Is it Factor Accumulation or Total Factor Productivity Explaining the Economic Growth in ECOWAS? An Empirical Assessment[⊗]

Yaya Sissoko,[6] Brian W. Sloboda[7] and Soloman Kone[8]

Abstract:
The purpose of this paper is to examine the sources of economic growth for the ECOWAS countries and to disentangle the relative contribution of each source. Malmquist Productivity Index decomposition is used to distinguish between technical efficiency versus technological change. In addition, an OLS and panel regression is used to estimate the contribution of various sources of growth to increases in GDP per capita. The paper concludes that 1) there was a modest increase in Productivity Index in ECOWAS countries (11.1% between 1981 and 2015) and 2) both factor accumulation and total factor productivity drive the economic growth with technological change and efficiency change being significantly greater contributors.

Keywords: Total factor productivity, Malmquist Productivity Index Economic Growth, ECOWAS, Fixed Effect, Random Effect,

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[6] Department of Economics, Indiana University of Pennsylvania Indiana, PA 15705-1087, ysissoko@iup.edu
[7] University of Phoenix, School for Advanced Studies (SAS) Center for Management and Entrepreneurship (CME) bsloboda@email.phoenix.edu
[8] LaGuardia Community College, City University of New York, skone@lagcc.cuny.edu

1.0 Introduction

The Economic Community of West African States (ECOWAS) is a regional organization of 15 West African countries was established in May 1975. The members of ECOWAS are Benin, Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea-Bissau, Liberia, Mali, Nigeria, Senegal, Sierra Leone, Cape Verde, Guinea, Niger, and Togo. The goal for its creation is to promote economic growth, national cooperation among countries, and the establishment of a monetary union.

ECOWAS was established with the main goal to enhance economic integration among its members via an economic and a monetary union. The basic goals of ECOWAS are to establish a an integrated market among its members, a single currency, the creation of a West African parliament, and the establishment of a judicial system. In 2000, five countries from the ECOWAS established the West African Monetary Zone (WAMZ) with the goal to have a strong stable currency whose exchange rate is pegged to the euro and guaranteed by the French Treasury.

This paper targets the growth performance of these ECOWAS countries. More specifically, can we isolate the physical capital and human capital's impact on economic growth directly, or is the growth of each ECOWAS country camouflaged through changes in productivity, technology, or efficiency? From this analysis, we want to know if each of the ECOWAS countries have different explanations for its growth or do the countries of ECOWAS follows the same growth pattern.

The balance of this paper is as follows: Section 2 presents the existing literature. Section 3 presents the methodology and the data sources. Section 4 presents the empirical results and Section 5 concludes the paper.

2.0 Literature Review

In the literature, the main drivers of economic growth are often attributed to physical capital, human capital, and advancements in technology. The original emphasis on economic growth was attributed to the investment in physical capital. However, in the 1960s, economic growth began to be examined via the human capital approach (Schultz, 1961; Bowman, 1962; Denison, 1967). The human capital became the centerpiece of the new growth or the endogenous economic growth with the goal to explain the economic growth of developing and developed countries (Romer, 1986, 1990; Lucas, 1988; Barro, 1991; Barro & Salai-i-Martin, 1995). The acceptance of the endogenous economic growth is as a reaction to the shortcomings of the standard neoclassical model. That is, the neoclassical model implies that economic growth tied to diminishing returns, then the developing economies should grow faster than the developed countries. The neoclassical approach predicts that the return differentials generated by large gaps in physical capital stocks would produce capital flows from developed countries to developing countries. However, the empirical research has rejected both implications of the neoclassical approach.

In addition to human capital, the TFP is another source of growth for countries (Fagerberg, 1994; Grossman & Helpman, 1994). The TFP is described the part of growth not explained by tangible and intangible (human) capital but as a 'residual' that is part of the growth accounting equation.

However, the latter assertion is often challenged by empirical evidence which supports human capital as the driver of economic growth (Nelson & Phelps, 1966). From their research, Boskin and Lau (2000) posited that technology augments both human capital and the physical capital, which is generally known as 'the generalized Solow-neutral.'

Under the auspices of the neoclassical growth theory, human and physical capital would have accumulated that leads to it returns of output to diminish. In other words, developing countries, with smaller endowments of tangible physical capital and intangible human capital, shall experience higher rates of growth for the same level of investment in human and physical capital than developed countries. Consequently, these differences enable developing countries to be able to catch up with the developed countries as the outputs of developing and developed countries converge. However, the latter has not been confirmed empirically. Though human capital is often a major source of economic growth in some studies, the empirical evidence has been ambiguous regarding human capital providing economic growth. In fact, several empirical studies have challenged the viability of human capital contributing to economic growth (Krugman, 1994; Young, 1995; Bils & Klenow, 2000; Trostel et al., 2002). Boskin and Lau (1990) has determined that technological change is the most important source of economic growth for developed countries since the Second World War. On the other hand, capital augmentation has been attributed as the main force underlying economic growth of many countries (Kim & Lau, 1994; Young, 1994).

