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Threshold Effects and Growth-Openness Nexus in Sub-Saharan Africa

Olayeni Olaolu Richard
Department of Economics, Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract: This study examines the growth effects of openness under the consideration that openness, though a growth variable may well be a threshold variable in Sub-Saharan Africa for the period 1970-2008. By using the threshold econometric analysis, it turns out that this is the case. In particular, it is found that openness serves to stratify the region into small open and highly open economies with the growth effects being higher in the former than in the latter countries. The study concludes that openness to trade may be harmful to some countries in the region while it may be helpful to others and that it will be a damning policy recommendation to treat this bi-modal group of countries as a homogenous entity as often presumed in the policy circles.

Key words: Economic growth, openness, threshold, SSA, helpful, stratify

INTRODUCTION

The economic fortune of the people of Sub-Saharan Africa presents a major challenge to the policymakers. The major concern is how to at least halve the number of the people living below the poverty line defined as US$1 per head daily. Understanding the basic features of the economies of Sub-Saharan African countries, thus becomes important.

There are many of such features one of which is that Sub-Saharan Africa is still relatively a closed economy compared to the rest of the world (Masanjala and Papageorgiou, 2003). Thus, the policy recommendation stemming from this feature is that Sub-Saharan African countries should be more integrated with the rest of the world (Sachs and Warner, 1997).

At least, two lines of influence could be adduced to this policy recommendation. First, the growth empirics have presented a good deal of evidence that open economies grow faster than closed ones and the more open an economy is the faster its growth rate (World Bank, 2001).

Second, the theoretical advances in growth theory are now more elaborate. Worthy of mention is the impression that the endogenous growth models such as Lucas (1988) have left on the policymakers and their policy recommendations. Trade liberalization thus becomes a basic policy tool and a norm.

The monotonic linear relation presumed in most of the policy recommendations however shirks when confronted with the data available on Sub-Saharan Africa. Against this backdrop, Rodrik (1999) and Hoeffler (2002) points out that the direct links between openness and growth are weak. He tacitly calls for nonlinear exploration of this relationship.

Literature: Dollar (1992) studies the effect of outward orientation. He investigates sources of growth in 95 developing nations over the period 1976-85 and reports that while per capita income for this period grew at an annual average of 3% for 16 Asian countries, it fell at a rate of 0.4% in Africa and 0.3% in Latin America. Dollar's conclusions emphasize that Asian developing economies were more outward oriented than African and Latin American countries.

Florax *et al*. (2002) use meta-analysis and response surface analysis to assess the robustness of the estimates in the empirical growth literature. The researchers analyze the significance and magnitude of the estimated coefficients and the sign variability in the empirical growth regressions. They report that of the 61 variables used in the regressions only 3 variables, years of openness, equipment and non-equipment investment and human capital are robust.

Harrison (1996) looks at a number of openness indicators that turn out to have a positive association with economic growth while they have weak correlation with each other. Furthermore, a VAR specification in Harrison's research produces evidence in support of bi-directional causality between openness and economic growth. The role of human capital has been emphasized in many studies.

Growth promoting outward orientation may require high levels of human capital. Using a large number of openness measures for a cross section of countries over the last three decades, Yanikkaya (2003) shows that trade liberalization does not have a simple and straightforward relationship with growth. However, contrary to the conventional view on the growth effects of trade barriers, the study shows that trade barriers are positively and in most specifications, significantly associated with growth,

especially for developing countries. Serranito (2009) investigates the trade-and-growth link by applying a new threshold econometric methodology developed by Hansen (2000) to standard growth regressions in order to capture a non-linear effect of trade on growth. Amongst all the threshold variables tested, trade policy indexes are the variables that best sort out the sample. The threshold test splits up the sample into two regimes of the open countries and the closed ones. For the open club, he finds that trade coefficients are rightly signed but are non-significant. By contrast as far as the closed club is concerned, he finds a significant relationship but the coefficients have the opposite sign. He interprets this to mean that for countries with already low barriers to trade, an increase in openness degree is not growth increasing whereas for high level trade barriers countries this is growth reducing.

Girma *et al*. (2003) explore whether the productivity payoffs from openness or trade liberalization are conditioned by the quality of a country's institutions and the extent of natural barriers. Their study endogenously searches for the variable that might be used to capture the heterogeneity and with what level of certainty can we attach to it. They find that there is a threshold in the effect of openness on growth that depends on the level of natural barriers but not institutions.

