Rough and Lonely Road to Prosperity: A reexamination of the sources of growth in Africa using Bayesian Model Averaging*

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Abstract

This paper takes a fresh look into Africa's growth experience by using the Bayesian Model Averaging (BMA) methodology. BMA enables us to consider a large number of potential explanatory variables and sort out which of these variable can effectively explain Africa's growth experience. Posterior coefficient estimates reveal that key engines of growth in Africa are substantially different from those in the rest of the world. More precisely, it is shown that mining, primary exports and initial primary education exerted differential effect on African growth. These results are examined in relation to the existing literature.

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1 Introduction

Recent empirical work on the determinants of economic growth has generated an almost universally pessimistic consensus about economic prospects in sub-Saharan Africa.[1] This consensus, originally due to Barro's (1991) finding of a negative African dummy, has since been further advocated by Easterly and Levine's (1997), Bloom and Sachs (1998), Collier and Gunning (1999ab) and Acemoglu, Johnson and Robinson (2001), just to name a few. Various studies have asserted that determinants of growth in Africa are generally the same as in the rest of the world, so that Africa's slow growth can be explained primarily in terms of a smaller effect of a few variables that are common between Africa and the rest of the world (see, e.g. Sachs and Warner 1997; Rodrik, 1998). As a result, much of the empirical growth literature controls for any idiosyncrasies of sub-Saharan Africa with a regional dummy (Easterly and Levine, 1997; Collier and Gunning, 1999a; Sala-i-Martin, 1997; Sachs and Warner, 1997). Other studies have asserted that African growth experience can be explained in terms of potential differential effects that certain variables may exert on Africa compared to non-Africa countries (see, e.g. Temple, 1998; Collier and Gunning, 1999a). This hypothesis has found support in work by Block (2001) and Brock and Durlauf (2001) who found that the determinants of growth, their marginal impacts and the mechanism through which those factors affect growth, may be different in Africa from the rest of the world and the world as a whole.

In this paper we further explore the possibility of heterogeneous effects of growth determinants on African growth. Our analysis is based on Bayesian Model Averaging (BMA) that allows us to consider both model uncertainty and parameter heterogeneity into an internally coherent procedure. In this sense, our approach follows closely Brock and Durlauf (2001) who first used this methodology to reexamine Easterly and Levine's (1997) finding that ethnic heterogeneity can explain sub-Saharan Africa's dismal growth. However our analysis is more general considering the effect of a large number of potential growth determinants on African and global growth. We show that this more general analysis can shed new light into the African growth puzzle.

Our main finding is that relevant growth variables for Africa are quite different. More precisely we show that mining, primary exports and initial primary education exerted differential effect on

[1] For the remainder of the paper, Africa is used generically for sub-Saharan Africa.

African growth compared to the rest of the world and the world as a whole. By investigating the magnitudes and directions of the effective variables we take first steps into understanding what is it about Africa that makes it different.

The paper is organized as follows. Section 2 takes a look at the data used in estimation. Section 3 discusses the basics of BMA theory with particular emphasis on how we incorporate parameter heterogeneity into model averaging. In section 4 we present and discuss our results. Section 5 concludes.

2 Data

Our estimation is based on a subset of the Sala-i-Martin (1997) dataset. This dataset contains a large number of variables without entailing loss of many African observations compared to most other cross-country datasets in the literature. Our baseline dataset includes 24 regressors for 104 countries of which 37 are sub-Sahara African countries (see Table 1). By many accounts, these are some of the most frequently used variables in cross-country growth regression exercises motivated by theory. Most data points represent a cross-section of average values measured over the 1960-1992 period, whereas the remaining data points represent initial conditions (i.e. 1960, or 1970 values). The dependent variable is per capita GDP growth and is measured as the difference in the natural logarithm of per capita GDP between 1960 and 1992 from Summers and Heston's (1991) purchasing power parity adjusted in chained dollars.[2] Tables A1 and A2 in the appendix present the list of the African countries and the definitions of variables (accompanied with their sources) used in our analysis.[3]

Table 1 compares the means and standard deviations of our baseline variables for Africa and the rest of the world. To summarize the most important trends, we note that Africa appears to have started from a more disadvantaged position than the rest of the world. In 1960 the level of per

[2] Due to lack of data for most African countries in our dataset for equipment and non-equipment investment, we use the ratio of investment to GDP from Summers and Heston's Real National Accounts as our investment measure. Sala-i-Martin (1997) notes that substituting the investment share of GDP with equipment and non-equipment investment does not critically alter his model's qualitative implications.

