Growth Accounting in ECOWAS Countries: A Panel Unit Root and Cointegration Approach

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Abstract Long term economic growth is necessary for poverty reduction and it can be enhanced by increasing the productivity of factors of production. There have been various policy efforts to strengthen economic growth in the ECOWAS region but sustainable economic growth coupled with accelerated poverty reduction remains a challenge. The paper therefore investigates the sources of economic growth in the ECOWAS region with a view to unearthing whether growth of the region during the period 1980–2012 was driven more by factor accumulation or factor productivity. The methodology involves the estimation of a production function with real capital stock and labour as inputs while real GDP is the output, over the period 1980–2012 for the ECOWAS countries. Panel unit root and panel cointegration tests including the Levin-Lin-Chu, Maddala-Wu and Im-Pesaran-Shin tests for unit root and the Pedroni, Kao and Westerlund tests for cointegration are applied. Fixed and random effect models of production function are estimated. The growth accounting technique is then applied to the estimated shares of capital and labour in production. The results show that during the period 1980–2012, with the exception of Nigeria and Cote d'Ivoire productivity growth was not the hard-core of the growth observed in the ECOWAS countries but the growth was driven by factor accumulation. In addition, the contribution of labour to growth was positive but low in all the countries, the contribution of capital was negative in Cote d'Ivoire and Nigeria but positive in the other countries and that of total factor productivity was negative in Burkina Faso, Cape Verde, Ghana, Guinea, Mali, Niger and Senegal. The policy implication of this result is that in order to enhance long run economic growth in ECOWAS countries there is need to exert more efforts at raising productivity of factors of production. This requires more efforts at building human capacity for labour to be more effective and more investment in infrastructure, especially energy, in order to make capital more productive.

Keywords Growth accounting • Panel unit root • Panel cointegration • ECOWAS

JEL Classification O47 • O55

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D. Seck (ed.), *Accelerated Economic Growth in West Africa*, Advances in African Economic, Social and Political Development, DOI 10.1007/978-3-319-16826-5_2

1 Introduction

The causes of differences in growth among countries and variations in growth over time is the centerpiece of the growth literature. The Solow growth model (Solow 1957) for example maintains that in the short run, economic growth is driven by savings while long run growth is driven by a mystery variable, representing the effectiveness of labour. This is discussed in Lucas, 1990 and Romer 2012. The effectiveness of labour is represented by knowledge or technology but the dynamics of labour effectiveness or technology is unexplained in the Solow model and the Neoclassical model in general. On this note, the Solow model is considered as an exogenous model. Later developments led to the endogenous growth model though other forms of exogenous models had been in existence (the infinite horizon model-Ramsy-Cass-Koopmans model and the overlapping generations model-the Diamond model). The endogenous model (Romer 1986; Lucas 1988) posit that investment in research and development (R&D) sector determines technology and the stock of ideas. Thus making workers more production determine long run growth. Hence it is productivity that determines long run growth.

Sustainable economic growth is a concern to policymakers as it is necessary though not sufficient for economic development. This has been long documented by academics and policymakers in both developed and developing countries. It is also emphasized in Todaro and Smith (2012). Knowledge of the contribution of factors of production to the growth process relative to their productivity is therefore necessary in an effort to have direction about sustainable growth that is inclusive and pro-poor.

The average growth of the ECOWAS countries was 3.5 % in 2000, which was lower than the Sub-Sahara African average of the same year, 5.5 %. In 2005 it increased to 5.3 % in ECOWAS and 6.2 % in Sub-Sahara Africa. In 2012, ECOWAS average growth was 6.4 % with sub-Saharan Africa average being 5.4 %. Taking country by country case from 1980 to 2012, some countries observed negative growth in some years while in the same years some others had high growth rates. In addition, in a given country, growth was negative in some countries but high in some years. Table 1 presents some growth trend for the ECOWAS region.

There is dearth of empirical studies on the sources of growth in Sub-Sahara Africa in general and ECOWAS Countries in particular. We are not aware of a study on the ECOWAS Countries as a group even though there are numerous common agenda courses discussed by the various ECOWAS Member States and the countries face challenge on poverty reduction and sustainable growth, though some countries have recently recorded extremely high growth rates—for example, Ghana grew by 15.0 % in 2011 driven by rebasing and Sierra Leone grew by 15.2 % in 2012 driven by discovery of iron ore. These rates were more than 100 % of the average growth rates of sub-Sahara Africa.

