Initial Conditions and Post-War Growth in sub-Saharan Africa*

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Abstract

We investigate the heterogeneous effects of pre-determined variables on post-World War II growth in sub-Saharan Africa using Bayesian Model Averaging (BMA). An innovation in our estimation methodology is that it incorporates parameter heterogeneity in model averaging. Our main finding is that the impact of initial conditions on subsequent growth in sub-Saharan Africa is quite different from the rest of the world. How and why these initial conditions have a differential effect on this region is examined.

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1 Introduction

One of the most intriguing questions in economic growth literature is why sub-Sahara African growth experience has been so dramatically low and so drastically different from the rest of the world. Numerous academic papers, and other policy and public media sources make use of cross-country datasets to illustrate the stark income gaps between Africa and other regions forming a strong consensus that Africa's post-World War II growth is an economic tragedy.[1]

The economics literature has been very active in trying to identify the sources and causes of this poor performance. Since Barro's (1991) finding that a dummy for Africa exerts a significant and negative effect on average growth rates in per capita GDP, there has been a proliferation of studies that seek to document and understand why Africa's economic performance has been markedly worse than that of other regions (see, e.g. Easterly and Levine, 1997; Sachs and Warner, 1997; Rodrik, 1998; Temple, 1998; Collier and Gunning, 1999; Block, 2001; Acemoglu, Johnson and Robinson, 2003; Artadi and Sala-i-Martin, 2003; Paap, and Franses and van Dijk, 2005). Possible sources of Africa's dismal performance have ranged from Africa's geographical and ecological peculiarity (see, e.g. Bloom and Sachs, 1998) to the institutional legacy of geography through colonialism (see, e.g. Acemoglu, Johnson and Robinson, 2001; 2002), the role of capital accumulation and adjustment (see, e.g. Berthelemy and Soderling, 2001), ethnic diversity (see, e.g. Easterly and Levine, 1997) or political instability (see, e.g. Bates, 2000). Yet, while these studies have managed to impose some structure on our understanding of Africa's poor economic performance, there is no systematic effort that considers all these possible growth determinants under a unified empirical framework.

This paper employs model averaging methods to more systematically study and understand the poor performance of African economies since the 1960's. More precisely, we investigate whether the African post-war growth process was different from the rest of the world. That is, we investigate whether the determinants of growth in Africa may be different or may have different effects on growth than in other parts of the world. Perhaps more importantly, we try to gain insights into exactly how or why it is that Africa may be different.

We employ Bayesian Model Averaging (BMA) that allows us to consider both model uncertainty (uncertainty about the preferred theory and model) and parameter heterogeneity (that countries are not homogeneous objects) into an internally coherent procedure.[2] The paper has two methodological contributions relative to most cross-country growth regression literature. First, by using model averaging, the paper is able to address the problems associated with ad hoc specification of control variables in growth regressions. Second, the paper allows for parameter heterogeneity, i.e. the possibility that Africa behaves differently from the rest of the world. This is done by comparing analyses that uses a global model (using all countries in the sample), versus analogous exercises that use an Africa interaction model (interacting all relevant variables with tan Africa dummy) and an Africa model (using Africa only countries). In addition, we try to limit the endogeneity problems that plague growth regressions by only considering pre-dated (1960) variables and

[1] Throughout the paper when we refer to Africa we refer to sub-Saharan Africa.

[2] Model uncertainty is a problem on two significant levels. The first and commonest case is that of theory uncertainty. There are a number of competing theories which try to explain Africa's dismal performance the most prominent of which are the geography hypothesis, the institutions hypothesis and the integration/policy hypothesis. Second, is the uncertainty inherent in model selection. Even amongst scholars that subscribe to the same school of thought, there is little consensus regarding which regressors to include in growth regressions. Parameter heterogeneity arises in most studies that use a representative single equation cross-country growth regression. In essence such studies not only assume a common production function across all countries, but also that the marginal impact of regressors on long-run growth is the same across the globe. For extensive discussions on these econometric issues see Durlauf, Johnson and Temple (2005).

exclude all other contemporaneously determined regressors.

Methodologically our paper is related to Fernández, Ley and Steel (2001a,b) and Sala-i-Martin, Doppelhofer and Miller (2004) which address model uncertainty in growth regressions. However, these papers are not concerned with the possibility of differential growth processes and thus do not incorporate parameter heterogeneity into model averaging as we do here. Our paper is more closely related to Brock and Durlauf (2001), and Brock, Durlauf and West (2003) in the sense that these authors apply model uncertainty to better understand the African growth process. The latter paper uses BMA to assess the question of whether a policymaker should favor a reduction of tariffs for sub-Saharan African countries, whereas the former paper uses model averaging to explore issues of heterogeneity between Africa and the rest of the world by reexamining Easterly and Levine's (1997) analysis about the role of ethnic conflict in growth. Unlike these two studies who are primarily concerned about the effect of one or two growth determinants, our analysis is vastly more general and extensive, considering the effect of a large number of possible growth determinants on African and global growth.[3]

Our analysis presents strong evidence that post-war growth in Africa was quite different from growth in the rest of the world. More precisely, we show that key variables (such as primary education, primary exports, mining and various geographical variables) that significantly affect African growth do not matter, or do not matter as much, for the rest of the world, and conversely. In addition, by exploring the posterior coefficient estimates of the effective variables we take first steps towards answering the question: what is it about Africa that makes it different. Robustness analyses, confirm that differences in the growth determinants between Africa and the world are not driven by experiences of a small group of wealthy countries (OECD countries) or a larger set of former European colonies.

The rest of the paper is organized as follows. In section 2 we take a brief look at the dataset used and present the model averaging technique with particular emphasis on our application. In section 3 we report baseline results followed by robustness analysis. Section 4 discusses the implications our results and section 5 concludes.

2 Estimation

2.1 The data

We focus on "exogenous" variables that are determined in 1960 or thereabouts, thus leaving all of the political-, investment- and openness-related variables that refer to the intervening period out. Of the 29 variables considered, 25 are from Sala-i-Martin (1997) while malaria prevalence and the fraction of land area in tropical location is from Sachs and Warner (1997). In addition, we created two dummies: one for OECD countries and another for former European colonies. We classify these 29 predetermined variables in six categories: variables capturing the initial level of development, geographical variables, religious variables, measures of ethnolinguistic diversity, colonial dummies and regional dummies.[4] The global dataset comprises

[3] In a related paper, Masanjala and Papageorgiou (2005) perform a similar model averaging exercise in which not only predate but also contemporaneously determined regressors, are considered.

[4] In Appendix A we Table A1 reports descriptive statistics for the 29 variables that will be used as regressors in our analysis, distinguished by region. This table also compares the mean values of our variables for Africa with those in the global sample, the non-OECD sample and the former European colonies sample. Table A2 lists the countries and Table A3 shows the definitions of variables used in this paper.

93 countries of which there are 69 former European colonies, 69 non-OECD countries, and 30 sub-Sahara African countries.[5] Economic performance is measured as the average growth rate in GDP over the 1960-1992 period.

Two patterns seem to stand out from a first look at our dataset. First, in 1960 the level of per capita GDP in Africa was about half the level of per capita GDP in the rest of the world, life expectancy at birth was only 41 years in Africa compared to 61 years in the world, and primary school enrolment was only 41% compared to 89% in the rest of the world. At the same time, African economies were almost three times as reliant on output from mining, and while primary commodities comprised about 61% of exports in the rest of the world, in Africa they accounted for 88% of the exports. More importantly Africa started with a very low level of human development. In Africa only 2% of the population aged 25 years and over had any secondary education in contrast to a range of 11% of the corresponding population in all developing countries to 21% globally. Similarly, whereas some 2-4% of the adult population in other regions had some tertiary education, in Africa virtually nobody had any tertiary education.