[3] We have also considered using theFernàndez, Ley and Steel (2001b) data which is also a subset of Sala-i-Martin (1997) dataset. However, this proved impractical because in constructing their dataset, Fernàndez, Ley and Steel (2001b) excluded most sub-Sahara African countries due to data unavailability for most of their additional variables and ended up with only 18 sub-Sahara African countries in their sample of 72 countries.

Table 1: Descriptives statistics

	Regressor	Africa		Rest of World	
		Mean	Std. Dev.	Mean	Std. Dev.
1	ln GDP per capita, 1960	6.585	0.531	7.719	0.782
2	Fraction of Mining in GDP	0.072	0.106	0.043	0.065
3	Primary Exports, 1970	0.884	0.148	0.654	0.300
4	Primary School Enrolment, 1960	0.418	0.278	0.841	0.214
5	Life Expectancy, 1960	40.908	5.339	58.778	10.607
6	Investment	9.484	6.137	18.823	6.908
7	Years Economy Open	0.083	0.184	0.477	0.345
8	Outward Orientation	0.432	0.502	0.358	0.483
9	Exchange Rate Distortion	161.595	41.057	108.164	24.708
10	Economic Organization	3.000	1.886	3.567	1.221
11	Population Growth	0.028	0.005	0.019	0.010
12	French Colony Dummy	0.378	0.492	0.090	0.288
13	British Colony Dummy	0.432	0.502	0.284	0.454
14	Fraction Speaking Foreign Language	0.064	0.189	0.439	0.423
15	Ethnolinguistic Fractionalization	0.649	0.250	0.310	0.251
16	Revolutions and Coups	0.268	0.252	0.180	0.252
17	War Dummy	0.405	0.498	0.418	0.497
18	Political Rights	5.689	1.269	3.112	1.773
19	Civil Liberties	5.437	1.098	3.177	1.662
20	Absolute Latitude	10.709	7.567	28.908	16.270
21	Fraction Protestant	0.157	0.138	0.160	0.262
22	Fraction Muslim	0.300	0.318	0.179	0.355
23	Fraction Catholic	0.197	0.167	0.421	0.417
24	Area (Scale Effect)	624.4	611.4	990.8	2125.9

Notes: The mean and standard deviation values of the 24 variables presented above are computed from our baseline Africa sample that consists of 37 sub-Sahara African countries. We use data from Sala-i-Martin (1997) which in turn were obtained from various sources. A list of these countries appear in Table A1 in the appendix. A brief description of the variables and their respective sources appear in Table A2.

capita GDP in Africa was about one half that of the rest of the world, life expectancy at birth was only 41 years compared to 59 years in the rest of the world and primary school enrollment was only 42 percent compared to 84 percent in the rest of the world. At the same time, African economies were almost twice as reliant on output from mining and while primary commodities comprised about 65 percent of exports in the rest of the world, in Africa they accounted for 88 percent of the exports.

African countries were on average less open to international trade. Interestingly, African countries had been "open" for only 8 percent of the entire 1960-1992 period, whereas the rest of the world was open for 48 percent. In addition, although Africa had fewer countries that leaned socialist (outward orientation), it implemented more protectionist policies (low economic organization) over the same period and exchange rates were grossly misaligned.

As Table 1 shows, Africa is geographically disadvantaged as well. For example a larger fraction of its land area lies in the tropics (absolute latitude), it consists of countries that are relatively small making it difficult to benefit from economies of scale, and it has a higher degree of ethnolinguistic fractionalization. Africa may also be constrained in its uptake of information and new technologies from the developed world. This is because although 78 percent of African countries are former British or French colonies, only 6.4 percent of the African population speaks a European language as a first language. Finally, Africa scores worse on institutions of government that are conducive to investment and private enterprise. Our descriptive statistics show that African citizens enjoyed a lower level of political rights and civil liberties than did the rest of the world, and that African countries were more likely to change holders of executive office through unconstitutional means (revolutions and coups).

3 Estimation Methodology

Our empirical strategy follows Brock and Durlauf (2001) and Brock, Durlauf and West (2001) who consider parameter heterogeneity as a special case of model averaging. 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.[4,5] 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 $M_{i,j}$ 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.