In brief, there is no dearth of debates about the sources of economic growth for developing and developed countries. Given these fundamental differences in the underlying sources of economic growth, there are perhaps two reasons for these sources of disagreements as mentioned by Grosskopf and Self (2006). First, earlier studies could have ignored institutional factors which could serve as an impetus of economic growth (Rodrick, 1997). Second is that the factors of production indirectly contribute to growth via another factor or via technology improvements and these factors may not be quite apparent. Put in another way, the econometric method could reveal and/or conceal the true attributes of economic growth.

3.0 The Data Sources and the Methodology

3.1 Description of the Data

The data covers the period 1981-2015, annually, and the World Development Indicators database of the World Bank is the source of the data. Table 1 summarizes and provides a description of each variable used in this analysis.

Table 1: Descriptions of the Variables

Variable	Description
Real per capita gross domestic product (GDP) at market prices (1987 constant US dollars)	GDP per capita is the gross domestic product divided by the population which does not include depreciation of physical assets or for the depletion and degradation of natural resources.
Physical Capital	Gross capital formation consists of outlays on additions to the fixed assets plus net changes in inventories. Fixed assets include land improvements such as fences, ditches, drains, and so on; plant, machinery, and equipment purchase; and the construction of roads, railways, and other infrastructure. Also structures such as schools, office building, hospitals, residential units, and commercial and industrial buildings are also included in this estimate. Physical capital is measured by the perpetual inventory method (PIM).
Human Capital	This measure shows the population between the ages of 15 and 64. The human capital stock variable measures the average years of education of the labor force between the ages of 15 and 64.
Population	The total population for each of the ECOWAS countries, which counts all residents regardless of citizenship status. The population estimates are midyear estimates.

3.2 The Method

The empirical approach employs a time series analysis which uses the parametric (using the traditional accounting growth approach) and the non-parametric approach (the data envelopment (DEA) analysis). More specifically, this paper identifies whether the economic growth of ECOWAS is explained by factor accumulation or productivity, by how much, and whether as an individual country within ECOWAS or collectively.

3.2.1 The Method Using a Nonparametric Approach

The data envelopment analysis (DEA) is a non-parametric approach that is used to analyze efficiency and performance by looking at the relationships between inputs and outputs. Within this framework, it is possible to construct a non-parametric best practices frontier over observations of the firms, and the efficiency measures are then calculated as deviations of each firm from this best practice frontier. Farrell (1957) decomposed economic efficiency into technical efficiency and allocative efficiency for a single period. A sequence of linear programming problems is solved to estimate these efficiency measures relative to the best practices frontier. The Malmquist productivity index (MPI) as used in this paper was introduced by Malmquist (1953) and reintroduced by Caves et al. (1982; hereafter it is denoted as CCD), and the MPI allowed for examining technical efficiency and allocative efficiency between time periods.

The use of the MPI does not require priori behavioral assumptions such as profit maximization or cost minimization, and it does not require input and output prices. In fact, an MPI is defined by output distance functions with respect to two different time periods. The output distance function d(x,y) takes a value of unity if the observed exchange belongs to the best practices frontier and takes a value less than one for operating below the best practices frontier. The geometric mean of two productivity indices is calculated to compute the MPI in which the first evaluates productivity under the base technology in period t and the second with respect to the technology from period t+1. According to Färe, Grosskopf, Norris, and Zhang (1994), the

output-oriented MPI between the time periods t and t+1 is written as a geometric mean of the two-time periods via distance functions as

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{d_o^t(x^{t+1}, y^{t+1})}{d_o^t(x^t y^t} \times \frac{d_o^{t+1}(x^{t+1}, y^{t+1})}{d_o^{t+1}(x^t y^t)} \right]^{1/2} \quad (1)$$

Where the notation $d_o^t(x_t y_t)$ represents the output distance function. A value greater than one will indicate an increased growth from period t to t+1, while a value less than unity indicates a decline. Another way to write this index is

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{d_o^{t+1}(x^{t+1}, y^{t+1})}{d_o^t(x^t y^t)} \left[\frac{d_o^t(x^{t+1}, y^{t+1})}{d_o^{t+1}(x^{t+1} y^{t+1})} \times \frac{d_o^t(x^t, y^t)}{d_o^{t+1}(x^t y^t)} \right]^{1/2} \quad (2)$$

Where the first term outside of the brackets measures the efficiency change (EC), while the second term represents the technological change (TC) between the two-time periods. Figure 1 illustrates the technological change and efficiency change underlying the MPI.

