Why has Growth slowed in Sub-Saharan Africa: A System GMM-IV Approach

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Why has Growth Slowed in Sub-Saharan Africa? A System IV-GMM Approach

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Abstract

In this paper we estimated the traditional cross-country growth model and corrected for model endogeneity bias and country-specific hetereogeneity effects. Using the System-IV Generalized Method of Moments (GMM) approach, we identified the key factors that determine GDP per capita growth rate in a panel regression model of 100 countries. Parameter robustness tests was applied to the models which also included: Within Fixed Effects; Pooled-Ordinary Least Square and Levels-IV GMM models, using the Extreme Bounds Analysis (EBA). We found that most of the estimated covariates that show significant coefficients in the regression model are actually fragile, except for initial income, institutions and real exchange rate over valuation. More importantly too, the results suggested that natural resource endowment, such as oil, may not have accounted for why some resource rich developing countries (e.g Nigeria) have grown slowly as is commonly argued in the literature.

JEL classification: E13, C33, Q33, O11

Keywords: Fixed Effects Models, Growth, Endogeneity, Heteroscedasticity, Method of Moments.

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Contents

1 Introduction

Several studies[2] have used cross-country regressions to search for the empirical links between long-term growth rates and a variety of economic policies, political objectives and institutional factors. Generally, each of these studies have only consider a small number of explanatory variables to establish a correlation between growth and the identified variables of interest. In a survey of growth econometrics, Durlauf et al., (2004) identified over 200 variables suggested in the literature to have been significantly correlated with growth. In most studies, researchers substantiate the validity of a growth determinant by developing a simple regression model or set of models and conduct inference as if the model generated the data. However, inference procedures based on a simple linear growth regression model which is conditional on the truth of that model, can grossly overstate the precision of the inference above a given phenomenon and ignore the uncertainty that surround the validity of the model.

In addressing the uncertainties associated with growth models, this paper investigates the inconsistencies that may be associated with the factors that have been argued to account for the growth stagnation in sub Saharan Africa. Many studies which include: Barro and Sala-i-Martin (2002), Collier and Gunning (1999) and, Sachs and Warner (1997) have found that there is a significant negative correlation between natural resource endowment and economic growth, such that the negative relationship have accounted for why resource abundant countries, most especially in sub Sahara Africa, have grown relatively slower than other countries. The methodologies adopted in these studies to arrive at this result follow the estimation of an 'endogenous' neoclassical growth model using a combination of traditional growth determinants[3] with other control variables which include an 'oil dummy' in a cross-country linearized growth regression. These models have as their dependent variable, the average GDP per capita growth rate over an extended time period and the right hand variables are simultaneously estimated as parameters of growth but each parameter is interpreted holding all other parameters constant. Some of the results suggested that the channels through which growth is retarded includes through: long-term decline in terms of

[2]See Rodrik (1997 and 2005), Barro and Sala-i-Martin (2004), Temple (2003)

[3]These are the variables identified in Solow, (1956), Mankiw et al., (1992) and discussed in Barro et al., (1991) and Durlauf et al., (2004))

trade; oil revenue volatility; the Dutch disease syndrome; crowding-out effects; increasing state dominance; socio-cultural and political hinderance etc.

This paper is a revisit to the analysis of growth performance in developing sub-Saharan countries, particularly as it relates to the estimation of parameters that account for economic growth and development. The paper used a battery of econometric techniques to investigate the robustness of growth covariates in a cross-country growth model in line with associated error components of the models. The paper is divided into five sections: Section one which is the introduction to the paper is followed by a survey of literature on the determinants of growth in section two. Section three highlights some stylized facts about the growth episodes of developing countries while section four presents the methodology and estimation techniques adopted in the study. Section five concludes and suggests policy options on the way forward.

2 The Determinants of Growth: A literature Survey

The development of economic growth literature can be classified into two framework of applied analysis that involves the application of economic theory to growth estimations. The first framework addresses the issue of 'convergence' which relates to whether contemporary differences in aggregate economies transient over sufficiently long time horizons or converges to an 'initial equilibrium'. The second framework concerns the identification of growth determinants which suggest the factors that explain the observed differences in growth among countries. In addressing the growth phenomenon two models that are legendary in growth literature on the appropriate specification of a growth equation are the neoclassical growth model-Solow-Swan,(1956) and the endogenous growth model- Romer,(1986) and Lucas,(1988).

Many of the differences between the neoclassical and endogenous growth models can be narrowed down to issues that concern the long-run effects of initial conditions on growth. This paper will focus, particularly, on the second framework that concerns the identification of growth covariates and their robustness in an heterogenous cross-country growth estimation models.In the literature, there are over 200 variables that have been identified to account for GDP per capita growth rate[4], such that the specifications of growth models have become so complex and sophisticated that the generalization of the intuitions from growth estimations for policy purposes have become even more complex. In this literature survey, we would discuss some of the theoretical framework that informed the choice of some of the key growth determinants and the order of their specifications in growth models. The major distinction between endogenous and neoclassical growth theories centered on the long-run effect of initial human and physical stocks (*Initial Income*) on current growth. The effect of initial conditions on long-run outcomes represents the primary empirical question that has been explored by growth economists. The suggestion that the effects of initial conditions eventually disappear is the basis for what is known as the 'convergence hypothesis' in growth literature[5].

