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Estimating The Effect Of Production Factors On Agricultural Output In ECOWAS: Using Least Square Dummy Variable (Fixed Effects) Model

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Abstract: ***The economic growth of the Economic Community of West African States (ECOWAS) has fallen short of 7% growth rate which is required to achieve the Millennium Development Goals (MDGs) due to the declining nature of agricultural productivity growth in ECOWAS. This study employed panel data in estimating the effect of production factors on agricultural output in ECOWAS member states (1971-2009) using least square dummy variable (fixed effects) model. The panel data employed in the study consists of information on agricultural production and means of production obtained from FAO AGROSTAT on thirteen selected ECOWAS member states. The panel data span over a period of 39 years (1971 -2009).***

In its broad objective, the study investigated the effect of the different production factors that influence agricultural output in ECOWAS member states. Specifically, the study was carried out to: describe the structure of the ECOWAS agriculture; and estimate the effect of the different production factors that influence agricultural output in ECOWAS member states.

On the average in ECOWAS, the GDP growth (4.30%) exceeded the GDP per capita (1.44%); the value of exports of goods and services ($2.58 billion) exceeded the value of imports of goods and services ($2.15 billion); the value of gross domestic product ($7.49 billion) exceeded the value of share of GDP from agriculture ($2.12 billion).

The study concluded that the capacity of agriculture to fuel the economic growth among the member states of ECOWAS is still grossly under-utilized due to very low investment in rural infrastructural growth, high prevalence of malaria, political instability, widespread corruption and domestic armed conflicts or incessant civil war.

Keywords: Data Envelopment Analysis, Standard Full Cumulative Approach, Efficiency, Productivity, ECOWAS

I. INTRODUCTION

West African countries are open small economies in which agricultural export is by far the dominant source of foreign exchange earnings. The region's exports mostly comprise a limited range of agricultural commodities. The export of primary commodities dominates economic activities in the West African region. The volume of exports is very concentrated on one or two commodities because of the predominance of oil, making the trade situation very vulnerable with such resultant effects as fluctuation in trade balance, low export growth and poor economic growth as oil prices vary. The limited diversity of exports has made many of them vulnerable to global commodity price fluctuations and there is the continued small share of intra-regional trade. Intra-ECOWAS trade is about 10% of their total international trade; however 40% of ECOWAS trade is with the EU (Ademola,

1997; Seka, 2009; BCEAO Statistical Bulletin, World Bank, 2011; ECOWAS Statistical Bulletin, 2011).

The productivity of ECOWAS agriculture has been hampered by the outcomes of past poor agricultural and economic policies in member states, civil and social unrest, burgeoning population, resource mismanagement and failure to build capital and strengthen local industries in certain member states like Guinea, Guinea Bissau, Sierra Leone, Liberia, Mali and Nigeria (ECA, 2002). Internal conflicts with its spillover effect have severely disrupted all the efforts aimed at engendering and sustaining the social and economic development of ECOWAS in the last two decades (Ayee, 2002; Atuobi, 2007). At the present level of resources (technical, technological, financial, etc.) in the sub-region have not allow ECOWAS member states to experience true economic liberalization (UNECA, 2012; Ogbonna et. al., 2013). The ECOWAS internal conflicts engineered by widespread of corruption have allowed the weapons trafficked across the sub-region are eventually used by rebel groups and criminals for fighting civil wars, as in the case of Liberia, Sierra Leone and Cote D¨Ivoire, among others, or used for armed robbery (Addo, 2005; Atuobi, 2007).

The economic growth of the ECOWAS region is still far below the minimum 7% required to attain the Millennium Development Goals, a problem that can be traced to the crawling nature of the per capita agricultural GDP in the sub-region. Thus, for future sustainable agricultural growth in the ECOWAS region, a greater emphasis will have to be on agricultural productivity growth of its member state, because suitable land areas for new cultivation are declining in nutrient and vigor, especially with the prevalence of environmental issues and climate change (IFPRI, 2010; World Bank, 2011).

The study is undertaken to provide answers to the following research questions: (i.) What is the structure of agricultural production sector in ECOWAS? (ii.) What are the various production factors that have contributed to agricultural productivity growth in ECOWAS member states?