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

[4] 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). For new developments on BMA see the "Bayesian Model Averaging Home Page" at `http://www.research.att.com/~volinsky/bma.html.`

[5] While an early contribution on model averaging in economics can be found in Moulton (1991) and Palm and Zellner (1992), it is fairly recently that the literature has employed BMA in a variety of economic applications. Examples include policy evaluations (e.g. Brock, Durlauf, and West, 2003; and Sirimaneetham and Temple, 2006) monetary policy (e.g. Levin and Williams, 2003), macroeconomic forecasting (e.g. Garratt, Lee, Pesaran and Shin, 2003), and economic growth (e.g., Durlauf, Kourtellos and Tan, 2006; Eicher, Papageorgiou and Roehn, 2007; and Ley and Steel, 2007a,b).

models, with weights given by the posterior model probabilities, so that

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

The posterior model probability is given by

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

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 follow most of the existing literature and 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).

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 (Fernàndez, 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 is the safest and most robust choice to use as the benchmark.

4 Estimation Results

We start our analysis by using BMA based on equation (1). We consider 24 regressors and as many Africa interaction dummies (plus an Africa dummy) using 104 country observations for which data were available. We then use BMA on the global sample without interactions. Table 2 presents the posterior means and standard deviations as well as the marginal probabilities of inclusion for each regressor for the interaction specification (Africa, columns 3-5; non-Africa, columns 6-8) and global sample (columns 9-11). The absolute value of the posterior mean to standard deviation ratio is used as our measure for identifying variable effectiveness in our analysis. 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 to standard deviation ratio to better tie economic and statistical significance. 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. We set the threshold value equal to 1.3, which is roughly equivalent to a 90% confidence interval in frequentist hypothesis testing. Although there is no consensus in the BMA literature about this threshold, our main findings are insensitive when this threshold is adjusted upwards or downwards.

In Table 2 posterior coefficient estimates in bold font represent variables that pass our effectiveness threshold (posterior mean/sd > 1.3). Comparing effective variables in Africa, Non-Africa (rest of the world) and Global (world as a whole) samples we observe that there are three variables that exert a distinct impact on Africa. In particular we observe that mining is effective only in Africa but not in Non-Africa or the world as a whole. This result becomes more powerful when we consider the magnitudes and directions of the posterior coefficient estimates. For Africa the posterior mean for mining is positive and about three times larger than that for the global sample (0.0574 versus 0.01765). Furthermore, the sign of the respective coefficient estimate for Non-Africa is negative (-0.00342) albeit ineffective.

Table 2 shows that initial primary schooling also affects the African region distinctly. More precisely, the results suggest that primary education is highly beneficial to African growth an effect that carries over to the global sample. However, primary education is shown not to explain the