Durlauf et al., (2004), in a review of growth econometrics, observed that the convergence hypothesis answers two fundamental questions concerning per capita income differences across countries. First, are the observed cross-country differences in per capita incomes temporary or permanent? Second, if they are permanent, does that permanence reflect structural heterogeneity or the role of initial conditions in determining long-run outcomes? Galor (1996), who coined the taxonomy *'convergence club'* explains that if the differences in per capita incomes are temporary, unconditional convergence - to a common long-run level- is occurring and if the differences are permanent solely because of cross-country structural heterogeneity, conditional convergence is occurring. The literature therefore suggests that it is important that initial income is included in any cross-country growth regression model to account for the effect of the difference in initial start-off point for the different countries. The variable is specified in the model with a negative sign, following the convergence postulate that countries with lower initial income should growth faster towards the steady state equilibrium than the countries with high initial income - given the rate of return to capita and technological

[4]See Levine and Renelt,(1991)

[5]For example Bernard et al., (1996), Caselli et al., (1996), Bliss et al., (1999), Brock et al., (2001), Bulli (2001) and Dollar and Kraay (2002) have shown that, the negative coefficient on initial income in a cross-country regression does not necessarily imply conditional convergence, because countries might instead simply be converging towards their own different steady-state growth paths.

progress[6].

The literature suggested that human capital can promote growth through different channels. For example, education determines the rate of technological innovation or absorption and exerts a countervailing effect on the diminishing returns to factors of production, such as capital. Countries with higher initial stock of human capital and knowledge have been found to be able to forge ahead through higher growth rates. Benhabib et al.,(1994) have found evidence that human capital affects total factor productivity growth (TFPG) through its impact on the capacity of a country to innovate and the capability of using and adapting foreign technology. Barro (2002), also found that good level of health directly raise labor productivity and hence growth.

2.1 Macroeconomic Policy Variables

Bosworth, et al.,(2003) found that growth is negatively associated with inflation, large budget deficits and distorted foreign exchange market. Easterly, et al., (2000) also found that macroeconomic stabilization and crises-related variables, such as, price inflation, parallel market premium on foreign exchange, real exchange rate over valuation, systemic banking and balance of payment crises, affects both cyclical output variability and long-term growth. It is argued in the literature that a key component to stabilization policy is sustenance of macroeconomic stability - which requires a thorough understanding of the interplay of both fiscal and monetary policy tools. Generally, one of the important variables considered in this interplay is average inflation rate, which represent an indication of the quality of interplay between fiscal and monetary policies. Loayza and Soto (2002) showed that inflation is a major channel through which fiscal and monetary policy distortions and external shocks are transmitted to other sectors of the economy. It is negatively correlated with long-term growth and positively correlated with other indicators of macroeconomic volatility, such as, fiscal deficits, black market premium and exchange rate overvaluation.

It has been shown that the domineering role of a state (government burden) can cause a significant drain on the private sector activities[7]. Government

[6] See Mankiw et al., (1992) and Durlauf (2004) for the production function optimization and the mathematical derivation of initial income sign in a growth model

[7] See Easterly (2001) and Makdisi et al., (2001).

consumption can have a positive effect on the economy, however it could be detrimental to growth if it inappropriately impose high tax levies to sustain ineffective fiscal spending, inefficient public service (bureaucratic bottlenecks) and engage in over-bearing state intervention in economic activities thereby distorting efficient market mechanism and prices.

Acemoglu and Robinson (2001), found that institutions measured in historical terms, are significant determinants of growth and growth volatility, likewise policies that influence the structure of the economy, such as the degree of openness of the economy. Wacziarg et al., (2003) found that openness affects growth positively to the extent that it magnifies the benefits of international knowledge spill-over and technological diffusion, as well as enforcing cost discipline through import competition and the drive for export. Although the literature is divided on the importance of openness for long-term growth[8], there are empirical evidences that suggest that the relationship between economic growth and international openness is indeed positive, and reflects the vicious cycle through which more openness lead to higher growth, which in turn lead to higher trade and more openness.

The significance of efficient public infrastructure in generating long-term growth, most especially for developing countries, has been highlighted in many of the literature[9]. Good and efficient public service infrastructure can impact positively on the economy by enhancing total factor productivity and boosting returns on private sector investment, which will facilitate fast and efficient growth. Dhonte et al.,(2000) and Williamson et al., (2002) found that demographic factors are important for growth such that when a country enters a period of demographic transition during which the proportion of working age population is increasing relative to the total population - a 'demographic window of opportunity' or a 'demographic gift' is opened up for the country.

These studies argued that, under such type of demographic transition, the high proportion of working-age population foster accelerated and sustained economic growth by increasing labor participation and savings. However, if

[8]While Barro (1996), found that openness is positively related to growth, Makdisi et al., (2000) found that openness has accounted for the negative growth performance of the Arab oil-rich countries

[9]For example Loayza and Soto (2002) and Elbadawi (2006)

growth level continue to stagnate, this potential opportunity would instead become a social menace of rising unemployment. The impact of demographic transition on growth is captured by the extent to which the rate of growth of the Economically Active Population (EAP) exceeds the rate of growth of the overall population. There are evidence in the literature suggesting that most developing oil-rich countries could not take advantage of the opened demographic window in their growth history and that has led to severe growth crises.

Elbadawi, (2006), Acemoglu, et al., (2003) and Collier, (1999) found that growth is affected by conflicts - either civil, regional, or international. Collier (1999) found that while regional and international wars are likely to impact greatly on short-run development because they usually cause significant damage to physical and human capital, civil wars and ethnic conflicts can be more devastating to long-term growth due to the greater destruction of 'social capital'. Bloom and Sachs (1998) and Gallup and Sachs (1998), found that favorable geographical and ecological conditions - in terms of access to long coaster line or sea navigable rivers and temperate climate, are robustly associated with superior growth records.

