Agricultural Growth and Poverty Alleviation: Empirical Evidence from 34 African Countries Using System Dynamic Panel Data Estimations

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Abstract
Agriculture is the backbone of every economy as every country feeds on its natural produces. However, if a country will progress then much effort should be channeled into agriculture in order to feed the industrial sector to add value to them. On this tenet, the study aims to assess the impact that agricultural growth has on poverty alleviation in Africa. The data used for the study were sourced from 1996 to 2017, a panel of 34 African countries. In a panel study, system dynamic panel data estimation method was used in its analysis and the results confirm that agricultural growth positively and consistently impacts poverty alleviation. Moreover, governments' effectiveness in making good policies and providing sound intervention to propagate economic growth will positively reduce poverty.

Keywords: *Agricultural growth; Poverty alleviation; Africa; System dynamic panel data estimations; Homogeneous causality*

1. Introduction

In recent times, in pursuit of development and cooperation, agriculture growth and rural poverty reduction have received much attention, but the effort to end poverty is woefully inadequate (Zipora, 2007). As it has been recognized by policymakers that the effort to end poverty has not been encouraging, this has resorted to developing the sectors which employ majority of the people in countries of low income status. Agricultural growth has proven to be an economic transformation machinery as its importance can be traced to transformation that Asia has witnessed through agriculture to eradicate poverty. Sub-Saharan Africa failed to achieve the MDG to reduce poverty by 50% by 2015. In effect, Africa had to grow its agriculture sector on average of 6% annually but could not achieve this objective (World Bank, 2006). The Millennium Development Goals (MDGs) first goal is to "eradicate poverty by mitigating the income disparity gap, creating more access to food for the marginalized and ensuring economic growth."

The definition of poverty has a varying understanding from different perspectives. Seligman and Johnson (1933) refer to poverty as unavailability of material belongings. The term poverty can be expressed from two concepts thus "relative and absolute poverty" (Aboyade, 1987). He further explained that absolute poverty means the inadequacies of facilities and necessities which include improper health care, lack of food, lack of education, transportation, shelter, etc. On the other hand, relative poverty falls under the situation when the level of income of a person is insufficient for sustenance as such person cannot live a good life, which is expected by the society he lives in. McNamara (1998) share the same view with Aboyade (1987) as a person's life is determined by the community he/she lives. According to FAO (2007) "the driver of economic growth and poverty alleviation is agricultural growth as about 85% of the people living in poverty in Sub-Saharan Africa are rural dwellers". Basically, their daily bread depends on agriculture. Out of the world's 738 million poor population, about 50% of the world's poor population lives in five countries, thus India, Nigeria, Bangladesh, Burundi and Congo (World Bank, 2019).

Many empirical studies have found that the contribution of agriculture relatively to poverty alleviation depends on three effects thus the participation, indirect and direct effects of growth. Arguably, the agriculture growth which is direct on poverty alleviation is potentially smaller than the effect of non-agriculture growth. Moreover, the reverse feedback effect of agriculture growth seemingly shows substantial in line with the indirect growth

effect through the nexus with non-agriculture growth. Fan (2005) investigated the relationship between agriculture and poverty in Asia; the study posits that poverty alleviation through agriculture in rural economies is far impactful than that of the urban economy or the overall economy. Perhaps, the role that agriculture plays in dynamic and varies with time, but the most important thing is that astronomical growth in agriculture has the potency to increase economic growth rapidly. In a study (Zipora, 2007) to investigate the linkage among hunger, poverty and agricultural growth in Africa, he concluded that agriculture is the backbone of Africa's economy hence could lift its poor population from poverty when production of agricultural products thus food rapidly could boost export of foreign exchange. Also, food will be in abundance to feed the marginalized and the poor. Arguably, Anowor et al. (2013) performed an econometric analysis to test for the significant relationship between agricultural growth and poverty alleviation; they confirmed that the two have strong and significant relationship. Therefore, an increase in agricultural production could lead to tremendous reduction in poverty as food will be in abundance for feeding and export for foreign currencies and will also provide a job for the jobless.

