Sub-Saharan Growth Surprises: Being Heterogeneous, Inland and Close to the Equator Doesn't Slow Growth Within Africa*

Matthias M. Cinyabuguma[a], Louis Putterman[b**]

[a]University of Maryland-BC, MD, USA, [b]Brown University, RI, USA
**Corresponding author: Louis Putterman, Louis_Putterman@brown.edu

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Abstract

We use two types of cross-country growth regression models to revisit explanations of slow growth in Africa looking at growth rate variation among African countries only. Both sets of models produce results that are surprising given conclusions based on global sample: within Africa, we find greater coastal population negatively and greater ethnic heterogeneity positively associated with growth, while distance from the equator is at first negatively and only later positively associated with growth. Our results suggest also that institutional and policy variables are endogenous to geographic and historical factors including the colonizing power and the religious and ethnic make-up of the country.

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1 Introduction

In an early study of the relationship between economic growth and policies, Robert Barro (1991) pointed out the unsatisfactory nature of dummy variables for Latin America and sub-Saharan Africa (hereafter, "Africa") that continued to be statistically significant even when additional controls were incorporated. This struck Barro and others as problematic because until one knows which economically relevant features of being located in a region account for its different performance, one lacks a full explanation of what determines growth rates. If we can identify the relevant features and control for them in the regression, the regional dummies should hold no further explanatory power.

The mystery of the Africa dummy attracted attention in part because of the distressingly poor economic outcomes recorded in so many African countries in the 1980s and 1990s.[1] Easterly and Levine (1997) suggested that much of the difference between African and other countries was due to ethnic heterogeneity, a variable exhibiting some of its highest values in Africa and found by those authors to negatively impact growth rates in a global sample with a quarter or so of the observations being African.[2] While accounting for ethnic heterogeneity alone failed to fully eliminate the Africa dummy from their regressions, they found that the Africa dummy became insignificant when they added the average growth rate of neighboring countries. Sachs and Warner (1997) argued that poor growth outcomes in Africa could be substantially attributed to lack of coastal access, the disease ramifications of tropical climates, and protectionist trade policies. They incorporated these variables in some of their specifications, found significant positive effects of coastal populations and trade openness, and significant negative effects of the fraction of each country's area located within the tropics. In their global sample, the Africa dummy became insignificant after controlling for these and other factors.

Like those papers, the present paper is concerned with what accounts for the poor economic performance of many countries within Africa. Rather than searching for explanations of African differences in the context of global cross section regressions, however, we undertake a cross section growth study taking advantage only of variations within Africa itself. Our goal is to assemble data for more African countries than have previously been included in such studies, and data for African countries only, to

[1] The World Bank calculated that the annual growth rate of per capita income between 1985 and 1995 was a negative 1.1% in sub-Saharan Africa, compared to (positive) 0.3% in Latin America and the Caribbean, 2.9% in South Asia, and 7.2% in East Asia and the Pacific.

[2] Subsequent studies have found that the relationship between ethnic heterogeneity and economic growth is not monotonic: having a few major groups contending for power seems to be more harmful than having many small groups, none of which can hope to dominate the others (Reynal-Querol (2002)). Sachs and Warner (1997) found ethnic heterogeneity had no explanatory power in their growth regressions after geographic variables and trade openness are controlled for. Bockstette et al. (2002) suggest that ethnic heterogeneity is a symptom of late development of intensive agriculture, high population density, and the state, and find that the ethnic heterogeneity variable has little or no explanatory power after controlling for population density and early state formation.

investigate the prescriptive and descriptive relevance in the African context of the causes of African slow growth suggested by more global studies. We also apply a novel combination of econometric methods to strengthen confidence in our findings.

Although data on some variables is missing for some of the sub-Saharan region's 43 countries, it is possible to assemble a large enough panel data set on growth and its determinants in the 1960-2000 period to derive robust econometric estimates of what accounts for better and worse performance within the sub-continent. If factors alleged to account for the African difference in global samples perform quite differently within Africa, their relevance to African and other development policy makers would be called into question. In our study, we find strong support for the usual positive relationship between investment rates and growth, and for the standard negative relationship between initial income and growth, which provides assurance that Africa is not all that different from other continents and that data for the continent's countries is not all that poor. But we were surprised to find that some of the main factors that Easterly and Levine (1997) and Sachs and Warner (1997) proposed as explanations for the African growth difference had precisely the reverse impacts on differences in performance within Africa itself. Ethnic heterogeneity is positively, not negatively, correlated with our growth residuals and with institutions and policies favoring growth. Countries in our sample were doing better if their populations lived inland, not near a coast. And rather than being good for growth, being further from the equator reduced growth rates for about half of the geographic range represented.