These studies suggested several channels through which favorable geography and ecology could promote overall economic growth. They also found that a high share of a country's area around coastal lines or sea navigable rivers and high economic density along the coast are important determinants of competitiveness, especially for transaction - intensive exports, such as manufactures. A high share of non-tropical (temperate) climate in a country is associated with less prevalence of vector-borne diseases and high agricultural productivity.

Finally, Sachs et al., (1997), found convincing evidence that countries with high initial share of natural resource exports to GDP in 1970 tends to grow slowly over time. They argued that natural resource abundance negatively affects growth through several channels, such that resource rich countries tend to exhibit the Dutch-disease syndrome in terms of overvalued exchange rates, and hence the difficulty to develop a viable export-oriented or import-competing manufacturing sector.

3 The Growth Experience of Developing Economies: Some Stylized Facts

The growth experience of developing countries, in the last five decades or so, can be classified into four episodes: 1960 - 84; 1985 - 94; 1995 - 2000; and 2001 - 2007 (Table 1). The choice of these four classifications enable us to capture the various major global shocks that characterize the growth pattern of the developing countries. The period 1960-84 captures the transition of developing economies from positive and strong growth in the 60's to slow and negative growth by the beginning of the 80s following the oil price boom of the early 70s and the oil price collapse of the early 80s. The second period of 1985 - 1994 corresponds to the decade that witnessed radical structural reforms to address the perceived negative macroeconomic consequences of resource dependence. The third period 1995 - 2000 marks the beginning of positive growth in some resource rich countries and era of growth crisis in the Asian sub-region following the region's financial crisis. The last period 2001 - 2007 marks the beginning of a new trend in oil price increase but with less negative consequences on the macroeconomic indicators of oil-rich countries. In the first period, GDP per capita grew at an annual average rate of 5.5% in the oil-rich region of the Middle-East and North Africa region. In the same period, GDP per capita grew at an annual average of 1.1% for the sub-Saharan Africa region[10] and 4.3% for South-East Asian region[11]. However, following the collapse of oil prices in the early 1980s, the annual average growth rate of per capita GDP for the oil economies in the second period (1985 -1994) declined to a meagre 1%, while the sub-Saharan African region recorded a negative annual average per capita growth rate of -1.1%.

The average annual growth rate collapsed in the second episode for both the oil-economies of the Middle East and North Africa, as well as the sub-Saharan African economies, while the South-East Asian countries were able to sustain and increase their strong growth performance to 5.2% from 4.3% in the first episode. Associated with the per capita annual average GDP growth

[10]The sub-Saharan African countries include Nigeria, Angola, Ghana, Liberia, Sierra leone, Bostwana, Burkina Faso, Ivory Coast, Republic of Congo, Gambia, Kenya, Madagascar, Malawi, Niger, Senagal, Togo, South Africa, Democratic Republic of Congo, Zambia and Zimbabwe

[11]The South -East Asian region includes countries like: Indonesia, Malaysia, Singapore, South Korea, and Thailand.

Table 1: GDP Growth rates and Volatility in Selected Developing Countries:

The Growth Performance and Volatility of Some Developing Countries 1960 - 2007

	1960 - 84		1985 - 94		1995 - 2000		2001 - 2007	
Countries/ Regions	Growth (%)	Growth Volatility (%)	Growth (%)	Growth Volatility (%)	Growth (%)	Growth Volatility (%)	Growth (%)	Growth Volatility (%)
UAE	- 4.3	2.3	-4.4	2.1	-1.4	5.1	1.2	2.1
Kuwait	-6.6	1.5	4.5	9.8	-3.2	1.2	3.7	3.2
Bahrain	5.5	2.8	1.5	4.0	1.6	1.3	1.8	2.1
Oman	8.3	2.0	1.0	4.0	0.8	2.2	1.7	3.1
Qatar	12.4	2.4	0.6	19.3	21.6	0.4	3.1	2.4
Libya	13.0	1.4	1.4	6.8	12.8	1.1	3.0	1.6
S/Arabia	3.2	2.1	-1.3	3.8	-1.0	1.8	1.7	1.8
Hong Kong	6.7	0.6	3.4	1.4	2.9	2.3	3.5	0.4
Indonesia	3.8	0.9	3.7	1.6	3.1	2.1	3.4	0.1
Malaysia	4.4	0.5	3.5	1.3	3.0	2.4	2.5	0.6
Singapore	6.9	0.6	5.2	0.7	3.3	1.9	4.2	0.1
S/Korea	6.6	0.6	6.2	0.7	3.9	2.2	4.5	0.2
Thailand	4.4	0.5	6.5	0.5	3.2	2.3	4.1	0.3
East Asia	4.3	0.6	5.2	0.3	2.9	2.2	5.1	0.7
SSA	1.1	3.5	-1.1	1.8	0.1	3.6	2.1	4.6
MENA	5.5	2.1	1.0	4.0	0.8	1.3	2.2	4.1

Sources: WDI World Bank (2008), Summers and Heston (2007), and Author's calculations.
MENA = Middle East and North Africa Region; SSA = Sub Saharan Africa Region.
Note:
Country-specific growth rates are the period averages of GDP per capita growth and the regional-type growth rates are measured as the median of average countries growth rates.
The calculation of growth rates uses the growth rate of Real GDP per capita measured in domestic currency.
Country-specific growth volatility is measured as the ratio of the standard deviation of growth over the absolute mean value of growth during the sample period and the region-specific volatility is measured as the median of the country-specific volatility.

rate over the two episodes is the growth volatility in the regions and countries. In the first episode, growth volatility in the Middle-East and North Africa (MENA) region was 2.1%, sub-Saharan Africa 3.5%, and East Asia 0.6%, and in the second period between 1985 - 1994, growth volatility increased significantly to 4.0% from 2.1% in the Middle-East and declined in both the East Asian and sub-Saharan regions to 0.3% and 1.8% respectively. In the third period between 1995 - 2000, the growth rate of the oil-rich economies dwindled further to an annual average rate of 0.8% though with a decline in growth volatility from 4.0% to 1.3%.