In different opinion, Okpara (2004), in his study to assess the role that agriculture plays in poverty alleviation in Nigeria with emphasis on farming households. In conclusion, he inferred that agriculture does not have positive role in the effort of alleviating poverty in Nigeria. The major problem that causes agriculture not to have positive role in poverty alleviation is family size of the farming households which contributes to high dependency ratio.

Some prolific scholars are of the view that the variation in advance technologies such as improved crop varieties and livestock is the empowerment of transformed agricultural sector (Shultz, 1964; Mellor, 1995:1996; Gollin, 2010). From their school of thought, rapid increase in agriculture promotes economic growth and creates employment at equilibrium by impacting stability and societal wealth. With emphasis on this literature, the study intends to assess the long run impact of agricultural growth on poverty alleviation in Africa and also to find out the causal relationship that exists among the variables considered. The study intends to establish the dynamic relationship between agricultural growth and poverty alleviation hence the use of system dynamic panel data estimation method proposed by Arellano & Bond (1991). The significance of the study is to contribute to the enormous literature on the subject matter for academic usage.

The various parts of the study can be found as; part 1 thus, the introduction, part 2 presents the data and methodology; part three discusses the findings and part concludes the study.

2. Data and Methodology

2.1 Data

The study employed secondary data sourced from World Development Indicators, Worldwide Governance Indicators and World Bank. The study utilized panel data of 34 African countries based on the availability of data for the period 1996 to 2017. The objective of the study is to assess the impact of agricultural growth or value added on poverty alleviation in Africa hence it settled on some variables to achieve its objective. The variables were chosen due to the pertinent effect or connection that they have with each other. Most importantly, the control variables were chosen due their correlation with both the independent and the dependent variables. For instance, government's effectiveness is a paramount factor in pursuit to alleviate poverty as well as economic growth or stability based on the Marxist economist and radical theorist assertions. Moreover, employment in the agricultural sector was chosen to control the effect of agricultural growth because agricultural growth literally means more productivity, which in other words means that employment has been created to support the growth. Table 1 displays a description of the variables and further details.

Table 1 Variable names and description

Variable name	Description	Measurement
hdi	Human development index- is the composite measure of life expectancy, income per capita measures, education and health. **Dependent variable**	poverty alleviation
lnaggrowth	Agriculture, forestry, and fishing, value added (constant 2010 US$) **Independent variable**	Agricultural growth
lnempagric	Employment in agriculture (% of total employmen ILO estimate) **control variable**	Employment
lngdppc	Gross domestic product per capita (constant 2010) **Control variable**	Economic growth
goveff	the perception that is held to the extent that policies formulated and implemented by government with regards to civil and public services delivery (Measured in score where -2.5 means weak, +2.5 means strong) **Control variable**	Government effectiveness

Source: World Development Indicators, Worldwide Governance Indicators, World Bank

2.2 Methodology

This study is a panel study, hence the use of panel data methodologies. The study intends to explore the dynamic relationship that exists between agricultural growth and poverty alleviation in Africa. The various steps that the study employs to achieve its objectives are as follows:

1. The first step that the study embarks on is to ascertain the nature of the variables. Hence, descriptive statistics are computed to find out the mean, median, standard deviation, Jarque-Bera, Kurtosis and Skewness of the variables. Subsequently, an important diagnostic test is performed thus unit root test to check for stationarity in the variables in order to reject the null hypothesis, which posits that there is an evidence of unit root in the variables, and not even one of the variables is stationary. Perhaps, four-unit root tests is performed due to their capabilities of solving for homogeneity and heterogeneity in the variables thus Levin et al. (2002) test, Im et al. (2003) test, and Maddala and Wu (1999) test (Levin, Lin & Chu test, Im-Pesaran & Shim test, ADF-Fisher Chi square and PP-Fisher Chi square tests).

