What explains the recent growth performance in Sub-Saharan Africa? Results from a Bayesian Averaging of Classical Estimates (BACE) Approach

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Abstract

This paper empirically identifies the main driving forces behind the recent development in economic growth across Sub-Saharan Africa based on a two-step procedure. Given the role of convergence in explaining the level of economic development, the first step employs the new extension of the sigma convergence developed by Phillip and Sul (2007) to test and endogenously identify the formation of different steady state paths across a sample of 34 countries selected based on available data over the period 1996-2010. Empirical results vindicate the existence of three main convergence clubs and a divergent group of 8 countries; suggesting that Sub-Sahara African countries do not form a homogenous club. The second step implements a Bayesian Averaging of Classical Estimates (BACE) method on the only convergent groups in order to explicitly account for the assumed conditional convergence in cross-sectional growth regressions. Estimation results prove support that 8 out of 18 selected explanatory variables documented in the literature are significantly and strongly associated with the long term economic growth. Particularly, investment and the relative price of exports are found to be favourable to the recent regional economic performance while public consumption and remittances appear to be of less contribution. Other important variables include scientific research, trade taxes, land availability and population growth which are unexpectedly found to be negatively associated with economic growth. Although their sign certainty probabilities are reportedly insignificant, these results raise a number of policy challenges including poor quality of institutions, the exposure to world shocks given the dependence to international trade taxes, the poor quality of human capital and more importantly a threat of skilled labour immigration.

Keywords: Economic growth, BACE, Convergence club, Sub Saharan Africa

JEL Classification: E20, E60, N17

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1 Introduction

The recent decades have witnessed a series of global turbulence with significant impact on the economic performance worldwide. Unlike western economies which have been weighed down by weak economic activity, the recovery has remained strong in developing countries and particularly in Sub-Saharan Africa (SSA) with an average economic growth rate of 5.8[1] percent in 2012, higher than the developing countries average of 4.9 percent (World Bank, 2013). This favourable growth prospect is broadly attributed to oil production, mining, agriculture, services and the domestic demand which, however, vary substantially across countries. SSA countries are characterised by different resources endowment resulting in divergent economic conditions as featured the histogram in Figure 1 (See Appendix). The real per capita growth rate[2] of 34 SSA countries with available data from 1996 to 2010 shows the mean value of 4.9 percent per annum, with a standard deviation of 15.15. The high median performs at a minimum growth rate of 4 percent per annum whereas the low median has growth rates below 2.5 percent. For quintiles, the highest quintile comprises 7 countries with growth rates above 19 percent per annum and the lowest quintile consists of 7 countries with annual growth rate below -6.3 percent

In the empirical literature, growth disparities across countries may arise as a result of different structural characteristics and/or initial economic conditions. This conclusion derives from the well-known convergence hypothesis stipulated by the neoclassical growth theory and which predicts that similar economies are to converge to a common steady state growth path. Accordingly, the observed differences in per capita income across SSA countries may suggest the multiplicity of steady state equilibra and possibly the existence of divergence. While the empirical growth literature is mostly based on cross-countries studies, they however rely on the conditional convergence assumption which is not always realistic; hence representing a potential source of outliers A number of studies have documented that outliers considerably affect both the standard errors (Roodman, 2007) and the average coefficient estimates (Bassanini and Scarpetta, 2001; Yanikkaya, 2003; Barro, 1996; Temple, 1999 and Hoover and Perez, 2004 amongst others). Additionally, besides the cross-sectional related issues such as endogeneity, model uncertainty, measurement error, Easterly (2004) argues that many cross sectional results are driven by outliers. This highlights the need to control for outliers when dealing with cross-sectional studies.

The common approach to test for outliers developed by Hadi (1992) is based on instrumental variable specification which associates outliers with influential observations. However, besides the influential observations, outlier can be contextual or collective; each of which being different in characteristics and detection (Han et al., 2012). The influential observation is classified as global outlier or point anomaly and corresponding to a situation where a data object significantly deviates from the rest of the dataset. The contextual outlier also

[1] This figure excludes South Africa which is the region's leading economy.

[2] The per capital growth rate is defined by the Gross Value Added (GVA) per Worker as described in Bartkowska and Riedl (2012).

known as conditional outlier is viewed as a generalisation of global outliers in that its characteristic significantly deviates from a selected context. Its detection therefore requires both contextual attributes and behavioural attributes. With the collective outliers, a subset of data objects collectively deviate significantly from the whole dataset, even if the individual observations may not be outliers. Its detection requires to consider not only the behaviour of individual observations but more importantly the need to have the background knowledge on the relationship among the group of data objects (Han et al., 2012). Consequently, if the cross-country studies of economic growth entail the convergence among countries, then the convergence pattern becomes a key measure for outliers' detection. Particularly, the presence of divergent countries among a set of regional economies that converge to one or multiple balanced growth paths can be associated with outliers. Therefore, prior to analysing the growth determinants across SSA countries, this study hypothesises and tests the presence of divergent countries which are henceforth referred to as outliers units.

Another important challenge faced by empirical growth researchers is the multiplicity of possible explanatory variables. Given the implicit property of variables in growth theories, empirical economists have devoted considerable effort to explicitly defining what variables belong to the so called "true" regression; resulting in a wide range of regressors which are not mutually exclusive. Sala-I-Martin *et al.* (2004) suggests a Bayesian reasoning to reconcile different possible growth determinants. This procedure departs from uncertainty about the "true" model and attaches probabilities to different possible models in the spirit of the empirical growth literature. They develop a weighting method known as Bayesian Averaging of Classical Estimates (BACE) to establish the robustness of variables in cross-country growth regressions. This methodology has several advantages[3] (Sala-I-Martin *et al.*, 2004): (i) Besides the benefits of standard Bayesian techniques, BACE entails the specification of only one hyper parameter which eases the interpretation and the robustness check; (ii) The interpretation of estimates is made simple for nontrained economists in Bayesian inference as the weights applied to different models are proportional to the logarithm of the likelihood function corrected for degrees of freedom; (iii) Repeated applications of OLS can be used to compute the estimates; (iv) There is no size restrictions for models and all variables are eligible for testing; (v) BACE considers the entire distribution of coefficients across models and does not focus on the bounds of distribution.

This study implements the BACE procedure on a panel of SSA countries over the period of 1995 2009 to empirically explain the main driving forces behind the recent growth performance. Unlike previous crosssectional growth studies which assume the conditional convergence hypothesis across countries, the present paper carries out the growth analysis on a convergent club of SSA

[3] One alternative to the BACE approach is the Bayesian Model Averaging (BMA) which combines the benefits of BACE and the possibility to control for heterogeneity and endogeneity. However, BMA is associated to the well-known within group bias which has been shown to be severe in short dynamic panels (Moral-Benito, 2012) as it is the case in this study with T= 15 only.

countries selected based on the new extension of the sigma convergence developed by Phillip and Sul (2007). As indicated earlier, the convergence pattern in cross-countries growth investigation is key for outliers' detection; the presence of divergent countries outlying the convergence assumption implied by the neoclassical growth theory. . The next section reviews the relevant explanatory variables of economic growth followed by the convergence test across SSA countries The empirical analysis is then discussed leading to the concluding remarks in the final section.

