

**Support for Economic Research in Africa (SISERA)
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UNDERSTANDING TOTAL FACTOR PRODUCTIVITY GROWTH IN SUB- SAHARAN AFRICA COUNTRIES

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1. Introduction

In comparison with countries in other regions of the developing world, it is generally agreed that Sub-Saharan Africa (SSA) countries under-performed over the last three decades. A major policy concern is then how to reverse this undesirable growth trend. The economic literature points to a diverse set of potential causes of SSA's poor economic performance, ranging from external shocks to domestic policies. In effect, during the 1980s, the exchange rate and trade policies were identified as the primary causes of slow growth in SSA-exchange rate overvaluation and tight trade restrictions were damaging.¹ Also, the growth slowdown was due to deteriorating and volatile terms of trade. During the last decade, these policies which reduced the SSA openness to world trade have largely been reversed. However, SSA closed the century with a mixed record. Therefore, the domestic policies may now be the main obstacles to growth in SSA. The domestic factors, which appear to have been important in explaining growth performance, are related to poor education, political instability, lack of economic infrastructure, poor institutions, lack of financial intermediation, etc.²

The external shocks and domestic policies could affect total factor productivity (TFP) through a number of ways. When foreign exchange access is controlled, there is frequently preferential treatment for the import of investment goods. Moreover, inappropriate levels of the official exchange rate proxied by the black market premium are generally inversely associated with "open" trade policies, therefore, the potential impact on productivity. A greater openness facilitates the economy's adoption of more efficient techniques of production leading to foster growth of TFP. The expansion of exports relaxes the foreign exchange constraint and allows for larger imports of key inputs in the production process.³ For the domestic factors, the variation in the level of education embodied in the labour force is one of the primary reasons for the observed differences in productivity among countries.⁴ For SSA countries particularly, the relevant bottleneck preventing the adoption of new technology is the lack of human capital necessary to implement the new technology in a productive fashion (Miller and Upadhyay, 2000). A poor state of infrastructure makes the supply of inputs unreliable, and can hinder growth by depressing the marginal product of private investments. The heavy regulation of financial markets-the direction of bank loans to state enterprises or "strategic" sectors-may have a negative impact on growth.

The search for the roots of SSA's growth is hardly new. Islam (1995), O'Connell and Ndulu (2000) among others used the panel regression framework to estimate productivity levels in a sample of 96 and 85 countries, respectively. However, productivity indices computed in these studies are limited to only one particular time period. Moreover, these studies do not focus specifically on SSA countries. The purpose of this paper is to shed

¹ Relative to other developing regions for instance, Collier and Gunning (1999) found that the parallel market exchange rate premium is 40.0 in SSA and 26.0 in other Least Developed Countries (LDCs). The quantitative restrictions between 1988-1990 is 46.0% in SSA and 21.0% in other LDCs while the terms of trade volatility is 16.4 in SSA and 12.8 in other LDCs.

² See Savides (1995), and Easterly and Levine (1997) among others for a review of the evidence.

³ See Edwards (1998), among others for more developments.

⁴ See Barro (1991), Mankiv et al. (1992), Levine and Renelt (1992), and Saarenheimo (1993) among others for empirical studies stressing the importance of the local level of human capital on growth.

further light on the sources of national economic growth in SSA with specific reference to policy changes. During the 1960-85 period most SSA countries followed a model of development in which the State played an active role. Some of them also chose policies which resulted in closing their economies to the rest of the world. However, performance has generally been dismal and absolute declines have recorded in a number of SSA countries. This persuaded them to change track. Since the late 1980s and early 1990s, most SSA countries have begun to dismantling controls and to move towards greater openness.

We follow a two-step procedure. We begin by empirically evaluating the TFP measures over time. Then, we evaluate the impact of inward and outward looking policy variables on productivity-identification of external and domestic key policy parameters fostering or hindering the productivity growth in SSA. One of the research priorities of the CEREG is on explaining African economic growth performance. Since the objective of this paper is to seek a better understanding of cross-country economic growth differences by evaluating the impact of external and domestic factors on TFP growth, we believe that this proposal fits into CEREG's institutional setup.