The broad objective of the study is to investigate the estimating the effect of production factors on agricultural output in ECOWAS member states (1971-2009) using least square dummy variable (fixed effects) model. To achieve the above objective, the specific objectives are to: describe the structure of the ECOWAS agriculture within the reference period; and estimate the effect of the different production factors that influence agricultural output in ECOWAS member states. The hypothesis of the study is (i.) There is no significant relationship between the growth in the per capita agricultural production and factor of agricultural production among ECOWAS member states.

II. MATERIALS AND METHODS

PANEL DATA AND PANEL UNIT ROOT TESTS

Panel (or longitudinal) data are cross-sectional and time-series. A panel data set contains *n* entities or subjects (e.g., firms and states), each of which includes *T* observations measured at 1 through *t* time period. Thus, the total number of observations is *nT*. Ideally, panel data are measured at regular time intervals (e.g., year, quarter, and month). Otherwise, panel data should be analyzed with caution. The use of panel data sets for economic research has several major advantages over conventional cross-sectional or time-series data sets (Park, 2009).

PANEL REGRESSION

FIXED EFFECTS MODEL USING LEAST SQUARE DUMMY VARIABLE (LSD): According to Ulrich and Frauke (2009), fixed-effects model controls for all time-invariant differences between the individuals, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics…[like culture, religion, gender, race, etc]. Fixed effects panel regression using least square dummy variable (LSDV) provides a good way to understand fixed effects. The effects of all the independent variables are mediated by the differences across countries. The dummy for each country allows for the estimation of the pure effects of all the independent variables by controlling for the unobserved heterogeneity. Each country dummy is absorbing the effects particular to each country (Baltagi, 2008; Baum, 2006). In order to capture estimating the effects of the different production factors on the agricultural output (i.e. per capita value of agricultural production) in ECOWAS agriculture, the fixed effects panel regression using least square dummy model was carried out.

The equation for the fixed effects model of this study is presented as:

$$Y_{it} = \beta_1 X_{1t} \ldots + + \ldots \beta_4 X_{4t} + \alpha_i + u_{it} \ldots\ldots\ldots\ldots\ldots (1.)$$

Where α_i (I =1….n) is the unknown intercept for each entity (n entity-specific intercepts); Y_{it} is the per capita value of agricultural production, where i = entity and t = time; X_{1t} - X_{4t} represent the independent variables like: Agricultural land area, fertilizer consumptions, tractorization and rural population; $\beta_1 - \beta_4$ are the coefficients of the various independent variables like: Agricultural land area, fertilizer consumptions, tractorization and rural population; u_{it} is the error term. The country dummies (for country effect) were also included in the analysis to capture the effects of various production factors specified in the model on each of the countries included in the analysis.

DATA, DATA SOURCE AND MEASUREMENT OF VARIABLES

Panel data on output and conventional agricultural inputs (land, labor, fertilizer, and machinery) for the 13 ECOWAS countries for the period 1971–2009 were accessed from the FAOSTAT database (FAO, 2011).The data collected from FAOSTAT include: (a.) Per Capita Value of Agricultural Production (1971-2009) (i.e. Value of agricultural production divided by the total population). (b.) Input data (1971-2009) which are: (i.) Agricultural land which include total arable land area, permanent cropland and pasture measured in ‘000 ha. (ii.) Fertilizer consumption measured in metric tonnes. (iii.) Agricultural machines which are number of tractors – wheel and crawler – used in agriculture as a measure of the use of modern technological tools. (iv.) Labour measured in

thousands and covers the economically active population involved in agriculture.

III. RESULTS AND DISCUSSION

THE PERFORMANCE PROFILE ON MEMBERS OF THE ECONOMIC COMMUNITY OF WEST AFRICAN STATES (ECOWAS)

In the ECOWAS Sub-region, the report based on the statistics from the database of the Food and Agricultural Organization (FAOSTAT, 2011) as shown in Table 1 reports that between 2000 and 2009, at annual % level, the mean population growth is 2.77%, the mean urban population growth is 3.95%, the mean rural population growth is 1.80%, the GDP growth is 4.30% and the GDP per capita is 1.44% , the mean GDP at current US$ is $11.8 billion, the mean life expectancy at birth (in total years) is 54.3years, the mean labour force participation rate (15-64years) is 71.5 and the mean food production index (1999-2000 = 100) is 118.4 respectively. Between 2005 and 2011, the mean Human Development Index (HDI) is 0.394. Between 1970 and 2009, the mean value of Gross Capital Formation is $1.19 billion; the mean value of exports of goods and services is $2.58 billion; the mean value of imports of goods and services is $2.15 billion; the mean value of Gross Domestic Product is $7.49 billion; the mean value of share of GDP from agriculture is $2.12 billion; the mean value of share of GDP from Mining, Manufacturing and Utilities is $2.53 billion and the mean total value added is $6.97 billion respectively.