2 Review of the growth determinants

In seeking to explain the poor economic performance in developing countries, empirical studies have identified a substantial number of variables that are fairly related to economic growth. These determinants comprise the initial conditions as well as the structural characteristics of the economy.

2.1 *The initial per capita income*

The inclusion of the initial level of per capita income in the growth regression is vindicated by the convergence hypothesis that poor countries are characterised by a high growth potential and hence have the propensity to catch up to the richer countries. An inverse relation is therefore expected between the growth rate of per capita income during a sample period and the level of per capita income at the beginning of that period (Barro, 2003); the correlation coefficient measuring the rate of convergence.

2.2 *The factors endowment*

Based on theoretical considerations that initial factors are crucial in determining an economy's long-run steady state path, growth regressions use different variables to capture the heterogeneity in factors endowments. Sokoloff and Engerman (2000) emphasize that the degree of inequality in wealth, human capital and political power roots in the factor endowment and persists over time. Common proxies for these variables include the labour force which reflects the economically active population as a share of total population (Bartkowska and Riedl, 2012) and the stock of capital which is alternatively replaced by education and/ or health in developing countries given the limited data, the arbitrary assumptions about the depreciation and the inaccurate measures of the benchmark stocks and investment flows (Barro, 2003). Further, the share of investment is used to account for the differences in factor intensities which reflect the relative importance of factors in the production process across economies (Bartkowska and Riedl, 2012).

2.3 *The structure of production*

One key component of the economic development entails the sophistication of the country's production structure. Since some products yield higher productivity than others, what a country produces matters for its growth path. Anand *et al.* (2012) argue that services are progressively becoming more productive, tradable and unbundled. In SSA, this increasing importance materialises in the success stories such as Nigerian's film industry or Kenya's call centers. The GVA for each sector as a share of total income is therefore considered in the growth regression to account for the production structure.

2.4 *The Economic policies and macroeconomic conditions*

There seems to be a consensus that policy variables as well as macroeconomic environment determine a country's economic performance. Because of their ability of shaping the framework within which the economic process takes place, economic policies influence the growth mechanism through a number of channels including investment in human capital and infrastructure, political and legal institutions (Barro and Sala-I-Martin, 1995). A special policy component is the trade policy which advocates the liberalisation as one of the effective strategies designed to improve the economic performance of developing countries. Openness might affect economic growth through the comparative advantage, the technology transfer and knowledge dissemination and the increasing economies of scale (Yanikkaya, 2003); exports and imports as a share of income and the terms of trade being the widely used proxies. Similarly, macroeconomic environment impacts the growth process through its effect on uncertainty. Accordingly, macroeconomic stability, fiscal policy, budget deficits and tax burdens have been shown to exert a significant effect on economic growth (Fisher, 1993). Empirical literature documents that the more economies are open to trade and capital inflows, the faster they grow and have higher per capita income. Favourable macroeconomic environment is likely to attract capital inflows in terms of Foreign Direct Investment (FDI) which is conducive to economic growth (Lensink and Morrissey, 2006). Besides FDI, remittances and foreign aids are two important sources of capital inflows whose effects on economic growth have attracted much attention amongst scholars. Unlike remittances, researchers are less favourable to the positive effect of foreign aids on economic growth; mismanagement, corruption and more interestingly the fiscal advantage to donors been the main reasons.

2.5 *Other structural characteristics*

Barro and Sala-I-Martin (1991) point to the importance of structural characteristics in explaining the formation of growth path. Relevant and often cited factors include the technology (Galor, 1996), the rate of population (Mora, 2008), the population density which reflect the geographical agglomeration (Bartkowska and Riedl, 2012) and the land area availability (Ding and Lichtenberg, 2010).

Moreover, physical location may represent a form of externalities which, according to Quah (1996) are relevant to convergence process among regional countries. This justifies the inclusion of region dummies in the growth regression in order to control for geographical spillovers.

3 Identification of outliers: The convergence analysis

The identification of outliers can be based on the convergence analysis. As indicated earlier, outlier should be broadly understood as helpful information about the development process under rare circumstances (Roodman, 2007); and as such may not be restricted to an influential observation. Considering the influence outlier countries may have on the average estimates in cross-section studies, this paper posits that divergent economies can be associated with outliers in cross-country growth regressions which, in fact, rely on the convergence hypothesis. Therefore, prior to investigating the main driving forces of economic growth in SSA, it is important to empirically test and remove the divergent countries

Following Bartkowska and Riedl (2012), a novel approach based on the Phillips and Sul (2007) s' convergence test referred as to the *log t* test is implemented on a panel of 34 SSA countries between 1996 and 2010.[4] Based on the cross-sectional variance of per capita incomes over time, this methodology has the advantage to allow individual behaviour to be transitionally divergent; hence mitigating the cointegration requirement of the respective time series. As pointed out Phillips and Sul (2007, the absence of cointegration does not necessary imply the lack of convergence. More importantly, this technique endogenously reveals a wide range of transitional behaviour among economies, namely divergence and convergence to a common or multiple steady states (club convergence).

Within a panel data framework, the *log t* test builds on an innovative decomposition of the variable of interest in the following way:

$$\log y_{it} = \phi_i \mu_t + \varepsilon_{it} \tag{1}$$

where y_{it} measures the income per capita proxied by the real gross value added (GVA) per worker on the basis of data obtained from the African Development Bank (ADB) socio-economic database; ϕ_i captures the country specific characteristic; μ_t represents the common factor and ε_{it} the error term.