The empirical literature on the international comparison of TFP generally uses three different approaches, namely (a) time-series growth accounting approach, (b) cross-section growth accounting approach and (c) panel regression approach.⁵ In the growth accounting approach⁶, the main focus is on the proportion issue. This concern the question of how much of output growth can be explained by measured input growth and how much is left to be explained by TFP growth. However, the main drawback of this approach is the requirement of equilibrium assumption to hold permanently, and the fact that a substantial part of the productivity is left unexplained. Also, the time-series growth accounting generally requires data for a long period of time. Due to the data requirements, this approach to international TFP comparisons has generally remained limited to the developed countries e.g. the G-7 or the OECD countries. Finally, the problem with the cross-section growth accounting approach is related to the requirement of prior ordering of countries, since TFP indices may be sensitive to the ordering chosen. One of the merits of the panel regression approach is that it provides TFP dynamics. Yet it is dynamics that can better reveal the determinants of TFP. This paper applies the panel regression approach to produce TFP indices for two different time periods.

The sample consists of 34 SSA countries (See Appendix for the list of countries). We begin by constructing five-year panels.⁷ The entire period extends from 1960 to 2000, and we have eight five-year panels, namely 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994 and 1995-2000. Our data encompasses 272 observations (34 countries and eight time blocks). Obviously, not all SSA countries are contained in the sample, which is determined by data availability. Given that the business environment in SSA went through a shift from inward looking in the mid 1980s to outward looking strategy, this period of investigation is split into two distinct subperiods representing respectively two distinct policy strategies, namely, the inward and outward looking strategies. We identify the structural breaks in the time series of each country

⁵ See Islam (1999) among others for a compact review and application of these methodologies.

⁶ See Abramovitz (1956) and Solow (1957) among others for more developments.

⁷ The main reason for considering data in five-year panels instead of yearly form is to minimise the role of the short-term (business cycle) fluctuations in the estimation of long run growth parameters (Islam, 2003).

using the Perron's (1989) test for structural change. The inward looking sub-period consists of the panel for 1960-1964, 1965-1969, 1970-1974, 1975-1979 and 1980-1984 and the outward looking sub-period consists of the panel for 1985-1989, 1990-1994 and 1995-2000.

The paper is divided into nine remaining sections. Section 2 gives the objectives of the study. Section 3 presents the methodology. Section 4 presents the data sources and definitions. Section 5 gives the policy relevance of the study. Section 6 presents the anticipated impact. Section 7 presents the project timeline. Section 8 gives the proposed budget. Section 9 presents the bibliographic references and section 10 gives the Curriculum Vitae of the team leader.

2. Objectives

The main objective of this paper is to assess the productivity of SSA countries, and to shed light on the main external and domestic driving forces of the overall productivity. Specifically, our analysis involves two steps.

we calculate the TFP indices using the panel regression approach of production function, then we evaluate the impact of external and domestic factors on the derived TFP indices.

3. Methodology

As stated in the introduction, our analysis involves two steps. First, we calculate TFP measures from production function specifications that include and exclude human capital as an input.⁸ Second, we search for significant external and domestic determinants of TFP. We adopt the Cobb-Douglas production function. Therefore, our two production functions, one excluding and one including the stock of human capital are expressed as follows:

$$(1) \quad Y = AK^\alpha L^\beta, \quad 0 < \alpha < 1 \quad \text{and} \quad 0 < \beta < 1$$

and

$$(2) \quad Y = AK^\alpha H^\gamma L^\beta, \quad 0 < \alpha < 1, \quad 0 < \gamma < 1 \quad \text{and} \quad 0 < \beta < 1$$

where Y is real GDP, K is the total physical capital stock, L is the number of workers (labour force), H is the measure of human capital and A is an index of TFP. We allow for possibility of non-constant returns to scale by not restricting $(\alpha + \beta)$ or $(\alpha + \beta + \gamma)$ to equal one.

Dividing equations (1) and (2) by the labour force (L) expresses output, the physical stock of capital and the human capital stock on a per worker basis. That is,

$$(3) \quad y = Ak^\alpha L^{\alpha+\beta-1}$$

and

$$(4) \quad y = Ak^\alpha h^\gamma L^{\alpha+\beta+\gamma-1}$$

where y is real GDP per worker, k is the per worker stock of physical capital and h is the per worker stock of human capital. The production functions (3) and (4) display

⁸ Although there is no consensus yet about the precise way in which human capital should enter the aggregate production function, researchers have all along recognised the importance of human capital in creation of income and growth. See Benhabib and Spiegel (1994) and Islam (1995 and 2003) for more developments.

increasing, constant or decreasing returns to scale as $(\alpha + \beta)$ or $(\alpha + \beta + \gamma)$ are greater than, equal to, or less than one, respectively. Rewriting equations (3) and (4) in natural logarithms yields the following equations,

$$(5) \quad \ln y = \ln A + \alpha \ln k + (\alpha + \beta - 1) \ln L$$

and

$$(6) \quad \ln y = \ln A + \alpha \ln k + \gamma \ln h + (\alpha + \beta + \gamma - 1) \ln L$$

Thus constant returns to scale implies that the coefficients on $\ln L$ equals zero.