Second, it appears that Africa's geographical endowments and the associated ecology are not only significantly different but they also put Africa at an economic disadvantage. Relative to countries in other regions, African countries may be less able to benefit from scale economies because they are smaller in area. Moreover, since African countries are more tightly wrapped around the equator, it is not surprising that 92% of sub-Sahara Africa's land area lies between the tropics of Cancer and Capricorn and malaria is endemic in 88% of the countries. In addition, exports from many African countries may be internationally uncompetitive due to high transportation costs. In Africa, 40% of the countries have no direct access to the sea in contrast to about 20% of countries in other regions. Finally, whereas only 19% of Africa's population lives within 100 kilometers of the coast, in the US and Europe, the comparable fractions are 67% and 89%, respectively.

2.2 Econometric methodology

Our empirical strategy is to consider parameter heterogeneity as a special case of model averaging. To address the issue of model uncertainty, we employ Bayesian Model Averaging (BMA) with the diffuse Unit Information Priors (UIP) regressor priors suggested by Raftery (1995) as our benchmark methodology. To allow for parameter heterogeneity we follow the approach suggested by Brock and Durlauf (2001) and Brock, Durlauf and West (2003) and treat parameter heterogeneity as a variable inclusion problem. Since the general principles behind BMA are now well understood, we restrict ourselves to only highlighting the crucial intuition behind the methodology and how we incorporate parameter heterogeneity in this framework.[6]

Consider n independent replications from a linear regression model where the dependent variable, per capita GDP growth in n countries grouped in vector y, is regressed on an intercept α and a number of explanatory variables chosen from a set of k_i $(i = 1, 2)$ variables in a design matrix Z_i of dimension n x k_i. Assume that $r(\iota_n : Z_i) = k_i + 1$, where $r(\cdot)$ indicates the rank of a matrix and ι_n is an n-dimensional vector of ones. Further define β_i as the full k_i-dimensional vector of regression coefficients.

Now suppose we have an $n \times k_{i,j}$ submatrix of variables in Z_i denoted by $Z_{i,j}$ $(i = 1, 2)$. Then let $M_{i,j}$

[5] African islands such as Comoros, Sao Thome and Principe, Seychelles, etc. may be important to our analysis but are omitted due to data constraints.

[6] For excellent introductions to model averaging and particularly BMA see Hoeting et al. (1999), and Raftery, Madigan and Hoeting (1997). For the technical challenges facing BMA (related more to economics applications) including the exhaustive computation required, and the choice of prior structure see Durlauf, Johnson and Temple (2005).

denote the model with regressors grouped in $Z_{i,j}$, such that

$$y = \alpha\iota_n + Z_{1,j}\beta_{1,j} + I\, Z_{2,j}\beta_{2,j} + \sigma\varepsilon, \tag{1}$$

where Z_1 is the matrix of all regressors and Z_2 is a submatrix of Z_1 that excludes all variables that are either perfectly collinear in the sub-Saharan Africa sample or not relevant for this sample due to negligible subsample variation. I is an indicator variable that equals 1 if the country is a sub-Saharan Africa country and 0 otherwise, $\beta_{1,2,j} \in \Re^{k_j}$ $(0 \leq k_{1,2,j} \leq k)$ groups regression coefficients corresponding to the submatrix $Z_{1,2,j}$, $\sigma \in \Re_+$ is a scale parameter, and ε is a random error term that follows an n-dimensional normal distribution with zero mean and identity covariance matrix. Exclusion of a regressor in a particular model implies that the corresponding element of β is zero. Note that equation (1) incorporates parameter heterogeneity in model averaging by including Africa dummy interactions in the set of variables considered, k.

Given this setup, the notion of BMA implies that the posterior probability of any given parameter of interest which has common interpretation across models, say Δ, is the weighted posterior distribution of that quantity under each of the models, with weights given by the posterior model probabilities, so that

$$P_{\Delta|y} = \sum_{j=1}^{2^k} P_{\Delta|y,M_j} P(M_j|y). \tag{2}$$

That is, the marginal posterior probability of including a particular regressor is the weighted sum of the posterior probabilities of all models that contain the regressor. The posterior model probability is given by

$$P(M_j|y) = \frac{l_y(M_j)p_j}{\sum_{h=1}^{2^k} l_y(M_h)p_h}, \tag{3}$$

where p_j is the prior model probability, $l_y(M_j)$, is the marginal likelihood of model M_j given by

$$l_y(M_j) = \int p(y|\alpha, \beta_j, \sigma, M_j)p(\alpha,\sigma)p(\beta_j|\alpha,\sigma,M_j)d\alpha\, d\beta_j\, d\sigma, \tag{4}$$

where $p(y|\alpha, \beta_j, \sigma, M_j)$ is the sampling model corresponding to equation (1), and $p(\alpha,\sigma)$ and $p(\beta_j|\alpha,\sigma,M_j)$ are the relevant priors.

Since we lack knowledge on model probability distribution, we assume a uniform distribution and that regressors are independent of each other, so that the prior probability of each model is $p_j = 2^{-k}$ and the prior probability of including any regressor equals $p_j = 1/2$. In our choice regarding the priors on the parameters space we follow Raftery (1995) and Hoeting et al. (1999) and impose the diffused Unit Information Prior (UIP).[7]

[7] The decision on the prior structure for the model and individual (within-model) regressors is a potentially contentious issue. With regards to the model prior structure Sala-i-Martin, Doppelhofer and Miller (2004) suggest that the model prior distribution should be skewed to favor smaller models especially in growth regression literature. Regarding the with-in model prior structure, considerable research has been conducted to obtain either data dependent priors (Raftery, Madigan and Hoeting, 1997), "automatic" priors (Fernandez, Ley and Steel, 2001b), or the Unit Information Prior (Raftery, 1995). Recent work by Eicher, Papageorgiou and Raftery (2007) provide guidance on the choice of appropriate prior structure especially relating to economic applications. They demonstrate that although this choice is crucially dependent on the particular application and datasets considered, the Unit Information Prior (UIP) is the safest and most robust choice to use as the benchmark.

3 Results

We start our baseline analysis by establishing the global BMA benchmark where we initially examine the potential effectiveness of 29 variables without any interactions (this is equivalent to setting $\beta_{2,j} = 0$ in equation 1). We then apply BMA based on the linear growth regression equation (1) by considering 29 regressors and 20 Africa interaction dummies using 93 country observations.[8] The interaction specification (1) can be interpreted as providing estimates for the control group (non-Africa sample), $\beta_{1,j}$, and estimates for the marginal effect of the treatment group (Africa sample), $\beta_{2,j}$. We then obtain the non-Africa effect given by the posterior means of $\beta_{i,j}$, and the Africa effect that is given by the composite posterior means of $\beta^{\text{Afr.}} = \beta_{1,j} + \beta_{2,j}$.[9] Subsequently, we examine the robustness of our baseline results to alternative samples.

3.1 Baseline results

[Table 1 here]

Table 1 presents the coefficient posterior means, $E(\beta|y)$, posterior standard deviation, $\sqrt{Var(\beta|y)}$, and the ratio of the absolute value of the former to the latter, $\frac{|E(\beta|y)|}{\sqrt{Var(\beta|y)}}$, for the global and interaction specifications (non-Africa and Africa). The absolute value of the posterior mean to standard deviation ratio (posterior mean/sd), is used as a measure for identifying variable effectiveness in our growth regression exercises. While posterior inclusion probability captures the probability of a candidate regressor's inclusion in the most effective models, here we chose to emphasize the posterior mean/sd ratio to better tie economic and statistical significance. In particular, we set the threshold value equal to 1.3, which is roughly equivalent to a 90% confidence interval in frequentist hypothesis testing.[10] We recognize that there is no consensus in the BMA literature about this threshold, but show that our main findings are insensitive when this threshold is reasonably adjusted upwards or downwards.