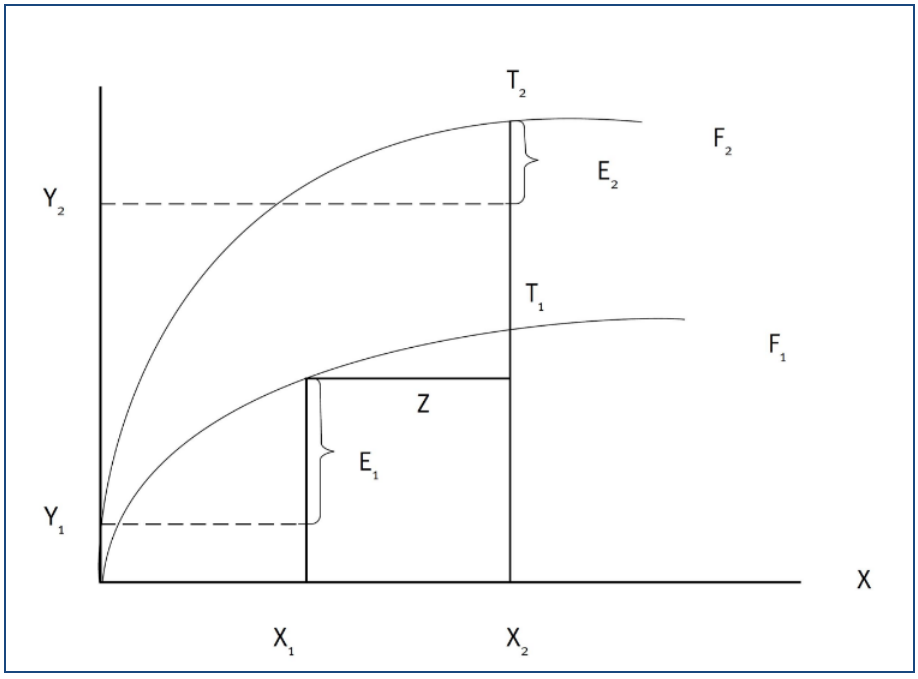

Figure 1: Illustration of Technological Change and Efficiency Change
Source: González-Rodriguez, Maria del Rosario, Rosario Martín-Samper, and Antonio Carlos Giuliani. (2015).

Figure 1 shows that growth as measured by t to t+1 can be interpreted as technological and technical efficiency changes. More specifically, efficiency changes from E_1 vs E_2 is shown as well as the technological change or the shift in the function (T_2-T_1). F_1 to F_2 shows the technological advancements between the two time periods, t and t+1. Technical efficiency corresponds to a better allocation of resources without waste generated; therefore, a consistent

movement towards the best-practice frontier for any time. From year t to t+1, a technical efficiency change would reveal a change between the two successive technical efficiency frontiers.

Recall that the MPI is decomposed into efficiency change and technological change. Again, the efficiency change tells us if a given DMU (decision-making unit) has moved closer to the best practice frontier, farther from the best practices frontier or remained unchanged. For the technical change component, a geometric mean is calculated based on the distance between the input mix at t and the input mix at t + 1.

The EC index can be disaggregated further into the pure efficiency change (PEC) and the scale efficiency change (SEC):

$$\mathrm{M}_0(\mathrm{x}^{\mathrm{t+1}}, \mathrm{y}^{\mathrm{t+1}}, \mathrm{x}^{\mathrm{t}}, \mathrm{y}^{\mathrm{t}}) = \mathrm{EC} * \mathrm{PEC} * \mathrm{SEC}$$

Where PEC is the TC based on variable returns, and SEC is comparison of the DEA outputs based on constant returns and variable returns to scale. Then, a ratio (DEAcrs/DEAvrs) of the two are taken. If SEC is greater than 1, then it means the DMU is at an optimal size. Thus, a MPI greater than 1 indicates a positive effect on productivity improvement. By contrast, the MPI less than 1 indicates a negative effect on productivity improvement.