The objective of the paper is therefore to investigate the contributions of capital, labour and their productivity (total factor productivity) to the growth of the region since the 1980s. Such investigation is imperative as it is informative in terms where

Table 1 Growth rates of ECOWAS countries

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
SUb-Sahara Africa	**5.7**	**5.2**	**5.6**	**5.9**	**6.2**	**6.4**	**5.6**	**2.5**	**4.5**	**5.2**	**5.4**
ECOWAS	**3.9**	**7.7**	**5.6**	**5.9**	**5.3**	**5.7**	**5.6**	**5.6**	**6.8**	**6.5**	**6.4**
UEMOA	**1.3**	**3.4**	**2.7**	**4.2**	**2.9**	**3.2**	**3.9**	**3.1**	**3.9**	**4.4**	**5.4**
• Benin	4.4	3.9	3.1	2.9	3.8	4.6	5.0	2.7	2.8	3.5	5.4
• Burkina Faso	4.6	8.0	4.6	8.6	5.5	3.6	5.2	3.2	5.2	5.5	9.0
• Cote d'Ivoire	−1.7	−1.4	1.2	1.7	0.7	1.6	2.3	3.8	3.0	4.0	9.8
• Guinea Bissau	−7.2	0.3	2.8	4.3	2.1	3.2	3.2	3.0	3.5	4.3	−1.5
• Mali	4.3	7.6	2.3	6.1	5.3	4.3	5.0	4.5	4.5	6.0	−1.2
• Niger	5.8	3.8	−0.8	7.4	5.8	3.4	9.6	−0.9	7.5	3.2	11.4
• Senegal	1.2	6.7	5.8	5.7	2.5	4.9	3.2	2.2	4.0	4.4	3.5
• Togo	−1.3	4.8	2.5	1.2	3.9	2.1	2.4	3.2	3.4	3.9	5.9
WAMZ	**4.6**	**9.1**	**6.4**	**6.4**	**5.9**	**6.4**	**6.1**	**6.4**	**7.6**	**7.1**	**6.7**
• Gambia	1.3	7.4	6.6	0.3	3.4	6.0	6.1	4.6	5.5	5.1	3.9
• Ghana	4.5	5.2	5.6	5.9	6.4	6.5	8.4	4.7	6.6	6.5	7.9
• Guinea	4.2	1.2	2.3	3	2.4	1.8	4.9	−0.3	1.9	4.0	3.9
• Liberia	7.8	−1.9	−2.8	1.4	3.1	3.2	3.5	3.6	3.7	3.9	8.3
• Nigeria	4.6	9.6	6.6	6.5	6	6.5	6.0	6.7	7.9	7.3	6.6
• Sierra Leone	6.5	10.7	9.6	7.6	6	6	4.0	3.2	5.0	4.9	15.2
Cape Verde	5.3	4.7	4.3	5.6	10.1	8.6	6.1	4.0	5.6	4.5	**1.0**

emphasis has to be placed by policymakers on their drive towards sustainable growth that is inclusive.

There are studies at country specific levels on the issue but a holistic study on ECOWAS Countries is not a common place in the literature. For example, Dike (1995) and Kallon (2013) where on Nigeria and Sierra Leone respectively. There are also studies on group of countries, for example, Zelleke and Sraiheen (2012) for 31 sub-Sahara African countries and Shaaeldin (1989) on Tanzanian, Zambia and Zimbabwe. The dearth of studies on growth accounting in the region is explained by the fact that data on the stock of capital is not readily available for many Sub-Sahara African Countries. However, data on gross capita formation which is essentially the change in the stock of capital is available in most of the statistical institutions in the ECOWAS region as in the case of data on output and labour—though unemployment data generation remains a challenge to most of the countries. Thus, in an effort to decompose the growth of output into total factor productivity growth and factor accumulation, we also construct a series for capital stock for each of the countries over the period 1980–2012.

The rest of the paper is organized as follows. Section 2 discusses the methodology. Section 3 is the empirical results and Sect. 4 is conclusion and policy implications.

2 Methodology

2.1 Specification of the Production Function

The production function is a function of capital and labour. While it can take various forms, for example the Leontiff form, the trans-log form and the Cobb-Douglas form, the Cobb-Douglas form is the form used in macroeconomic policy framework and the growth literature. Our specification of the production function therefore follows the Cobb-Douglas production function as given in Eq. (1). Constant returns to scale and positive but declining marginal productivity is assumed here.

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

Where Y is output, K is the stock of capital, L is labour and A is a shift parameter measuring total factor productivity.

