Infrastructural Development, Sustainable Agricultural Output and Employment in ECOWAS Countries

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A R T I C L E   I N F O

A B S T R A C T

This study examines the effect of infrastructural development on agricultural output and employment in Economic Community of West African States (ECOWAS) utilizing panel autoregressive distributed lag (PARDL) methodology. This study demonstrates that infrastructures that support agriculture productivity foster employment creation. Estimated results reveal that information and communication technology positively affect agricultural output while access to electricity has positive effect on agricultural employment. Transport infrastructure had negative and insignificant effect on agricultural performance. A major contribution of this paper is that investment in infrastructural development with a view to improving agricultural productivity potentially contributes to employment generation.

1. Introduction

Infrastructural development is used to describe improvement in physical and non-physical infrastructure that is vital to a country's economic development. Infrastructural development is a key driver for economic progress and a critical enabler for productivity (Patel & Obeng, 2014; [13,14]). Economic development theorists have identified infrastructure as critical in agricultural productivity. This implies that the productivity capacity of agriculture depends on adequacy of infrastructure, especially those that aid agricultural productivity.

Agricultural infrastructural investment has majorly focused on irrigation, transportation, electric power and agricultural markets. However, following the World Bank Report (1994), the definition of agricultural infrastructural infrastructure was narrowed down to comprise long-lived engineered facilities and other services which include roads, electricity supplies and telecommunication. The relationship between infrastructural development and agricultural productivity can been seen in the fact that Agricultural related infrastructures are expected to reduce farmers' costs and accelerate output and produce more employment opportunities in the agricultural sector. [7] claims that agricultural productivity is closely is greatly influenced by infrastructure like road, ICT. [1] show that agricultural output increases with the improvement in the quality of the roads. As further argued by ([22]), roads, electricity supplies, telecommunication and other infrastructure are important stimulant to agricultural output, especially in rural areas.

In the past decade, improvement in infrastructural development has been recorded by ECOWAS countries. According to AFDB (2016), development in the ICT sector is followed, rather not closely, by growth in the transport sector. Despite this, the current state of road networks in Africa generally, in comparison with other continents of the world shows that Africa continues to lag behind in both availability and quality of road networks. In ECOWAS, two initiatives have been put in place towards improving infrastructure in the region. The first is the Program for Infrastructure Development for Africa (PIDA) designed to support the African Union Abuja Treaty and the Africa Economic Community. The second is the Africa Infrastructure Country Data (AICD) endorsed by NEPAD, the development banks and several other bodies. The key focus of both programs is to provide new ways and means of putting infrastructure to boost agricultural productivity, create jobs and ignite growth. Through public-private partnership, the ECOWAS infrastructure Projects Preparation and Development Unit (PPDU) on regional infrastructure was also established to ensure that the PIDA initiative was successfully implemented. Despite these measures, basic infrastructures available in ECOWAS countries are still inadequate and have remained behind global performance.

World Bank Report (2018) indicates that the agricultural sector employed 43% of Benin's employed population, 28% of Burkina-Faso's (a far cry from a record of an average of 85% in the early 2000s), 68% of Cape Verde's, 48% of Cote d'Ivoire's, 27% of Gambia's, 41% of Ghana's, 68% of Guinea's, 83% of Guinea-Bissau's, 43% of Liberia's, 58% of Mali's, 75% of Niger's, 36% of Nigeria's (a substantial decline

from an average of 58% in the 1990s and early 2000s), 53% of Senegal's, 61% of Sierra-Leone's and 38% of Togo's population. Moreover, earnings from the agricultural sector constitute a major part of the gross domestic product of most of these economies. It is therefore evident that there is low employment in the agricultural sector and this could be attributed to several factors including lack of modern infrastructure that aid agriculture productivity. [7] asserts that the transformation of the agricultural sector has the potency of stabilizing the economy for growth and employment creation.