During the second growth episode, the East Asian economies performed reasonably well, in terms of growth volatility, compared to the Middle-East and sub-Saharan Africa. Even though annual average per capita GDP growth in the region increased from 4.3% in the first period to 5.2 the second period, growth volatility declined further from 0.6% to 0.3%. However, at individual country level, most of the East Asian economies recorded marginal increases in growth volatility. Although the sub-Saharan African region recorded a negative growth of -1.1% in the second period, growth volatility declined from 3.5% to 1.8%, suggesting that they actually performed better than the Middle-East and North African economies in term of growth volatility.

The third growth period between 1995 - 2000 witnessed the Asian financial crisis of the 1990s when the region's growth volatility increased considerably to more than 2.0% compared to the MENA region with 1.3%, and annual average GDP per capita growth rate declined from an average of 5% the second period to less than 3% in the third period. Even with the increase oil prices in the 1990s, the Asian economies still performed better that oil-economies in terms of GDP per capita growth rate, regardless of the financial crisis witnessed in the region. In the fourth period between 2001 - 2007, growth performance still remained low and more volatile in the oil rich countries compared to the the East Asian countries. The sub-Saharan African region was worse-off compared to the other two regions in both growth performance and growth volatility.

These growth experiences of developing countries, over the period, clearly showed that the sub-Saharan African countries and the oil-rich economies have witnessed slower and more volatile growth compared to other developing countries in the Asian sub-region and the developed economies. Nigeria, in particular, as an oil-rich countries experienced slow, negative and volatile growth prior to the recent structural reforms and financial restructuring.

4 Methodology

In order to address the endogeneity and country-specific heterogeneity effects associated with the estimation of endogenous growth model, we compared four econometric approach of estimating growth models: Pooled-Ordinary Least Squares; Fixed (within) Effects, Level Generalized Method of Moments and Instrumental variable generalized method of moments. The pooled ordinary least squares estimator does not correct for both individual effects and regressors endogeneity; the fixed effects estimator controls for individual effects but ignores endogeneity; the level generalized method of moments estimator controls for measurement errors and endogeneity, but ignores unobservable individual effects; and the system instrumental variable generalized method of moments estimator which simultaneously controls for country-specific effects, measurement error and endogeneity. We have adopted the above four estimation methodologies because they have received the most extensive application in cross-country growth regression, particularly in the studies we have earlier reviewed. We estimated a dynamic endogenous growth specification of the form:

$$y_{it} = \alpha_0 y_{i,t-1} + \alpha_t(y_{i,t-1} - y^T_{i,t-1}) + \beta' X_{it} + \eta_i + \xi_t + \varepsilon_{it} \tag{1}$$

where
$y_{i,t}$ is the log of output per capita for country i at time t;
y^T_{it} represents the trend component of output per capita;
$(y_{it} - y^T_{it})$ is therefore the output gap at the start of the period;
$X_{i,t}$ is the growth determinants earlier discussed;
η_i represents the unobservable country specific effects;
ξ_t is the country invariant period-specific effects; and
$\epsilon_{i,t}$ is the disturbance term.

In the IV-GMM estimation, the lag components of the regressors are used as instruments. The differenced transformation is given by:

$$\begin{aligned}(y_{it} - y_{i,t-1}) - (y_{i,t-1} - y_{i,t-2}) = \\ \alpha_0(y_{i,t-1} - y_{i,t-2}) + \beta'(X_{it} - X_{i,t-1}) + (\varepsilon_{it} - \varepsilon_{i,t-1})\end{aligned} \tag{2}$$

so that:

$$\Delta y_{it} = \alpha_0 \Delta y_{i,t-1} + \Delta X_{it}\beta^{'} + \Delta v_{it} \tag{3}$$

A System-GMM estimator is used to simultaneously estimate the models in equations 1 and 2, under the following moment conditions[12].

$$E[(y_{i,t-1} - y_{i,t-2})x(\eta_i + \varepsilon_{i,t})] = 0 \tag{4}$$

that the dependent variable is not correlated with the unobservable individual effects and the error term - no serial correlation;

$$E[(X_{i,t-1} - X_{i,t-2})x(\eta_i + \varepsilon_{i,t})] = 0 \tag{5}$$

that the explanatory variables are not correlated with the individual effects and the error term - endogeneity bias.

$$E[(y_{i,t-s}x(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \tag{6}$$

that the lagged dependent variable is not correlated with the instrumental error term.:

$$E[(X_{i,t-s}x(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0 \tag{7}$$

for $s \geq 2$; $t = 3, ..., T$

that the explanatory variables are uncorrelated with the instrumented disturbance term[13].

4.1 Data

In the four estimations, we have used an unbalanced panel data with 5-year period averaging. The sample period covers from 1960 - 2007 for 100 countries. We considered 13 growth determinants with average GDP per capita growth rate as the dependent variable to be explained. The data are obtained from the World Bank Development Indicators (WDI), Penn

[12]developed in Arrelano and Bover (1995) and Blundell and Bond (1998)

[13]Arellano (2003) shows that the system-IV GMM estimator can still generate consistent estimated parameters even with a first-order serially correlation.