Taking the log of Eq. (1) it can then be differentiated with respect to time to yield Eq. (2).

$$\frac{\partial LnY}{\partial t} = \frac{\partial LnA}{\partial t} + \alpha \frac{\partial LnK}{\partial t} + (1-\alpha)\frac{\partial LnL}{\partial t} \tag{2}$$

The parameters α and $1-\alpha$ are the output elasticities of capital and labour respectively and

$\frac{\partial LnY}{\partial t}$, $\frac{\partial LnK}{\partial t}$, $\frac{\partial LnL}{\partial t}$ *and* $\frac{\partial A}{\partial t}$ are the growth rates of output, capital, labour and total factor productivity respectively while $\alpha \frac{\partial LnK}{\partial t}$, $(1-\alpha)\frac{\partial LnL}{\partial t}$ *and* $\frac{\partial A}{\partial t}$ are the contributions of capital, labout and total factor productivity to growth of output.

Hence, information on the elasticities of capital and labour and the growth rates of output, capital and labour can be used to obtain the growth of total factor productivity. In this regard, our task is to estimate the values of α and hence $1-\alpha$ in Eq. (1) from time series data on output, capital and labour. Once these are known, using the growth rates of capital and labour for historical series, the contributions of capital and labour to growth can be obtained. With these contributions and the growth of output also computed, Eq. (2) can be used to obtain the growth of TFP (its contribution to growth) by the use of Eq. (3), which is obtained from Eq. (2).

$$\frac{\partial LnA}{\partial t} = \frac{\partial LnY}{\partial t} - \alpha\frac{\partial LnK}{\partial t} + (1-\alpha)\frac{\partial LnL}{\partial t} \tag{3}$$

2.2 How the Output Elasticities Are Estimated

In order to estimate the output elasticities, we express Eq. (1) in terms of output per worker (for which labour is used as a proxy). Thus Eq. (1) in terms of output per worker and capital per worker is given as in Eq. (4).

$$\frac{Y}{L}t = A\left(\frac{K}{L}\right)_t^\alpha \tag{4}$$

Taking logarithm on both sides of Eq. (4) therefore gives:

$$y = a + \alpha k \tag{5}$$

Thus, with data on output per worker and capital per worker, the parameter α (output elasticity of capital) and hence $1-\alpha$ (output elasticity of labour) can be obtained.

2.3 Data Consideration

Data is obtained on real GDP, Labour and Gross Fixed Capital Formation for all the ECOWAS countries over the period 1980–2012 except for Liberia, which is left out due to data availability, especially on Gross fixed Capital formation (investment) over the estimation period. The data is obtained from World Bank's World Development Indicators (WDI).

To the extent that the available data is on Gross Capital formation and not capital, this data is used to generate the times series for capital stock using the perpetual inventory method.

The stock of capital is obtained for the period 1980–2012 for each country by assuming a depreciation rate (δ) of 5 % for capital and following Hall and Jones (1999) we apply Eq. (6) to obtain the initial capital stock (the capital stock for 1980-initial capital stock-).

$$K_{1980} = \frac{I_{1980}}{\delta + I_{g(1980-2012)}} \tag{6}$$

Where Ig is the growth of investment (gross fixed capital formation) from 1980 to 2012. Because investment growth is negative for some countries over some periods and the possibility of non-normality of the series for some countries, we use the median of the annual growth rates instead of the average of annual growth rates to represent the growth rate of investment over the period 1980–2012. The data for capital stock is in real form as the constant price gross capital formation was is used.

Hence, the following equation which gives the relationship between gross fixed capital formation (I) and capital stock is used to obtain the capital stock for the period 1981–2012 once the capital stock for 1980 (initial capital stock) is known.

$$I_t = \Delta K_t + \delta K_{t-1} \tag{7}$$

From Eq. (7) capital stock is given as:

$$K_t = I_t + (1 - \delta)K_{t-1} \tag{8}$$

2.4 Estimation Technique for the Specified Model

The specified model given in Eq. (5) deals with time series data on 14 ECOWAS countries from 1980 to 2012. Hence the time dimension (T) is 33 and the number of countries (N) is 14. This is a panel data set with large T and small N. To this effect, the conventional spurious regression problems common in time series data emerges here if it is not checked for. To this end, we test for the existence of unit root in output per worker and capital per worker. That is, we apply panel unit root tests to each series. The conventional panel unit root tests are applied. That is, we apply both the homogenous panel unit root and the heterogeneous panel unit root tests. The homogeneous panel unit root tests are the Levin-Lin-Chu (LLC), Breitung and Hadri tests. The heterogenous panel tests are the Im-Pesaran and Shin (IPS), Maddala-Wu and Choi tests. The homogenous unit root tests assume that the unit rot process are the same for all the countries. That is, either the series for all the countries have unit root or they do not have while in the heterogenous case, the assumption is that some countries could have unit root in a series while the others do not have. However, it does not tell the countries that do not have unit root in case the hypothesis of the existence of unit rot is rejected.