Papageorgiou (2002) employs the data-sorting method developed by Hansen (2000) which allows the data to endogenously select regimes using different variables. It is shown that openness as measured by the trade share to GDP is a threshold variable that can cluster middle-income countries into two distinct regimes that obey different statistical models. He finds that openness may not be as crucial in the growth process of low and high income countries but it is instrumental in identifying middle-income countries into high and low growth groups. El Khoury and Savvides (2006) examine, the relationship between openness in services trade and economic growth. They estimate a threshold regression model to test whether openness in services trade has a different impact on low and high income countries. They consider openness in both telecommunication and financial services. The results of their study confirm the existence of a two regime split (threshold effect) with low income economies benefiting from greater openness in telecommunication services and high income economies from financial services openness.

MATERIALS AND METHODS

Empirical model: It has been shown that logarithm of the level of per capita income can be decomposed into two parts as follows (Barro and Sala-I-Martin, 2003):

$$\ln(y(t)) = (1 - e^{-\lambda t})\ln(k^{*\alpha}) + e^{-\lambda t}\ln y(0) \quad (1)$$

The steady-state capital per effective labour derived from the Solow fundamental equation is given by:

$$k^{*} = \left(\frac{s}{n + a + \delta}\right)^{1/(1-\alpha)} \quad (2)$$

Substituting the values of k^{*} in Eq. (2) yields the Empirical model:

$$\ln(y(t)) = \eta_1 \ln y(0) + \eta_2 \ln s + \eta_3 \ln(n + a + \delta) + \varepsilon \quad (3)$$

Where:

s	=	The saving rate
n	=	The population growth rate
a	=	The growth rate of domestic capital
δ	=	The rate of depreciation
n+a+δ	=	The effective growth rate

The coefficients on these explanatory variables are functions of the model's deep parameters, λ and α. Following Islam (1995), the preceding can be written in a dynamic panel structure as follows:

$$\begin{aligned} \ln y_{i,t} = {} & \eta_0 + \eta_1 \ln y_{i,t-1} + \eta_2 \ln s_{i,t} + \\ & \eta_3 \ln(n_{i,t} + a + \delta) + X'_{i,t}\prod + \varepsilon_{i,t} \end{aligned} \quad (4)$$

where, $X_{i,t}$ is a vector of control variables. Equation 4 is the basic model. To capture, the threshold effects in this basic growth model, we consider the following equation:

$$\begin{aligned} \ln y_{i,t} = {} & \eta_0 + \eta_1 \ln y_{i,t-1} + \eta_2 \ln s_{i,t} + \eta_3 \ln(n_{i,t} + a + \delta) + \\ & \eta_4(1 - \partial^{O}_{i,t})(\ln Op_{i,t} - \ln\overline{\overline{Op}}) + \eta_5 \partial^{O}_{i,t}(\ln Op_{i,t} - \\ & \ln\overline{\overline{Op}}) + \chi'_{i,t}\Lambda + \varepsilon_{i,t} \end{aligned} \quad (5)$$

Where:

$\varepsilon_{i,t}$	=	The error term
$\chi_{i,t}$	=	The vector of the control variables excluding openness
$\partial^{O}_{i,t}$	=	The dummy capturing the threshold effects

And is defined as:

$$\partial^{O}_{i,t} = \begin{cases} 1 \text{ if } Op_{i,t} > \overline{\overline{Op}} \\ 0 \text{ if } Op_{i,t} \le \overline{\overline{Op}} \end{cases} \qquad (i,t) \in (N_+, T_+)$$
$$\text{and } \overline{\overline{Op}} \in (\underline{Op}_{i,t}, \overline{Op}_{i,t}) \quad (6)$$

Equation 5 and 6 both form the cornerstone of the estimation that follows.

Data sources and measurement: Analysis of this study was conducted using the panel data for Sub-Saharan Africa over the period 1970-2008 making 39 years in all. A total of 41 countries were included in the study, namely; Angola, Benin, Botswana, Burundi, Burkina Faso, Central African Republic, Cameroon, Chad, Comoros, Cote d'Ivoire, Cape Verde, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, Togo, Uganda, Zambia and Zimbabwe. The data were obtained mainly from the World Development Indicators (WDI) (World Bank, 2007) and Penn World table.