World table and Geographical Information System (GIS). The data set used in both the pooled OLS and fixed effects estimations are in log-level form, while the GMM estimation used first-difference order and the instrumental variable GMM (IV-GMM) used the lagged components of the variables as instruments.

4.2 Measurements and Definition of Variables

In formalizing the the significance of initial condition in our model, we used the logarithm (log) of GDP per capita (1970) in country i and time t. Human capita is measures as the ratio of total secondary school enrolment (regardless of age) to the population of the age group that officially corresponds to that level of education. As a measure of inflation, we used the log of annual percentage change in consumer price index as against GDP deflator used in some studies, because our measure allows for no identification restrictions to be imposed on GDP per capita and initial income for consistency of the model. We used lagged value of the measured inflation as instrument for inflation in the intrumental variable IV-GMM estimations.

Government consumption is measured as the ratio of government expenditure to GDP net expenditure on education, infrastructure and defence[14]. Institution is measured using the International Country Risk Guide (ICRG) index. The index is based on political, economic and financial indicators which includes; government repudiation and expropriation, corruption, rule of law, quality of bureaucracy, accountability and transparency, democracy and good governance. Each country is scored a ranking between 1 to 7, where 7 is highest score representing the best quality of institution and 1 is the least score representing autocratic regimes and highly corrupt and inefficient governments. Openness is measured as the ratio of exports plus imports to GDP[15]. As a measure of public infrastructure, we used the total mileage of tarred road network in a country and controlled for the country size and population by taking the ratio of the kilometers of tarred road network to country size (squared kilometer in land coverage) and total population.

[14]These three categories of expenditure are positive for growth and cannot be associated with distortionary effects which are negatively correlated with growth.

[15]The measure of openness accounts for the relationship of openness to the logs of population and country size.

Output-gap is measured as the difference between potential and actual GDP at the start of the period[16] while time dummies are used to capture exogenous shocks that are country-invariant but time-specific, as a measure of period-specific variable. We measured demography (EAP/POP) as the average growth of the ratio of economically active population (16 -64 years) over total population for the sample period. Using the Geographic Information System (GIS) data series, geography is measured as population density around 100km of the coast, and ecology is measures as the percentage of a country's land in temperate climate. The natural resource variable is measured using a dummy classification of 1 for a net oil exporting country and 0 for non-oil exporting countries[17]. The descriptive statistics of each variable are contained in table 2.

Table 2: Descriptive Statistics

Descriptive Statistics.				
Variable	Mean	SD	Minimum	Maximum
GDP Growth rate	.011	018	-.052	.076
Log Initial GDP	8.22	1.45	4.81	9.66
Initial Output gap	-.006	.017	-.011	.013
Average EAP/POP	.006	.003	-.003	.011
Log Sec. School	6.100	.214	5.116	6.041
Openness	.097	.466	-1.334	1.114
War/Conflict	.221	.911	.010	9.871
Log Inflation	1.996	1.248	-1.231	6.443
Institution	.711	.210	.321	1.001
Log Government	3.112	.468	.984	4.112
Infrastructure	2.433	.080	-.234	1.576
Coastal Density[$(\ln(100 + x)$]	4.876	.312	3.661	8.112
Climate[$(\ln(100 + x)$]	3.889	.244	3.456	7.976
Oil	.062	.267	.000	1.000

[16]Potential output is obtained using the band-pass filter developed in Baxter and King, (1999).

[17]This method has been adopted in many other studies which include Elbadawi (2006) and Lederman et al., (2007).

4.3 Results and Empirical Analysis

Table 3 shows the results of the four approaches. Generally, the System IV-GMM approach shows a more reliable results because the model corrects for both endogeneity and individual heterogeneity effect simultaneously. However, it is important to add that, given that we have used period averages, the estimated coefficients are average estimates which are more appropriately interpreted using the model descriptive statistics.

Table 3: The Determinants of Growth: Using Pooled-OLS, Fixed Effects, Level-GMM and System GMM estimators