Following the tests for unit root is the test for cointegration, as long as the variables are not stationary. This was explored in this paper. However, in panel data context when the variables are stationary, one should proceed to the estimation of the pool, fixed or random effect model while taking note of the need to test which of them is the most appropriate representation of the data. This method is applied in this paper.

Where there is cointegration a panel error correction is estimated. An alternative to the estimation of a panel error correction model is to estimate the dynamic Ordinary Least Squares (DOLS) or Fully Modified Ordinary Least Squared (FMOL) as they ensure having consistent estimators. The existence of no cointegration (long run relationship among the variables) implies that the variables must be differenced appropriately to obtain stationarity and the transformed variables should be used to estimate a fixed and a random effect model to account for country specific heterogeneity effects. Following which the Hausman test can be carried out to determine the more appropriate representation.

3 Empirical Results

3.1 Panel Unit Root Tests

In this section we present the results of the unit root tests. The idea is to avoid estimating the per worker production function with possible non-stationary variables without accounting for the non-stationarity. Such a flaw leads to misleading inferences as the estimates would be inconsistent. In doing so we use the homogenous class of tests as well as the heterogeneous class of tests for panel unit root. While the former assumes that all the countries have a common unit root process or do not have unit root, the latter assumes that the countries have different unit root processes, implying that while some of them may have unit root others do not have unit root. The Levin-Lin-Chu (LLC), Breitung and Hadri tests, which are the homogenous panel tests, are applied and under the heterogenous panel tests the Im-Pesaran and Shin (IPS), Maddala-Wu and Choi tests are applied. It is also important to note that while the LLC and the Breitung tests have the null hypothesis as '*the variable has unit root*' the null hypothesis under the Hadri test is '*the variable is stationarity*'. In addition, while the IPS test and the homogenous panel tests are individual test, the Maddala-Wu and Choi tests are Fisher type tests in the sense that they involve application of unit root tests to each country followed by combining the results through an F-test of joint existence of unit root in the variable for all the countries.

Table 2 shows the results of the unit root tests. The results show that while output per worker is stationary after first differencing capital per worker is stationary after second differencing. It is also necessary to mention that among the homogenous panel unit root methods applied, while the LLC and the Breitung tests suggests

Table 2 Results of the panel unit root tests

	LLC	Breitung	Hadri	IPS	Maddala-Wu	Choi	Conclusion
Lny	0.9057	0.9947	0.0000	0.9908	0.3884	0.9845	Lny is I(1)
ΔLnY	0.0000*	0.0003*	0.0000	0.0000*	0.0000*	0.0000*	
Lnk	0.0000*	0.9956	0.0000	0.0402*	0.0001*	0.0427*	Lnk is I(2)
ΔLnK	0.4331	0.7365	0.0000	0.2194	0.2560	0.2247	
Δ^2Lnk	0.0000*	0.0000*	0.0429*	0.0000*	0.0000*	0.0000*	

Note: The figures in the table are the probability of failing to reject the null. Hence, a p-value that is higher than 0.05 implies that we fail to reject the null hypothesis of the existence of unit root (the null of stationarity—in the case of the Breitung test). Asterisks have been placed on cases of rejection of the null hypothesis

output per worker is stationary in first difference form, the Hadri test suggests that it is not stationary even after first differencing. However, all the heterogenous panel tests reveal that output per worker is stationary in level. Hence, we support the option that output per worker is stationary after firs differencing. It is thus said to be I(1). In the case of capital per worker, apart from the results of the Breitung and Hadri tests which suggests non-stationarity, all the other tests reveals stationarity in level. However, the tests for the stationarity of the variable in first difference form reveals that it is not stationary in the first difference form, according to all the test types. Given that when a variable is stationary in level its first difference must be stationary, which is not the case here we tested the second difference of the variable for stationarity. The result reveals that by all the test types, capital per worker is stationary after second differencing. Hence, it is said to be I(2).