The relationship between infrastructural development, agricultural output and agricultural employment continues to attract attention among policy makers. Despite several studies, there is no general consensus regarding the effect of infrastructural development on agricultural output and agricultural employment. The results of previous studies that examined such relationship in developing countries with conflicting results cannot be used to generalize for ECOWAS. Given the huge investment on infrastructural development, it is imperative to evaluate its impact on agricultural output and agricultural employment. With series of collaborations made by ECOWAS countries to improve infrastructure, little attention has been placed on its effect on agricultural output and agricultural employment. At macro level, the relationship between infrastructure, the growth of agriculture output and employment is still not clear for ECOWAS countries. Going beyond previous studies, the aim of this paper is to examine the effect of infrastructural development on agricultural output and agricultural employment in ECOWAS rather than merely examining the impact of infrastructure on agricultural growth. The estimation results indicate that information and communication technology have positive effect on agricultural output while access to electricity has positive effect on agricultural employment. Transport infrastructure had negative and insignificant effect on agricultural performance. A major contribution of this paper is that investment in infrastructural development with a view to improving agricultural output potentially contributes to employment generation.

2. Literature Review

Infrastructural development helps to make goods and available at relatively cheaper rate. This is premised on the Science based agricultural development thesis which emphasizes the use of high and efficient technology to aid productivity. The theory anchors on the development of physical infrastructure to drive optimal agricultural productivity beyond non-tangible assets [19]. Ideally, infrastructural development should improve agricultural productivity through several ways. For instance, rural infrastructure raises agricultural productivity which induces growth in the rural areas, bringing about higher agricultural wages and employment opportunities [12].

Several studies have examined the influence of infrastructural development on agricultural output and agricultural employment with varying outcomes. [14] opine that the development of rural infrastructural stimulates agricultural productivity, economic growth and overall quality of life. [11] provide evidence that various infrastructure affects agriculture output differently depending on the type of commodity. In a study involving African countries, it was found that transport network is essential in the promotion of cocoa and coffee production. Result depicts that in some countries, a percentage improvement in infrastructure increases growth by about 0.5 percent. In Democratic Republic of Congo, [21] estimated the impact of road infrastructure on agricultural production and household wealth. The simulation result reveal that road infrastructure improve market access and in turn affect agricultural productivity and household wealth. Jedwab, [17] examined the impact of transportation infrastructure on agriculture productivity in Ghana using data at a very fine spatial level. The study finds a strong positive effect of railroad on cocoa production. [6] implemented a differences-in-differences estimation to assess the impact of the change in road access on agricultural productivity of smallholder farmers in Kenya. Findings suggest that, since road access improvement occurs more in poorer road access

areas, investment in rural road infrastructure enhances the productivity of rural farmers. In a related study, Escobal & Ponce (2002) compare effect of road infrastructure on agricultural productivity of farmers living near rehabilitated roads to suitable controls in Peru. Results show that rehabilitated road accessibility can be related to changes in income sources, as the rehabilitated road enhances non-agricultural income opportunities, especially from wage employment sources.

[10] used simple linear regression to determine major driving factors associated with agricultural productivity. Results reveal that agricultural land and rainfall had a positive effect on productivity while labor and government effectiveness had a negative effect while agricultural research, extension and country openness had no significant effect. [18] study was on the impact of infrastructure on agricultural development in Bizana, Eastern Cape using both qualitative and quantitative data. Findings reveal that farmers are faced with a number of infrastructural challenges including inadequate access to water, shortage of dams, absence of storage facilities, insufficient health facilities and transport systems especially road network. The state of the local roads determines the quantity of produce to be harvested and transported by the farmer, and the poor state of roads reduces the income generated by the farmers. The study opines that the fundamental infrastructure, which forms the foundation for the agricultural sector and enables the sector to be in sync with other sectors, be prioritized. [12] empirical evidence indicates that there is significant positive relationship between rural infrastructure and agricultural productivity. Electricity and roads infrastructure were found to be most significant determinants of agricultural productivity with rural roads providing important connectivity with growing markets and lessening input and transaction costs. Access to electricity also created employment opportunities for rural households to improve income. [16] also analyzed the effect of rural infrastructure on agriculture output. Findings show rural infrastructure positively affects agricultural output.