In this original specification, the behaviour of the individual country $\log y_{it}$ is explained by the common factor μ_t and two country-specific components ϕ_i and ε_{it}. Bartkowska and Riedl (2012) suggest a modified version of the *log t* test which attempts to evaluate the share of the common growth path that

[4] The choice of these countries is based on data availability of all the variables included in the empirical analysis over the sample period.

explains the individual country per capita income. Formally, equation (1) can be rewritten as follows:

$$\log y_{it} = \left(\phi_i + \frac{\varepsilon_{it}}{\mu_t}\right)\mu_t = \delta_{it}\mu_t \tag{2}$$

where δ_{it} absorbs the error term and the country-specific component; hence defining the time-varying idiosyncratic term. It therefore measures the share of the common growth path that country i undergoes. To get rid of the common factor, Bartkowska and Riedl (2012) construct the relative transition coefficients h_{it} which represents the transition path of economy i relative to the cross-country average.

$$h_{it} = \frac{\log y_{it}}{N^{-1}\sum_{i=1}^{N}\log y_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N}\delta_{it}} \tag{3}$$

Intuitively, h_{it} captures the individual country behaviour in relation to other countries. It further illustrates the relative departure of country i from the common growth path μ_t Therefore, countries move toward the same transition path when $h_{it} \to 1$ for all i as $t \to \infty$; indicating that the cross-country variance of h_{it} converges to zero; that is, $V_t^2 = N^{-1}\sum_i (h_{it}-1)^2 \to 0$as $t \to \infty$ The absence of convergence may lead to a number of possible outcomes. The formation of club convergence arises when V_t converges to a positive number. V_t may also remain bounded above zero and not converge or diverge. Consequently, under the null hypothesis of convergence, various transitional patterns of countries are possible, including temporary divergence whose classical convergence methods commonly fail to detect. Unlike traditional convergence testing procedures, in the Phillips and Sul (2007)'s approach, the testing procedure is extended to sub-samples[5] (clusters) if the convergence is rejected for the overall sample. Practically, the countries are sorted in descending order from the last period of the time series dimension of the panel. Then, the clusters are formed by adding countries one by one to a group of the two highest-income countries at the beginning and repeatedly running the *log t* test to check whether they converge. If not, the same steps are applied on the remaining countries. In case of no convergence clubs, those countries are said to be divergent.

Unsurprisingly, the results of the *log t* test[6] applied to per capita incomes across 34 SSA countries over the period from 1996 to 2010 reject the hypothesis of the overall convergence at the conventional level of significance. This suggests that SSA countries do not converge to the same balanced growth path; hence they do not form a homogeneous club. Furthermore, the clustering mechanism procedure identifies three main clusters[7] and eight diverging countries (See Table 1).

The general pattern that emerges from the identified convergence clubs in SSA is that the region effect is less apparent, that is, the tendency of countries

[5] See Phillips and Sul (2007) for further details about the formation of clusters.
[6] MATLAB code kindly provided by Monika Bartkowska was used for the estimation
[7] The fourth club consists of only two countries, namely, Mauritius and Namibia.

belonging to the same sub-regional blocs to cluster together. With the exception of club 4 which groups two Southern African Development Community (SADC) member countries, the remaining clubs are formed with countries from different main African sub-regional groupings, namely, East African Community (EAC), Economic Community of West African States (ECOWAS) and Central African Economic and Monetary Community (CEMAC). Additionally, it seems that the geographical distance might not significantly determine the club membership as the spatial filter[8] was applied before running the *log t* test. Only limited neighbouring countries form part of the same convergence club. This is the case for Cameroon, Central African Republic and Equatorial Guinea on one hand and Mali, Senegal and Guinea- Bissau on the other hand (club 1).

Given the possibility to have larger convergence clubs from the merging of the original clusters (Bartkowska and Riedl, 2012), the falling apart of eight diverging countries makes them to be viewed as outliers among the selected countries for the panel growth regression. Though it might be interesting to investigate the cross-club development tendencies, the objective of the present study is to access the robustness of the long-run growth determinants in the absence of outliers; outliers' deletion being expected to improve the quality of estimates.

4 The BACE analysis

The classical cross-country or panel regression has the following specification:

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n + \varepsilon \tag{4}$$

where y is the vector of growth rates, α is a vector of constants, and $x_1, ..., x_n$ are vectors of regressors which differ across both economists and empirical studies; hence raising the uncertainty about the "true" model. As a result, an important number of explanatory variables have been identified in the growth literature which however, requires empirical application to have a very large sample in order to derive meaningful inference from the multiplicity of possible regressors. To alleviate this issue, some empirical economists rely on data-mining which is also subject to spurious inference (Sala-I-Martin *et al.*, 2004). Recently, Bayesian approaches have been advocated as a natural way to address the model uncertainty. BACE is a particular category of these techniques which was proposed by Sala-I-Martin *et al.* (2004) to determine the significance of variables in cross-country growth regressions. This technique combines the averaging of estimates across models with classical OLS estimation derived from the Bayesian assumption of diffuse priors.

Unlike classical econometrics where parameters are assumed to have a true, though unknown, value, the Bayesian-type parameters are considered to be

[8] The spatial filter helps alleviate the influence of geographical location on the convergence club formation. The present application implements the Getis' filtering procedure (Getis, 1995; Getis and Griffith, 2002). For further details, the reader is referred to Bartkowska and Riedl (2012).

random and so can have a density.

Recall that in the basic Bayes' rule, the density of β is given by:

$$g(\beta|z) = \frac{f(z|\beta)g(\beta)}{f(z)} \tag{5}$$

This is true for any random variables z and β. $g(\beta)$ is the prior densisty of a parameter vector β, commonly known as the researcher's information about β prior to seeing the data. The likelihood function $f(\beta|z)$ summarises the information about β contained in the data. The vector z is the observed data with prior density $f(z)$, reflecting the prior opinion about the data. $g(\beta|z)$ is the density of β conditional on the data and is well known as the posterior density.

Sala-I-Martin *et al.* (2004) define the "model averaging" as a special case of Baye's rule in which the parameter space is divided into two regions M_0 and M_1. These regions are referred to as models, each of which being assigned a prior probability $P(M_i)$ by the researcher. These prior probabilities summarise the researcher's beliefs pertaining to the relative likelihood of the two models (regions). With the two models, Bayes' rule implies:

$$g(\beta|z) = P(M_0)\frac{f(z|\beta)g(\beta|M_0)}{f(z)} + P(M_1)\frac{f(z|\beta)g(\beta|M_1)}{f(z)} \tag{6}$$

Equation (6) can be rewritten in terms of the posterior probabilities as follows:

$$g(\beta|z) = P(M_0|z)\frac{f(z|\beta)g(\beta|M_0)}{f(z|M_0)} + P(M_1|z)\frac{f(z|\beta)g(\beta|M_1)}{f(z|M_1)} \tag{7}$$

where $P(M_i|z)$ is the posterior probability of the i'th model conditional on the data. Therefore equation (7) indicates that the posterior distribution of the parameters is the weighted average of the two possible conditional posterior densities with the weights given by the posterior probabilities of the two models. BACE methodology implemented in this study follows Sala-I-Martin *et al.* (2004) by considering linear regression models for which each model is a list of included variables, with the slope coefficients for all of the other possible regressors set equal to zero.