3.2 *Panel Cointegration and Panel Error Correction Model Test Results*

To the extent that the model variables are not stationary we proceed to the test for cointegration, which tests for the existence of a long run relationship between output per worker and capital per worker in the ECOWAS countries. We use the Pedroni, Kao, Johansen Fisher type and the Westerlund test. It is also necessary to mention that the null hypothesis of the Pedroni and Kao tests is that there is no cointegration, the null hypothesis of the Johansen Fisher type test is that these are at most k cointegrating vector (for $k = 0$, 1 as there are only two variables in the model), the null hypothesis for the Westerlund test is that there is no panel error correction model (PECM) underlying the two variables. It is worthy to note that the existence of panel error correction implies the existence of cointegration, as it is only under the existence of cointegration that there can be a panel error correction model. In addition, while the Pedroni, Kao and the Johansen Fisher type tests are tests for homogenous panels, the Westerlund test is a test for heterogenous panel. Tables 3, 4, 5 and 6 show the results of the various panel cointegration tests Table 7

Table 3 Result of Pedroni residual test for cointegration

Series: LNYPW DLNKPW				
Sample: 1980–2012				
Null hypothesis: no cointegration				
Trend assumption: no deterministic trend				
Automatic lag length selection based on SIC with a max lag of 7				
Newey-West automatic bandwidth selection and Bartlett kernel				
Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	*Prob.*	*Statistic*	*Prob.*
Panel v-statistic	−2.354231	0.9907	−1.774932	0.9620
Panel rho-statistic	1.338345	0.9096	1.051731	0.8535
Panel PP-statistic	−0.503396	0.3073	0.153665	0.5611
Panel ADF-statistic	−0.994842	0.1599	0.118871	0.5473
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	*Prob.*		
Group rho-statistic	1.865396	0.9689		
Group PP-statistic	0.736924	0.7694		
Group ADF-statistic	1.154369	0.8758		

is the country Johansen cointegration test from which the Johansen Fisher type panel cointegration test is obtained. Apart from the result of the Johansen Fisher panel test, the null hypothesis of no cointegration is not rejected by all the panel test types.

The Johansen Fisher panel test however shows that there is one cointegrating relationship at the 5 % level of significance by both the trace and maximum-Eigen versions of the test. Because of the fact that this test is a combination of individual p-values from various country Johansen cointegration tests, we therefore tested the robustness of this result by examining the individual country result, given in Table 7. This reveals that the null hypothesis of no cointegration is rejected only in Benin and Ghana at the 5 % level of significance while it is not rejected for all the other countries. Hence, it is more robust to conclude the existence of no cointegration between output per worker and capital per worker in the ECOWAS countries than concluding on the existence of cointegration. This is confirmed by the fact that the Pedroni and Kao tests for cointegration and the Weterlund test for the existence of panel error correction model (an indirect way of testing for cointegration) all reject the null hypothesis of cointegration between the two variables.

Table 4 Result of Kao residual test for cointegration

Series: LNYPW DLNKPW		
Sample: 1980–2012		
Included observations: 462		
Null hypothesis: no cointegration		
Trend assumption: no deterministic trend		
Automatic lag length selection based on SIC with a max lag of 8		
Newey-West automatic bandwidth selection and Bartlett kernel		
	t-statistic	*Prob.*
ADF	0.697909	0.2426
Residual variance	0.002323	
HAC variance	0.003306	

Table 5 The Westerlund panel error correction test

Statistic	Value	Z-value	P-value
Gt	−1.953	1.902	0.971
Ga	−8.836	1.747	0.960
Pt	−5.241	3.045	0.999
Pa	−6.009	1.784	0.963

Table 6 The Johansen Fisher cointegration test

Series: LNYPW DLNKPW				
Sample: 1980–2012				
Included observations: 462				
Trend assumption: linear deterministic trend				
Lags interval (in first differences): 1 1				
Unrestricted cointegration rank test (trace and maximum Eigenvalue)				
Hypothesized No. of CE(s)	*Fisher Stat.*[a] *(from trace test)*	*Prob.*	*Fisher Stat.*[a] *(from max-Eigen test)*	*Prob.*
None	65.74	0.0001	60.12	0.0004
At most 1	39.89	0.0676	39.89	0.0676

[a]Probabilities are computed using asymptotic Chi-square distribution

3.3 The Output per Worker Model

Inasmuch as output per worker is integrated of order one and capital per worker is integrated of order two and the two variables are not cointegrated, the relationship between the two model is estimated by transforming the variables to ensure stationarity. In this regard, the first difference of output per worker and the second difference of capital per worker are used to estimate the output per worker production function. This is estimated without incorporating an error correction term in the model as there is no cointegration between the two variables. The model is estimated by assuming that the country specific heterogeneity is fixed and then