Using state-level data for 1970-1993, [5] developed a simultaneous equation model to estimate the direct and indirect effects of different types of infrastructure on agriculture productivity and rural poverty in India. According to the result, an additional investment in rural roads and agricultural research leads to higher agricultural productivity, generates employment and improve per capita income. Investment in other infrastructure (including irrigation, soil and water conservation, health, and rural and community development) also had positive influence, but with modest effect. Similar study was also conducted by [4] using a traditional source accounting approach to identify the specific role of rural infrastructure and other infrastructure in explaining productivity difference among regions. It was found that roads and irrigation have positive and significant influence on agricultural output. Using district-level data for 30 years, [16] analyzed the effect of rural infrastructure on agricultural development in the southern Indian state of Karnataka. The regression analysis shows that infrastructure had positive and significant effect on agricultural productivity growth. Further, the combined effect of availability and utilization of infrastructure had larger effect on agricultural productivity. The finding collaborates the findings of [13] that infrastructural development fosters agricultural productivity, reduces transaction costs associated with agricultural activities and by so doing increase the income of farmers.

In Nigeria, various studies have examined the effect of infrastructure on agricultural productivity and employment. However, a notable feature of all the studies in the use of survey data. For instance, [8] used household agricultural production and income data from 288 rural dwellers to examine the effect of road infrastructural development on agricultural output and income of rural households. The results indicate that rural roads have a significant positive effect on agricultural output, reduce transportation costs, stimulate the demand for rural labour and improve rural income. [20] examined the impact of road transport on agricultural productivity. It employed both descriptive and analytical statistical methods to analyze the data gathered. The findings shows that road transport has both positive and negative impact on agricultural

productivity. The bad conditions of the road affect cost of transportation of agricultural produce which in turn reduce farmers' income. In a study on the influence of rural transportation on agricultural productivity, [9] adopted the Herfindhal Index and Technical Efficiency Approaches and find road has positive effect on agricultural productivity. Similarly, [2] examined access to infrastructure and its effects on agricultural productivity using descriptive statistics and total factor productivity model. The total factor productivity model adopted reveal that farm size and labour had positive and significant effect on productivity. In terms of the infrastructural elements, improvement in soil practices and extension visits had positive effects on productivity. In a recent study, Ogunyele, et al (2018) investigated the effects of road transport infrastructure on agricultural productivity, using annual data from 1985-2014. The study concluded that a positive and statistically significant relationship exists between road transport infrastructure and agricultural productivity. Evidence was found of a unidirectional causality from agricultural sector development to transport infrastructure.

3. Theoretical Framework and Model Specification

The study anchors on the [3] framework with slight modification by assuming Cobb-Douglas production function of the form:

$$Q_t = A_t K_t^\rho F_t^\theta L_t^{1-\rho-\theta} \tag{1}$$

where Q = Agriculture productivity, A = Technical progress, K = Capital stock, F = Infrastructure, L = Labour force, t = time period. Given that (K) is enhanced by (F) just like (F) is influenced by (K), then their respective marginal products can be given as:

$$\frac{\partial Qt}{\partial kt} = \theta A_t K_t^\rho F_t^{\theta-1} L_t^{1-\rho-\theta} > 0 \tag{2}$$

$$\frac{\partial Qt}{\partial Ft} = \rho A_t K_t^\rho F_t^{\rho-1} L_t^{1-\rho-\theta} > 0 \tag{3}$$

Since investment in infrastructure is financed from government budget, Eqs. (2) and (3) assumes a constant savings rate and that capital depreciates each year, infrastructure for the next year is a proportional of total savings such that:

$$F_{t+1} = \lambda Q_{t+1} \tag{4}$$

From Eq. (4), it is implied that investment in capital stock is deduced as:

$$K_{t+1} = (1 - \lambda t)sQ \tag{5}$$

Substituting capital accumulation equations, that is Eqs. (4) and (5) into Eq. (1) yields equation for the evolution of growth rate of agricultural output which is stated as:

$$(Q)_{t+1} = (A)_{t+1} S^{\rho+\theta}(1-\lambda t)\rho\lambda t^\theta (Q)t^{\rho+\theta}\left(L_{t+1}\right)\rho+\theta \tag{6}$$