In the ECOWAS Sub-region, the report from the map of graphs on ECOWAS countries in Figure 8, between 1970 and 2010, the per capita GDP and per capita agricultural GDP have both been on the increase though at a very high margin difference. While the per capita GDP has soared very high, the per capita agricultural GDP has simply crawled up over the entire period. By implications, it means that the capacity of agriculture to fuel the economic growth of ECOWAS is still grossly under-utilized. The agricultural sector of ECOWAS has not been able to contribute immensely to the development of its economy despite the conduciveness of the environment, climatic factors as well as available human resources.

Variable	Mean	S. D	Min	Max
Urban population growth (annual %) (2000 - 2009)	3.95	0.88	2.21	8.04
Rural population growth (annual %) (2000 - 2009)	1.795	1.016	-4.47	4.58
GDP growth (annual %) (2000 - 2009)	4.298	5.01	-31.3	27.46
GDP per capita growth (annual %) (2000 - 2009)	1.439	4.70	-33.07	22.62
GDP current (Current US $Billion) (2000 - 2009)	11.8	30.6	0.199	207
Life expectancy at birth, total (years) (2000 - 2009)	54.3	6.5	41.85	71.31
HDI (2005 -2011)	0.394	0.078	0.265	0.57
Gross Capital Formation (US $Billion) (1970 -2009)	1.19	2.62	0.088	19.8
Exports of Goods and Services (US $Billion) (1970 -2009)	2.58	6.99	0.039	72.1
Imports of Goods and Services (US $Billion) (1970 -2009)	2.51	4.36	0.032	36.7
Gross Domestic Product (US $Billion) (1970 -2009)	7.49	17.2	0.162	130
Share of GDP from Agricultural Sector (US $Billion) (1970 -2009)	2.21	5.14	0.042	47.1
Total Value Added (US $Billion)(1970 -2009)	6.97	16.7	0.167	142

Source: Data Analysis, 2014

Table 1: The Performance Profile on ECOWAS

PANEL UNIT ROOT TEST

In order to avoid spurious regression and analysis in this study, panel unit roots tests were carried out to first examine whether the variables are stationary. If variables are non-stationary, ordinary panel techniques of estimation by least squares will be inconsistent and standard inference of the coefficient will also be impossible. In this study, four unit root tests for panel data are applied to assess stationarity. The tests are Levin Lin and Chu t-stat, IPS, ADF Fisher chi square, and Phillip Perron Fisher chi square. All the tests include individual constants and individual trends. Levin Lin and Chu (LLC) assume a common root unit root process while Phillip Perron (PP), IPS and Augmented Dickey Fuller (ADF) allow for individual unit root process so that the autoregressive coefficient can vary across units (Levin et. al., 1993, 2002). The tests are provided by the econometric software package E-view 5. Table 2 below presents the results of panel unit root test. Through the estimation, it was found that all variables are I(1) except for Rural Population (X_4) which is I(2). Under the level data sets, LLC, IPS, ADF-fisher and PP-fisher test are almost non-stationary series for all the variables (Agricultural land area, fertilizer consumption, tractorization, rural population and per capita value of agricultural production). Under the difference form, all variables reject the unit root null hypothesis (i.e. Agricultural land area, fertilizer consumption, tractorization and per capita value of agricultural production are stationary at I(1) while rural population is at I(2)). The results reported in Table 2 shows that at 1st differencing ((i.e. X_1, X_2, X_3, and Y) and 2nd differencing (i.e. X_4) respectively, all variables are stationary using LLC, IPS, ADF-fisher and PP-fisher test.