2. After it is evidenced that there is no unit root in the variables, the next step is to check for the problem of multicollinearity in the independent variables. The rule of thumb for collinearity states that no two independent variables should be in high correlation with the dependent variable at a coefficient of -/+0.70 or above. Other than that, it will be considered as multicollinearity. In spite of this, the correlation matrix will be computed to check for multicollinearity as well as the correlation linkage between the dependent and the independent variables.

3. It is important to identify the long run relationship that exists between the dependent and the independent variables. Therefore, the cointegration test is performed to check whether the variables are cointegrated to confirm that there is a long run relationship between them. However, Pedroni (1999; 2004) and Kao (2000) cointegration tests are considered to find out the long run relationship between the independent and the dependent variables in order to infer that the regression estimations that will be done are long run estimations.

4. Notably, the next step is to analyze the data with Arellano-Bond system dynamic panel data (generalized method of the moment: one-step and two-step methods) to estimate the coefficients of the variables. The study used both one-step and two-step GMM method for its estimations. The two-step method is used to robust check the one-step method due to the function of less propensity of effect by heteroskedasticity than the one-step method. Moreover, Sargan test is performed to assess the validity of the instrument used in the procedure. Furthermore, AR (1) and AR (2) tests are also computed to examine the autocorrelation of the residuals; the

value of AR (2) depicts that the hypothesis of zero second-order serial correlation exists among the variables cannot be rejected (Lingyun and Xiaolu, 2018).

5. The step is to identify the direction of causality between the dependent and the independent variables hence the test for bivariate panel causality. Dumitrescu and Hurlin (2012) proposed out a simple method to assess the hypothetical homogenous non-causality against the alternative of heterogeneous non-causality. However, the homogeneous causality test identifies two directions of causality, thus unidirectional and bidirectional. The bidirectional homogeneous causality refers to the causal relationship in which all the two variables involved have equal causality on each other and the unidirectional homogeneous causality refers to the causal relationship in which only one variable causes the other, but the other has no causality on the latter.

Model specification

$$hdi_{it} = \sum_{j=1}^{p} a_j\, hdi_{i.t-j} + \beta_1 lnagricgrowth_{it} + \beta_2 lnempagric_{it} + \beta_3 lngdppc_{it} + \beta_4 goveff_{it} + v_i + \varepsilon_{it} \qquad i = 1, \ldots\ldots, N\ t = 1, \ldots.. T_i$$

In the equation (1 - 3), i represents the 34 cross sectional countries in Africa, t represents the period of time from 1996 to 2017, v represents the panel level effect, and ε_{it} represents the independent and identically distributed (i.i.d.) over the sample with variance σ_{ε}^{2}, j represents the time lag to be determined by Arellano-Bond test for the serial correlation. Hdi is the dependent variable and it represents human development proxy measure of poverty alleviation, lnagricgrowth represents agricultural growth (independent variable), lnempagric represents employment in the agricultural sector, lngdppc represents economic growth measured by gross domestic product per capita and goveff represents government effectiveness.

3. Empirical findings and discussion

3.1 Descriptive statistics

The descriptive statistics of the variables are displayed in table 2; from the table, it can be reported that the annual average growth rate in Agricultural value added in Africa stood at 20.81% from 1996 to 2017 whiles poverty alleviation stood at 0.462 on the average annually which below the standard measure of average performance in the effort of poverty alleviation thus human development index. Moreover, economic growth from 1996 to 2017 stood at an annual growth rate of 6.954% and employment in the agricultural sector grew at 3.762% annually. Governments' effectiveness in formulating and implementing policies that could ensure the eradication of poverty was fairly weak on the average annually at a score of -0.547.

Table 2 Descriptive statistics

	hdi	lnagricgrowth	lnempagric	lngdppc	goveff
Mean	0.465	20.808	3.762	6.954	-0.547
Median	0.462	21.393	3.909	6.692	-0.572
Maximum	0.790	25.462	4.528	9.386	1.049
Minimum	0.000	0.000	1.526	5.346	-1.884
Std. Dev.	0.155	3.973	0.644	0.988	0.593
Skewness	-0.715	-4.353	-1.281	0.634	-0.002
Kurtosis	4.461	23.282	4.164	2.410	2.549
Jarque-Bera	130.282	15182.620	246.636	61.013	6.347
Probability	0.000	0.000	0.000	0.000	0.042
Observations	748	748	748	748	748

Note: Agricultural growth, Employment in agricultural and economic growth are in their natural logarithm.