On the premise that the evolution of technical progress is given as A_t, investment in infrastructure is λt while the size of labour force is L_t. If each of these is stochastically determined exogenously, then the model for agriculture productivity can be expressed as:

$$\beta_t = \beta_0 + \eta_t + U_t \tag{7}$$

Eq. (7) portrays that agricultural productivity depends on a constant (β_0), a trend rate of growth (η) and a random term that is stationary. While the determining force in the exogenous growth model is technical progress, in the endogenous growth model, chances are that shock to infrastructure on the level of agriculture productivity.

3.1. Empirical Model

The empirical model for the study flows from the objectives which are in two folds: (i) to estimate the impact of infrastructural development on agricultural output and (ii) to ascertain the impact of infrastructural development on agricultural employment. In line with this, the study is guided by the following hypotheses: (i) infrastructural development has no significant effect on agricultural output, and (ii) infrastructural development has no significant effect on agricultural employment.

In reality, modeling the relationship between infrastructural development and agricultural output on one hand and the relationship between infrastructural development and agricultural employment on the other hand is likely to be more complex than the production function modeled above. In line with literature, model for estimation is specified in augmented mean group estimator (AMG) in panel form as:

$$\begin{aligned} \text{lnagr\_p}_{it} = {} & \beta_i + \lambda_{1i}\text{lnelc\_g}_{it} + \lambda_{2i}\text{lntran\_s}_{it} + \lambda_{3i}\text{lnifc\_a}_{it} \\ & + \lambda_{4i}\text{lnempa\_g}_{it} + \lambda_{5i}\text{lnagr\_d}_{it} + \varepsilon_{it} \end{aligned} \tag{8}$$

$$\begin{aligned} \text{lnempa\_g}_{it\,it} = {} & \lambda_i + \lambda_{1i}\text{lnelc\_g}_{it} + \lambda_{2i}\text{lntran\_s}_{it} + \lambda_{3i}\text{lnifc\_a}_{it} \\ & + \lambda_{4i}\text{lnagr\_d}_{it} + \lambda_{5i}\text{lngdp\_g}_{it} + \lambda_{6i}\text{lnfdi\_m}_{it}\ \varepsilon_{it} \end{aligned} \tag{9}$$

where agr_p is agricultural output (agricultural value added as % of GDP), elc_g is electricity (access to electricity in rural areas as % of population), tran_s = transport infrastructure (rural roads), ifc_a is access to and use of information and communication technology (access and use of ICT composite index, which comprise of percentage of individuals using the internet, fixed-broadband internet subscriptions per 100 inhabitants, active mobile-broadband subscriptions per 100 inhabitants, mobile-cellular telephone subscriptions per 100 inhabitants, international internet bandwidth per internet user, percentage of household with computer, percentage of households with internet access), empa_g is agricultural employment (% of employed population in agriculture), agr_d = arable agricultural land (% of total land area), gdp_g = economic growth (GDP growth, % annual growth in US$ million), fdi_m is foreign direct investment (% of GDP in US$ million), λ_1, λ_2, λ_3, λ_4 and λ_5 is estimated coefficient for each variable, i (i = 1,...,N) denotes the individual countries, while t denotes time (t = 1,...,T).