Columns 1-2 of Table 1 feature the 29 regressors considered. Columns 3-5 report the coefficient posterior means, standard deviations and relevant posterior mean/sd ratio for the Global sample. Here we replicate the results of the previous literature that assumes that African and non-African countries are have identical determinants of their growth performance, and that the magnitude of these determinants is also unchanged across subsamples. Posterior coefficient estimates in bold font represent variables that pass our effectiveness threshold (posterior mean/sd > 1.3). The results from the Global sample highlight six variables whose initial values are significant in explaining post-war cross-country variation in growth. These are initial GDP, initial life expectancy, the share of primary commodities in exports in 1970, the initial ratio of mining output to GDP, being located in East Asia and the fraction of the population that is Muslim. By and large, these results are consistent with findings by Fernandez Ley and Steel (2001a) and Doppelhofer, Miller and Sala-i-Martin (2004).

[8] The nine regressors that are not interacted with the Africa dummy are: sub-Saharan Africa, Latin America, Fraction Buddhist, Fraction Confucian, Fraction Hindu, Fraction Jewish, East Asian, OECD and Tertiary Education Enrollment (1960). The last variable is not interacted because tertiary education in sub-Saharan Africa in 1960 was negligible so there was no variability in this series.

[9] The composite posterior standard deviations are obtained from $Var(\beta^{\text{Afr.}}) = Var(\beta_{1,j}) + Var(\beta_{2,j}) + 2Cov(\beta_{1,j}, \beta_{2,j})$.

[10] Raftery (1995) suggests that for a variable to be considered as effective the posterior inclusion probability must exceed 50%. This is roughly equivalent of requiring a ratio of posterior mean/sd = 1, that in frequentist statistics implies that the regressor improves the power of the regression. While Raftery's (1995) interpretation for BMA would imply a threshold value of the mean/sd ratio of about 1, we are more stringent following Eicher, Papageorgiou and Roehn (2006) and set the effectiveness threshold for the posterior mean/sd ratio higher to 1.3.

Columns 6-11 of Table 1 report BMA results generated by allowing for the possibility of parameter heterogeneity related to the Africa sample. As mentioned previously, the non-Africa results (columns 6-8) are obtained as the posterior coefficient estimates for the control group whereas the Africa results (last 3 columns) are obtained as the composite posterior coefficient estimates representing the effect of the control group plus the marginal effect of the treatment group (in our case Africa).

Focusing on the Africa results, BMA identifies twice as many effective variables as in the Global sample. A closer look at the variables flagged as important reveals that three of those, initial GDP, initial life expectancy, and fraction Muslim are effective in all three samples (Global, non-Africa and Africa), albeit as we discuss subsequently the magnitude of the coefficient for the fraction Muslim is about three times larger in the Africa sample than in the other two samples. In addition, there are two variables, the share of mining output in GDP and the share of primary commodities in total exports, that are identified as important for the Global and Africa samples but not the non-Africa sample, (albeit once again, that the magnitudes of the posterior coefficient estimates are three times larger in the case of Africa sample), and one variable, the fraction speaking a European language, that is shown to be effective only for the Africa and non-Africa samples but not the Global sample.

Perhaps more strikingly, BMA identifies six additional variables that are only relevant in explaining African growth and not Global or non-African growth patterns. These include four geographical variables, namely, absolute latitude, if the country is landlocked, the country's land area and tropical location, in addition to primary education and the degree of urbanization. Finally, it is worth noting that there are two dummy and another two religious variables that are shown to be effective only in the non-Africa group of countries. Those are the East Asia and OECD dummies and Fraction Confucian and Fraction Hindu.

3.2 Robustness

[Table 2 here]

To examine the robustness of our baseline results we consider three alternative samples as follows. First, we run BMA using the Africa-only subsample that includes 30 sub-Sahara African countries and considers 20 relevant variables.[11] Second, in order to ensure that differences in the growth determinants between Africa and the world are not driven by the wealthy OECD countries, we consider our interaction specification using the non-OECD subsample (63 countries).[12] Finally, to be sure that our results are not masked by the fact that sub-Sahara African countries were former colonies, we consider a BMA exercise using a former-colony sample (also 63 countries) and as previously interacting the relevant variables with an Africa dummy.[13]

In Table 2, columns 3-5 report results from using only the sub-Sahara African subsample, columns 6-8 report Africa results from using the non-OECD subsample, and columns 9-11 present Africa coefficient estimates using the former-colony subsample. We will not comment extensively about these results because the main finding is clear. That is, results from each of the three robustness analyses are qualitatively very

[11] The Africa-Only sample is a strict subset of our global sample. The 20 variables considered are the same as those interacted with the Africa dummy in the interaction model.

[12] This simply requires, excluding the 30 OECD countries from our global sample and, as in the benchmark specification, interacting variables with an Africa dummy.

[13] When considering the non-OECD sample, in addition to the other nine regressors dropped in the baseline estimation also the OECD variable is dropped. When considering the former-colony sample, in addition the Colony variable is dropped. Also note that it is a pure coincidence that the number of countries (63) in the two samples is the same.

similar to our benchmark results in the preceding analysis. Briefly, note that when we consider only the sub-Saharan Africa subsample (Africa-Only) we obtain an identical set of effective variables (and with very similar magnitudes) to that in our benchmark estimation. The same holds true when we consider the non-OECD sample and the former-colony sample (in the later sample, secondary school enrolment is also effective but with negative sign).[14]

The benchmark and robustness results taken together represent evidence of remarkable parameter heterogeneity relating to sub-Saharan Africa in growth regressions. Our evidence suggests that for the relevant period, Africa's growth determinants and their respective effects were quite different from the rest of the world.

4 Discussion

To gain insights into the nature of growth in Africa, we investigate how differently certain variables impact growth in the region and why this may be the case. We do so by taking a careful look at the signs and magnitudes of posterior coefficient estimates for the effective variables reported in Table 1. A valuable feature of reporting posterior coefficient estimates is that they can be broadly interpreted as in frequentist analysis, therefore allowing us to more easily evaluate their impact both in terms of direction and magnitude.

First, we highlight the finding that African post-war growth is positively and significantly affected by the initial enrollment rates of primary schooling. A 1 percentage point increase in initial enrollment results in a 2.2 percentage points increase in growth rates. This is an insightful result in light of the extensive development (primarily micro) literature that suggests that for poor countries primary education is a key determinant of growth and that there is something about reading and writing that is essential to productivity in early development.

Africa's growth is also significantly and negatively affected by the degree of urbanization to the extent that a 1% increase in the fraction of the population that is urban-based decreases post-war growth by 7.2%. This is a surprising finding and certainly in contrast to conventional thinking that relates urbanization to specialization, industrialization and consequent economic growth and development. A fundamental characteristic of urbanization is the structural shift in employment from agriculture to non-agriculture pursuits. But we know that non-agricultural sectors are scarce in Africa. So then if territorial response to structural changes in the economy does not cause urbanization in the region what does? Could it be that some noneconomic element attracts people in cities? Could it be that European colonization and their institutions is part of the explanation? This is an interesting finding in its own sake and worthy of further investigation.