Model:	Pooled-OLS (1)	Fixed Effects(With-in) (2)	Levels-IV GMM (3)	System-IV GMM (4)
Catch-up Effect				
Initial GDP per capita	-0.0156	-0.0351	-0.02101	-0.0062
	(0.000)	(0.000)	(0.000)	(0.000)
Cyclical Output Gap			-0.3142	-0.3562
			(0.000)	(0.000)
Demographic Gift				
EAP-POP growth (60-07)	3.4481	–	2.8441	3.0214
	(0.000)	–	(0.000)	(0.000)
Structural, Stabilization, and Institutional Factors				
Human Capital	-0.1512	-0.0352	0.0602	0.1125
	(0.000)	(0.422)	(0.001)	(0.000)
Openness	-0.0372	0.0303	0.0134	0.0268
	(0.044)	(0.000)	(0.438)	(0.000)
Public Infrastructure	0.0031	0.0722	0.0271	0.0582
	(0.145)	(0.148)	(0.001)	(0.000)
Inflation	-0.0234	-0.0267	-0.0166	-0.0311
	(0.421)	(0.002)	(0.032)	(0.001)
Institution(ICRG)	0.0622	0.0713	0.0624	0.0857
	(0.002)	(0.001)	(0.000)	(0.000)
Govt. Consumption	-0.0348	-0.0215	-0.0121	-0.0364
	(0.052)	(0.452)	(0.511)	(0.013)
Real Exchange rate 0vervaluation	-0.0674	-0.1025	-0.0482	-0.0530
	(0.006)	(0.022)	(0.403)	0.000)
Conflict				
Intl. War	0.0022	0.0042	-0.0032	0.0061
	(0.508)	(0.736)	(0.663)	(0.528)
Geography and Ecology				
Population Density(Coast)	0.0282	–	0.0312	0.0311
	(0.644)	–	(0.731)	(0.001)
Temperate Climate	0.0442	–	0.0471	0.0314
	(0.000)	–	(0.000)	(0.000)
Oil Dummy	-0.642	–	-0.0324	-0.0021
	(0.003)	–	(0.457)	(0.621)
External Shocks				
Term of Trade Shocks		0.0110	–	–
		(0.041)	–	–
Period Dummy				
1975 - 1979				-0.0287
				(0.001)
1980 - 1984	-0.0203	-0.0420	-0.0213	-0.0362
	(0.0032)	(0.010)	(0.000)	(0.000)
1985 - 1989	-0.0211	-0.0023	-0.0130	-0.0126
	(0.006)	(0.020)	(0.000)	(0.000)
1990 - 1994	-0.0239	-0.0422	-0.0357	-0.0422
	(0.000)	(0.000)	(0.002)	(0.000)
1995 - 1999	-0.0442	-0.0034	-0.0370	-0.0236
	(0.000)	(0.003)	(0.001)	(0.000)
2000 - 2007	-0.0231	-0.0033	-0.0245	-0.1021
	(0.428)	(0.006)	(0.003)	(0.001)
Intercept	-0.3022	0.0251	-0.3221	-0.2404
	(0.003)	(0.006)	(0.001)	(0.001)
No. Countries/Observations	100/872	100/872	100/872	100/872
Sargan Test			0.622	0.034
Serial Correlation Test				
First Order	0.012	0.003	0.000	0.000
Second Order	0.311	0.462	0.263	0.241

Note: Dependent variable is growth rate of GDP per capita, P-values are in parentheses.
Period 1975 - 79 was controlled for the pooled OLS, fixed effects and levels-IV GMM in order to fix the sample size for all regressions.

The pooled-OLS estimation result which is contained in column 1 shows a positive correlation between economic growth and openness, temperate climate, human capital, demography and institutions and a negative correlation with initial income, inflation and government consumption. There is also a significant negative correlation between exchange rate overvaluation and economic growth. Infrastructure, war and population density around the coast show an insignificant positive correlation with growth suggesting that they are not necessarily important determinants of cross country long-term growth. The result also showed a very significant negative correlation between oil abundance and economic growth[18].

Column (2) shows the regression results using fixed (within) effects estimator. In this result, we find a negative convergence coefficient of around 4% compared to the 2% when using pooled-OLS - suggesting that (ceteris paribus) countries with lower initial per capita income grew a lot faster than predicted, when we control for differences amongst the countries (country-specific heterogeneity).

Inflation rate, government consumption and exchange rate over-valuation are negatively correlated the growth, while institution (ICRG) was found to be positively and significantly associated with growth. The non-traditional variables, such as demography, ecology and geography are found to be unimportant in explaining growth in the model. The level GMM estimation (column 3) shows a negative convergence coefficient of around 2% while the system GMM (column 4) shows a coefficient of around 1%[19]. In column 4 (system IV-GMM), the cyclical output gap variable has a significant negative coefficient suggesting that cyclical reversion effects are indeed present in panel data, while demography is positively correlated with growth.

Human capital, openness, public infrastructure and institution have shown

[18]Many studies have relied on this correlation to explain why some developing oil-rich countries have experienced poor and slowed growth.

[19]This contradicts a convergence speed of 10% reported in Caselli et al.,(1996) using a level GMM estimation but in line with Loayza and Soto (2002) and El-badawi (2006), which show a convergence speed of less than 1% - suggesting that the number of years required to half the income difference between two growing economies solely due to convergence effect is indeed longer than predicted in previous studies, including Barro and Sala-i-Martins (2004), and Mankiw et al., (1992).

positive correlation with growth in both the level and system IV-GMM estimation (columns 3 and 4). In the system IV-GMM, we found that all variables are significantly important for growth, including openness, compared to the level GMM where openness is not significant. In both estimations, institution is an important and significant determinant of long-term growth. Inflation, government consumption and exchange rate overvaluation are negatively correlated with growth, although in the level GMM, government consumption and exchange rate overvaluation are not significant. In the system IV-GMM all variables are significant with high coefficients and robust p-values suggesting that these variables could provide important explanation for the growth experience of developing oil-rich economies as suggested in the literature. We also found that in the level-GMM estimation, conflicts, population density around the coast and oil resource endowment are particularly not important for growth, even though they are negatively correlated with growth as predicted in the theory. Temperate climate is positively correlated with growth in both regressions. It is important to note that in both the level GMM and system IV-GMM models, the oil dummy, though negatively correlated with growth, is not significant.

The period-specific dummies all show negative correlation with growth suggesting that country invariant period specific external shocks are detrimental to growth. In both estimations, the Sargan test of the null hypothesis that the instruments are not correlated with the error term suggests that the instruments used in the model are valid, while the serial correlation test suggests that there is no evidence of either first-order or second-order serial correlation in the system-IV-GMM estimation model.