3.2. Data and Estimation Technique

Data for the study covers the entire ECOWAS countries from 2000-2017. The data were sourced variously from World Bank's World Development Indicators and Africa Infrastructure Development Index. ECOWAS is a regional economic union established in 1975. It comprises of two blocs, the West African Economic and Monetary Union (UEMOA) and the West African Monetary Zone (WAMZ), (*see appendix for the list of countries in each zone*). Collectively, these countries cover an area of 5,114,162 km^2 (1,974,589 sq mi), and had an estimated population of over 349 million in 2015. The level of youth unemployment in the region is still high with an average of 65 percent ECA/SRO-WA (2015) estimated that the youth unemployment rate in the region is generally 1.9 times higher than that of adults

For robustness of analysis, three forms of infrastructure are included which are expected a-priori to be positive. Two indicators which are agricultural output (value added) and agricultural employment are chosen to capture the performance of the agricultural sector. The choice of these variables is guided by literature and previous studies. In the second model, economic growth is included as a control variable alongside foreign direct investment because they have a great role in the potential agricultural output and employment to be generated in the long run. Access to electricity creates various income-earning opportunities for rural farmers. Transport in the form of rural roads raises agricultural productivity, which in turn induces improved opportunities. Rural roads provide the important connectivity with growing markets as they lessen input costs and transaction costs of rural producers and consumers [12]. While foreign directed investment, electricity, information and communication technology, transport, agriculture land is expected to have positive effect, economic growth is expected to have negative effect.

Table 1
Variable and Descriptive Statistics.

Variable	Mean	Standard deviation	Minimum	Maximum
agr_p	30.78	13.85	6.41	79.04
empa_g	52.31	18.56	3.96	84.69
elc_g	32.97	21.82	0.01	92.61
tran_s	7.26	6.19	1.08	28.27
ifc_a	3.46	5.38	0.00	32.87
agr_d	48.62	16.76	17.62	80.92
gdp_g	4.63	5.04	-30.15	33.74
fdi_m	1.92	3.15	0.90	5.15

Source: Author's compilation.

The augmented mean group (AMG) estimation technique is adopted for our model estimation for its ability to capture both short and long run effects from a general autoregressive distributed-lag model when crossectional dependence, cointegration and non stationarity are established. In essence, it has the ability to assess the cointegration of variables despite being of different orders of integration I(0) and I(1). It takes the cointegrating form of the simple ARDL and is better at handling small samples and dynamic source of biases. [15] note that the pooled mean group (PMG) estimator merges both pool and averages allowing the intercept, short-run coefficient, and error variances to differ across the groups. In a study such as this where countries under study have economic, geographical or other factors which are common to them as well as heterogeneous levels of technology and productivity which may affect them in different ways, the AMG is a preferred estimator because it accommodates cross-sectional dependence and parameter heterogeneity which is common in cross-country production functions. In the implementation of the AMG, a pooled regression model augmented with year dummies is estimated by first difference ordinary least squares. The introduction of year dummies in estimations is to wipe out bias from cross sectional dependence. The time dummy coefficient approximates the unobserved common factors that are potentially driving the variables in each panel unit. The regression model also includes an intercept α_i, which captures time-invariant fixed effects as:

$$y_{it} = \alpha_i + \beta_i x_{it} + d_i \hat{\mu}_t + c_i t + e_{it} \tag{10}$$

More importantly, AMG estimates are generated as averages of the individual country estimates, an indication that the parameters are averaged across the panel to obtain the group-specific model.

4. Result and Discussions

4.1. Summary Statistics

Before proceeding to the regression analysis, it is instructive to get first hand information on the behaviour of the variables in the empirical analysis. In this regard, the summary statistics and correlation that exist among the variables was conducted. The descriptive statistics of the variables is presented in Table 1.

The descriptive statistics show that, on the average, agricultural output stood at 308 while for percentage employment in the agricultural sector stood at 52. Mean access to electricity was 33 in relation to people with access to electricity in rural areas, mean transport infrastructure stood at 78 while mean access to and use of information and communication technology stood at 35 per 100 inhabitants. Mean arable agricultural land is 46 of total land area, while the economy grew at the average of 4.6 percent. The mean foreign direct investment stood at US\$ 1.92. The result of the correlation matrix reveal that the highest correlation was 0.5417 between electricity and transport infrastructure which is less than 0.80, an indication that the problem of multicolinearity does not arise (*see appendix*).

4.2. Panel Unit Root Test

The Levin-Lin-Chu (2002), Im-Pesaran-Shin (2003), ADF-Fisher and the PP-Fisher tests with null hypothesis of no unit root was carried out, however only the Im-Pesaran-Shin (2003) test result is presented in Table 2.

