this point we have assumed that labor shares in production are the same in agriculture and non-agriculture. Gollin et al. (2012) suggest that sector differences in labor shares can explain much of the productivity gap. We should remember that up to an average of 60% of the workforce in the sampled countries work in the agricultural sector but most countries' agricultural contribution to national GDP does not exceed 25%. Goedde et al. (2019) reported for McKinsey & Company that more than 60 percent of the population of sub-Saharan Africa is smallholder farmers, yet only about 23 percent of sub-Saharan Africa's GDP comes from agriculture. The good news however is that agricultural productivity is following an increasing trend although remaining very low compared to that in non-agricultural sector. What African countries need, especially the members of ECOWAS, is to create conditions not only for productivity growth in agriculture –conditions or requirements that we have already discussed based on how production factors can be used to raise agriculture productivity – but also help the bulk of their economies in a way that the surplus of labor in the agriculture can smoothly transition to other non-agricultural sectors to render the economic growth effectively nationwide and tackle poverty problems at all social level.

VII. Conclusion

The debate on agriculture as a tool to boost growth and to reduce poverty is neither new nor consensual among researchers. In order to share our views and contribute to the discussion, this study is conducted to investigate the effect of agricultural productivity on economic growth and on poverty alleviation among ECOWAS countries. It however, starts by analyzing and discussing the effect of physical capitals, financial capital, land and labor as factors of production on overall agricultural productivity.

For our analyses, we mainly rely on past literature to frame the models that were appropriate to answer our research questions and validate hypotheses formulated. Our production technology is a Cobb-Douglas function primary characterized by productivity as the outcome variable and capital (financial and physical), labor and agricultural land as production factors. In empirical perspective, the model is log-linearized and extended to study the impact of agricultural productivity on growth and poverty. Our first regression employed a fixed effects (FE) model with country dummies fitting production factors and agricultural productivity. Next, by using the agricultural productivity and agricultural productivity gap (APG) as key variables affecting growth and poverty, we needed to solve endogeneity problems, so exogenous factors to productivity were used as instrumental variables in the rest of the regressions. Two main models including two-stage least squares (2SLS/IV) and generalized methods of moments (GMM/IV) were used to obtain consistent estimates. For robustness check, other independent variables as controlling factors included agricultural value added, manufacturing value added, service value added, aggregate number of female workers and prevailing inflation rate. Data were collected from secondary sources (World Development Indicators, FAO-Stat and African Development Bank) covering a panel of 13 ECOWAS countries and 26 years (1990-2015).

Results obtained from preliminary regressions confirm –as we hypothesized – that financial capital, physical capital and land input have positive and significant impact on agricultural productivity. As opposed to other determinants, increased agricultural labor is associated with a decrease in productivity. This was also expected as we explained that only tailored education for farmers is likely to induce the positive return on productivity, so human capital holds more importance. Other interesting results include the positive and significant impact of cross-sector productivity on one hand and positive but non-significant impact of cross-country variables (FDI and trade openness). Agricultural productivity, as we turn to aggregate factors, was associated with positive, negative and significant impact on growth and poverty index respectively. Results are more volatile in this part. For instance, using the 2SLS/IV, we found that the elasticity is around 3% when there is a 1% increase in agricultural productivity. Similar remarks pop up with a decrease to 15.93% in HPI when agricultural productivity increases by 1%. As we checked on the APG's effects on the same aggregates, growth seems to respond negatively but the coefficients are non-significant as opposed to the case of poverty index which as well responded negatively but highly significant.

In terms of policy implications, there are interesting takeaways from our findings. Beginning with the positive effect of physical capital on agricultural productivity which seems quite obvious, effectiveness will require some institutional facilitation. The positive impact implies that farmers are encouraged to acquire all sorts of capitals (tractors, machineries, fertilizers…) to aid in increasing their agricultural yields. As important as this appears, it is extremely hard for the many ECOWAS farmers to purchase capitals on their own, calling for financial institutions to play a role. Lending private credits to farmers should be encouraged by governments by a means of reduced interest rates, and training programs to the effective and efficient use of these materials should be put in place. The coefficient on labor input holds an important message. Pooling non-competent farmers in the sector will only worsen the outcome to be delivered. In place, governments can start training the laborers, encourage them to form cooperative, put in place measure to discourage land fragmentation. This can be successful only if the agricultural sector has strong linkage with other economic sectors in order to allow productive labor to migrate to other stages of the value chains. Another angle

to look at this situation from is by attracting foreign investors. These investors will not necessary be conveyed in the farming industry but rather in the manufacturing sector in order to create higher demand for raw agricultural products to be transformed into intermediate and final goods at home, creating opportunities for jobs in the downstream.
We have shown that increased agricultural productivity can be participative to economic growth nationwide if judged from the positive relationship between the two variables. GDP growth is probably the most visible aspect of a healthy or a falling economy. In this sense, every factor (endogenous or exogenous) affecting growth rate is taken seriously by top entities of a country. So our finding is very appealing to ECOWAS government that agriculture should not be neglected or given less attention for the time being. This is also important given the finding that the sector participates as well to poverty reduction. Using the agricultural productivity gap (APG) we are very clear that productivity in agriculture has higher reducing impact on poverty than has the non-agricultural sector. Action required to make agriculture benefit the entire economy is to allocate efficiently the production factors. Farmers should be given the opportunity to be trained, to have access to credits, to be supported by policies that allow their products to reach consumer markets.

This study, although significant insights have emerged and have been discussed to aid in policy formulation for countries in the ECOWAS, there are some flaws which are worth mentioning. Firstly, there is a measurement issue on agricultural productivity. We only consider the labor productivity, but it is very likely that other proxies, especially land productivity will matter as well and needed to be analyzed. Other independent variables such as infrastructure (soft and hard) were not included, but are believed to affect agricultural productivity. The second is the methodological approach. We have focused our approach on econometric frameworks, using linear and log-linear regression to explain the situation for all the 13 countries sampled. There are also other models with high accuracy result such CGE, growth accounting, two-sector models that we have ignored. It is clear that we cannot use all of them at once, but they are very relevant to point out. The sample used was also a cluster and the entities are non-stochastically selected. All the countries belong to a regional bloc so might be sharing some factors –e.g. monetary, trade policies among other things.

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