Another critical issue that face Bayesian economists is the choice of priors; diffuse priors being the standard remedy in Bayesian theory. The application of diffuse priors is also justified in the presence of a large set of possible regressors which, according to Sal-I-Martin *et al.* (2004), makes it infeasible to fully specify priors. However, the use of diffuse priors remains questionable when different regression models contain different sets of variables. One solution to this problem consists of getting results for diffuse priors by taking a limit of informative priors, specified as prior information concerning both β, the vector of slope coefficients and the error standard deviation. Considering the limit as the data becomes very informative relative to the prior information (that is as the prior becomes "dominated" by the data), the approximation of the ratio of the posterior probabilities of two regression models (known as the posterior

odds ratio) is given by:

$$\frac{P(M_0|z)}{P(M_1|z)} = \frac{P(M_0)}{P(M_1)} T^{(k_1-k_0)/2} \left(\frac{SSE_0}{SSE_1}\right)^{-T/2} \tag{8}$$

where SSE_i is the OLS sum of squared errors under model i, T is the sample size and k_i is the number of explanatory variables included in model M_i. This approximation of the odds ratio generated by a wide range of reasonably diffuse prior distributions is similar to the ratio of the Schwarz model selection criteria for the two models, exponentiated.

Similarly, the specification of the prior probabilities attached to the different models has odd and troubling implication in linear regression with a large number of potential regressors. A reasonable prior model size can be determined by assigning equal probability for each possible model, that is by chosing $\bar{k} = K/2$ with K representing the number of regressors. One major implication is that the expected model size increases with the number of explanatory variables available to researchers. While this criterion leads to a large prior model size, Sala-I-Martin *et al.* (2004) indicate that the use of a small $\bar{k}$ in growth regressions delivers robust results since most empirical growth studies include a moderate number of explanatory variables. Accordingly, their study relies on a prior model size of 7 which, in turn, defines the baseline choice of the present application. In contrast to these authors who consider 69 growth regressors, the empirical results of this study rely on a smaller model size ($\bar{k}$=5) as it includes less regressors (21).

Finally, the weights for different models are derived from the posterior probabilities of each model. Normalising the weight of a given model by the sum of the weights of all possible models, with K possible regressors leads to the following expression:

$$P(M_j|z) = \frac{P(M_j)T^{k_j/2}SSE_j^{-T/2}}{\sum_{i=1}^{2^k} P(M_i)T^{k_i/2}SSE_i^{-T/2}} \tag{9}$$

Once the model weights are computed, Bayes' rule is applied which states that the posterior density of a parameter is the average of the posterior densities conditional on the models as shown in equation (7) for the two models. The posterior mean defined as the expectation of a posterior distribution is computed with respect to β across (7). Taking expectations with 2^k terms gives:

$$E(\beta|z) = \sum_{j=1}^{2^k} P(M_j|z)\hat{\beta}_j \tag{10}$$

where $\hat{\beta}_j = E(\beta|z, M_j)$ is the OLS estimate for β with the regressor set that define model j. $\hat{\beta}_j$ is the posterior mean conditional on model j. The posterior

variance[9] is given by:

$$var(\beta|z) = \sum_{j=1}^{2^k} P(M_j|z) var(\beta|z, M_j) + \sum_{j=1}^{2^k} P(M_j|z) \left(\hat{\beta}_j - E(\beta|z)\right)^2 \quad (11)$$

Furthermore, the posterior inclusion probability is estimated; that is, the posterior probability that a particular variable is in the regression (i.e., has a non-zero coefficient). It is defined as the sum of the posterior model probabilities for all of the models including that variable. Posterior mean and the variance conditional on the inclusion of the variable are also reported.

It is however important to highlight that the BACE approach supposes strict exogenity of the explanatory variables which, in the present study are indeed more likely to be explained by the dependent variable (economic growth); hence raising the issue of endogeneity. While the Bayesian Model Averaging (BMA) has been emphasized for its ability to mitigate the endogeneity issue, it is however subject to severe within group bias, particularly in short dynamic panels (Moral-Benito, 2012). With our short time period, the choice of BACE leads to the trade-off endogeneity against within group bias.

4.1 Data

The lack of and/or missing data remain a major challenge for empirical research in developing countries in general and in African countries in particular. Of the multiplicity of explanatory variables that the literature has identified to be significantly linked to economic growth, eighteen (18) have been selected on the basis of data availability and the technical requirement of "balanced" panel. Although many other variables could be found in some of the countries under study, the BACE methodology does not accommodate missing observations, hence restricting the choice to variables that are available across all cross-sections and over the entire sample period (this is referred to as "balanced" data set). More importantly, since some countries have been tested non convergent and thus considered as outliers as discussed earlier, the 18 variables are selected for 26 convergent countries over the period 1996 to 2010.

Note that these variables include a region dummy which is further categorised into four main sub-regional grouping, namely, CEMAC, EAC, SADC and ECOWAS. Though the income per capita data exist for the 53 SSA countries, the availability of data for all other variables restricts the sample to 34 countries over the period 1996 to 2010. After outlier detection and removal (eight countries), the total size of the dataset becomes 21 variables (excluding the dependent variables) for 26 countries. Table 2 provides variables names and summarises their descriptive statistics. The data is obtained from different sources. Polity and Research are provided by the African Development Indicator (ADI)'s World Bank database while Resource and Tradtax are drawn from

[9] Note that any variable excluded from a particular model has a slope coefficient with degenerate posterior distribution at zero

Authorised Economic Operator (AEO) database. Baring these four variables, the data on the remaining regressors come from the Africa Development Bank (ADB) socio-economic database.

4.2 Results

To motivate the choice of the model size, Table 3 reports the posterior inclusion probabilities for the two candidate priors discussed earlier, that is, $\bar{k} = 7$and $\bar{k} = 5$.Unlike the baseline model size ($\bar{k} = 7$) associated with a posterior model size of 4.19, the prior model size of $\bar{k} = 5$ delivers a posterior model size of 5.26 which is very close to the expected model size. The first column ranks variables in descending order of the posterior inclusion probability. The posterior inclusion probability technically measures the weighted average goodness-of-fit of all regressions including a particular variable, relative to models not including that variable. This goodness-of-fit measure is adjusted to penalise highly parameterised models in the spirit of the Schwarz model selection criteria. Thus, variables that have high marginal contribution to the goodness-of-fit of the regression model are those with high inclusion probabilities (Sala-I-Martin *et al.*, 2004). Therefore, variables can be distinguished according to whether seeing the data causes the increase or decrease of the associated inclusion probability relative to the prior probability determined by $\bar{k}/21$. The baseline model size selects two variables for which the posterior probability increases; that is variables with inclusion probability greater than 7/21=0.3333(these are the first 2 variables in the first column of Table 3). However, with the preferred model size, there are 8 variables for which the posterior probability is greater than 5/21=0.2381 (these are the first 8 variables in the third column of Table 3) The belief that these variables belong in the regression is strengthened by the data, hence providing the rationale to be called "significant". The remaining variables prove little or no support for inclusion as seeing the data reduces the already modest primary evaluation of their inclusion probability.