The estimation of equations (5) and (6) without consideration of possible country-specific or time-specific effects can generate misleading results for ordinary least square (OLS) regressions. We focus on the fixed-effects estimation since the random-effects estimation requires that the omitted variables are uncorrelated with the exogenous variables or the included right hand side variables, an unrealistic assumption in the context of our model. Given the limited time dimension, rather than adjusting the data as deviations from the mean across countries, we include time-specific dummy variables (i.e., five dummy variables for the five-time inward looking periods and three dummy variables for the three-time outward looking periods). We still adjust the data as deviations from the means overtime within each country rather than include country-specific dummy variables, which would necessitate 34 additional variables. Our inward and outward looking panels combine data in five-year blocks as follows: 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984 and 1985-1989, 1990-1994, 1995-2000, respectively. By adding random errors to equations (5) and (6), the equations to be estimated for the inward looking period are as follows:

$$(7) \quad \ln y = \ln A + \alpha \ln k + (\alpha + \beta - 1) \ln L + \sum_{i=1}^5 \theta_i \text{time}_i + \mu_i + v_{it}$$

and

$$(8) \quad \ln y = \ln A + \alpha \ln k + \gamma \ln h + (\alpha + \beta + \gamma - 1) \ln L + \sum_{i=1}^5 \theta_i \text{time}_i + \mu_i + v_{it}$$

The equations to be estimated for the outward looking period are as follows:

$$(9) \quad \ln y = \ln A + \alpha \ln k + (\alpha + \beta - 1) \ln L + \sum_{i=1}^3 \theta_i \text{time}_i + \mu_i + v_{it}$$

and

$$(10) \quad \ln y = \ln A + \alpha \ln k + \gamma \ln h + (\alpha + \beta + \gamma - 1) \ln L + \sum_{i=1}^3 \theta_i \text{time}_i + \mu_i + v_{it}$$

where μ_i is the individual country effect, v_{it} is the transitory error that varies across both country and period and time ($i=1, \dots, 5$ for the inward looking period and $i=1, \dots, 3$ for the outward looking period) represents the time dummy variables and the variables for each country measure deviations from their country means over time. We then calculate the country-specific fixed effects of intercepts as follows,

$$(11) \quad \mu_i = \overline{\ln y_i} - \hat{\alpha} \overline{\ln k_i} - \hat{\delta}_1 \overline{\ln L_i}$$

and

$$(12) \quad \mu_i = \overline{\ln y_i} - \hat{\alpha} \overline{\ln k_i} - \hat{\gamma} \overline{\ln h_i} - \hat{\delta}_2 \overline{\ln L_i}$$

where a bar over a variable indicates the mean of that variable, a caret over a parameter indicates the estimate of that parameter, $\delta_1 = (\alpha + \beta - 1)$ and $\delta_2 = (\alpha + \beta + \gamma - 1)$ and $i=(1,2,3,\dots,34)$ is the index across countries. It is important to note that the time-specific fixed effects appear directly as the respective coefficients of the time dummy variables.

We finally study the role of external and domestic variables in influencing TFP. Our estimating equation takes the following form:

$$(13) \quad \ln TFP_{it} = \beta_0 + \sum_{i=1}^8 \beta_i \ln Z_{it} + \varepsilon_{it}$$

where $\ln TFP_{it}$ is the logarithm of the two different measures of TFP based on estimated production function that exclude and include the stock of human capital. $\ln Z_{it}$ is the logarithm of (a) the outward looking variables such as black market exchange rate premium, openness to world trade, the volatility of the openness variable, and terms of trade volatility, and (b) the domestic policy variables such as transport and telecommunication infrastructures, the extent of financial intermediation, and the interaction variable between openness and human capital. β are the parameters to be estimated, and ε_{it} is a residual term assumed to be iid. We estimate equation (13) using the fixed-effects method, where each variable in each country is measured as a deviation from its mean over time. To address the issues of endogeneity, we also estimate equation (13) using (a) once-lagged values of independent variables and (b) the instrumental variable technique where the lag dependent variable is considered as instrument.