4.4 Sensitivity Analysis

Using Extreme Bound Analysis (EBA) as proposed in Leamer, (1983) and developed by Levine and Renelt(1992) and Sala-i-Martin, (1997), we test the robustness of the parameters estimated in models[20]

[20] A growth determinant is robust if its statistical significance in the growth regression is not conditional on the choice of information set - for example on whether other variables are added to or excluded from the regression model

The model follow a specification:

$$Y = \beta_i I + \beta_m M + \beta_z Z + \mu \tag{8}$$

where

Y is GDP growth rate

I is a vector of growth determinants that are common to all growth regressions

M is the growth determinant we want to test for robustness

Z is a vector of the control variables included in the model

β_i, β_m and β_z are parameters to be estimated.

We examine the sensitivity of the coefficient β_m on the various combinations of Z. For each M-variable we run a basic bivariate regression without including any Z-variables. We add from one of three of the Z-variables in every possible combination into the equation and compute the 'extreme bounds' of β_m from the estimated β_m. The upper extreme bound is the highest (maximum) estimated coefficient of β_m plus 2 multiply by its standard error

$$\beta_m^{\max} + 2\sigma(\beta_m^{\max})$$

and the lower extreme bound is the lowest (minimum) estimated coefficient of β_m minus 2 multiply by its standard error

$$\beta_m^{\min} - 2\sigma(\beta_m^{\min})$$

An M-variable is considered as a robust growth determinant if all estimated β_m are statistically significant and the extreme bounds are of the same sign.

We constructed a cummulative distribution function (CDF) based on the non-weighted normality assumption.

We estimated the baseline model which contains a combination of 3 fixed I-variables and 1 M-variable with GDP per capita growth rate as the dependent variable. We combine the group of 17 Z-variables in sets of 3 variables with each M-variable and the 3 I-variables to estimate a total of M = $\frac{21!}{3!18!}$ models in this analysis. The results are contained in Tables 4 and 5

4.5 The Result

Using the Leamer approach[21], all the M-variables failed the robustness test except government expenditure (Column 5). Using Sala-i-Martin (1997) approach, we found that more variables are robust at both 99% CDF(0) and 95% level of significance. Column (7) shows the normal non-weighted cumulative distribution function of the estimated β_m coefficient for all M-variables. If we use 99% CDF(0) we find that initial income and real exchange rate over - valuation and institution are robust, even though the variables failed the Leamer's EBA robustness test. If we use 95% CDF(0), we find that period specific shocks (1985-89 and 1990-94) are robust, however they are not significant in atleast 95% of the regressions - which is the second condition- and therefore failed the robustness test.

In all, all the variables failed the sensitivity test, except for initial income and real exchange rate over valuation. This suggests that growth estimation results should be interpreted with caution because they vary significantly according to the specification of the growth models. The significant of a variable is dependent on the combination of other variables in the model. However, given that we have found that initial income,institution and real exchange rate over valuation are robust in the sensitivity analysis test, they represent key factors that explain GDP per capita growth rate in an economy. The initial income variable is only important in the sense that technological progress and total factor productivity needs to be enhanced in order to drive economic growth faster to its steady state equilibrium. The real exchange rate component requires that prices are competitive and transparent to encourage real export sector growth and for countries like Nigeria, non-oil export growth. It is confirmed in this analysis that central to fast and positive growth are strong and efficient political and economic institutions.

[21]In the Leamer (1983) variant, a variable of interest (M) is robust, if the lower and upper extreme bounds are of the same sign.

Table 4: Sensitivity Test Results: Extreme Bound Analysis

M-variable (1)	(2)	β_m (3)	Standard Error (4)	Extreme Bounds (5)	% of Significance (6)	CDF(0) (7)	Robustness/ Fragile (8)
Initial Income	Baseline	-0.043	3.056				
	Maximum	-0.014	2.239	4.464	97.63	.100	Robust
	Minimum	-0.026	2.824	-5.674			
Output Gap	Baseline	-0.126	2.347				
	Maximum	-0.046	2.672	5.298	76.24	.8872	Fragile
	Minimum	-0.198	2.110	-4.418			
Demography (EAP/POP)	Baseline	0.065	3.442				
	Maximum	0.524	2.675	5.874	78.87	.8691	Fragile
	Minimum	0.026	2.442	-4.859			
Human Capital	Baseline	0.661	1.789				
	Maximum	1.224	1.447	4.118	80.11	.9121	Fragile
	Minimum	0.173	2.523	-4.873			
Openness	Baseline	0.326	3.116				
	Maximum	0.781	2.871	6.523	70.23	.8620	Fragile
	Minimum	0.057	2.446	-4.835			
Public Infrastructure	Baseline	0.067	1.897				
	Maximum	0.204	1.884	3.972	23.44	.9026	Fragile
	Minimum	0.007	2.664	-5.321			
Inflation	Baseline	-0.061	3.481				
	Maximum	-0.024	3.261	6.546	87.66	.9079	Fragile
	Minimum	-0.076	2.886	-5.848			
Institution	Baseline	0.074	2.881				
	Maximum	0.128	2.211	4.550	98.62	.9988	Robust
	Minimum	0.023	2.863	-5.703			
Government Consumption	Baseline	-0.072	2.472				
	Maximum	-0.022	2.749	5.476	80.44	.9162	Fragile
	Minimum	-0.110	3.462	6.814			
Real Exchange rate O/V	Baseline	-0.068	1.872				
	Maximum	-0.026	2.114	4.202	98.75	.9995	Robust
	Minimum	-0.035	2.348	-4.731			

Dependent variable is growth rate of per capita GDP.
The baseline β_m is the estimated coefficient from the regression with the M-variables and the I-variable only (without any Z-variable)
The Robust/ Fragile designation indicates whether the variable of interest is robust or fragile
The % of significance indicates whether the estimated β_m is significant in at least 95 % of the regressions
CDF(0) follow Sala-i-Martin (1997) calculations - with non-weighted normal distribution assumption

Table 5: Sensitivity Test Results: EBA (Cont.)