Perhaps even more notable is the result that Africa seems to be significantly and negatively affected by geography be it location (as proxied by either absolute latitude, location in the tropics or being landlocked) or the land area. For example, a one degree movement towards the tropics reduces African growth prospects by 2.3 percentage points. That tropical location has deleterious consequences on growth corresponds to the

[14] We present the complete set of results that report estimates under the non-OECD and former-colony subsamples in Appendix B, Tables B1 and B2, respectively. Other robustness analyses were also performed. For example, we have re-estimated our benchmark estimation but now using Latin America (20 countries) rather than sub-Saharan Africa as the treatment group. Results reported in Table B3 show that there is very little if any parameter heterogeneity related to Latin America in growth regressions. In addition, we redo our benchmark BMA exercise after extending our Africa sample to include 4 North African countries (Algeria, Egypt, Morocco and Tunisia for which data are available) and show that our benchmark results are not sensitive to adding these countries.

traditional explanation of Africa's slow growth. Traditionally, Africa's slow growth in per capita incomes has been explained in terms of the peculiarity of its geography (see, e.g. Diamond, 1997; Landes, 1998). According to this view, tropical location (in our case measured by tropical location dummy or absolute latitude) influences geographical and ecological variables which in turn, shape economic development directly, by influencing productivity, and indirectly, by influencing the choice of political and economic institutions. In much of sub-Saharan Africa, since output from rainfed subsistence agriculture accounts for close to 40% of GDP, there is a high correlation between overall economic growth and agricultural growth. Whether tropical climate manifests itself through the fragility and low fertility of tropical soils or unstable tropical rainfall (either too little or too much rainfall) the result is that it renders economic growth more prone to vagaries of weather than in countries in other continents.

However, geography may also affect growth in another major way - Africa's inability to adopt or adapt productivity enhancing technologies from other regions (as proxied by the fraction of the population that speaks European language). Sowell (1998) argues further that although the geographical context is not all that matters, geography has played a significant role in making cultural interaction more difficult for both between Africa and the rest of the world and within Africa. This lack of interaction is evident from the fact that in Africa only 3% of population speaks a European language in contrast to 33% of population in other former colonies. Of more recent vintage is the finding that the land area for most African countries is too small to benefit from scale economies.

Africa grows differently even when the same variable is important in explaining growth globally or in the non-Africa samples. For instance, the share of mining in GDP is significant in explaining both global and African growth. Yet, whereas a 1% increase in the share of mining output increases global growth rate by 3.1%, in Africa the same change results in a 9.8% increase (an impact factor of more than 3). A positive effect of the share of mining on growth in the global context was first observed by Miller, Doppelhofer and Sala-i-Martin (2004). The fact that mining has higher posterior marginal impact on growth in Africa than in the rest of the world should come as no surprise since 9 of the world's 14 so-called mineral-based economies are in Africa and most of them have low per capita income. Notice that although mining has a positive effect and Africa's all-time fastest growing economy, Botswana, is mostly dependent on exports of diamonds, for the most part, it is the declining share of mining in GDP that is more pertinent in explaining Africa's slow growth. For instance, whereas in 1980 Africa exported 1.3 million metric tons of copper, by 1993 copper exports had fallen by over 50% to just 0.6 million metric tons. Similarly, Africa's iron exports declined by 40% from 28 million tons in 1980 to 18.9 million in 1993 (World Bank, 2000) while between 1970 and 1990s Nigeria's oil refineries operated at 25% capacity. In short, since mining is positively related to economic growth, as share of mining output in GDP declined so did economic growth rates.[15]

In contrast, whereas an increase in the initial share of primary commodities in exports reduces global growth rate by 1.7 percentage points in Africa it reduces growth by 4.7 percentage points (again an impact of approximately 3). As in the case of mining, while the abundance of natural resources is often cited as a redeeming feature of Africa's geography and a source of comparative advantage in natural resources exports

[15]One final point is worth noting about mining. When we consider the impact of the share mining on growth in the global sample, we find a positive and significant effect of 0.031. However, this result aptly demonstrates how the global estimation masks the actual importance of mining in Africa. This is because when we consider the interaction model under the former-colony sample (columns 6-8 in Table 2) we find that the coefficient associated with share of mining is still significant, positive and very large (0.105) in Africa while it is significant and negative (-0.046) in the non-African colonies (column 4 in Table B1 in Appendix B)!

(see, e.g. Collier and Gunning, 1999; Landes, 1998), export concentration in primary commodities has also meant that African terms of trade remain ransomed to the capriciousness of international commodity prices. For the most part, African economies remain undiversified, relying for their foreign exchange earnings on a few primary commodities, usually the ones which have been the mainstay of the economy since colonial days. Although agricultural output accounts for 40% of GDP, agricultural commodities comprise over 80% of the export bundle for most countries (World Bank, 2000). A detrimental consequence of Africa's over reliance on primary commodities is that although manufacturing output accounts for 11% of Africa's GDP, in the post-war period the share of African manufacturing output in global output has averaged about 1% (UNCTAD, 2002).[16]

5 Conclusion

In this paper we took a fresh look into the potential determinants of growth in sub-Saharan Africa. In particular, our investigation was focused on the heterogeneous effects of pre-determined (1960) variables on post-war growth using Bayesian Model Averaging (BMA). Our use of Bayesian-averaging techniques allowed us to consider model uncertainty, and parameter heterogeneity in a conceptually coherent framework.

Our main results suggest that initial conditions exerted a significant and differential impact on Africa's post-war growth performance compared to the rest of the world. Specifically, regressors such as primary education, primary resources, and geography are shown to be particularly important in African post-war growth. By examining the posterior coefficient estimates of the effective variables we took first steps in gaining insights into what is it about sub-Saharan Africa that makes it a different group.

There is scope for extending this line of research further. Is African growth experience different because it was colonized? Is it because it was extracted so severely? Could the colonial institutions placed in Africa be influenced by the geographical peculiarities of the region? Future use of BMA on new and novel datasets (i.e. Acemoglu, Johnson and Robinson, 2001) may prove instrumental in answering these questions.

[16] Although, to save space, we only discuss the cases of mining and primary exports, qualitatively similar implications obtain when we compare the impact of the fraction of the population that speaks a European language and the fraction of the population that is Muslim in the Africa and the non-Africa samples.

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Table1: Posterior Coefficient Estimates