After the construction of the appropriate input and output data, we compute MPI. Each of the components of the MPI require solving a sequence of linear programming problems, and the generalized sequence of the linear programming problems for each country, k′ = 1, . . . K and t = 1, . . . , T, is

$$\left(D_0^t(x_{K'}^t, y_{K'}^t)\right)^{-1} = \max\theta$$

$$subject\ to\ \ \theta y_{k'm}^t = \delta_{k=1}^K z_k^t y_{km}^t \quad m = 1, \ldots\ldots, M$$

$$\delta_{k=1}^K z_k^t x_{km}^t = x_{k'm}^t \qquad n = 1, \ldots\ldots, N$$

$$z_k^t = 0 \qquad k = 1, \ldots\ldots K$$

3.2.2 The Method using the Parametric Approach

After the estimation of the results from the DEA, a regression analysis is used to test for the significance of the factor inputs and TFP in determining output growth in the ECOWAS countries. Each of the variables apart from the TFP are expressed in growth rates and recall that the estimates of the TFP are merely the differences between pair-wise years and treated as a rate of change. As a stepping stone for the parametric approach, recall the neoclassical production function

$$Y_t = A_t L_t^{\alpha} K_t^{\beta} H_t^{\varphi} U_t \quad (4)$$

Where t is time, A_t represents technology or TFP, L_t is labor, K_t is physical capital, and H_t is human capital. U_t represents an external shock to the production function. Equation (4) is expressed as growth rates by taking the first difference of its logs which becomes

$$\Delta y_t = \gamma \Delta a_t + \alpha \Delta l_t + \beta \Delta k_t + \varphi \Delta h_t + \varepsilon_t \quad (5)$$

In equation (5), the letters in lowercase represent the natural logarithm transformation of the variables, and follows $N(0,\sigma^2)$. After running the standard OLS regressions, a panel regression is estimated to test which variables are responsible for the economic growth of ECOWAS using the panel data least squares, the fixed effects, and random effects. A panel regression was used because it blends the inter-individual differences, and intra-individual dynamics of these ECOWAS countries have several advantages over the standard cross-sectional or time-series regressions. More important, the panel regressions can capture the complexity of the factors contributing to the economic growth of the ECOWAS countries which cannot be adequately captured in single regression equation.

4.0 Empirical Results

4.1 Descriptive statitistics

Table 2: Descriptive Statistic of the Variables for the ECOWAS Countries

	Δ(GDP/POP)	ΔHKS	Δ K/L	GDP/POP
Benin	0.2388	0.0028	0.0221	673.8187
Burkina	0.1845	0.0026	0.0310	433.0996
Cabo Verde	0.0547	0.0098	0.0518	1963.8670
Ivory Coast	0.2763	0.0022	0.0289	1412.0530
Gambia	0.3047	0.0022	0.0230	509.5383
Ghana	0.2306	0.0031	0.0325	1033.2340
Guinea	0.1189	0.0028	0.0131	358.0859
Guinea Bassau	0.2640	0.0042	0.0353	540.2468
Liberia	0.1521	0.0025	0.1107	517.2731
Mali	0.1687	0.0027	0.0510	478.9298
Niger	0.3359	0.0025	0.0333	370.1804
Nigeria	0.2428	0.0019	0.0458	1639.7970
Senegal	0.1790	0.0026	0.0192	907.4025
S Leone	0.9187	0.0029	0.0550	439.9982
Togo	0.1910	0.0027	0.0379	522.2003

Note: GDP/POP is per capita real GDP; Δ(GDP/POP) is the rate of change of per capita real GDP; ΔK/ L is the rate of change of the capital-labor ratio; and ΔHKS is the rate of change of the human capital stock.

From Table 2, Cape Verde and Ghana have the highest per capita real GDP, but their growth rates are not the highest in ECOWAS. On the other hand, Cape Verde and Ghana have a high rate of change of capital-labor ratio. More noticeable, Cape Verde has the highest rate of change in the growth of the human capital stock while Ghana did not. It could be that Ghana perhaps

had a high stock of human capital at the start of the period in this analysis while Cape Verde devoted more resources to the stock of human capital. On the contrary, the low human capital growth as revealed in Table 2 should not be a sign of low human capital formation in the ECOWAS countries. These results, however, show that physical capital is a larger share of output growth relative to human capital in these ECOWAS countries.

4.2 Results from the Data Envelopment Analysis (DEA) or Total Factor Productivity Results: Nonparametric Approach

We estimate the MPI and its two components – efficiency change and technical change – for the ECOWAS countries for each pair of years from 1981-2015. In addition, to the efficiency and technical change, pure efficiency change and the scale efficiency change are also estimated. The DEA results are summarized in table 3.

Most ECOWAS countries experienced progress in productivity during the period. The averages for each of the measures were estimated for the time period 1981-2015. During 1981-2015, the annual productivity growth of ECOWAS countries was 11.1% which indicates a modest progress. The overall technical improvement rate increased by 44.4% and thus contributed to the modest growth of the TFP of the ECOWAS countries during this time period. In fact, the technical improvement indicates a significant positive effect. The annual TFP change showed a rising trend during most of the time periods. Overall, the ECOWAS countries were shown to have positive efficiency change, indicating a trend of moving towards the best practices frontier. The average annual EC rate from 1981 to 2015 was 38.5% (Table 3), indicating that the technical efficiency of the ECOWAS countries was improving. By breaking down the EC into the PEC and SEC, we see that these measures contributed positively to the overall EC in the ECOWAS countries as revealed by the 8.4% (PEC) and the 20.2% (SEC). Despite the improvements in EC, the TC provides a greater contribution to the overall improvement in the TFP for the ECOWAS.