Variables	PP Fisher	LLC	ADF Fisher	I.P.S	Decision
X_1	190.70 (0.00)	-9.89 (0.00)	129.30 (0.00)	-	Stationary at I(1) (No intercept and trend).
X_1	184.20 (0.00)	-10.21 (0.00)	151.24 (0.00)	-11.19 (0.00)	Stationary at I(1) (With intercept).
X_2	670.26 (0.00)	-15.96 (0.00)	281.61 (0.00)	-	Stationary at I(1) (No intercept and trend).
X_2	237.16 (0.00)	-10.13 (0.00)	138.23 (0.00)	-8.74 (0.00)	Stationary at I(1) (With intercept)
X_3	206.39 (0.00)	-10.95 (0.00)	158.35 (0.00)	-	Stationary at I(1) (No intercept and trend).
X_3	151.05 (0.00)	-12.31 (0.00)	130.37 (0.00)	-8.75 (0.00)	Stationary at I(1) (With intercept).
X_4	76.31 (0.00)	-8.19 (0.00)	107.68 (0.00)	-	Stationary at I(2) (No intercept and

					trend).
X_4	38.20 (0.00)	-2.05 (0.00)	69.14 (0.00)	-5.42 (0.00)	Stationary at I(2) (With intercept)
Y	824.03 (0.00)	-18.86 (0.00)	374.31 (0.00)	-	Stationary at I(1) (No intercept and trend)
Y	281.97 (0.00)	-14.05 (0.00)	201.41 (0.00)	-14.84 (0.00)	Stationary at I(1) (With intercept)

Source: Data Analysis, 2014

Table 2: Panel Unit Root Test Results

RESULTS OF PANEL REGRESSION (FIXED EFFECTS USING LEAST SQUARE DUMMY VARIABLE MODEL) FOR THE ESTIMATION OF THE EFFECTS OF VARIOUS PRODUCTION FACTORS ON THE AGRICULTURAL OUTPUT IN ECOWAS

From the results of panel regression (fixed effects using least square dummy variable model) for the estimation of the effects of various production factors on the agricultural output in ECOWAS (1971 - 2009) in Table 3, an adjusted R square of 0.9585 shows that 95.85 percent of the explained variation in the per capita value of agricultural production is due to the joint effect of such exogenous variables like agricultural land area, fertilizer consumptions, tractorization and rural population, which were specified in the model. All the variables such as agricultural land area, fertilizer consumptions, tractorization and rural population included in the model significantly influence the per capita value of agricultural production at 1 percent level of significance respectively.

Lnpercapitalvalueofagric Production	**Coefficient.**	**Std. Err.**	**z**	**P>|t|**
Constant	0.910	0.711	1.28	0.201
Lnagricarea	0.945	0.122	7.72*	0.000
Lnfertilizerconsumption	0.032	0.010	3.04*	0.002
Lntractorization	0.144	0.015	9.80*	0.000
Lnrural population	-0.500	0.057	-8.71*	0.000
Burkina Faso	-1.575	0.146	-10.78*	0.000
Cote D'Ivoire	-1.559	0.232	-6.71*	0.000
Gambia	0.050	0.126	0.39	0.693
Ghana	-1.572	0.189	-8.32*	0.000
Guinea	-1.604	0.218	-7.36*	0.000
Liberia	-2.266	0.077	-29.46*	0.000
Mali	-2.564	0.308	-8.33*	0.000
Niger	-4.764	0.307	-15.53*	0.000
Nigeria	-0.049	0.333	-0.15	0.882
Senegal	-1.027	0.155	-6.64*	0.000
Sierra Leone	-0.746	0.060	-12.50*	0.000
Togo	-0.671	0.058	-11.50*	0.000
Adjusted R-square = 0.9790 F(16, 490) = 149.86 Prob > chi2 = 0.0000				

Source: Data Analysis, 2014

Table 3: Results of Fixed Effects Using Least Square Dummy Variable Model for the Estimation of the effects of various production factors on the agricultural output in ECOWAS

While tractorization, fertilizer consumptions and rural population had a direct (positively) significant relationship with the per capita value of agricultural production in ECOWAS, rural population had an inverse (negatively) significant relationship with the per capita value of agricultural production. The result shows that one percent increase in fertilizer consumption will result in 0.032 percent increase in the per capita value of agricultural production in ECOWAS agriculture.One percent increase in the numbers of tractors, wheels and crawlers (i.e. tractorization) being engaged by the rural farming households in their various farming activities in the sub-region will result in 0.144 percent increase in the per capita value of agricultural production in ECOWAS. Also, one percent increase in the rural population (i.e. agricultural labour force) will result in 0.500 percent decrease in the per capita value of agricultural production in ECOWAS agriculture. By implication, the growth of the per capita value of agricultural production in ECOWAS agriculture will be improved and efficiently sustained through qualitative extension advisory services, heavy investment in rural infrastructure in order to curtail high rate of rural-urban migration in the sub-region as well as the creation of agricultural capacity for mechanized farming on large acreage of farmland as against the widespread of smallholding farms among ECOWAS countries.