	Regressor	**Global**[a]			**Non-Africa**[b]			**Africa**[c]		
		$E(\beta\|y)$	$\sqrt{Var(\beta\|y)}$	$\frac{\|E(\beta\|y)\|}{\sqrt{Var(\beta\|y)}}$	$E(\beta\|y)$	$\sqrt{Var(\beta\|y)}$	$\frac{\|E(\beta\|y)\|}{\sqrt{Var(\beta\|y)}}$	$E(\beta\|y)$	$\sqrt{Var(\beta\|y)}$	$\frac{\|E(\beta\|y)\|}{\sqrt{Var(\beta\|y)}}$
1	ln GDP per capita, 1960	**-0.01494**	(0.00279)	[5.3548]	**-0.01520**	(0.00264)	[5.7575]	**-0.01337**	(0.00373)	[3.5802]
2	Life expectancy, 1960	**0.00109**	(0.00028)	[3.8928]	**0.00150**	(0.00019)	[7.8947]	**0.00150**	(0.00020)	[7.4013]
3	Primary school enrolment, 1960	0.01225	(0.01054)	[1.1622]	-0.00067	(0.00322)	[0.2080]	**0.02231**	(0.01064)	[2.0956]
4	Secondary school enrolment, 1960	-0.00086	(0.00444)	[0.1936]	-0.00026	(0.00200)	[0.1300]	-0.00020	(0.00346)	[0.0584]
5	Tertiary education enrolment, 1960	-0.00013	(0.00316)	[0.0411]	-0.01283	(0.02728)	[0.4703]	-	-	-
6	Primary export, 1970	**-0.01691**	(0.00677)	[2.4977]	-0.00008	(0.00111)	[0.0720]	**-0.04718**	(0.01055)	[4.4707]
7	Mining, 1960	**0.03112**	(0.01887)	[1.6491]	-0.02039	(0.02114)	[0.9645]	**0.09831**	(0.01378)	[7.1354]
8	Urbanization rate, 1960	0.00000^r	(0.00002)	[0.0008]	-0.00030	(0.00193)	[0.1554]	**-0.07211**	(0.02356)	[3.0605]
9	Labor force size, 1960	0.00000^r	(0.00000)^r	[0.0809]	0.00000^r	(0.00000)^r	[0.0775]	0.00000^r	(0.00000)^r	[0.0574]
10	Malaria prevalence, 1960s	-0.00287	(0.00471)	[0.6093]	0.00003	(0.00054)	[0.0555]	-0.00147	(0.00552)	[0.2657]
11	Absolute latitude	-0.00001	(0.00005)	[0.0200]	-0.00001^r	(0.00005)	[0.2288]	**-0.00080**	(0.00039)	[2.0288]
12	Landlocked	-0.00137	(0.00293)	[0.4675]	-0.00386	(0.00358)	[1.0782]	**-0.00639**	(0.00359)	[1.7776]
13	Land area	0.00000^r	(0.00000)^r	[0.0310]	0.00000^r	(0.00000)^r	[0.4502]	**-0.00001**^{r}	(0.000003)	[3.8443]
14	Tropics	-0.00127	(0.00360)	[0.3527]	0.00029	(0.00141)	[0.2056]	**-0.02962**	(0.01318)	[2.2479]
15	OECD	0.00492	(0.00566)	[0.8692]	**0.01337**	(0.00312)	[4.2852]	-	-	-
16	Sub-Saharan Africa	-0.00010	(0.00087)	[0.1149]	**0.05836**	(0.03237)	[1.8029]	-	-	-
17	East Asian	**0.02055**	(0.00458)	[4.4869]	**0.02051**	(0.00402)	[5.1019]	-	-	-
18	Latin America	0.00000	(0.00001)	[0.0000]	0.00000	(0.00001)	[0.0000]	-	-	-
19	Former colony	0.00000	(0.00012)	[0.0000]	-0.00001	(0.00018)	[0.0555]	0.00040	(0.00263)	[0.1535]
20	Ethnolinguistic fractionalization	0.00000	(0.00002)	[0.0000]	0.00000	(0.00001)	[0.0000]	-0.00010	(0.00110)	[0.0952]
21	Fraction European language	0.00174	(0.00332)	[0.5241]	**0.00859**	(0.00253)	[3.3952]	**0.05716**	(0.02433)	[2.3498]
22	Fraction English speaking	0.00000	(0.00001)	[0.0000]	0.00000	(0.00001)	[0.0000]	0.00000^r	(0.00001)	[0.0011]
23	Fraction Buddhist	0.00038	(0.00263)	[0.1444]	0.00137	(0.00403)	[0.3399]	-	-	-
24	Fraction Catholic	-0.00025	(0.00176)	[0.1420]	-0.00073	(0.00304)	[0.2401]	-0.00073	(0.00304)	[0.2405]
25	Fraction Confucian	0.00228	(0.00937)	[0.2433]	**0.02860**	(0.01439)	[1.9874]	-	-	-
26	Fraction Hindu	0.00082	(0.00407)	[0.2014]	**0.01785**	(0.00828)	[2.1558]	-	-	-
27	Fraction Jewish	0.00000^r	(0.00000)^r	[0.0008]	0.00034	(0.00242)	[0.1405]	-	-	-
28	Fraction Muslim	**0.01034**	(0.00614)	[1.6840]	**0.01594**	(0.00517)	[0.0831]	**0.03959**	(0.01033)	[3.8335]
29	Fraction Protestant	-0.00081	(0.00316)	[0.2563]	-0.00068	(0.00298)	[0.2281]	-0.00068	(0.00299)	[0.2284]

Notes: Posterior standard deviations are in parentheses and absolute posterior mean/sd are in brackets. Posterior coefficient estimates in bold represent variables that pass our effectiveness threshold of absolute posterior mean/sd > 1.3.

[a] Global = Posterior coefficient estimates from global specification (no Africa interactions) using all 93 countries.

[b] Non-Africa = Posterior coefficient estimates for the Non-Africa sample from specification with Africa interactions.

[c] Africa = Composite posterior coefficient estimates for the Africa sample from specification with Africa interactions.

[r] Estimates subject to rounding error. The absolute posterior mean/sd estimates are net of rounding errors.

Table 2: Robustness of Posterior Coefficient Estimates

	Regressor	Africa-Only[a]			Africa-Colony[b]			Africa-NonOECD[c]		
		$E(\beta\|y)$	$\sqrt{Var(\beta\|y)}$	$\frac{\|E(\beta\|y)\|}{\sqrt{Var(\beta\|y)}}$	$E(\beta\|y)$	$\sqrt{Var(\beta\|y)}$	$\frac{\|E(\beta\|y)\|}{\sqrt{Var(\beta\|y)}}$	$E(\beta\|y)$	$\sqrt{Var(\beta\|y)}$	$\frac{\|E(\beta\|y)\|}{\sqrt{Var(\beta\|y)}}$
1	ln GDP per capita, 1960	**-0.01352**	(0.00394)	[3.4297]	**-0.01222**	(0.00306)	[3.9887]	**-0.01172**	(0.00321)	[3.6502]
2	Life expectancy, 1960	**0.00155**	(0.00048)	[3.1942]	**0.00130**	(0.00029)	[4.5195]	**0.00156**	(0.00028)	[5.6094]
3	Primary school enrolment, 1960	**0.02328**	(0.00784)	[2.9709]	**0.02153**	(0.00885)	[2.4330]	**0.02259**	(0.01136)	[1.9885]
4	Secondary school enrolment, 1960	-0.00293	(0.03172)	[0.0923]	**-0.06476**	(0.04083)	[1.5860]	-0.03103	(0.03593)	[0.8637]
5	Tertiary education enrolment, 1960	-	-	-	-	-	-	-	-	-
6	Primary export, 1970	**-0.04717**	(0.00951)	[4.9627]	**-0.03038**	(0.01012)	[3.0022]	**-0.04459**	(0.01161)	[3.8413]
7	Mining, 1960	**0.10040**	(0.01209)	[8.3044]	**0.10528**	(0.01275)	[8.2551]	**0.09770**	(0.01377)	[7.0940]
8	Urbanization rate, 1960	**-0.07132**	(0.02268)	[3.1446]	**-0.04824**	(0.02224)	[2.1694]	**-0.06878**	(0.02466)	[2.7895]
9	Labor force size, 1960	0.00000^r	(0.00000^r)	[0.3353]	0.00000^r	(0.00000^r)	[0.5286]	0.00000^r	(0.00000^r)	[0.3696]
10	Malaria prevalence, 1960s	-0.00025	(0.00553)	[0.0451]	-0.00296	(0.00681)	[0.4353]	-0.00279	(0.00744)	[0.3749]
11	Absolute latitude	**-0.00085**	(0.00029)	[2.8704]	**-0.00088**	(0.00021)	[4.1816]	**-0.00080**	(0.00037)	[2.1424]
12	Landlocked	**-0.00666**	(0.00330)	[2.0185]	**-0.00761**	(0.00382)	[1.9924]	**-0.00638**	(0.00420)	[1.5174]
13	Land area	**-0.00001**	(0.00000^r)	[4.2884]	**-0.00001**	(0.00000^r)	[3.8135]	**-0.00001**	(0.000003)	[3.6786]
14	Tropics	**-0.03164**	(0.01088)	[2.9081]	**-0.03209**	(0.01005)	[3.1938]	**-0.02998**	(0.01341)	[2.2359]
15	OECD	-	-	-	-	-	-	-	-	-
16	Sub-Saharan Africa	-	-	-	-	-	-	-	-	-
17	East Asian	-	-	-	-	-	-	-	-	-
18	Latin America	-	-	-	-	-	-	-	-	-
19	Former colony	0.00099	(0.00320)	[0.3082]	-	-	-	0.00218	(0.00478)	[0.4561]
20	Ethnolinguistic fractionalization	-0.00081	(0.00311)	[0.2588]	0.00007	(0.00074)	[0.0911]	-0.00017	(0.00146)	[0.1163]
21	Fraction European language	**0.05871**	(0.01875)	[3.1312]	**0.05859**	(0.02132)	[2.7475]	**0.05070**	(0.02305)	[2.1991]
22	Fraction English speaking	-0.00333	(0.02721)	[0.1225]	0.05203	(0.06590)	[0.7895]	0.01153	(0.01392)	[0.8283]
23	Fraction Buddhist	-	-	-	-	-	-	-	-	-
24	Fraction Catholic	-0.00032	(0.00442)	[0.0720]	0.00043	(0.00313)	[0.1366]	-0.00238	(0.00614)	[0.3882]
25	Fraction Confucian	-	-	-	-	-	-	-	-	-
26	Fraction Hindu	-	-	-	-	-	-	-	-	-
27	Fraction Jewish	-	-	-	-	-	-	-	-	-
28	Fraction Muslim	**0.04108**	(0.00744)	[5.5252]	**0.03585**	(0.00699)	[5.1302]	**0.03838**	(0.01044)	[3.6760]
29	Fraction Protestant	-0.00114	(0.00606)	[0.1880]	-0.00373	(0.00882)	[0.4233]	-0.00405	(0.00976)	[0.4151]