The BACE estimation[10] results from the preferred model size are reported in Table 4. namely, the posterior distributions for all of the β's, the posterior means and variances given in equations (10) and (11) using the posterior model weight defined in equation (9), the posterior inclusion probability discussed in the previous section, the posterior confidence in the sign of the coefficients and finally the fraction of regressions in which the coefficient has a classical t-test greater than two. Columns 4 and 5 display the posterior mean and standard deviation of the distributions, conditional on the inclusion of the variable in the model. The conditional posterior mean is the "right" estimate of the marginal effect of the variable. It is comparable to coefficient estimates in standard regression

[10]I use the GAUSS code kindly provided by the authors at http://www.nhh.no/Default.aspx?ID=3075. For the sake of convergence, the present application uses the stratified sampling. Particularly, one set of regressions have been sampled using the prior probability sampling weights and thereafter, the approximate posterior inclusion probabilities computed from those regressions are used for the subsequent sampling probabilities. The reader is referred to Sala-I-Martin et al. (2004) for further technical details.

controlled for model uncertainty. Similarly, the conditional standard deviation measures how well estimated the variable is conditional on its inclusion[11] Given the posterior density, it is also possible to estimate the posterior probability that conditional on a variable's inclusion a coefficient has the same sign as its posterior mean in column 4. This is known as "sign certainty probability", reported in column 6. Similar to the classical assumption that a variable is 5-percent significant in a two-sided test if 97.5 percent of the probability in the sampling distribution were on the same side of zero as its coefficient estimate; the "sign certainty probability" represents another measure of significance. Considering the 0.975 cut-off identifies 2 variables, all of which being part of the set of 8 "significant" variables for which the posterior inclusion probability is greater than the prior inclusion probability. The remaining 6 have high sign certainty probabilities, ranging between 0.889 and 0.9353. These contrasting results are also reported by Sala-I-Martin *et al.* (2004) who emphasize that there is no standard reason why a variable could not have a very high posterior inclusion probability and still have a low sign certainty probability

In the final column, Table 4 shows the fraction of regressions with classical significant variables at the 5-percent level[12] (that is, with$t$-statistic greater than 2 in absolute value). Good comparison tool for extreme bounds analysis, this statistic suggests that top variables are still fragile as many individual regressions can be identified in which the variable is insignificant.

4.2.1 Robust SSA growth determinants

These are the top variables referred to as major growth driving forces (the first panel of Table 4) They include:

The investment ratio. Investment participates to the capital formation which is widely accepted as the core determinant of economic growth. So, irrespective of the type of the economic system, the economic growth process cannot be accelerated without capital accumulation. Unsurprisingly, the most significant variable chosen by the BACE technique is the average ratio of gross formation capital to real GVA, found to be positively related to economic growth in SSA The posterior mean coefficient is very accurately estimated to be positive, the sign certainty probability indicating that the probability mass of the density to the right of zero equals to 0.9883. Moreover, the fraction of regressions for which the investment ratio has a t-statistic greater than two in absolute term is 87 percent. This results confirms the upward trend of the investment prospect across SSA and corroborates the IMF (2012)'report that investment has been a key determinant of the recent regional economic performance. It might also be attributed to the increase in FDI due to the high rate of return on investment in Africa compared to other developing regions[13]

[11] However, the ratio of the posterior mean to the posterior standard deviation cannot be interpreted as a $t-$statistic since the posterior is a mixture t-distribution and it is not a sampling distribution (Sala-I-Martin *et al.*, 2004).

[12] Please refer to Sala-I-Matin *et al.* (2004) for further details in computing this statistic.

[13] The United Nations World Development Report estimates the return on investment of 20

The Research output represents the second robust growth determinants in SSA. This variable accounts for the human capital component of the capital formation which predicts a positive relationship between knowledge accumulation and economic growth through human capital improvement. Research output is reported to be negatively related to economic growth with an inclusion probability of 0.7385 though empirical studies are mostly favourable to the positive correlation between the two variables (Inglesi-Lotz and Pouris, 2013). However, it is acknowledged that the nature of this relationship may vary depending on the level of development of the country in general and the scientific sector in particular (Vinkler, 2008 and Lee *et al.*, 2011). Accordingly, considering the macroeconomic conditions in SSA, the negative association between research output and economic growth in SSA might reflect the immigration of the African scientific human capital to developed countries with sophisticated technology sector and attractive labour market conditions. In the absence of a dynamic technology sector in SSA, the increase in research output offers their authors better job opportunities in modernised economies resulting in the immigration of skilled workers. The subsequent shortage in qualified labour force translates into a decrease in productivity which negatively impacts the growth process. The nature of this relationship in SSA is further confirmed by the high sign certainty probability (0.9858). Moreover, 74 percent of regressions prove support of the significance of the research output coefficient estimate as vindicated the fraction of regressions with $|t\text{-stat}| > 2$.

Trade taxes as percentage of GVA is the third variable significantly related to economic growth with an inclusion probability of 0.3553. Trade taxes account for the trade policy, the third main economic policy besides monetary and fiscal policies whose growth enhancing effect has been widely emphasized in the economic development literature. In the SSA context, the negative relationship of trade taxes with growth though insignificantly precise (sign certainty probability less than 0.975), suggests that increasing trade taxes is likely to decrease the international competitiveness and hence the economic performance. Besides this direct effect, the negative growth effect of the trade taxes may channel through the quality of institution. While the African trade structure is dominated by the resource-based exports, natural resource abundance may have a positive or a negative effect on economic growth depending on the quality of institutions and/or political environment. Resource abundance may fuel corruption (Sachs and Warner, 1995) and political instability (Ross, 2001; Collier and Hoeffler, 2005 and Holder, 2006), resulting in mismanagement with negative impact on economic growth. Accordingly, the negative relationship found between trade taxes and economic growth in SSA may reveal the poor quality of institutions and/or political instability characteristic of these countries which in turn corroborates the "resource curse" hypothesis.