The unit root test result indicates that transport infrastructure, agricultural land and foreign direct investment have no unit root, while economic growth, agricultural output, employment in the agriculture and electricity have unit root at level form but became stationary after first difference, and thus are integrated of I(1). Hence nonstationarity of dataset poses no problem for the AMG estimator

4.3. . Lemma 1: To determine the impact of infrastructural development on agricultural output

In line with the first objective, we estimated the impact of infrastructural development on agricultural output and the result presented in Table 3.

The result of the impact of infrastructural development on agricultural output presented in Table 3 indicates that other things remaining equal, a percentage increase in access to electricity and information and communication technology improve agricultural output by 0.33 percent and 0.28 percent respectively. Although the result is in line with the *a-priori* expectation, the effect is less than unity, an indication that the infrastructure have not contributed meaningfully to agricultural output. The positive but insignificant effect of access to electricity implies that enough has not been done in the sector to yield considerable positive effects in the agricultural sector. This could also imply that the level of access to electricity in the rural areas where there is ample land and greater practice of agricultural activities is quite poor. Contrary to expectation, both transport and agricultural land are negatively related to agricultural output. As indicated, a percentage increase in transport infrastructure and agricultural land reduces agricultural output by 2.93 and 0.39 percent averagely, though not statistically significant, an indication that transport infrastructure and agricultural land has negative effect on agricultural output. This contradicts the findings Jedwab, et al (2018) that transport infrastructure has positive effect on agriculture productivity in Ghana, Ogunyele, et al (2018) in the case of Nigeria and [16] in the southern Indian state of Karnataka. The results however contradict the work of [10] that agricultural land positively reinforces productivity. On the basis of the finding, we accept the hypothesis that infrastructural development has no significant impact in agricultural output.

4.4. Lemma II: To ascertain the impact of infrastructural development on agricultural employment

In line with the second objective of the paper, which is to ascertain the impact of infrastructural development on agricultural employment, the estimated result is presented in Table 4. The result shows that access to electricity, transport infrastructure and agricultural land are positively related with agricultural employment. On the converse, economic growth, access to information communication technology and foreign direct investment has negative effect on agricultural employment

As visualized by the coefficients, a 10 percent increase in access to electricity, investment in transport infrastructure and agriculture arable land improves agricultural employment by 0.25 percent, 6.27 percent and 0.85 percent respectively while a similar increase in economic growth, access to information communication technology and foreign direct investment reduces agricultural employment by 0.11 percent, 0.91 percent and 3.43 percent respectively. Among the explanatory variables, transport infrastructure has the greatest positive impact on agricultural employment. These results are consistent with those of [5,12] that transport infrastructure and access to electricity improve

Table 2
Result of Panel Unit Root Test.

Variable	Im-Pesaran-Shin (level) Statistic	Im-Pesaran-Shin (level) p-value	Im-Pesaran-Shin (1st diff) Statistic	Im-Pesaran-Shin (1st diff) p-value	Order of integration
agr_p	-0.86015	0.1949	-9.17284	0.0000	I(1)
agr_p	2.55236	0.9947	-4.01066	0.0000	I(1)
elc_g	5.98720	1.0000	-9.38150	0.0000	I(1)
ifc_a	-10.2332	0.0000			I(0)
tran_s	-2.51330	0.0060			I(0)
agr_d	-1.82200	0.0342			I(0)
fdi_m	-2.13632	0.0163			I(0)

Source: Author's compilation.

Table 3
Result of impact of infrastructural development on agricultural output.

	Coefficient	z-statistic	*p*-value
elc_g	0.3279	1.67	0.095
tran_s	-2.9271	-0.54	0.589
ifc_a	0.2739	2.09	0.037
empa_g	1.4731	3.22	0.001
agr_d	-0.3939	-0.49	0.623
Constant	-0.3349	-0.50	0.620
Wald Chi²(5) = 18.39 Prob > Chi² =0.0025			
Number of observations = 196			

Source: Authors compilation.