Notes:Posterior standard deviations are in parentheses and absolute posterior mean/sd are in brackets. Posterior coefficient estimates in bold represent variables that pass our effectiveness threshold of absolute posterior mean/sd > 1.3.

[a] Africa-Only = Posterior coefficient estimates from Africa-only specification (no interactions) using 30 sub-Sahara African countries.

[b] Africa-Colony = Composite posterior coefficient estimates for the Africa sample from specification with Africa interactions using 69 former colonies. To save space we present the Non-Africa results in the working paper version.

[c] Africa-NonOECD = Composite posterior coefficient estimates for the Africa sample from specification with Africa interactions using 69 Non-OECD countries. To save space we present the Non-Africa results in the working paper version.

[r] Estimates subject to rounding error. The absolute posterior mean/sd estimates are net of rounding errors.

Appendix A

Table A1: Descriptive Statistics of Regressors

	Regressor	Global		Africa		Non-OECD		Colonies	
		Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
	Initial level of development								
1	ln GDP per capita, 1960	7.361	(0.91)	6.526	(0.51)	6.991	(0.67)	7.160	(0.80)
2	Fraction of mining, 1960	0.052	(0.08)	0.074	(0.11)	0.064	(0.93)	0.063	(0.09)
3	Primary exports, 1970	0.713	(0.28)	0.875	(0.16)	0.821	(0.21)	0.809	(0.20)
4	Primary school enrolment, 1960	0.708	(0.30)	0.429	(0.26)	0.616	(0.30)	0.661	(0.29)
5	Life expectancy, 1960	53.34	(12.2)	41.18	(4.27)	48.21	(9.35)	50.00	(10.7)
6	Secondary school enrollment, 1960	0.210	(0.22)	0.029	(0.03)	0.117	(0.12)	0.148	(0.17)
7	Tertiary education enrollment, 1960	0.036	(0.05)	0.000	(0.00)	0.018	(0.03)	0.029	(0.05)
8	Urbanization, 1960	0.356	(0.25)	0.131	(0.09)	0.279	(0.22)	0.312	(0.24)
9	Labor force, 1960	7698	(2199)	2853	(3379)	6080	(2340)	6908	(2473)
	Geographical variables								
10	Area	874.2	(1828)	604.9	(628)	685.4	(1187)	1050	(2079)
11	Absolute latitude	23.41	(18.7)	10.09	(7.78)	15.97	(11.2)	17.44	(12.6)
12	Malaria prevalence, 1960	0.359	(0.44)	0.880	(0.26)	0.484	(0.44)	0.445	(0.45)
13	Tropical location	0.563	(0.47)	0.919	(0.25)	0.746	(0.41)	0.709	(0.42)
14	Landlocked	0.172	(0.38)	0.400	(0.49)	0.203	(0.40)	0.174	(0.38)
	Regional Variables								
15	sub-Saharan Africa	0.323	(0.47)	1.000	(0.00)	0.435	(0.50)	0.406	(0.49)
16	Latin America	0.215	(0.41)	0.000	(0.00)	0.275	(0.45)	0.289	(0.45)
17	East Asian	0.097	(0.30)	0.000	(0.00)	0.101	(0.30)	0.073	(0.26)
18	OECD	0.258	(0.44)	0.000	(0.00)	0.000	(0.00)	0.072	(0.26)
	Colonial Variables								
19	Former Colony	0.742	(0.44)	0.933	(0.25)	0.913	(0.28)	1.000	(0.00)
	Ethnolinguistic Diversity								
20	Ethnolinguistic fractionalization	0.407	(0.30)	0.648	(0.26)	0.471	(0.30)	0.445	(0.30)
21	Fraction European language	0.319	(0.41)	0.021	(0.26)	0.328	(0.41)	0.331	(0.40)
22	Fraction speaking English	0.080	(0.24)	0.006	(0.03)	0.034	(0.16)	0.093	(0.26)
	Religious variables								
23	Fraction Buddhist	0.043	(0.16)	0.000	(0.00)	0.044	(0.16)	0.025	(0.11)
24	Fraction Catholic	0.356	(0.37)	0.206	(0.17)	0.336	(0.36)	0.378	(0.36)
25	Fraction Confucian	0.015	(0.07)	0.000	(0.00)	0.011	(0.05)	0.007	(0.04)
26	Fraction Hindu	0.026	(0.13)	0.000	(0.00)	0.036	(0.15)	0.023	(0.11)
27	Fraction Jewish	0.009	(0.08)	0.000	(0.00)	0.012	(010)	0.013	(0.10)
28	Fraction Muslim	0.212	(0.35)	0.296	(0.32)	0.271	(0.37)	0.247	(0.36)
29	Fraction Protestant	0.168	(0.23)	0.175	(0.14)	0.111	(0.14)	0.138	(0.16)

Notes: The values above are the means and standard deviations (in parentheses) of the 32 variables for the four samples considered in our analysis.