The initial level of income. The next important determinant of economic growth in SSA is the initial level of income per worker which is the measure of

percent in Africa compared to 14 percent in Latin America and the Caribbean and 15 per cent in Asia.

conditional convergence. This variable derives from the convergence hypothesis of the neoclassical growth theory and confirms that our sample countries are to converge to a common steady state growth path The inclusion probability is 0.3031 and the posterior mean conditional on inclusion (4.6977) is of positive sign; confirming that these countries do not form a homogenous club While the extreme bound test labels this variable as not robust (given the small fraction of regressions with $|t\text{-stat}| > 2$), the sign certainty probability shows that the probability mass of the density to the left of zero equals 0.921 which is less than the 0.975 significance threshold. However, since the posterior inclusion probability is greater than the prior inclusion probability, omitting this variable is likely to result in poor performance regression Further, it is reasonable to moderate this prediction in the SSA context by arguing that the positive coefficient of the initial level of income, indeed, indicates the possibility for convergence clubs identified earlier to merge and form a single club convergence. In fact, the negative sign of the initial income coefficient estimate reported in the empirical growth literature refers to the beta convergence which theoretically relies on the diminishing returns to capital. However, Barro and Sala-I-Martin (1990) content that besides capital and labour mobility, the potential to imitate the leading countries (which is less costly that innovate) also determines the tendency of poor economies to grow at a faster rate and catch up with rich ones. Accordingly, the positive sign of the income level coefficient found in this study might indicate that the effect from capital and labour mobility has been dominated by the effect from the spread of technology (through imitation) which, unlike the former, does not depend on diminishing returns to capital (Barro and Sala-I-Martin, 1990). This interpretation is plausible for the SSA context given the insecurity of property rights which facilitates the imitation.

The dummy for CEMAC countries. Different forms of trade agreements and hence different economic groupings participate to the trade policy which, as indicated earlier, is one of the core determinant of economic development. BCA results report a positive association between the dummy for CEMAC and the income growth although it is proven significant in only 8 percent of the regressions with the sign certainty probability of 0.9152. The posterior mean implies that the growth rate for CEMAC countries were 934 percentage points above the level that would be predicted by the countries' other characteristics. This might possibly reflect the exceptional growth potential of these countries with Equatorial Guinea, Gabon and Cameroon ranked as a High Income, Upper Middle Income and low Middle Income countries respectively (World Bank, 2013).

The land area availability is part of the natural resources which indeed play a crucial role for the economic development. This variable reportedly has a negative relationship with economic growth with an inclusion probability of 0.2749 possibly suggesting the limited control, management and development capacities of SSA countries with a large land endowment. While many economists are favourable to the positive relationship between large land endowment and economic growth, the opposite result might not be surprising at least for two reasons. First, in the absence of adequate infrastructures and good governance,

large land is likely to be associated with more political instability, particularly in centralised countries. Examples in SSA include Mali, Democratic Republic of Congo and the previous Soudan. Second, this negative effect may channel through urbanisation. Since SSA countries are mostly rural based, larger land exacerbates urbanisation constraints resulting in massive rural exodus and urban cities overcrowdings with negative impact on economic performance.

The term of trade has an inclusion probability of 0.2715 and a positive relationship with growth consistently to the empirical growth literature. This variable captures not only the trade liberalisation, but also the world economic conditions. Natural resources suppliers of developed world, SSA countries remain dependent to developed economies for manufacturing goods and are therefore subject to world shocks. With a sign certainty probability of 0.889, the rise of the relative price of exports appears to have played a significant role in explaining the recent economic performance, specifically in 28.8 percent of regressions. Unlike trade taxes, the positive association between growth and the term of trade may suggest the recent improvement in the quality of institutions as pointed out by IMF (2012).

Finally, *the population growth rate* has a negative correlation with economic growth. This could be expected in SSA since large population growth is associated with more unemployment, food insecurity and education and health inequalities. Theoretical models document that a large population growth could impact positively or negatively on productivity depending on whether the effect on human capital and knowledge expansion is stronger than the induced diminishing returns to more intensive use of land and other natural resources. Accordingly, rapid population growth in SSA seems to have intensified the development constraints in terms of both social infrastructures and human capital (including health, education and training facilities improvement) resulting in a decrease in savings per capita as well as growth of physical capital per worker.

4.2.2 Marginal SSA growth determinants

The first three variables in the category of minor growth determinant (second panel of Table 4) have relatively precise sign (sign probability greater than 80 percent) although their posterior inclusion probabilities are lower than their prior probabilities. These variables include the *Government expenditure as a share of GVA*, the *ratio of remittances to GVA* (which are positively related to growth) and the *dummy for EAC sub-region* (with negative relationship).

Conversely, the remaining 10 variables show little evidence of significant correlation with growth. Their inclusion neither improves the goodness-of-fit of growth regressions, nor are their estimates robust across various sets of conditioning factors. It is worth stressing out that democracy variable (*Polity*) is not robustly related to growth, hence contrasting the finding by Chisadza and Bittencourt (2014) who report a significant negative association between income and democracy in SSA. The observed difference may be attributed to the presence of outliers. By implementing a cross country growth regression on 48 SSA countries, these authors implicitly assumed the convergence hypothesis

to be valid, hence ignoring the presence of potential divergent countries which possibly act as outliers with significant effects on the quality of estimates (Easterly, 2004). Additionally, their model is subject to omitted variables bias as it includes only few controls while disregarding most of the top variables found by the present study to improve the robustness of the growth regression.

It is further noticed that the *foreign direct investment* has no strong relationship with growth between 1996 and 2010. This could be due to the fact that investment may have captured most of the effect. Similar reason applies to *openness* possibly indicating that the bulk of the effect has been captured by the *term of trade*.

Other unexpectedly weak explanatory variables are the *labour force* and the *resource rent*. In a severe lack of employment opportunities, the increase in labour force tends to leave the productivity unchanged given the diminishing return hypothesis. The resulting waist in the labour factor may in turn lead to the decrease in income per worker. On the other hand, the extent to which resource rent affects the economic performance depends on the quality of institution (Fosu, 2011). Good institutional environment ensures high growth rate to resource abundance countries while poor quality of institutions deliver important inequalities in resource rich economies which depresses the economic growth This is likely to be the case in most SSA countries subject to poor institutional environment. More importantly, *foreign aid turns* out to have exerted a negative effect though marginal, on the recent growth (with a sign certainty probability of 50 percent). Consistent with Easterly (2006 and 2009), such effect may channel through corruption which has a detrimental effect on economic growth Alesina and Weder (1999) show that more corrupt governments receive more aid. Since Africa region is the world largest recipient of foreign aid, this result may reveal the intensity of corruption across SSA countries which typically have high Corruption Perception Index (CPI) as defined by Transparency International.

4.3 Some policy implications and recommendations

Globally, investment and the relative price of exports have been favourable to the recent economic performance in SSA. The induced trend however appears to have been weakened by a handful of factors including scientific research, trade taxes, land area and population growth. The unexpected negative association found between these variables and the economic growth raises important policy challenges. Therefore, the crucial question becomes what should policy makers in these countries be concerned with? The following discussion emphasizes three main pillars which, arguably, have the potential of reversing the observed negative causation and hence "blessing the cursing".