Table 7 The individual country results of the Johansen cointegration test

	Trace test		Max-Eigen test	
Cross section	Statistics	Prob.[a]	Statistics	Prob.[a]
Hypothesis of no cointegration				
Benin	30.7597	0.0001	30.7547	0.0001
Burkina	10.4108	0.2505	7.8171	0.3976
Cape Verde	11.6677	0.1736	10.2201	0.1979
Cote d'Ivoire	21.6956	0.0051	16.5315	0.0215
The Gambia	10.7822	0.2252	7.6804	0.4121
Ghana	18.4396	0.0175	15.2366	0.0350
Guinea	5.8062	0.7183	5.6737	0.6554
G Bissau	9.7633	0.2994	7.3836	0.4448
Mali	6.4809	0.6387	6.4506	0.5561
Niger	15.1709	0.0559	13.2782	0.0711
Nigeria	12.3855	0.1394	12.2782	0.1006
Senegal	8.8930	0.3754	8.6798	0.3138
Sierra Leone	6.6096	0.6234	6.0035	0.6128
Togo	10.5315	0.2420	9.2886	0.2629
Hypothesis of at most one cointegration relationship				
Benin	0.0050	0.9428	0.0050	0.9428
Burkina	2.5937	0.1073	2.5937	0.1073
Cape Verde	1.4476	0.2289	1.4476	0.2289
Cote d'Ivoire	5.1640	0.0231	5.1640	0.0231
The Gambia	3.1018	0.0782	3.1018	0.0782
Ghana	3.2030	0.0735	3.2030	0.0735
Guinea	0.1325	0.7159	0.1325	0.7159
G Bissau	2.3797	0.1229	2.3797	0.1229
Mali	0.0303	0.8618	0.0303	0.8618
Niger	1.8926	0.1689	1.8926	0.1689
Nigeria	0.1073	0.7433	0.1073	0.7433
Senegal	0.2132	0.6442	0.2132	0.6442
Sierra Leone	0.6061	0.4363	0.6061	0.4363
Togo	1.2429	0.2649	1.2429	0.2649

[a]MacKinnon-Haug-Michelis (1999) p-values

assuming that it is random. The two models are then tested for choice of the appropriate form, though with large time dimension in panel the fixed effect result is the same as the random effect result. However, the Hausman test is also used to choose the appropriate model from the two.

Tables 8 and 9 show the results of the fixed effect and random effect models respectively. The former is estimated using the within estimator while the latter is estimated using the GLS. Both fixed effect and random effect models show that, the share of capital in production is 0.95 in the ECOWAS countries. Implying that the share of capital in the output of ECOWAS was 95 % and that of labour was 5 %

Table 8 Fixed effect estimates of the production function

Dependent variable: DLNYPW				
Sample (adjusted): 1982–2012				
Periods included: 31				
Cross-sections included: 14				
Total panel (balanced) observations: 434				
Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob.*
DDLNKPW	0.948601	0.135957	6.977209	0.0000
C	0.007081	0.002183	3.243196	0.0013
Effects specification				
Cross-section fixed (dummy variables)				
R-squared	0.201688	Mean dependent var		0.006916
Adjusted R-squared	0.175014	S.D. dependent var		0.050072
S.E. of regression	0.045480	Akaike info criterion		−3.309159
Sum squared resid	0.866653	Schwarz criterion		−3.168386
Log likelihood	733.0876	Hannan-Quinn criter.		−3.253593
F-statistic	7.561224	Durbin-Watson stat		1.956798
Prob (F-statistic)	0.000000			

during the period 1980–2012. Table 10 shows the result of the Hausman test, which reveals that the null hypothesis of random effect specification cannot be rejected based on the p-value (0.6221). It is important to note that under the alternative hypothesis of random effect, the random estimators are consistent and efficient but the fixed effect estimator is inconsistent and inefficient. In addition however, when the time dimension T is large, the random effect coefficient and the fixed effect coefficient are the same. This is observed here as our T is large (from 1980 to 2012) with the coefficient in the fixed effect model being 0.948 and the random effect coefficient being 0.947. Table 11 shows the tests for random versus pool model, which uses the Breausch-Pagan test. The result shows that the null hypothesis that the pool model is the same as the random effect model is rejected in favour of the alternative that the random effect is the appropriate model.

3.4 Estimating the Productivity of Labour and Capital

Having obtained the share of capital and labour in output, we present in this sub-section the estimates of their productivity and determine whether the growth of the ECOWAS countries was more of factor-quantity growth or factor productivity growth. In doing this we give recourse to the production function and then decompose the growth of output into the contribution of capital accumulation, the contribution of labour growth and the contribution of total factor productivity.