Income is conventionally measured as GDP denominated in terms of the currency of that particular country. In the present study, GDP measured in this way is inadequate since countries will necessarily be compared. Thus, GDP adjusted for Purchasing Power Parity (PPP) based exchange rate was used. Such measure is available in the World Bank (2007). Thus, we measure the variables for this study as follows: y is real Purchasing Power Parity (PPP) adjusted GDP based on the foreign exchange; $\ln(s_k)$ is the logarithm of real investment as ratio to GDP plus foreign direct investment; $\ln(n+a+\delta)$ is the logarithm of population annual growth rate plus 0.05; GOV is the logarithm of real government consumption as ratio to GDP; Op is the logarithm of the ratio of exports plus imports to GDP and M2 is the financial deepening measured as ratio of M2 to GDP.

RESULTS AND DISCUSSION

Estimating the threshold point: The starting point in estimating the threshold effects is to first get to know about the threshold point or points. The precise way to compute these points is as follows. Suppose, the threshold point is already known. One could simply plug the threshold point in the estimating equation. For instance if we knew, the threshold point to be zero all that would be required is to set the threshold point equal to zero.

This will be the case if we know that the negative values of the threshold variable behave differently than its positive values. But in most problems as in the present case, the threshold point is not known. Thus, the bulk of the threshold equation regression lies squarely in grid searching. This is done by first ordering the observations on threshold variable (i.e., openness in this case) in descending order (Chan, 1993) and each of such values is considered as a potential threshold point. Depending on how much smoothness is desired and on the number of the observations on the threshold variable, the number of regressions needed to identify the threshold point may run from few regressions to several hundreds of regressions. By the definition of the threshold point, the existence of this point implies the existence of regimes in the data. If many of such points are identified, they will imply the occurrence of multiple regimes.

Of course, it may be possible to find a global threshold point and a sequence of local threshold points. This will be interpreted to mean that within each regime there are sub-regimes thereby emphasizing stratification or heterogeneity.

In the threshold econometrics, it is not a good practice to search for the optimal threshold point at the tails of the distribution. Therefore, we were constrained to grid-search over the interval (15-200) at the increment rate of 0.1. Thus in order to estimate whether the value of the threshold variable binds on the growth process, we run 1,750 regressions for Eq. 5 while incorporating the definition in Eq. 6. The corresponding set of sums of squared residuals is shown in Fig. 1. More formally, we estimate:

$$Op^* = \arg\min\{S_0(\overline{Op}) : \overline{Op} \in (\underline{Op}, \overline{Op})\}$$

which is the critical value of openness that minimizes the sums-of-squared-residuals. This value is estimated to be 68.3 of the real national income while the corresponding sum of squared residual is estimated to be 10.37732.

Estimating threshold effects of openness: Having determined the threshold point, we want to find the effects on economic growth of the threshold existence in

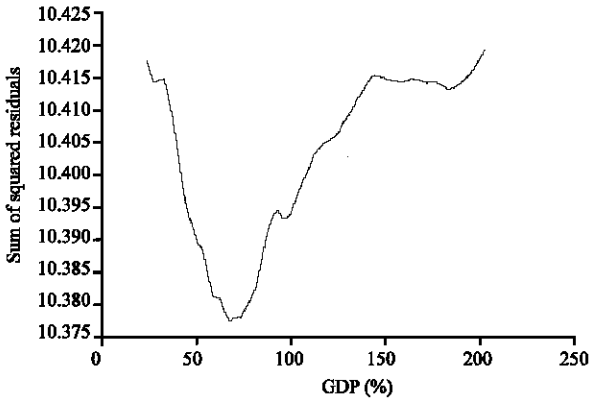

Fig. 1: Openness of imports and export threshold in Sub-Saharan Africa

Table 1: Estimated threshold model

Independent variables	Coefficients	p value
$In(GDP)_{i,t-1}$	0.9891	0.0000
$In(S_k)_{i,t}$	0.0284	0.0000
$In(n_{i,t}+a+\delta)$	-0.0453	0.0114
$\partial^{O}_{it}\{In\ (OP)_{i,t} - In\ (68.3)\}$	0.0194	0.0147
$(1 - \partial^{O}_{it})\{In\ (OP)_{i,t} - In\ (68.3)\}$	-0.0135	0.0156
$In\ (M2)_{i,t}$	0.0025	0.5524
$In\ (GOV)_{i,t}$	-0.0071	0.0459

the data. In order to examine these effects, we estimate the following auxiliary estimating model which incorporates the estimated threshold point. In particular, the model to be estimated is given by:

$$\ln y_{i,t} = \eta_0 + \eta_1 \ln y_{i,t-1} + \eta_2 \ln s_{i,t} + \eta_3 \ln(n_{i,t} + a + \delta) + \eta_4(1-\partial^{O}_{i,t})(\ln Op_{i,t} - \ln 68.3) + \eta_5 \partial^{O}_{i,t}(\ln Op_{i,t} - \ln 68.3) + \chi'_{i,t}\Lambda + \varepsilon_{i,t} \quad (7)$$