The skilled labour immigration. Unlike high-income countries which are generally migrant-receiving skilled labour, low-income countries are migrant-sending skilled labour. Recognising the inherent contribution of the immigrant skilled labour to the development of the high-income economies (Ruhs, 2008), the labour policy in SSA, at its core, should prevent this migration flux which

creates shortages of skilled workers. This could reduce the importation of international skilled workers which is costly for these countries already vulnerable to economic losses.

The fiscal performance. Because of the trade booms, SSA countries are subject to the so called "voracity effect". This effect occurs when the institutions are fractionalised and influential groups contend to appropriate a larger share of national wealth amid a temporary windfall gain by exerting pressure on the fiscal authorities to increase public spending that directly benefits their constituencies (El Anshasy and Katsaiti, 2013). This voracity effect highlights the poor governance and institutional qualities which result in the shifting of government spending towards less productive types. In such condition, an efficient allocation of resources can be achieved through fiscal decentralisation providing that the economic benefit of decentralisation relies on good governance. Considering the significant effect that fiscal structure exerts on the level of development (Easterly and Rebelo, 1993), this policy measure should be accompanied by a less dependence to international trade taxes which render the fiscal policy of these countries vulnerable to world shocks.

The social development. The increasing growth rate of population in SSA coupled with a double digit unemployment raise a number of social challenges which arguably explain the negative association found between economic performance and population growth. Social development solutions can therefore be advocated as efficient strategy to maximise the positive externalities associated with population development which in turn promote economic growth. More specifically, investments in health and employment-driven education, promoting equalities (income and gender) can help reduce the unexpected effects of population growth in SSA.

5 Concluding remarks

This paper uses a Bayesian Averaging of Classical Estimates (BACE) method to identify the major driving forces behind the recent economic performance across SSA countries. Unlike previous cross-sectional or panel growth studies which assume the conditional convergence across units, this study first tests the convergence pattern of the sample countries using the extended version of the Phillips and Sul (2007) log t test. Empirical results from a sample of 34 SSA countries over the period 1996-2010 prove support to three main convergence clubs and a divergence group of eight countries. In the second step, the BACE methodology developed by Sala-I-Martin *et al.* (2004) is implemented on the only convergent groups; hence accounting for the implicit convergence hypothesis of the growth model.

The main findings support the IMF (2012)'s report that investment and exports have been key drivers of the recent growth performance in SSA. In fact, more than one-third of the 18 selected variables used in the analysis can be said to have significantly influenced the recent economic growth while several more have had marginal contribution The positive robust correlation is due to the

investment ratio, regional dummy CEMAC, the relative price of exports and the initial level of income. The positive association between the initial level of income and economic growth provides further insight on what determines the tendency of poor countries to grow at a faster rate and catch up with rich ones. The almost exclusively reported negative sign of the income level in the existing literature highlights the capital and labour mobility channel endorsed on the diminishing return hypothesis. On the other hand, the established positive sign of the income level coefficient emphasizes the potential to imitate the leading countries (imitation effect) which, unlike the former, does not depend on the diminishing return assumption (Barro and Sala-I-martin, 1990). The insecurity of property rights justifies the relevance of such channel in the SSA context. Further, public consumption and remittances are positively related to growth, although of marginal significance.

Other important variables include scientific research, trade taxes, land availability and population growth which are unexpectedly found to be negatively associated with economic growth. Although their sign certainty probabilities are reportedly insignificant, these results raise a number of policy challenges across SSA including the poor quality of institutions, the exposure to world shocks given the dependence to international trade taxes, the poor quality of human capital and more importantly a threat of skilled labour immigration. These policy implications discussed above rely on the assumed both exogeneity and linear relationship between growth and the explanatory variables and therefore could be further improved within a BMA (provided a larger time period) and nonlinear frameworks, respectively

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Table 1: Convergence pattern

Club1	Club2	Club3 & 4	Divergent
Angola	Burundi	Ghana	Botswana
Benin	Chad	Madagascar	Burkina Faso
Cameroon	Gambia	Niger	Congo, Rep.
Central African Republic	Guinea	Nigeria	Cote d'Ivoire
Equatorial Guinea	Malawi	Rwanda	Gabon
Guinea-Bissau	Mozambique	Tanzania	Sierra Leone
Kenya		Uganda	South Africa
Lesotho		Mauritius	Swaziland
Mali		Namibia	
Senegal			
Togo			

Note: Real income per capita is measured by GVA per worker at constant 2005 prices (in US $).

Table 2: Variable Definition and Data Description

Variable	Definition and source	Mean	Std Dev
GROWTH	growth rate of GVA per worker, Bartkowska and Riedl (2012)	3.1851	15.0874
INCOME	GVA divided by the total active population, constant prices, in logs	6.6221	0.7886
LABOUR	Active population as a share of total population, Pickett (1973)	0.4112	0.0583
CAPITAL	Gross capital formation divided by GVA, Barro (2003)	0.2502	0.1788
LAND	Land Area, Barro and Lee (1993)	16.7079	1.7704
POLITY	Combined polity score, Barro (2003)	-0.7641	7.4295
AGGLO	Population density (area in km^2), Bartkowska and Riedl (2012)	80.521	116.751
SERVICES	GVA in the service sector divided by total GVA, Bartkowska and Riedl (2012)	0.4419	0.1322
RESOURCE	Resources rent divided by the total GVA, Brunnschweiler (2008)	0.0674	0.1445
GOVT	Public consumption relative to total GVA, Barro (2003)	0.1643	0.0615
AID	Total Aid divide by total GVA, Minoiu and Reddy (2010)	0.1681	0.1129
REMIT	Remittances relative to GVA, Pradhan, Upadhyay and Upadhyaya (2011)	49.6700	25.6097
FDI	Forein direct investment as a share of GVA, Nunenkamp and Spatz (2004)	6.4234	10.9495
TRADTAX	Trade taxes as a share of GVA, Easterly and Rebelo(1993)	0.0638	0.0628
OPEN	Exports+Imports relative to GVA, Barro(2003)	0.8354	0.4518
TOT	Term of Trade, Barro (2003)	-0.3062	3.9402
POP	Growth rate of total population, Barro and Lee (1993)	2.6646	0.7423
RESEACH	Number of scientific and technical journal articles, Lee *et al.* (2011)	52.5456	89.8522
REGION DUMMY	CEMAC	0.1538	0.3679
	EAC	0.1154	0.3258
	SADC	0.3077	0.4707
	ECOWAS	0.2308	0.4297

Note: baring the Income and Land which are the 1996 value, all the remaining variables including the dependent variable are average value over the sample period 1996- 2010.