Table 9 Random effect estimates of the production function

Dependent variable: DLNYPW				
Sample (adjusted): 1982–2012				
Periods included: 31				
Cross-sections included: 14				
Total panel (balanced) observations: 434				
Swamy and Arora estimator of component variances				
Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob.*
DDLNKPW	0.946777	0.135907	6.966378	0.0000
C	0.007080	0.004747	1.491475	0.1366
Effects specification				
			S.D.	*Rho*
Cross-section random			0.015772	0.1074
Idiosyncratic random			0.045480	0.8926
Weighted statistics				
R-squared	0.101153	Mean dependent var		0.003180
Adjusted R-squared	0.099072	S.D. dependent var		0.047873
S.E. of regression	0.045440	Sum squared resid		0.891977
F-statistic	48.61561	Durbin-Watson stat		1.901087
Prob (F-statistic)	0.000000			
Unweighted statistics				
R-squared	0.091392	Mean dependent var		0.006916
Sum squared resid	0.986390	Durbin-Watson stat		1.719121

Table 10 The Hauseman tests for fixed versus random effect model

Test cross-section random effects				
Test summary		Chi-Sq. statistic	Chi-Sq. d.f.	Prob.
Cross-section random		0.242965	1	0.6221
Cross-section random effects test comparisons				
Variable	Fixed	Random	Var (Diff.)	Prob.
DDLNKPW	0.948601	0.946777	0.000014	0.6221

Table 11 Breusch-Pagan LM test for random effects versus pool model

ya[id,t] = Xb + u[id] + e[id,t]			
Estimated results:			
		Var	*sd = sqrt(Var)*
	ya	0.0025072	0.0500717
	e	0.0020684	0.0454795
	u	0.0002488	0.0157724
Test: Var(u) = 0			
	chi2(1) = 55.21		
	Prob > chi2 = 0.0000		

Table 12 Contributions of capital, labour and TFP to growth in ECOWAS

Country	Contribution of capital to growth	Contribution of labour to growth	Contribution of TFP to growth	Actual GDP growth	Actual growth of capital	Actual growth of labour
Benin	2.2	0.2	1.6	4.0	2.4	3.2
Burkina	6.6	0.1	−1.6	5.1	6.9	2.8
Cape Verde	7.8	0.1	−0.4	7.5	8.2	1.6
Cote d'Ivoire	−1.9	0.1	3.2	1.5	−2.0	2.8
Gambia	1.7	0.2	1.5	3.5	1.8	3.5
Ghana	8.9	0.1	−4.7	4.4	9.4	2.7
Guinea	6.9	0.1	−3.6	3.4	7.3	3.0
Guinea Bissau	1.3	0.1	1.3	2.7	1.4	2.2
Mali	4.3	0.1	−0.9	3.5	4.5	2.5
Niger	3.0	0.2	−0.6	2.5	3.1	3.4
Nigeria	−2.7	0.1	6.3	3.7	−2.8	2.6
Senegal	4.9	0.1	−1.8	3.3	5.1	2.9
Sierra Leone	1.4	0.1	0.8	2.3	1.5	2.0
Togo	1.9	0.1	0.1	2.2	2.0	2.8

Table 12 shows the contributions of capital accumulation, labour growth and total factor productivity to growth in the ECOWAS countries during the period 1982–2012.

The table shows that in seven (7) of the 14 ECOWAS countries in the Sample, total factor productivity made a negative contribution to growth. These are Burkina Faso, Mali, Niger and Senegal among the UEMOA countries (with TFP growth of −1.6 %, −0.9 %, −0.6 % and −1.8 % respectively) and Ghana, Guinea and Cape Verde in the non-UEMOA countries (with −4.7 %, −3.6 % and −0.4 % respectively). While in the rest of the countries TFP contributed to growth, the contribution to growth was strong in Nigeria and Cote d'Ivoire with a growth contributions of 6.3 % and 3.2 % respectively. Another observation is that the countries that had high contribution of capital accumulation, which are Cape Verde (7.8 %), Ghana (8.9 %), Guinea (6.9 %), Mali (4.3 %) and Senegal (4.9 %) are the countries with negative contribution of total factor productivity. This suggests that while capital accumulation was evident in these countries, its productivity was not an opportunity to the countries, implying there was decay in capital quality rather than increase in its quality or productivity. It was in Nigeria and Cote d'Ivoire that TFP growth was strong, contributing 6.3 and 3.2 % to growth of output. However, in both countries real capital accumulation was negative. Suggesting that capital declined in real terms but its productivity however increased. It is also observed that from all the countries that had higher than 3 % growth rate during the period 1980–2012, which are Benin (4.0 %), Burkina Faso (5.1 %), Cape Verde (7.5 %), Gambia (3.5 %), Ghana (4.4 %), Guinea (3.4 %), Mali (3.5 %), Nigeria (3.7 %), Senegal (3.3 %) it was only Gambia and Nigeria that experienced positive contribution of TFP growth to growth of output. This also suggests that higher growing economies in ECOWAS are not factor-productive bias. This is a reflection of poor standard of leaving since it is increased in the productivity of factors of production, including labour that has a long term welfare impact on the economy.