3.2 Unit root tests

To check whether there is no evidence of unit root in the variables, the study performed four tests thus Levin, Lin & Chu test (LLC), Im-Pesaran & Shim test (IPS) and Maddal & Wu tests (ADF-Fisher & PP-Fisher tests). The outcome of the tests can be reported as, at level form, hdi showed stationarity in three tests except for IPS, lnagricgrowth, lnempagric and lngdppc showed stationary in only LLC test whiles goveff showed stationary in all the tests. Furthermore, the study continued the tests in first difference to ensure stationarity among the variables. Lo and behold, at first difference, all the variables became stationary at 1% significance in the four tests.

Table 3 unit root test

Level Form	LLC	IPS	ADF-Fisher	PP-Fisher
hdi	-9.565***	-1.142	137.177***	115.660***
lnagricgrowth	-2.959**	2.010	58.096	79.954
lnempagric	-1.655**	3.999	47.859	39.470
lngdppc	-3.434***	2.778	64.112	78.377
goveff	-3.698***	-5.013***	252.219***	487.763***
First difference				
hdi	-10.919***	-10.222***	239.358***	291.908***
lnagricgrowth	-25.009***	-22.217***	501.398***	614.577***
lnempagric	-10.237***	-10.816***	263.294***	415.622***
lngdppc	-13.342***	-13.897***	312.330***	365.034***
goveff	-92.090***	-79.783***	4998.72***	5524.95***

Note: *** indicates 1% significance level, ** indicates 5% significance level

3.3 Correlation matrix

A correlation matrix was computed to find out the correlation linkage between the dependent and the independent variables; also to check whether there is multicollinearity among the independent variables. From all indications, the study can confidently confirm that there is no multicollinearity among the variables. From table 4, the highest coefficient can be reported as 0.723 thus lngdppc and the second highest is 0.341, thus goveff. However, no two independent variables have coefficients of -/+0.70 or above. In addition, lnagricgrowth and lnempagric showed negative correlation with poverty alleviation thus human development index but only lnempagric showed significant correlation. Also, lngdppc and goveff showed positive and significant correlation with poverty alleviation.

Table 4 Correlation matrix

Correlation Probability	hdi	lnagricgrowth	lnempagric	lngdppc	goveff
hdi	1				
lnagricrowth	-0.015	1			
lnempagric	-0.207***	-0.052	1		
lngdppc	0.723***	-0.138***	-0.147***	1	
goveff	0.341***	-0.115**	-0.081**	0.485***	1

Note: *** indicates 1% significance level, ** indicates 5% significance level

3.4 Cointegration test

The result of the cointegration test performed by the study is displayed in table 5. The outcome confirms that the independent and the dependent variables are cointegrated; hence there is a long run relationship existing between them. From the table, it is established that four (4) out of the seven tests performed under the approach of Pedroni (2004) for both within-dimension and between-dimension showed significance at 1% and 5% level

respectively. Moreover, a Kao (2000) test was also performed to buttress the result of Pedroni and the outcome confirms that at 1% significance level, the variables are cointegrated.

Table 5 Cointegration test

Alternative hypothesis: common AR coefs. (within-dimension)						
Pedroni Cointegration	Statistic	Prob.	Sig.	Weighted Statistic	Prob.	Sig.
Panel v-Statistic	0.156	0.438		-0.816	0.793	
Panel rho-Statistic	1.804	0.964		2.117	0.983	
Panel PP-Statistic	-1.805	0.036	**	-1.649	0.050	**
Panel ADF-Statistic	-2.567	0.005	**	-2.223	0.013	**
Alternative hypothesis: individual AR coefs. (between-dimension)						
	Statistic	Prob.	Sig.			
Group rho-Statistic	4.313	1.000				
Group PP-Statistic	-1.690	0.046	**			
Group ADF-Statistic	-3.503	0.000	***			
Kao Cointegration	t-Statistic	Prob.				
ADF	-7.878	0.000	***			