Table 3: Malmquist Productivity Index (MPI) variation of ECOWAS Countries, 1981-2015

Period	Efficiency Change (EC)	Pure Efficiency Change (PEC)	Scale Efficiency Change (SEC)	Technical Change (TC)	Malmquist Productivity Index
1981-1982	2.63990	1.09639	2.40781	0.48823	1.28886
1982-1983	0.75402	0.87374	0.86299	2.25704	1.70186
1983-1984	1.08036	1.03502	1.04380	0.65481	0.70743
1984-1985	0.73421	0.91159	0.80542	1.34178	0.98515
1985-1986	0.39467	0.75283	0.52425	0.98147	0.38736
1986-1987	1.35541	1.08972	1.24381	1.68500	2.28387
1987-1988	2.56546	1.44572	1.77451	0.47182	1.21045
1988-1989	0.30175	0.92155	0.32744	1.96888	0.59411
1989-1990	0.69543	0.66659	1.04326	1.97697	1.37484
1990-1991	2.88618	1.43706	2.00839	0.34698	1.00145
1991-1992	0.68160	0.86213	0.79060	3.59090	2.44756
1992-1993	0.40470	0.63889	0.63344	0.52404	0.21208
1993-1994	2.27107	1.13312	2.00426	0.64200	1.45803
1994-1995	1.10875	1.09328	1.01415	0.78878	0.87456
1995-1996	1.85651	1.50161	1.23634	0.89766	1.66651
1996-1997	0.18511	0.46400	0.39895	5.38511	0.99686
1997-1998	3.68925	1.82349	2.02318	0.29356	1.08302
1998-1999	0.75595	0.99703	0.75820	0.68273	0.51611
1999-2000	1.12116	1.21569	0.92224	1.00123	1.12255
2000-2001	1.09971	0.67041	1.64035	0.67032	0.73715
2001-2002	1.21980	1.16356	1.04834	1.52570	1.86106
2002-2003	0.54099	0.83872	0.64502	1.10668	0.59870
2003-2004	0.24647	0.89727	0.27469	5.15166	1.26974
2004-2005	3.93422	0.90035	4.36965	0.15506	0.61003
2005-2006	1.79725	1.88265	0.95464	0.50734	0.91182
2006-2007	0.46743	0.42231	1.10682	2.49164	1.16466
2007-2008	4.31663	2.83453	1.52287	0.23902	1.03177
2008-2009	0.28970	0.57844	0.50083	4.04666	1.17231
2009-2010	1.97345	0.95607	2.06411	0.47502	0.93742
2010-2011	1.09675	1.52120	0.72098	1.36517	1.49725
2011-2012	1.28503	1.10937	1.15834	0.80856	1.03903
2012-2013	0.36425	0.52409	0.69501	1.83991	0.67019
2013-2014	2.53081	1.26085	2.00722	0.52268	1.32280
2014-2015	0.46410	1.34396	0.34532	2.20340	1.02259
Average	1.38553	1.08421	1.20227	1.44376	1.11056

Note: The estimates were prepared using the Data Envelopment Analysis Online Software. https://deaos.com/login.aspx?ReturnUrl=%2f.

4.3 The Regression Analysis as Follow-up from the Nonparametric Estimation

Table 3 shows that technological change drives its TFP growth. Each of the ECOWAS countries shows an improvement in their technology that is reflected as an improvement in their productivity change over time despite a decline in performance in terms of their efficiency change. Cape Verde is the only country in which the technological change shows a decline in performance, while the results of its efficiency reveals the opposite. TFP registers a decline as well for Cape Verde.[9] Then, a regression analysis based on the equations (4) and (5) was used to test for the significance of the factor inputs and the TFP to determine growth. Equation (5) is estimated via an OLS regression, and Table 4 summarizes the results.

[9] There are numerous results, and they are omitted for the sake of brevity.