Table 3: Posterior inclusion probabilities with different prior model sizes

$\bar{k} = 7$		$\bar{k} = 5$	
Variables	Posterior inclusion probability	Variables	Posterior inclusion probability
Prior inclusion probability = 7/21= 0.3333		Prior inclusion probability= 5/21= 0.2381	
1 CAPITAL	0.8758	1 CAPITAL	0.8203
2 RESEACH	0.7252	2 RESEACH	0.7385
3 TRADTAX	0.2168	3 TRADTAX	0.3553
4 INCOME	0.2082	4 INCOME	0.3031
5 CEMAC	0.1865	5 CEMAC	0.2841
6 POP	0.1846	6 LAND	0.2749
7 TOT	0.1804	7 TOT	0.2715
8 LAND	0.1600	8 POP	0.2684
9 REMIT	0.1261	9 GOVT	0.1983
10 EAC	0.1141	10 REMIT	0.1770
11 OPEN	0.0938	11 EAC	0.1671
12 GOVT	0.0915	12 AGGLO	0.1641
13 POLITY	0.0912	13 POLITY	0.1510
14 SADC	0.0903	14 FDI	0.1478
15 ECOWAS	0.0859	15 ECOWAS	0.1461
16 FDI	0.0849	16 SADC	0.1443
17 AGGLO	0.0848	17 OPEN	0.1405
18 SERVICES	0.0789	18 RESOURCE	0.1374
19 RESOURCE	0.0755	19 LABOUR	0.1319
20 AID	0.0755	20 SERVICES	0.1279
21 LABOUR	0.0743	21 AID	0.1187

Note. Variables are ranked by the posterior inclusion probability which is the sum of the posterior probabilities of all models containing the variable.

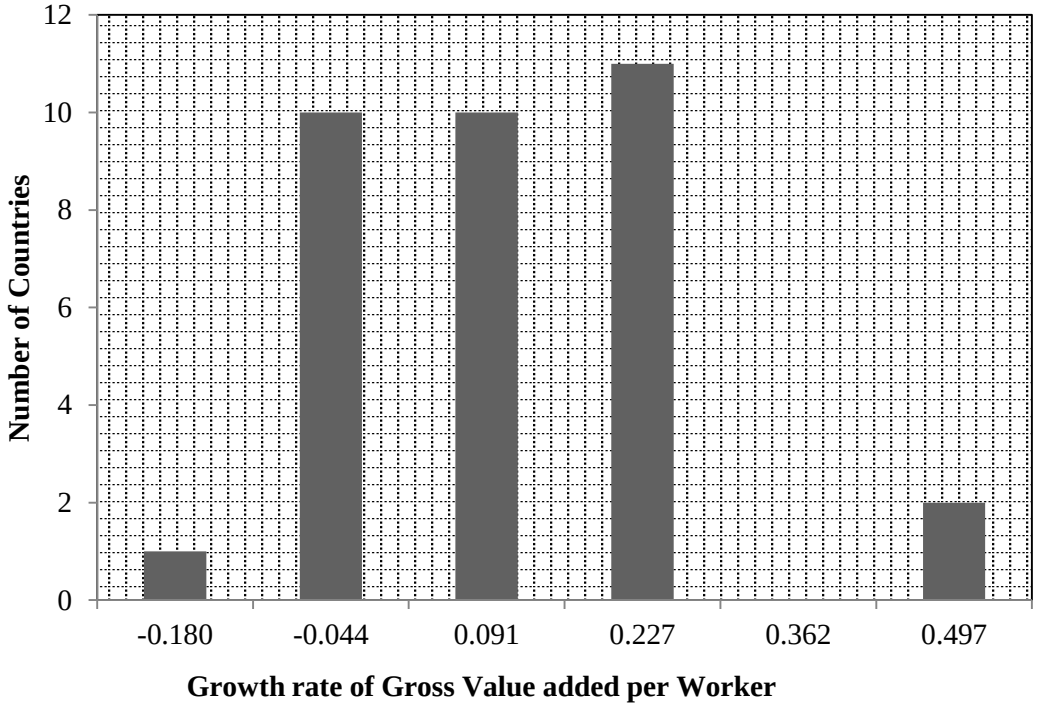
Table 4: BACE estimates for all Variables

Variables	Rank	Posterior inclusion probability	Posterior mean conditional on inclusion (%)	Posterior std. conditional on inclusion (%)	BACE sign certainty probability	Fraction of regressions with |*t*sat|>2
MAJOR GROWTH DRIVING FORCES						
CAPITAL	1	0.8203	0.5493	0.1767	0.9883	0.8725
RESEACH	2	0.7385	-0.000639	0.0003	0.9858	0.7408
TRADTAX	3	0.3553	-0.7117	0.4768	0.9353	0.1201
INCOME	4	0.3031	0.0469	0.0324	0.9210	0.1390
CEMAC	5	0.2841	0.0934	0.0664	0.9152	0.0801
LAND	6	0.2749	-0.0288	0.0239	0.9060	0.1698
TOT	7	0.2715	0.0140	0.0102	0.8890	0.2880
POP	8	0.2684	-0.0451	0.0326	0.9069	0.0842
MINOR GROWTH DETERMINANTS						
GOVT	9	0.1983	0.5135	0.5288	0.8283	0.0173
REMIT	10	0.1770	0.0010	0.0011	0.8164	0.0239
EAC	11	0.1671	-0.0723	0.0778	0.8149	0.0188
AGGLO	12	0.1641	-0.0002	0.0004	0.6303	0.0331
POLITY	13	0.1510	0.0026	0.0033	0.7808	0.0031
FDI	14	0.1478	0.0014	0.0045	0.6076	0.1049
ECOWAS	15	0.1461	-0.0466	0.0616	0.7746	0.0085
SADC	16	0.1443	0.0427	0.0606	0.7554	0.0125
OPEN	17	0.1405	0.0601	0.0948	0.7288	0.1754
RESOURCE	18	0.1374	-0.1457	0.3833	0.6254	0.0761
LABOUR	19	0.1319	-0.2643	0.5276	0.6868	0.0178
SERVICES	20	0.1279	-0.1462	0.2558	0.7121	0.0917
AID	21	0.1187	-0.0097	0.2722	0.5082	0.0021

Note. Variables are ranked by the posterior inclusion probability which is the sum of the posterior probabilities of all models containing the variable. The posterior mean and standard deviations are conditional on inclusion in the model and apply to the linear marginal effect of the variable; the posterior mean having the usual interpretation of a regression β . The "sign certainty probability" is the posterior probability that the coefficient is on the same side of zero as its mean conditional on inclusion. It measures the posterior confidence in the sign of the coefficients. In the last column is reported the fraction of regressions in which the coefficient has a classical *t*-test greater than two, with all regressions having equal sampling probability.

Appendix

Figure 1: Distribution of per capita growth rate across 34 SSA countries



Note. The chart shows the number of countries that lie in different arrays for the growth rate of real Gross Value Added (GVA) per worker from 1996 to 2010. The figures are author's own calculation using data from African Development Bank (ADB) database.