Note: *** indicates 1% significance level, ** indicates 5% significance level

3.4 Regression results

To achieve the study's objective, Arellano and Bond (1991) system dynamic panel data estimation method was chosen to perform the data analysis in order to identify the dynamic relationship that exists between agricultural growth and poverty alleviation. Table 6 exhibits the results of the regression analysis and from the table, it is established that at a lag of 1 in dynamic estimation poverty alleviation is positive and statistically significant at 1% level. Taking into consideration the impact of agricultural growth on poverty alleviation, it is evidenced in table 6 that agricultural growth has direct and statistically significant as well as consistent impact on poverty alleviation in the long run. However, the estimation in the one-step GMM approach showed an insignificant impact, but the two-step method showed 1% significance. Government is for the people, by the people and to the people; hence, every effort to alleviate poverty resides in the premises to incumbent government. However, in table 6, it can be witnessed that government's effectiveness is drafting or formulating and implementing sound policies that could positively affect the lives of the people by providing safe and effective civil and public services as well as interventions help in poverty alleviation. Perhaps, at 1% significance level, a percentage increase in the efforts of government's effectiveness will lead to 0.043% increase in the effort to alleviate poverty. Economic growth literally translates into development hence poverty alleviation; economic gains mean production of goods and services are within expectation to meet consumption and exports. Moreover, as production of goods and services soar, employment also increases hence people will get income to expend to better their lives. In spite of this, table 6 displays that economic growth has positive and statistically significant impact on poverty alleviation at 1% significance level. Moreover, a percentage increase in economic growth will lead to consistent 0.096% or 0.098% increase in poverty alleviation or reduction in poverty. Employment in the agricultural sector in Africa portrays negative relationship with poverty alleviation. Evidence from the study's analysis confirms that a percentage increase in employment in the agricultural sector could lead to 0.027% decrease in the efforts to alleviation poverty. Agricultural in Africa does not heavily rely on sophisticated machinery to yield higher productivity to improve the lives of farmers. The majority of the population in Africa is into farming as it employs most of its indigenes. However, they are unable to produce to sustain themselves; most of the poor population indulge in agriculture without having the financial muscles to produce more to feed themselves and add Midas-touch to it.

The fitness of the model for the study can be found in table 6; it can be reported that the two-step method has the fitness and capability to statistically be used for the study's inference. This is because the Sargan test for the one-step showed significance, which should not be the case as the rule of thumb posits that the null hypothesis

should accept thus insignificance. However, the AR (1&2) of the two-step method showed significance and the Sargan test also showed insignificantly. Furthermore, the study can emphatically and statistically infer the results produced by the two-step method which is appropriate due to its capabilities.

Table 6 System dynamic panel data estimation method

	One-step method	Two-step method
hdi	0.176	0.176
L1	(9.69)***	(133.18)***
lnagricgrowth	0.001	0.001
	(1.58)	(9.59)***
lnempagric	-0.027	-0.027
	(-6.10)***	(-96.55)***
lngdppc	0.096	0.098
	(28.90)***	(308.14)***
goveff	0.043	0.043
	(6.94)***	(105.08)***
constant	-0.198	-0.198
	(-5.43)***	(-72.81)***
Wald chi2	1700.77***	414782.65***
sargan test	915.407	21.996
Prob.	0.000***	1.000
AR(1)		-3.254***
AR(2)		-2.011**
observations	726	726

Note: *** indicates 1% significance level, ** indicates 5% significance level. HDI represents poverty alleviation, lnagricgrowth represents agricultural growth, lnempagric represents employment in the agricultural sector, lngdppc represents economic growth and goveff represents government effectiveness. Agricultural growth, employment in agricultural and economic growth are in their natural logarithm. Z-statistics are in parentheses.