Table 4: Results from OLS: Dependent variable: natural logarithm of growth of per capita GDP

	Intercept	Δpks	Δhks	tfp
	6.1721	0.0198	-0.4106	0.3436
Benin	(0.0001)	(0.8386)	(0.0103)	(0.0001)
	0.3342	0.9392	0.3152	0.2529
Burkina	(0.5680)	(0.0676)	(0.9311)	(0.1624)
	3.6879	0.2601	-0.1988	0.0003
Cabo Verde	(0.0083)	(0.0185)	(0.3310)	(0.9991)
	1.746	-0.1181	0.4338	-0.5152
Ivory Coast	(0.1378)	(0.2382)	(0.0315)	(0.1328)
	6.660	-0.2318	-0.2516	-0.3670
Gambia	(0.000)	(0.3313)	(0.0809)	(0.0077)
	6.963	0.1355	-0.5865	-0.1212
Ghana	(0.0000)	(0.0468)	(0.0035)	(0.2251)
	6.432	0.0218	-0.2983	0.0343
Guinea	(0.0006)	(0.8185)	(0.2832)	(0.8245)
	3.032	0.0373	0.2487	-0.6290
Guinea Bassau	(0.0964)	(0.3418)	(0.4477)	(0.0051)
	-0.2068	-0.001	0.5054	-0.0865
Liberia	(0.9124)	(0.9866)	(0.0311)	(0.6965)
	5.026	-0.057	-0.2706	0.1077
Mali	(0.0000)	(0.6132)	(0.0008)	(0.4301)
	5.849	-0.1495	-0.3230	0.3245
Niger	(0.0000)	(0.3121)	(0.0185)	(0.0258)
	4.281	0.001	-0.1865	1.010
Nigeria	(0.0070)	(0.9914)	(0.2637)	(0.1301)
	1.984	0.4201	0.1738	0.3856
Senegal	(0.1455)	(0.0242)	(0.4161)	(0.2433)
	3.899	0.066	-0.0780	-0.1296
Sierra Leone	(0.0016)	(0.9630)	(0.6969)	(0.2797)
	3.467	0.1550	-0.0001	-0.1101
Togo	(0.0009)	(0.0290)	(0.9993)	(0.2856)

Note: Δpks, Δhks represent natural logarithmic growth rates of physical capital stock and human capital stock, respectively; tfp is the natural logarithm of the total factor productivity. For the standard errors, these are adjusted using the estimator under the Heteroskedasticity and Autocorrelation Consistent Covariance (HAC) or Newey-West estimator. The p values for each of the coefficients are in parentheses

The results from the regression show that growth of the physical capital stock or capital accumulation is directly linked to economic growth in the countries of Cape Verde, Ghana, and Senegal. Now growth of human capital stock is significant for economic growth in Ivory Coast, Ghana, Liberia, and Senegal. Finally, economic growth of Benin, Gambia, Guinea Bissau, and Niger appear to be significantly affected by the growth of TFP.

Using the results from the last regression, we determine which factor, if any, has a direct impact on economic growth. For those ECOWAS countries where TFP growth is significant, we focus

on the components of TFP growth: technological change (TC) and efficiency change (EC). Recall from the DEA results presented in table 2, it reveals which component of TFP acts as its driving force. Depending upon this component, we regress the factor inputs on TC or EC. That is, a regression analysis is estimated via equation (5) to test which factor, has a potential impact on growth via these variables. The regression equations for technical change and efficiency change are

$$\text{Technical Change (TC)} = \delta_1 \Delta k_t + \delta_2 \Delta h_t + e_{1t}^t$$

$$\text{Efficiency Change (EC)} = \delta_3 \Delta k_t + \delta_4 \Delta h_t + e_{1t}^t$$

Based on the results of the TFP, the selected ECOWAS countries had their TFP driven by technological change. Table 5 summarizes these results.

Table 5: OLS Regression: Dependent variable – Natural Logarithm of Technological Change (TC)

	Intercept	Δpks	Δhks
	0.3384	0.1435	0.0134
Benin	(0.6365)	(0.0449)	(0.8585)
	0.1288	0.1138	0.0469
Gambia	(0.7613)	(0.1169)	0.3155
	0.3113	0.3101	-0.0123
Guinea Bassau	(0.7375)	(0.000)	(0.9400)
	-0.9159	0.1650	0.1898
Liberia	(0.0247)	(0.2217)	(0.0141)
	0.3697	0.0154	0.0730
Niger	(0.5877)	(0.8694)	(0.5199)

Note: Δpks, Δhks represent the natural logarithms growth rates of physical capital stock and human capital stock, respectively. For the standard errors, these are adjusted using the Heteroskedasticity and Autocorrelation Consistent Covariance (HAC) or Newey-West estimator. The p values for each of the coefficients are in parentheses

The results show that for Benin and Guinea Bassau, physical capital accumulation drives the technological change technological change is driven by physical capital accumulation. Now for Liberia, human capital drives the technological change.