Table1: Posterior Coefficient Estimates

	Regressor	**Africa**[a]			**Non-Africa**[b]			**Global**[c]		
		Postmean (*composite*)	*Postsd* (*composite*)	*Postprob* (*interaction*)	*Postmean*	*Postsd*	*Postprob*	*Postmean*	*Postsd*	*Postprob*
1	Fraction of Mining in GDP	**0.05740**	(0.01506)	[100]	-0.00342	(0.01200)	[9.6]	0.01765	(0.01775)	[59.8]
2	Primary School Enrollment, 1960	**0.01737**	(0.00647)	[47.8]	0.00975	(0.01059)	[51.3]	**0.02284**	(0.00683)	[99.8]
3	Primary Exports, 1970	**-0.02564**	(0.00813)	[72.6]	**-0.01091**	(0.00639)	[86.0]	**-0.01798**	(0.00476)	[100.0]
4	ln GDP per capita, 1960	**-0.01375**	(0.00209)	[6.1]	**-0.01358**	(0.00224)	[100.0]	**-0.01336**	(0.00240)	[100.0]
5	Investment	**0.00032**	(0.00026)	[0.3]	**0.00032**	(0.00026)	[71.0]	**0.00059**	(0.00022)	[99.4]
6	Years Economy Open	**0.01822**	(0.00439)	[0.1]	**0.01823**	(0.00434)	[100.0]	**-0.01827**	(0.00433)	[100.0]
7	War Dummy	**-0.00619**	(0.00204)	[0.4]	**-0.00621**	(0.00200)	[99.9]	**-0.00363**	(0.00276)	[75.0]
8	Fraction Catholic	**-0.01386**	(0.00378)	[0]	**-0.01386**	(0.00377)	[99.9]	**-0.01120**	(0.00458)	[94.0]
9	Fraction Protestant	**-0.02092**	(0.00510)	[0.1]	**-0.02089**	(0.00500)	[99.9]	**-0.02121**	(0.00593)	[99.2]
10	Life Expectancy, 1960	**0.00054**	(0.00030)	[0]	**0.00054**	(0.00030)	[85.7]	0.00018	(0.00029)	[35.4]
11	British Colony Dummy	0.00311	(0.00390)	[47.9]	-0.00103	(0.00243)	[18.8]	-7.07E-07	(0.00006)	[0]
12	Ethnolinguistic Fractionalization	-0.00516	(0.00570)	[14.1]	-0.00347	(0.00475)	[41.9]	-0.00546	(0.00523)	[62.5]
13	Outward Orientation	-0.00153	(0.00319)	[22.8]	4.42E-09	(4.48E-06)	[0]	-0.00002	(0.00027)	[0.7]
14	Political Rights	-0.00021	(0.00069)	[9]	0	(—)	[—]	-0.00064	(0.00097)	[36.9]
15	Civil Liberties	-0.00013	(0.00056)	[5.4]	0	(—)	[—]	-0.00022	(0.00067)	[12.9]
16	Area (Scale Effect)	-1.07E-07	(8.32E-07)	[3]	1.88E-08	(1.43E-07)	[2.4]	2.28E-09	(5.04E-08)	[0.4]
17	Absolute Latitude	-4.20E-06	(0.00005)	[0.8]	-5.44E-07	(0.00001)	[0.4]	5.36E-07	(0.00001)	[0.4]
18	Population Growth	0.00131	(0.02896)	[0.1]	0.00171	(0.02354)	[0.8]	0.00795	(0.05265)	[3.4]
19	Revolutions and Coups	0	(—)	[—]	0	(—)	[—]	-0.00004	(0.00063)	[0.6]
20	Exchange Rate Distortion	-4.05E-07	(0.00001)	[0]	-4.08E-07	(0.00001)	[0.7]	-0.00002	(0.00003)	[36.2]
21	French Colony Dummy	9.72E-07	(0.00010)	[0]	0	(—)	[—]	-2.32E-07	(0.00005)	[0]
22	Fraction Muslim	0.00122	(0.00318)	[0]	0.00122	(0.00318)	[16.4]	0.00194	(0.00425)	[22.4]
23	Economic Organization	0.00040	(0.00069)	[0]	0.00040	(0.00069)	[30.6]	0.00014	(0.00046)	[10.9]
24	Fraction Speaking Foreign Language	7.15E-09	(0.00001)	[0]	0	(—)	[—]	3.82E-08	(0.00003)	[0]
	Sub-Saharan Africa dummy	—	—	—	-0.00096	(0.00416)	[5.3]	—	—	—

Notes: We 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 $\beta^{Afr.} = \beta_{1,j} + \beta_{2,j}$. The composite posterior standard deviations are obtained from $Var(\beta^{Afr.}) = Var(\beta_{1,j}) + Var(\beta_{2,j}) + 2Cov(\beta_{1,j}, \beta_{2,j})$. Posterior standard deviations are in parentheses and posterior regressor probabilities are in brackets. Posterior coefficient estimates in bold represent variables that pass our effectiveness threshold of absolute posterior mean/sd > 1.3.

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

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

[c] Global = Posterior coefficient estimates from global specification (no Africa interactions) using all 104 countries.

growth pattern of the Non-African countries. The posterior coefficient estimates suggest that the observed positive global effect of primary education is entirely driven by its effect on Africa whereas it is ineffective for the rest of the world.

Finally, primary commodity exports in 1970 is shown to have a strong negative and quite partial effect on African growth. Although results in Table 2 show that primary exports are effective in Africa, Non-Africa and the world, this effect is quite biased toward Africa. Specifically, the posterior mean for Africa is -0.02564, for Non-Africa is -0.01091 and for the world is -0.01798. Therefore, although primary exports are negatively related with African and Non-Africa growth, the magnitude of this effect is more than twice for Africa than the rest of the world.

Table 2 shows that there are seven variables that are equally effective in explaining growth in Africa and Non-Africa (Life Expectancy, initial income, years open, war, fraction Catholic and Protestant, and investment). These variables are broadly consistent with the results in Fernàndez, Ley and Steel (2001b) and Sala-i-Martin, Doppelhofer and Miller (2004) who only consider the global sample but for a larger set of variables.