Table 4
Result of the impact of infrastructural development on agricultural employment.

Variable	Coefficient	z-statistic	Probability value (z-stat)
elc_g	0.2484	2.10	0.036
tran_s	6.2721	1.20	0.231
ifc_a	-0.1137	-0.46	0.648
agr_d	0.8549	1.54	0.123
gdp_g	-0.9143	-2.04	0.041
fdi_m	-0.3428	-0.93	0.353
Constant	-23.1981	-0.57	0.571
Wald Chi²(6) = 13.49 Prob > Chi² =0.0358			
Number of observations = 196			

Source: Authors compilation.

employment opportunities in the agricultural sector, especially in rural areas, The positive effect of access to electricity on agricultural employment further indicates that in the region, availability of electricity does not deter people from engaging in agriculture, rather it encourages them. In this regard, such infrastructure need to be channeled towards encouraging increased labour involvement in agriculture. This is in line with literature that rural roads improve agricultural productivity which in turn creates employment opportunities to rural households. While the availability and quality of rural infrastructure are never substitutes to efficient macroeconomic and agriculture-specific policies, inadequate infrastructure can be a significant constraint to agricultural growth and productivity. Contrary to expectation, information and communication technology has positive effect on agricultural employment. The negative effect of foreign direct investment on agricultural employment, which is contrary to expectation, is an indication that foreign direct investment, especially those not targeted at agricultural productivity may have indirect effect on agricultural employment. Overall, we accept the null hypothesis that infrastructural development has no significant on agricultural employment in ECOWAS. With a value of 0.0358, which is less than 0.05, the overall probability chi square for the augmented mean group estimation is significant.

5. Conclusion and Policy Recommendation

Though investment in infrastructural development is being advocated for developing countries of Africa by many, little empirical exists on the beneficial impact of infrastructural development on sustainable agriculture. Using a pane data for ECOWAS, this paper offers support for the proposition that investment in infrastructural development with a view to improving agricultural productivity potentially contributes to employment generation.

The results show that the selected form of infrastructure (electricity, transport infrastructure and information and communication technology) has close relationship with agricultural productivity across ECOWAS. Indeed, the model presented and specified in this paper improves upon previous studies at the macro and regional level in terms of including richer explanatory variables within the estimation that explicitly takes into unobservable country-specific factors.

Thus, a number of policy interventions could be effective towards the attainment of sustainable agriculture in ECOWAS region. The result supports the view that infrastructural development is effective in achieving sustainable agriculture in ECOWAS. While electricity and information telecommunication technology enhances agricultural output, electricity, transport and agricultural land areas improves agricultural employment, although they have minimal impact. In designing sustainable agricultural policy in ECOWAS region, emphasis should be on the provision of electricity, roads and sustenance of information telecommunication technology environment and making use of more land for agricultural activities. Though empirical results on the relationship between infrastructure, agriculture output and employment in the agricultural sector are mixed, the usefulness of infrastructural development agriculture in ECOWAS should not be underestimated.

Appendix

ECOWAS COUNTRIES	
FRANCOPHONE-COUNTRIES	*ANGLOPHONE-COUNTRIES*
Benin, Burkina Faso, Cote d'Ivoire, Mali, Niger, Senegal, Togo and Guinea Bissau	Cape Verde, The Gambia, Ghana, Guinea, Liberia, Nigeria, Sierra Leone

Correlation Result

	EMPAG	ELCT	TRANS	ICT	AGL	GDPG	FDI
EMPAG	1.0000						
ELCT	-0.0984	1.0000					
TRANS	-0.0659	0.5417	1.0000				
ICT	-0.0287	0.4525	0.2467	1.0000			
AGL	-0.1672	0.2059	-0.2809	-0.0064	1.0000		
GDPG	-0.0733	0.0599	0.0372	-0.0796	0.1018	1.0000	
FDI	0.0320	-0.2258	-0.0569	-0.0529	-0.2857	-0.1879	1.0000

Source: Authors compilation

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