Where:

$\varepsilon_{i,t}$ = The error term

$\chi_{i,t}$ = The vector of the control variables excluding openness

$\partial^{O}_{i,t}$ = The dummy capturing the threshold effects

And is defined as:

$$\partial^{O}_{i,t} = \begin{cases} 1 & \text{if } Op_{i,t} > 68.3 \\ 0 & \text{if } Op_{i,t} \leq 68.3 \end{cases} \quad (i,t) \in (N_+, T_+) \quad (8)$$

Estimating the above model, we have the results shown in Table 1. It is found that below the threshold point openness enhances economic growth given that the coefficient on:

$$\partial^{O}_{i,t}\{\ln(Op)_{i,t} - \ln(68.3)\}$$

is positively signed. This is strongly so considering the low p-value for this variable. The result suggests that in those countries where the threshold point is not breached during the time under review output elasticity of openness is 0.0194. Of greater importance to us, however is the coefficient on:

$$(1-\partial^{O}_{i,t})\{\ln(Op)_{i,t} - \ln(68.3)\}$$

Like in the previous case, this coefficient was statistically different from zero given its low p value. When considered in conjunction with the coefficient on

$$\partial^{O}_{i,t}\{\ln(Op)_{i,t} - \ln(68.3)\}$$

that is $\eta_4 = 0.0194$ which is the growth effect of openness on the growth rate in small open economies, openness seems to have a dampening effect on the growth once the threshold point is breached. More concretely, breaching the threshold point reduces the growth effects of openness by $\eta_5 = 0.0135$. Therefore for the highly open economies that overshoot the threshold point, the growth effect of openness on the growth rate is the sum of these two separate elasticity coefficients that is η_4-η_5 = 0.0194-0.0135 = 0.0059.

Table 2: Openness regimes in Sub-Saharan Africa

High open economies	Small open economies
Benin, Botswana, Dem. Rep. Congo, Rep. Congo, Cote dIvoire, Equatorial Guinea, The Gambia, Mauritania, Mauritius, Namibia, Nigeria, Senegal, Seychelles, Swaziland Togo and Zambia	Angola, Burundi, Burkina Faso, Central African Republic, Cameroon, Chad, Comoros, Cape Verde, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sao Tome and Principe, Sierra Leone, South Africa, Uganda and Zimbabwe

Thus, for highly open economies the growth retarding effect of openness is twice the same effect among small open economies. In a related study, Asiama and Kugler (2003) find that Sub-Saharan African countries are not homogenous. The present result indicates that openness in trade can serve to highlight this phenomenon for the sub-region. In Table 2, the countries in the sub-region are classified. Total 16 countries can be classified as small open economies while the remaining 25 countries can be said to be high open economies.

This classification is based on the average openness measure compared with the value of openness measure corresponding to the threshold point. It is typical in threshold analysis to find in addition to the global threshold point some local threshold points that usually reveal the existence of multiple regimes. However as Fig. 1 shows, it is safe to say that Sub-Saharan Africa has been fragmented mainly into two regimes of small open and relatively highly open economies, respectively. In other words, we have that Sub-Saharan African economy as whole was bi-modal and not entirely homogenous as we are routinely led to believe.

In fact in the previous study, we found that openness stratifies these economies into high growth small open economies on the one hand and low growth highly open economies on the other.

We also found that the region is not severely heterogeneous. Failure over the years to properly delineate this fact about Sub-Saharan Africa has probably led to the view that Sub-Saharan African countries are homogenous the view that is often reflected in policy recommendations and the establishment of institutions (e.g., the proposal for common currency in West Africa). More importantly, we have that openness to trade turns out to be a threshold variable.

CONCLUSION

Methodologically, this finding suggests that it would be statistically wrong to attempt to lump all the countries together since, they really are not homogenous as often presumed. In terms of policy issues, it behooves the institutional bodies and organizations to give due recognition to individual differences among the Sub-Saharan African countries when formulating and recommending policies. In particular, these countries cannot be expected to evenly gain from enlarged openness to trade. For some of them, such policy is really harmful in terms of growth loss.

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