Speaking of the regressors considered in this exercise it is important to note that one should consider our results as the lower bound of the parameter heterogeneity and model uncertainty related to Africa. The reason is that to allow for a reasonable number of sub-Sahara African countries in our sample (37) we had to give up on potential growth regressors for which data was missing for these African countries.[6]

Our main findings of the differential effects of mining, primary exports and primary education on Africa compared to the rest of the world has a common underlying message. That is, previous empirical research that found evidence in favor of global effects of these three variables on growth were likely masking that fact that the effect was primarily driven by Africa. This message is particularly powerful when considering effective growth policies. For example our results suggest that when international organizations debate over the appropriate educational aid package, primary education should be the sensible choice for Africa but not for the rest of the world. In addition, whereas in other regions of the world it may make sense to move resources away from mining and

[6] Despite this obvious limitation we preformed some robustness analyses with larger number of variables (maximum of 75 variables; 41 regressors and 34 interactions) in which we used a modification of BMA called Iterative BMA to handle the vast increase in computation. Albeit the drastic reduction of our Africa sample (down to 26 countries), results were broadly consistent except richer as expected. These results are available upon request.

into more skill-biased and technology sectors, our results suggest that for Africa mining is a strong engine of growth therefore aid to this sector maybe warranted.

Thinking about our results more broadly they also raise a number of interesting and challenging questions. For example, what is the underline cause of the differential effect of primary commodities and mining in Africa? Is it Africa's geography or could it be that the answer lies in the institutional establishment of colonialists that in addition played a notable role in the educational system of most African countries? Another equally intriguing question is whether our results point to initial conditions as the main explanation of Africa's unique growth experience (Masanjala and Papageorgiou (2007) venture in this direction).

5 Conclusion

In this paper we set out to capture effective growth determinants for sub-Saharan African countries. Following Brock and Durlauf (2001) and Brock, Durlauf and West (2003) we have used Bayesian Model Averaging (BMA) methods that allowed us to incorporate parameter heterogeneity into model uncertainty and thus more coherently test for any differential effects that relevant growth variables may exert on Africa compared to the rest of the world. Our main conclusion is that relevant growth variables for Africa can be quite different. In particular, variation in sub-Saharan growth is shown to be much more closely associated with the share of the economy made up by primary commodity production and primary education compared to the rest of the world. Perhaps more importantly we show, contrary to Sala-i-Martin, Doppelhofer and Miller (2004), that the share of mining in the economy is a robust and positive determinant of growth in Africa but not the rest of the world, or the world as a whole.

Our results have implications for the growth literature in general, and African growth in particular. First, our findings contribute to the mounting evidence of parameter heterogeneity in growth regressions. Second, the differential effect of primary commodity exports, mining, and primary education shown in this analysis raises new challenging questions about African development: why these variables in particular have distinct growth effects in sub-Saharan Africa? Third, our results on Africa suggest that assuming that countries are homogeneous objects is highly inappropriate and can lead to misguided policy recommendations.

Our analysis is subject to some limitations. First, our analysis does not consider the endogeneity problem common to growth regressions. In Masanjala and Papageorgiou (2007), we focus entirely on how African growth can be explained by initial conditions – exogenous variables that are predetermined in 1960 or thereabouts, and thus leave all investment-, political- and openness-related variables that refer to the intervening period out. Although predetermined variables can still suffer from endogeneity problems these are likely to be less severe. The logical next step is to explicitly incorporate endogeneity in BMA (a first attempt to do so is in Durlauf, Kourtellos and Tan, 2006). Second, our analysis imposes strong homogeneity assumptions on the growth process of African countries. Assuming parameter homogeneity in our growth regressions is equivalent to assuming that all sub-Saharan Africa countries have identical production technologies. In a pioneer paper, Brock, Durlauf and West (2003) use a tree structure that considers parameter heterogeneity and model uncertainty sequentially, in order to facilitate policy evaluation under several forms of uncertainty. Future work that aims to merge the literatures on endogenous clustering (i.e., Durlauf and Johnson, 1995; and Hansen, 2000) with model averaging – hence considering parameter heterogeneity and model uncertainty *simultaneously* – is very promising.