4. Data Sources and Definitions

We calculate productivity growth using real gross domestic output (GDP) as output. The number of workers measures Labour input. The human capital is measured by the secondary school enrolment ratio. From the data on real investments, the capital stock is calculated using the perpetual inventory method i.e. $K_t = (1 - \delta)K_{t-1} + I_t$. Like O'Connell and Ndulu (2000) we assume a depreciation rate (δ) of 4% per year. Concerning the determinants of TFP, openness is measured as imports plus exports to GDP⁹. The black market exchange rate premium is the ratio of official exchange to illegal market exchange rate. The volatility of the openness and terms of trade measures is the standard deviation of these variables for the five years that constitute the respective five-year period in the sample. The measures of the transport and telecommunication infrastructures are (a) the kilometres of road per worker and (b) the telephone per worker. The “*financial depth*” is measured by the ratio of the broad money supply (M2) to GDP. We hypothesise that (a) openness is associated with higher productivity, (b) benefits from openness are higher for a more educated population, (c) overvalued exchange rate and poor financial intermediation impact negatively on productivity and (d) the state of infrastructures determines the level of productivity. Data are from Yearbook of Labour Statistics, World Bank World Tables, IMF International Financial Statistics Yearbook (various issues) and African Development Indicators.

⁹ We will also examine the regression results with the export to GDP as measure of openness.

5. Policy Relevance of the Study

The general hindrance to policy evaluation in SSA countries is the existing empirical information gap. This study is embarked on an attempt of providing further understanding of the sources of TFP growth in the SSA countries. Indeed, it is expected that at the end of the study we would be able to produce empirical estimates of TFP across SSA countries and over time. It would then be possible for us to identify factors fostering or hindering the growth of TFP in SSA countries. Indeed, by splitting the period of study into two distinct subperiods representing two distinct development strategies, we will be able to provide evidence on whether or not the inward and outward looking policies benefit TFP. From the estimation of equation (13), we would be in a position to provide empirical relationships between TFP and a wide array of factors (degree of overvaluation of the exchange rate, openness to world trade, human capital, the state of a country's infrastructure, and the degree of financial intermediation). From the estimation of equation (13) we would also be equipped to prescribe trade policy, educational and public policy recommendations. This would constitute ways for policymakers to reverse the trend i.e. to improve TFP and then economic growth within the SSA region.

6. Anticipated Impacts

The expected impact of this study is at three different levels:

from presentation at the monthly seminar of our research institute (CEREG), this study will enable discussions among member researchers on the causes of slow economic growth within SSA countries.

by utilising two assistant researcher, namely Doctorate students, this study will have a great capacity building impact.

by organising a one-day seminar bringing together different policy makers, and by preparing policy briefs this paper will constitute a guide for policy decision makers. The objective here is to show the policy implications of our results. Specifically, we aim at identifying key policy issues on which to concentrate if SSA countries would like to grow. These issues are related to human capital, political and macroeconomic (in)stability, economic infrastructures, institutions, financial markets and open policies. Also, the idea here is to gain some ideas of the relative importance of each of the previous policy issues in the growth process of SSA countries.

7. Research Plan and Timetable

The research is planned for a period of twelve months (one year) as follows:

Activity	Duration in month
Collection and review of relevant literature	2.00
Data collection at the World Bank, IMF, and United Nations offices	1.00
Data cleaning and computer analysis	3.00
Empirical analysis	2.00
Compilation of Interim Report	2.00
Presentation and review of the Interim Report	1.00
Preparation of the first policy brief	

Preparation and presentation of the Final Report	1.00
Preparation of the second policy brief	
Organisation of a one-day national seminar	
Total duration	12.00

9. References

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Appendix

List of the sample of SSA countries

1. Angola
2. Benin
3. Botswana
4. Burkina Faso
5. Burundi
6. Cameroon
7. Central African Republic
8. Chad
9. Congo Republic
10. Congo Democratic Republic
11. Ethiopia
12. Gabon
13. Ghana
14. Ivory Coast
15. Kenya
16. Liberia
17. Madagascar
18. Malawi
19. Mali
20. Mauritania
21. Mauritius
22. Mozambique
23. Niger
24. Nigeria
25. Rwanda
26. Senegal
27. Sierra Leone
28. Somalia
29. Sudan
30. Tanzania
31. Togo
32. Uganda
33. Zambia
34. Zimbabwe