The final part of the analysis is the estimation of a panel regression to test which variables are responsible for the economic growth in the ECOWAS countries. These regressions would be estimated via panel data least squares, the fixed effects, and the random effects. Panel regression was selected because it blends the inter-individual differences, and intra-individual dynamics of the ECOWAS countries which cannot be revealed by single equation models using time series or cross-sectional data. Table 6 summarizes these results

Table 6. Estimation of the Panel Data Regressions: Dependent Variable – Natural logarithm Per Capita GDP Growth

	Panel Data Least Squares	Fixed Effects	Random Effects
Intercept	3.921	4.141	4.001
	(0.000)	(0.000)	(0.000)
Δpks	0.0157	0.0149	0.0154
	(0.7271)	(0.7666)	(0.7198)
Δhks	-0.0851	-0.1148	-0.0939
	(0.1156)	(0.0267)	(0.0701)
tfp	0.2746	0.2517	0.2588
	(0.0000)	(0.0000)	(0.0000)

Note: tfp is the natural logarithm of total factor productivity; for the standard errors, these are adjusted using the White cross-section standard errors and covariance. The p values are given in parentheses.

For the fixed effects, we apply the Redundant Fixed Effects to determine if the use of fixed effects is appropriate. The cross-section F test and the cross section χ^2 have p values $p<.0001$, meaning that the cross-section effects would be applicable. For the random effects, a central assumption in random effects estimation is the assumption that the random effects are uncorrelated with the explanatory variables. One common method for testing this assumption is to employ the Hausman (1978) test to compare the fixed and random effects estimates of coefficients with the null hypothesis that the random effect is preferred. The test reveals that the $p <.0001$ which indicates that the fixed effects would be suitable. From Table 6, TFP is the source of economic growth in the ECOWAS countries, not human capital or physical capital. Then, we break down TFP into its components of technological change (TC) and efficiency change (EC). Afterwards, a second panel regression is estimated with TC and EC as explanatory variables instead of the use of the TFP. These results are summarized in table 7.

Table 7. Estimation of the Panel Regressions: Dependent Variable – Natural logarithm Per Capita GDP Growth

	Panel Data Least Squares	Fixed Effects	Random Effects
Intercept	3.573	3.843	3.651
	(0.000)	(0.000)	(0.000)
Δpks	0.0450	0.0505	0.0414
	(0.1787)	(0.1431)	(0.1579)
Δhks	-0.5043	-0.0796	-0.0562
	(0.3617)	(0.1279)	(0.2932)
TC	-0.7592	-0.0972	-0.0673
	(0.4928)	(0.5483)	(0.5394)
EC	0.3539	0.3018	0.3226
	(0.0000)	(0.0000)	(0.0000)

Note: TC is the natural logarithm of technical change, and EC is the natural logarithm of efficiency change, respectively; for the standard errors, these are adjusted using the White cross-section standard errors and covariance.

The results from the least squares, the fixed effects, and random effects are consistent. In fact, these results show that the efficiency change is largely responsible for the economic growth in

ECOWAS. Ironically, human capital, physical capital, and technological change do not appear to have much impacts on the economic growth for ECOWAS. Recall from the nonparametric analysis that the results indicated TFP as the main source of growth in the ECOWAS.

5.0: Final Thoughts and Concluding Remarks

ECOWAS has experienced a spectacular economic growth in recent decades, and this remarkable growth has received much attention and led to the speculation for the impetus of this growth. This empirical analysis provides an empirical evidence that provided an explanation for its growth. From this empirical assessment, there is no single, physical or human capital accumulation model that can explain growth for ECOWAS. The factor accumulation and TFP growth seem like plausible explanations for its economic growth; however, individual ECOWAS countries may offer other explanations for its growth. From the empirical analysis, technological change is the main driver of growth for all the ECOWAS countries, but TFP does not emerge as the driving force for growth in ECOWAS. That is, there could be other factors that could drive the technological change.

Next, a careful interpretation of the empirical results becomes crucial because the empirical evidence shows that TFP and investment are procyclical. That is, the regression results would not imply a causality from TFP growth to output growth in the long-run. From this analysis, the evidence for human capital to promote economic growth is relatively weak for individual countries and the group of ECOWAS countries. Despite the lack of robust results for human capital promoting growth, human capital is found to be an important factor for growth in Ivory Coast, Ghana, and Niger. The impacts of efficiency change as revealed by the panel regressions seem to be the major driver of the growth in the ECOWAS.