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Appendix

Table A1: List of African countries in our dataset and key initial conditions

	Country	Growth	GDP60	LifExp60	PrimSch60
1	Angola	0.00	6.79	37.5	0.21
2	Benin	-0.01	7.02	38.9	0.27
3	Botswana	0.06	6.28	45.7	0.42
4	Burkina Faso	0.00	6.15	36.3	0.08
5	Burundi	0.00	6.38	41.8	0.18
6	Cameroon	0.01	6.55	43.4	0.65
7	Cent'l Afr. Rep.	-0.01	6.49	39.3	0.32
8	Chad	-0.02	6.50	34.9	0.17
9	Congo	0.02	6.97	47.3	0.78
10	Ethiopia	0.00	5.52	42.2	0.07
11	Gabon	0.02	7.49	40.9	1.00
12	Gambia	0.01	6.20	32.3	0.12
13	Ghana	0.00	6.77	45.2	0.38
14	Cote d'Ivoire	0.00	6.88	39.5	0.60
15	Kenya	0.01	6.46	45.0	0.47
16	Lesotho	0.04	5.66	47.7	0.83
17	Liberia	-0.01	6.55	41.5	0.31
18	Madagascar	-0.02	7.06	41.0	0.52
19	Malawi	0.01	5.91	37.9	0.67
20	Mali	0.00	6.20	35.9	0.10
21	Mauritania	0.00	6.75	35.3	0.08
22	Mauritius	0.02	7.94	59.4	0.98
23	Mozambique	-0.02	7.03	35.2	0.48
24	Niger	0.00	6.22	35.4	0.05
25	Nigeria	0.01	6.32	39.7	0.36
26	Rwanda	0.01	6.24	46.5	0.49
27	Senegal	0.00	6.92	39.6	0.27
28	Sierra Leone	0.01	6.94	31.5	0.23
29	Somalia	0.00	6.92	36.1	0.09
30	South Africa	0.01	7.65	49.2	0.89
31	Sudan	0.00	6.82	38.8	0.25
32	Tanzania	0.02	5.74	40.6	0.25
33	Togo	0.01	5.89	39.5	0.44
34	Uganda	-0.01	6.52	43.2	0.49
35	Zaire	-0.01	6.13	42.1	0.60
36	Zambia	-0.01	6.86	41.8	0.42
37	Zimbabwe	0.00	6.92	45.5	0.96
Mean		**0.00**	**6.58**	**40.9**	**0.42**
Std. Dev.		**0.016**	**0.531**	**5.339**	**0.278**

Notes: The 37 countries listed above constitute the Africa sample in the baseline dataset. Columns 3-6 present rounded values of the average per capita GDP growth (1960-1992), initial per capita GDP (1960), initial life expectancy (1960), and initial primary schooling (1960), respectively.

Table A2: Variable definition and sources

Variable	Definition	Source
Growth	Average growth of GDP, 1985 international prices (1960-1992)	SH
GDP60	GDP per capita in 1960	SH
LifExp60	Life expectancy at birth in 1960	WB
PrimSch60	Average years of primary schooling in total population over 25 in 1960	BL
OutOrient	Index of outward orientation	Br
Area	Size of country's land area in millions of square kilometers	L
PopGrowth	Average growth of population (1960-1990)	SH
YrsOpen	Fraction of years economy open (1965-1990)	SW
Rev/Coup	Average number of revolutions and coups per year (1960-1984)	Bk
War	Dummy for countries participated in at least one external war (1960-1985)	Bk
Rights	Index of political rights (ranges from 1-7 where 1 represents most freedom)	BL
CivilLib	Index of civil liberties (ranges from 1-7 where 1 represents most freedom)	BL
AbslLat	Measure of distance form the equator	BL
Frac	Prob. two randomly selected people are from different ethnolinguistic group	TH
PrimExp70	Share of exports of primary products in GDP in 1970	WB
RERD	Real exchange rate distortion	BL
British	Dummy if country is former British colony	BL
French	Dummy if country is former French colony	BL
Catholic	Fraction of population Catholic	Br
Protestant	Fraction of population Protestant	Br
Muslim	Fraction of population Muslim	Br
Mining	Fraction of GDP in mining	HJ
EconOrg	Type of Economic Organization: measure of degree of capitalism	HJ
Other	Fraction speaking foreign language	Br
Invest	Ratio of real domestic investment (public and private) to real GDP	SH

Notes: Bk = Banks (1997), Br = Barro (1991), BL = Barro and Lee (1993), HJ = Hall and Jones (1999), L = Lee (1993), SH = Summers and Heston (1991), SW = Sachs and Warner (1995), TH = Taylor and Hudson (1972), WB = World Bank (2000).