Table A2: List of Countries in Four Samples

	Country	Global	Africa	non-OECD	Colony		Country	Global	Africa	non-OECD	Colony
1	Algeria	✓	x	✓	✓	48	Argentina	✓	x	✓	✓
2	Benin	✓	✓	✓	✓	49	Brazil	✓	x	✓	✓
3	Botswana	✓	✓	✓	✓	50	Chile	✓	x	✓	✓
4	Burundi	✓	✓	✓	✓	51	Colombia	✓	x	✓	✓
5	Cameroon	✓	✓	✓	✓	52	Ecuador	✓	x	✓	✓
6	CAR.	✓	✓	✓	✓	53	Paraguay	✓	x	✓	✓
7	Congo	✓	✓	✓	✓	54	Peru	✓	x	✓	✓
8	Egypt	✓	x	✓	✓	55	Uruguay	✓	x	✓	✓
9	Ethiopia	✓	✓	✓	x	56	Venezuela	✓	x	✓	✓
10	Gabon	✓	✓	✓	✓	57	Hong Kong	✓	x	✓	✓
11	Gambia	✓	✓	✓	✓	58	India	✓	x	✓	✓
12	Ghana	✓	✓	✓	✓	59	Iran	✓	x	✓	x
13	Kenya	✓	✓	✓	✓	60	Iraq	✓	x	✓	✓
14	Lesotho	✓	✓	✓	✓	61	Israel	✓	x	✓	✓
15	Liberia	✓	✓	✓	x	62	Japan	✓	x	✓	x
16	Madagascar	✓	✓	✓	✓	63	Jordan	✓	x	✓	✓
17	Malawi	✓	✓	✓	✓	64	S. Korea	✓	x	✓	x
18	Mali	✓	✓	✓	✓	65	Malaysia	✓	x	✓	✓
19	Morocco	✓	x	✓	✓	66	Nepal	✓	x	✓	x
20	Niger	✓	✓	✓	✓	67	Pakistan	✓	x	✓	✓
21	Nigeria	✓	✓	✓	✓	68	Philippines	✓	x	✓	✓
22	Rwanda	✓	✓	✓	✓	69	Singapore	✓	x	✓	✓
23	Senegal	✓	✓	✓	✓	70	Sri Lanka	✓	x	✓	✓
24	Sierra Leone	✓	✓	✓	✓	71	Syria	✓	x	✓	✓
25	Somalia	✓	✓	✓	✓	72	Taiwan	✓	x	✓	x
26	South Africa	✓	✓	✓	✓	73	Thailand	✓	x	✓	x
27	Sudan	✓	✓	✓	✓	74	Austria	✓	x	x	x
28	Tanzania	✓	✓	✓	✓	75	Belgium	✓	x	x	x
29	Togo	✓	✓	✓	✓	76	Denmark	✓	x	x	x
30	Tunisia	✓	x	✓	✓	77	Finland	✓	x	x	x
31	Uganda	✓	✓	✓	✓	78	France	✓	x	x	x
32	Zaire	✓	✓	✓	✓	79	Germany	✓	x	x	x
33	Zambia	✓	✓	✓	✓	80	Greece	✓	x	x	x
34	Zimbabwe	✓	✓	✓	✓	81	Ireland	✓	x	x	x
35	Canada	✓	x	x	✓	82	Italy	✓	x	x	x
36	Costa Rica	✓	x	✓	✓	83	Netherlands	✓	x	x	x
37	Dom. Rep.	✓	x	✓	✓	84	Norway	✓	x	x	x
38	El Salvador	✓	x	✓	✓	85	Portugal	✓	x	x	x
39	Guatemala	✓	x	✓	✓	86	Spain	✓	x	x	x
40	Haiti	✓	x	✓	✓	87	Sweden	✓	x	x	x
41	Honduras	✓	x	✓	✓	88	Switzerland	✓	x	x	x
42	Jamaica	✓	x	✓	✓	89	Turkey	✓	x	x	x
43	Mexico	✓	x	x	✓	90	UK	✓	x	x	x
44	Nicaragua	✓	x	✓	✓	91	Australia	✓	x	x	✓
45	Panama	✓	x	✓	✓	92	N. Zealand	✓	x	x	✓
46	Trin. & Tob	✓	x	✓	✓	93	Papua NG	✓	x	✓	✓
47	United States	✓	x	x	✓	Note: ✓ = in sample; x = not in sample					

Table A3: Definitions of Variables

Mnemonic	**Regressor**
	Initial level of development
GDP60	ln GDP per capita in 1960
Mining60	Fraction of mining in GDP in 1960
PRIEXP70	Percentage of primary commodities in exports in 1970
P60	Percentage of pop. above 25 with primary schooling in 1960
LIFE60	Life expectancy in 1960
S60	Percentage of pop. above 25 completed secondary schooling in 1960
H60	Percentage of pop. above 25 with tertiary education in 1960
URB60	Fraction of urban based population in 1960
LAB60	Size of labor force in 1960
	Geographical variables
Area	Land area
ABSLAT	Distance from the equator
MALA66	Malaria prevalence in 1960s
TROPICVAR	Fraction of land area in located in tropics
LANDLOC	Dummy = 1 if country has no sea ports
	Regional variables
SSA	Dummy = 1 if country is in sub-Saharan Africa
LAAM	Dummy = 1 if country is in Latin America
EAST	Dummy = 1 if country is in South-East Asia
OECD	Dummy = 1 if country belongs to OECD
	Colonial variables
COLONY	Dummy = 1 if country is a former colony
	Ethnolinguistic diversity
FRAC	Prob. two randomly selected people belong to different ethnic groups
OTHER	Fraction speaking European language
ENGLISH	Fraction speaking English
	Religious variables
BUDDHA	Fraction Buddhist
CATH	Fraction Catholic
CONFUC	Fraction Confucian
HINDU	Fraction Hindu
JEW	Fraction Jewish
MUSLIM	Fraction Muslim
PROT	Fraction Protestant

Appendix B

Table B1: Robustness of Posterior Coefficient Estimates (Former Colonies)

	Regressor	All-Colony	Non-Africa-Colony	Africa-Colony
1	ln GDP per capita, 1960	−0.01553 (0.00347)	−0.01230 (0.00312)	−0.01222 (0.00306)
2	Life expectancy, 1960	0.00144 (0.00026)	0.00127 (0.00027)	0.00130 (0.00029)
3	Primary school enrolment, 1960	0.00062 (0.00346)	0.01147 (0.01101)	0.02153 (0.00885)
4	Secondary school enrolment, 1960	−0.00056 (0.00469)	−0.06041 (0.02349)	−0.06476 (0.04083)
5	Tertiary education enrolment, 1960	0.00000 (0.00162)	−0.00395 (0.02070)	−
6	Primary export, 1970	−0.01603 (0.01037)	−0.01866 (0.00872)	−0.03038 (0.01012)
7	Mining, 1960	0.03700 (0.01939)	−0.04622 (0.01954)	0.10528 (0.01275)
8	Urbanization rate, 1960	−0.00013 (0.00192)	−0.00170 (0.00708)	−0.04824 (0.02224)
9	Labor force size, 1960	0.00000 (0.00000)	0.00000 (0.00000)	0.00000 (0.00000)
10	Malaria prevalence, 1960s	−0.00005 (0.00075)	0.00045 (0.00216)	−0.00296 (0.00681)
11	Absolute latitude	0.00000 (0.00000)	−0.00090 (0.00020)	−0.00088 (0.00021)
12	Landlocked	−0.00166 (0.00371)	−0.00040 (0.00178)	−0.00761 (0.00382)
13	Land area	0.00000 (0.00000)	0.00000 (0.00000)	−0.00001 (0.00000)
14	Tropics	−0.00029 (0.00172)	−0.02274 (0.00753)	−0.03209 (0.01005)
15	OECD	0.00208 (0.00535)	0.00035 (0.00233)	−
16	Sub-Saharan Africa	0.0002 (0.00047)	0.00209 (0.00792)	−
17	East Asian	0.01159 (0.00809)	0.00999 (0.00657)	−
18	Latin America	−0.00526 (0.00581)	−0.01712 (0.00565)	−
19	Former colony	−	−	−
20	Ethnolinguistic fractionalization	0.00000 (0.00000)	0.00007 (0.00079)	0.00007 (0.00074)
21	Fraction European language	0.01112 (0.00689)	0.01775 (0.00425)	0.05859 (0.02132)
22	Fraction English speaking	0.00103 (0.00444)	0.03164 (0.00774)	0.05203 (0.06590)
23	Fraction Buddhist	0.00063 (0.00439)	0.00002 (0.00076)	−
24	Fraction Catholic	−0.00143 (0.00400)	0.00068 (0.00319)	0.00043 (0.00313)
25	Fraction Confucian	0.01813 (0.04782)	0.01366 (0.04328)	−
26	Fraction Hindu	0.00000 (0.00014)	−0.00005 (0.00145)	−
27	Fraction Jewish	−0.00041 (0.00345)	0.00118 (0.00548)	−
28	Fraction Muslim	0.00252 (0.00500)	0.00029 (0.00251)	0.03585 (0.00699)
29	Fraction Protestant	−0.00067 (0.00420)	−0.00381 (0.00890)	−0.00373 (0.00882)

Table B2: Robustness of Posterior Coefficient Estimates (Non-OECD)