The physical geography and its human geography in ECOWAS are quite distinctive. For physical geography, each of the countries in ECOWAS is heterogeneous. More importantly, the greater share of ECOWAS' population is in landlocked, resource-scarce countries as opposed to coastal, resource-scarce countries which could have an impact on economic growth. Because of the heterogeneity of the ECOWAS countries, there needs to be a greater emphasis on the development of the appropriate strategies in physical and human capital to improve economic growth. As for the human geography, there is not much distinction among the ECOWAS countries. That is, most of the ECOWAS countries have small populations but these populations are ethnically diverse. Consequently, policy reform and the maintenance of internal security becomes more difficult. Fortunately, each of the countries in ECOWAS has made progress on both problems, but additional work needs to be done. Also, democracy is more important for improving economic performance, and there should be a greater focus on the public sector as being decentralized, not a major source of its economy. In fact, the countries of ECOWAS have moved to greater democratization over the past decades and attempted to reduce the size of the public sector with the eventual goal of promoting greater economic growth.

As mentioned earlier, ECOWAS was established in 1975 with a goal to improve trade among members, enhance national cooperation, and the creation of a monetary union. This treaty was revised in 1993 which provided policies to improve economic growth and enhance political cooperation among the members of ECOWAS. More specifically, the revised treaty established revisions to itsspecific goals: the development of a common market, the adoption of a single

currency, establishment of a parliamentary system for West African, and the creation of a robust judicial system. The judicial system would mainly interpret and mediate disputes regarding ECOWAS policies and serves as a mediator in disputes with member countries. The judicial system would examine any alleged abuses of human rights by member countries of ECOWAS. These improvements in the treaty would continue to promote greater economic growth by improving intra and inter trade among the ECOWAS countries and with other countries and regional organizations in Africa.

References

Barro, R. J. (1991). Economic growth in a cross section of countries. *The Quarterly Journal of Economics*, *106*(2), 407-443.

Barro, R. J., & Sala-i-Martin, X. (1995). *Technological diffusion, convergence, and growth* (No. w5151). National Bureau of Economic Research.

Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary Economics*, *34*(2), 143-173.

Bils, M. and P. J. Klenow. (2000). Does schooling cause growth?, *American Economic Review, 100*(5), 1160–83.

Boskin, M. J., & Lau, L.J. (2000). Generalized Solow-Neutral Technical Progress and Postwar Economic Growth, NBER Working paper 8023, National Bureau of Economic Research, Cambridge, MA.

Bowman, M. J. (1962). Human capital: Concepts and measures', in S. Mishkin (ed.), *Economics of Higher Education*, Washington, D.C: US Department of Education.

Caves, D. W., Christensen, L. R. & Diewert. W.E. (1982). The Economic theory of index numbers and the measurement of input, output and productivity. *Econometrica 50*(6), 1393–414.

Coelli, T., Rao, D.S, & Battese, G. E. (1998). *An introduction to efficiency and productivity analysis*, Boston: Kluwer Academic Publishers, Boston.

Denison, E. (1967). *Why growth rates differ*, Washington, D.C: The Brookings Institution.

Fagerberg, J. (1994). Technology and international differences in growth rates. *The Journal of Economic Literature 32*, 1147–75.

Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *American Economic Review*, *84*(1), 66-83.

Grosskopf, S., & Self, S. (2006). Factor accumulation or TFP? A reassessment of growth in Southeast Asia. *Pacific Economic Review*, *11*(1), 39-58.

Grossman, G. M. and E. Helpman (1994). Technology and trade, NBER Working Paper No. W4926, National Bureau of Economic Research, Cambridge, MA.

Kim, J. I. & Lau, L.J. (1994). The sources of economic growth of the east Asian newly industrialized countries. *Journal of Japanese and International Economics 8*, 235–71.

Krugman, P. (1994). The myth of Asia's miracle. *Foreign Affairs*, 62-78.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42.

Malmquist, S. (1953). Index numbers and indifference surfaces. *Trabajos de estadística*, *4*(2), 209-242.

Nachega, J. C., & Fontaine, T. (2006). *Economic growth and total factor productivity in Niger* (No. 2006-2208). International Monetary Fund.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, *94*(5), 1002-1037.

Romer, P. M. (1990, March). Human capital and growth: theory and evidence. In *Carnegie-Rochester Conference Series on Public Policy* (Vol. 32, pp. 251-286). North-Holland.

Schultz, T. (1961). Education and economic growth, in N. B. Henry (ed.), *Social Forces Influencing American Education*, Chicago: University of Chicago Press.

Trostel, P., Walker, P.I & Woolley, P. (2002). Estimates of the economic returns to schooling for 28 Countries, *Labour Economics 9*(1), 1–16.

Young, A. (1994). Lessons from the East Asian NICs: A contrarian view. *European Economic Review 38*(3–4), 964–73.

Young, A. (1995). The tyranny of numbers: confronting the statistical realities of the East Asian growth experience. *The Quarterly Journal of Economics*, *110*(3), 641-680.