M-variable (1)	(2)	β_m (3)	Standard Error (4)	Extreme Bounds (5)	% of Significance (6)	CDF(0) (7)	Robustness/ Fragile (8)
Intl. War	Baseline	-0.003	2.664				
	Maximum	-0.001	2.872	5.743	10.38	.8466	Fragile
	Minimum	-0.012	3.114	-6.240			
Coastal Pop. density	Baseline	0.016	4.225				
	Maximum	0.062	3.447	6.956	44.63	.8941	Fragile
	Minimum	0.004	2.886	-5.768			
Temperate Climate	Baseline	0.056	4.416				
	Maximum	0.164	3.427	7.018	71.88	.8676	Fragile
	Minimum	0.024	3.208	-6.440			
Oil Dummy	Baseline	-0.165	3.611				
	Maximum	-0.114	3.862	7.610	16.78	.8961	Fragile
	Minimum	-0.186	3.276	-6.738			
Trade terms	Baseline	0.007	0.345				
	Maximum	0.016	0.274	0.564	12.90	.9072	Fragile
	Minimum	0.002	0.117	-0.232			
Time Dummy(75-79)	Baseline	-0.032	0.118				
	Maximum	-0.014	0.151	0.288	60.87	.7963	Fragile
	Minimum	-0.046	0.096	-0.238			
Time Dummy(80-84)	Baseline	-0.012	0.765				
	Maximum	-0.006	0.221	0.436	78.80	.9096	Fragile
	Minimum	-0.021	0.187	-0.399			
Time Dummy(85-89)	Baseline	-0.064	0.087				
	Maximum	-0.023	0.091	0.159	78.23	.9572	Fragile
	Minimum	-0.046	0.096	-0.238			
Time Dummy(90-94)	Baseline	-0.064	0.076				
	Maximum	-0.036	0.089	0.142	77.23	.9616	Fragile
	Minimum	-0.086	0.049	-0.184			
Time Dummy(95-99)	Baseline	-0.006	0.093				
	Maximum	-0.003	0.071	0.139	47.64	.8352	Fragile
	Minimum	-0.010	0.077	-0.164			
Time Dummy(00-04)	Baseline	-0.021	0.063				
	Maximum	-0.012	0.055	0.098	55.87	.9244	Fragile
	Minimum	-0.038	0.064	-0.166			

Dependent variable is growth rate of per capita GDP.
The baseline β_m is the estimated coefficient from the regression with the M-variables and the I-variable only (without any Z-variable)
The Robust/ Fragile designation indicates whether the variable of interest is robust or fragile
The % of significance indicates whether the estimated β_m is significant in at least 95 % of the regressions
CDF(0) follow Sala-i-Martin (1997) calculations - with non-weighted normal distribution assumption

5 Conclusion and Policy Recommendations

In this paper we have looked at empirical issues relating to the estimation of cross-country growth regression models and the policy implications following from the estimated results. We investigated whether the factors that have been attributed to the slow growth performance of developing sub Saharan African countries (within the context of a global growth model) could really account for the slow growth in the sub region. We particularly emphasized the problems in pooling together an heterogenous sample of countries in a cross country growth regression without controlling for the effects of such heterogenous intercepts in the general outcomes of the regression results. These, to a great extend, will bias the generalization of the outcomes of such heterogenous clustering of different countries if appropriate error correction mechanisms are to included in the models.

Using a panel data approach, we identified four variants of panel estimation procedures of cross-country growth model in line with existing literature. In addition to the well known and theoretically supported growth determinants in Levine et al.,(1992) and Barro, (2002), we have adopted other intertemporal growth correlates in Loayza et al., (2002) and El-badawi, (2006). The four estimators adopted include: the pooled ordinary least squares estimator which ignore both individual effects and regressors endogeneity; the fixed effects estimator which controls for individual effects but ignores endogeneity; the level generalized method of moments estimator which controls for measurement errors and endogeneity, but ignores unobservable individual effects; and the system instrumental variable generalized method of moments estimator which simultaneously controls for country-specific effects, measurement error and endogeneity.

We observed that while the results of growth regressions have vary significantly amongst the various modelling approach, the instrumental-variable GMM estimation approach provides more consistent and unbiased parameters of long-run growth determinants. We found that, in all specifications adopted in the study, initial income, institution and real exchange rate overvaluation are robust determinants of long-run growth differentials amongst countries. These findings enable us to conclude that growth has been slow in sub saharan African principally, because of low income, weak institutions and over valued exchange rate.

All other variables that have been attributed to the growth dilemma of developing countries can been connected, one way or the other, to these three channels. Issues, such as, corruption, poor infrastructure, bureaucracy, conflicts and government expenditure could all be captured in poor and weak institutions. Therefore, developing sub Saharan African countries can reserve their poor growth trend by evolving a strong and efficient institutional and legal framework. Issues, such as, inflation, Dutch disease, black market premium, balance of payment disequilibrium, terms of trade deficits and export growth could all be channeled through optimal real exchange rate valuation. Exchange rate over-valuation discourages domestic export and encourages import thereby making the developing countries persistently import dependent at the detriment of the growth of the domestic real sector such as manufacturing and agriculture.

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