	Regressor	**All Non-OECD**	**NonAfrica-NonOECD**	**Africa-NonOECD**
1	ln GDP per capita, 1960	−0.01363 (0.00039)	−0.01209 (0.00306)	−0.01172 (0.00321)
2	Life expectancy, 1960	0.00110 (0.00039)	0.00153 (0.00029)	0.00156 (0.00028)
3	Primary school enrolment, 1960	0.00797 (0.01134)	0.00344 (0.00887)	0.02259 (0.01136)
4	Secondary school enrolment, 1960	−0.01063 (0.02309)	−0.03103 (0.03593)	−0.03103 (0.03593)
5	Tertiary education enrolment, 1960	−0.00489 ()0.03002	−0.11090 (0.08124)	–
6	Primary export, 1970	−0.01550 (0.01146)	−0.00378 (0.00749)	−0.04459 (0.01161)
7	Mining, 1960	0.02972 (002189)	−0.05100 (0.02143)	0.09770 (0.01377)
8	Urbanization rate, 1960	−0.00002 (0.00064)	0.00000 (0.00003)	−0.06878 (0.02466)
9	Labor force size, 1960	0.00000 (0.00000)	0.00000 (0.00000)	0.00000 (0.00000)
10	Malaria prevalence, 1960s	−0.00096 (0.00318)	0.00001 (0.00033)	−0.00279 (0.00744)
11	Absolute latitude	0.00000 (0.00002)	−0.00039 (0.00045)	−0.00080 (0.00037)
12	Landlocked	−0.00018 (0.00127)	−0.00368 (0,00409)	−0.00638 (0.00420)
13	Land area	0.00000 (0.00000)	0.00000 (0.00000)	−0.00001 (0.000003)
14	Tropics	−0.00006 (0.00240)	−0.01074 (0.01353)	−0.02998 (0.01341)
15	OECD	–	–	–
16	Sub-Saharan Africa	−0.00051 (0.0273)	0.04142 (0.03855)	–
17	East Asian	0.01746 (0.00745)	0.02276 (0.00713)	–
18	Latin America	−0.00041 (0.00222)	−0.00381 (0.00646)	–
19	Former Colony	0.00000 (0.00001)	−0.00218 (0.00487)	0.00218 (0.00478)
20	Ethnolinguistic fractionalization	0.00000 (0.00000)	0.00039 (0.00254)	−0.00017 (0.00146)
21	Fraction European language	0.01001 (0.00698)	0.01397 (0.00404)	0.05070 (0.02305)
22	Fraction English speaking	0.00001 (0.00046)	0.01153 (0.01392)	0.01153 (0.01392)
23	Fraction Buddhist	0.00582 (0.0122)	0.00104 (0.00443)	–
24	Fraction Catholic	−0.00636 (0.00776)	−0.00238 (0.00614)	−0.00238 (0.00614)
25	Fraction Confucian	0.00415 (0.02302)	0.01093 (0.02772)	–
26	Fraction Hindu	0.00032 (0.00272)	0.01074 (0.01329)	–
27	Fraction Jewish	0.00000 (0.00035)	0.00793 (0.01278)	–
28	Fraction Muslim	0.00359 (0.00613)	0.01053 (0.00976)	0.03838 (0.01044)
29	Fraction Protestant	−0.00286 (0.00896)	−0.00456 (0.01050)	−0.00405 (0.00976)

Table B3: Robustness of Posterior Coefficient Estimates (Latin America)

	Regressor	**Global**	**Non-LAmerica**	**LAmerica**
1	ln GDP per capita, 1960	−0.01494 (0.00279)	−0.01493 (0.00274)	−0.01491 (0.00276)
2	Life expectancy, 1960	0.00109 (0.00028)	0.00116 (0.00025)	0.00116 (0.00025)
3	Primary school enrolment, 1960	0.01225 (0.01054)	0.00849 (0.00991)	0.00877 (0.00996)
4	Secondary school enrolment, 1960	−0.00086 (0.00444)	−0.00026 (0.00244)	−0.00153 (0.00751)
5	Tertiary education enrolment, 1960	−0.00013 (0.00316)	0.00000 (0.00032)	−0.00774 (0.03893
6	Primary export, 1970	−0.01691 (0.00677)	−0.01594 (0.00825)	−0.01480 (0.00951)
7	Mining, 1960	0.03112 (0.01887)	0.03223 (0.01864)	0.03259 (0.01975)
8	Urbanization rate, 1960	0.00000 (0.00002)	0.00000 (0.00000)	−0.00029 (0.00369)
9	Labor force size, 1960	0.00000 (0.00000)	0.00000 (0.00000)	0.00000 (0.00000)
10	Malaria prevalence, 1960s	−0.00287 (0.00471)	−0.00414 (0.00591)	−0.00414 (0.00591)
11	Absolute latitude	0.00000 (0.00001)	0.00000 (0.00001)	−0.00027 (0.00035)
12	Landlocked	−0.00137 (0.00293)	−0.00206 (0.00363)	−0.00206 (0.00363)
13	Land area	0.00000 (0.00000)	0.00000 (0.00000)	0.00000 (0.00000)
14	Tropics	−0.00127 (0.00360)	−0.00406 (0.00571)	−0.00394 (0.00589)
15	OECD	0.00492 (0.00566)	0.00114 (0.00318)	—
16	Sub-Saharan Africa	−0.00010 (0.00087)	0.00000 (0.00001)	—
17	East Asian	0.02055 (0.00458)	0.02092 (0.00470)	—
18	Latin America	0.00000 (0.00000)	0.00012 (0.00149)	—
19	Former colony	0.00000 (0.00012)	0.00000 (0.00007)	—
20	Ethnolinguistic fractionalization	0.00000 (0.00002)	0.00000 (0.00017)	0.00054 (0.00357)
21	Fraction European language	0.00174 (0.00332)	0.00091 (0.00276)	0.00214 (0.00502)
22	Fraction English speaking	0.00000 (0.00000)	0.00000 (0.00005)	0.00000 (0.00005)
23	Fraction Buddhist	0.00038 (0.00263)	0.00005 (0.00100)	—
24	Fraction Catholic	−0.00025 (0.00176)	−0.00003 (0.00063)	0.00265 (0.00629)
25	Fraction Confucian	0.00228 (0.00937)	0.00120 (0.00684)	—
26	Fraction Hindu	0.00082 (0.00407)	0.00016 (0.00213)	0.00016 (0.00213)
27	Fraction Jewish	0.00000 (0.00003)	0.00000 (0.00000)	—
28	Fraction Muslim	0.01034 (0.00614)	0.00745 (0.00692)	—
29	Fraction Protestant	−0.00081 (0.00316)	−0.00002 (0.00051)	−0.01238 (0.02012)

Technical Appendix

BMA in R©

We employ BMA using the programming language R©. The key motivation for using R© as opposed to previous software used to run BMA such as Fortran, S-Plus, and Gauss, is that it is publicly available from http://cran.r-project.org/src/contrib/Descriptions/BMA.html, it is easy to use and very efficient as shown in application in the statistics literature. We use the `bicreg` function developed by Raftery (1995) to apply BMA to variable selection for linear regression models.

The following is an example of the code used in this project. This reproduces the benchmark Global results (columns 3-5 in Table 1).

```
# Read in library
library(BMA)
# Read in data file
mydata<- read.table(file="c:/lt/het/r220/chris/data/rglobal.txt", header=TRUE)
# y=dependent variable and x=regressors
y<- mydata[,1]
x<- cbind(mydata[,2:30])
# Check data
fix(x)
fix(y)
# Running bicreg
lma<- bicreg(x, y, strict = FALSE, OR = 100000, nbest=10, maxCol = 33)
summary(lma)
# Options
imageplot.bma(lma)
```

R© offers some nice options like the *imgageplot* (last line of the simple code presented above). Below is the imageplot for the Global results (columns 3-5 in Table 1). The horizontal axis presents the best models ranked by the posterior model probability and the vertical axis presents the regressors that are included in each of those models with a blue entry corresponding to a coefficient estimate with a negative sign whereas a red entry corresponds to a positive sign.

Figure 1: Imageplot for Best Models in Global Sample