3.5 Homogeneous causality test

Another objective of the study is to ascertain the homogeneous causal relationship among the variables. In order to achieve this objective, the study chose Dumitriscu and Hurlin (2012) homogeneous causality test to find the direction of causality among the variables. In so doing, the null hypothesis that asserts that none of the variables homogeneously causes another will either be rejected or accepted. Evidence from the test can be found in table 7; from the table, there is an evidence of bidirectional and unidirectional consequentially. The bidirectional relationship can be found between; poverty alleviation and agricultural growth, poverty alleviation and employment in agriculture, poverty alleviation and economic growth, poverty alleviation and government effectiveness, agricultural growth and employment in agriculture, agricultural growth and economic growth, agricultural growth and government effectiveness, economic growth and employment in agriculture, economic growth and government effectiveness. Also, a unidirectional causal relationship can be witnessed by government effectiveness in employment in agriculture. At this juncture, the null hypothesis is rejected because there is evidence of homogeneous causality.

Table 7 Homogeneous causality

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.	Sig.
lnagricgrowth does not homogeneously cause hdi	3.471	2.517	0.012	**
hdi does not homogeneously cause lnagricgrowth	4.920	5.653	0.000	***
lnempagric does not homogeneously cause hdi	3.784	3.195	0.001	***
hdi does not homogeneously cause lnempagric	6.142	8.297	0.000	***
lngdppc does not homogeneously cause hdi	5.015	5.858	0.000	***
hdi does not homogeneously cause lngdppc	8.225	12.804	0.000	***
goveff does not homogeneously cause hdi	4.165	4.018	0.000	***
hdi does not homogeneously cause goveff	3.761	3.145	0.002	**
lnempagric does not homogeneously cause lnagricgrowth	5.180	6.215	0.000	***
lnagricgrowth does not homogeneously cause lnempagric	4.183	4.057	0.000	***
lngdppc does not homogeneously cause lnagricgrowth	4.872	5.549	0.000	***
lnagricgrowth does not homogeneously cause lngdppc	4.841	5.482	0.000	***
goveff does not homogeneously cause lnagricgrowth	3.182	1.892	0.059	**
lnagricgrowth does not homogeneously cause goveff	3.454	2.480	0.013	**
lngdppc does not homogeneously cause lnempagric	4.242	4.186	0.000	***
lnempagric does not homogeneously cause lngdppc	4.789	5.369	0.000	***
goveff does not homogeneously cause lnempagric	3.176	1.879	0.060	*
lnempagric does not homogeneously cause goveff	2.560	0.546	0.585	
goveff does not homogeneously cause lngdppc	4.524	4.796	0.000	***
lngdppc does not homogeneously cause goveff	4.452	4.640	0.000	***

Note: *** indicates 1% significance level, ** indicates 5% significance level. HDI represents poverty alleviation, lnagricgrowth represents agricultural growth, lnempagric represents employment in the agricultural sector, lngdppc represents economic growth and goveff represents government effectiveness. Agricultural growths, employment in agricultural and economic growth are in their natural logarithm.

4. Conclusion

The findings of the study were based on its objectives to assess the impact that agricultural growth has on poverty alleviation in Africa and to also find the direction of causality among the chosen variables. In so doing, the study considered a panel of 34 African countries and used secondary data sourced from 1996 to 2017.

In conclusion, the study infers that agricultural growth is consistent and has strong impact on poverty alleviation. This could be realized when governments intensify their efforts in the formulation and implementing credible and sound policies that could propagate economic growth. Moreover, the provision of other jobs to the population by not relying on their usual agricultural employment could help in poverty alleviation because the study found an inverse relationship between employment in agriculture and poverty alleviation. Most importantly, more yields are needed to economically support the farmers in Africa hence modernization of the agricultural sector could help farmers to produce enough to make economic gains out of it. Because some countries have comparative advantage in the production of agricultural products for imports into Africa, this deprives indigenous farmers to make some gains from their products thereby making them poor.

The study acknowledges its limitations, which should pave the way for further studies. The sample did not cover all African countries and not all factors that could affect the relationship between agricultural growth and poverty alleviation were considered.

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