Another observation from the table is that in spite of differences in real GDP growth among the countries, the contribution of labour growth in all the countries is 0.1 % with the exception of Benin, Gambia and Niger where it was 0.2. This suggests a limit to the contribution of growth of labour to output growth in the region and it also suggests that there is no relationship between labour growth and its productivity. That is, in spite of growth in the number of workers, for which the labour force is the proxy here, the contribution of its growth to growth of output is very limited.

4 Conclusion

Economic growth is desired by policymakers in both the developed and developing countries. It is however desired not for its own sake but for development purpose, which involves improvement in the welfare of the people. Economic growth varied across the ECOWAS Countries in the last four decades with higher growth in countries that were relatively politically stable and in those that experienced relative macroeconomic stability as well, though external shocks in various forms were occasionally constraints—for example, the 2008 financial crisis was an external shock component. The labour force in the region also grew though unemployment issue still remains a challenge. The environment also attracted capital, especially in the 2000s, which experiencing more stability in the political and macroeconomic sense.

The paper south to investigate in the ECOWAS countries whether output growth during the period 1980 to 2012 was driven by total factor productivity or accumulation of capital and growth of labour. The methodology involved estimation of a production function with output per worker depending on capital per worker. Series for capital stock was first of all constructed for each country from 1980 to 2012 based on data on Gross Fixed Capital formation based on the perpetual inventory method. The method of estimating the production functions involved testing for unit root in the variables and the results of the unit root tests necessitated testing for co-integration. Growth accounting technique was then applied to decompose the growth of the countries into capital accumulation, labour growth and factor productivity growth.

A number of results were obtained. First, output per worker variable is not stationary but is stationary after first differencing while capital per worker is stationery after second differencing. The cointegration tests reveal that there is no cointegration between output per worker and capital per worker in the ECOWAS region. The share of capital in total output during the period was 0.95 and the share of labour was 0.5. Growth of total factor productivity was negative in 7 of the 14 countries, during the period 1980–2012 and where it was positive, it was low in most of the countries. It was strong only in Nigeria and Cote d'Ivoire with 6.3 % and 3.2 % respectively. In the two countries with relative strong growth of total factor productivity, the contribution of capital to growth during the period was negative. This emanated from negative growths in real capital in the two countries (Nigeria and Cote d'Ivoire). The two countries that had relatively strong growth of output (above 4.0 %) had negative total factor productivity growth and strong growth of capital (Ghana 8.9 %, with average annual Real GDP growth of 4.4 % and Cape Verde, 7.8 %, with average annual real GDP growth of 7.5 %) during the period 1980–2012. Hence growth of the region during the period 1980–2012 was driven more by factor accumulation, especially capital but not factor productivity, which is what sustains long run growth and development. The contribution of labour force growth to growth of output (representing worker growth) was 0.1 % in each country except in Benin, Gambia and Niger where it was 0.2 %. Suggesting weakness in absorbing labour in jobs (high unemployment).

In terms of policy implications, since capital is the greatest contributor to growth in the ECOWAS region, it is imperative for the policy makers to design strategies for labors' contribution to increase as this would ameliorate income inequality problem. This rests on the idea that ECOWAS Countries are labour surplus and capital scare. As a majority of the people are employed in the agricultural sector, which do not involve huge capital in operation while few individuals have access to capital inequality in income widens.

Supply side policy should be directed to putting weight on increasing the productivity of labour, which would not only reduce income inequality problem but would also help to reduce poverty, hence contributing to inclusive growth. This requires efforts at expanding access to quality education; ensuring increased access to health care that is affordable; and increased investment in rural infrastructure. Raising productivity growth should also involve strong weight on technological progress, which can be easily achieved in the case of the ECOWAS countries through technological transfer rather than innovation. This requires efforts at building good governance, the legal framework, political stability and attractive package for foreign direct investments in the agricultural sector.

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