The country effects was captured in the analysis and the result revealed negative country effects on such countries Burkina Faso, Cote D'Ivoire, Ghana, Guinea, Liberia, Mali, Niger, Senegal, Sierra Leone, and Togo which were significant at 1 percent level of significance. Only Nigeria had a negative country that was not significant negative at all the known levels of significance being the only country with a positive current account balance because of its large exports of crude oil and gas which commanded high world prices (ECOWAS Statistical Bulletin, 2011).

In ECOWAS, political crises linked to wars and to the democratization process; the steady degradation of the soil and climate; difficulties accessing factors of production; increasing poverty and lack of control over stocks of foodstuffs; irregular rainfall in the region; and lack of control over water resources, an indispensable factor for agriculture may be responsible for the negatively significant country effects stated above (UNECA, 2012; Ogbonna et. al., 2013).

IV. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study employed panel data in estimating the effect of production factors on agricultural output in ECOWAS member states (1971-2009) using least square dummy variable (fixed effects) model. In its broad objective, the study investigated the effect of production factors on agricultural output in ECOWAS member states (1971-2009) using least square dummy variable (fixed effects) model. Specifically, the study was carried out to: describe the structure of the ECOWAS agriculture; estimate the effect of the different production factors that influence agricultural output in ECOWAS member states;

In the ECOWAS sub-region based on the FAOSTAT (2011), between 2000 and 2009, at annual % level, the mean urban population growth rate (3.95%) is far greater than the mean rural population growth (1.80%). There is a wide gap between the GDP growth (4.30%) and the GDP per capita (1.44%). The mean life expectancy at birth (in total years) is 54.3 years and the mean labour force participation rate (15-64years) is 71.5%. The mean value of Gross Domestic Product is $7.49 billion and the mean value of share of GDP from agriculture is $2.12 billion. The variables that significantly influence the per capita value of agricultural production in

ECOWAS are: fertilizer consumptions, tractorization and rural population. Though all the four panel unit root tests employed to assess stationarity which Levin Lin and Chu t-stat, IPS, ADF Fisher chi square, and Phillip Perron Fisher chi square show that all the variables included in the study (Per Capita Value of Agricultural Production, Agricultural Land Area, Fertilizer Consumptions and Tractorization) are I(1) except for Rural Population (X_4) which is I(2). The Im-Pesaran-Shin (IPS) test was adopted being an extension of Levin Lin and Chu (LLC) t-stat.

The 95.85 percent of the explained variation in the per capita value of agricultural production from the results of the panel regression (fixed effects using least square dummy variable model) for the estimation of the effects of various production factors on the agricultural output in ECOWAS (1971 - 2009) is due to the joint effect of such exogenous variables like agricultural land area, fertilizer consumptions, tractorization and rural population, which were specified in the model. While agricultural land area, tractorization and fertilizer consumptions had direct (positively) significant relationship with the per capita value of agricultural production in ECOWAS, rural population had an inverse (negatively) significant relationship with the per capita value of agricultural production at 1% level of significance respectively. From the major findings of this study, the capacity of agriculture to fuel the economic growth of ECOWAS is still grossly under-utilized despite the conduciveness of the environment, climatic factors as well as available human resources. The ECOWAS sub-region has not been able to utilize its capacity for the maximum production of feasible outputs with respect to goods and services that can help develop its per capita GDP. It is therefore recommended that ECOWAS member states begin to thoroughly implement and execute the content of the ECOWAS agricultural policy (ECOWAP) so as to allow for ease of use of available technologies and production inputs more efficiently to produce more from its available input base, develop their capacity for export market and thereby raising the per capita agricultural GDP that has simply crawled up over the years in the sub-region.

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