We know of a few studies that have worked with country samples exclusively from Africa. Bertocchi and Canova (2002) used African observations to investigate whether different colonizing powers affected the subsequent economic performance of the countries they colonized in different ways. They found that this was indeed the case. Savvides (1995) uses a fixed effect framework covering 28 countries (Maghreb included) with four seven year periods over 1960-87. His study focuses on trade policy and he finds economic growth to be correlated with growth in the trade-GDP ratio, investment, initial income, schooling, and growth of the government. Odjo and Oshikoya (1995) apply OLS and GLS techniques to study the economic performance of 17 African countries. On average, their findings contend that investment, external debt, population growth, human capital and proxies for macroeconomic environment significantly determine long-run growth in Africa.[3] Gyimah-Brempong et al.(1999) explore the relationship between instability, investment and economic growth in sub-Saharan Africa. Through a dynamic panel approach they confirm the inverse relationship between political instability and economic growth identified by ear-

[3] Hadjimichael et al.(1995) focus on the evolution of savings, investment, and net financial balances of the government and private sectors. They also evaluate the relative contributions of policy and exogenous factors – such as deteriorating terms of trade – to the growth, savings, and investment performance of sub-Saharan African countries, as well as evaluating the impact of foreign assistance.

lier studies. Garner (2005) examines whether Acemoglu et al.'s "reversal of fortunes" applies to Africa. He finds, consistent with them, that population density in 1500 is a negative predictor of average country income today. Gennaioli and Rainer (2005) test the theory that countries whose ethnic groups were more centrally organized before colonization have better public goods provision, and they find the evidence to be supportive. While these analyses are interesting, their focuses are still relatively narrow, and none check for robustness by using the alternative methodologies which we discuss presently.

We succeeded in assembling a sufficiently large data set to generate statistically significant findings with respect to many of the economic, geographic, institutional, and social-historical factors most widely used as explanatory variables in the empirical growth literature. Since our goal is to obtain results for an African-only sample with respect to explanatory factors that the general growth literature has viewed as accountable for 'the African difference,' we made sure to include the key social and geographic variables used in the Easterly-Levine and Sachs-Warner studies. Some of the variables studied are available in cross section only, but others have both cross sectional and time series variation. One strategy we adopted for dealing with this problem was to conduct a panel data analysis with a GMM model using variables that change over time and according to country, and then to conduct an OLS regression analysis of the relationship between the time-invariant variables and the country fixed effects from the panel regressions.[4]

A different methodological issue leads us to adopt a second method as an alternative to the GMM-fixed effects approach. Some of the historical and geographical variables in our study seem likely to be exogenous relative to institutional and policy variables that we expected to be more proximate determinants of growth. To deal with the likely differences between endogenous and exogenous factors' impacts on growth, we estimated a number of two-stage least squares models and tested for endogeneity and the role of instrumental variables, also carrying out over-identifying restrictions tests (There is of course an important strand of literature employing instrumental variables procedures to deal with endogeneity of institutions).[5] To the extent possible, we tried to include the same variables in both our GMM-fixed effects analyses and in our 2SLS-IV analyses, so that findings could be compared and contrasted, increasing our confidence in some of the qualitative findings.

Like other studies we find that African economies have grown more slowly when they suffered from more corruption, more civil wars, less political rights, and less economic openness. However, each of the

[4] Details on the two-stage GMM dynamic estimation are provided in section 3.1.

[5] Examples include Mauro's (1995) use of ethno-linguistic fractionalization as an instrument for corruption; Hall and Jones's (1999) use of language and other instruments for "social infrastructure;" Acemoglu et al.'s (2001, 2002) use of settler mortality and urbanization in 1500 as instruments for political institutions; and Easterly and Levine's (2003) finding that institutions and policies are proximate channels through which tropical climate, germs and crops have affected economic development.

latter proximate determinants of growth is confirmed to be better treated as an endogenous product of historical and geographic factors than as an exogenous variable. Other findings include the discovery that countries in which state-level polities existed in the centuries prior to colonization have performed better than countries that did not have state-level polities, or in which such polities had been less enduring. Countries with larger Muslim populations exhibit slower growth. Former British and French colonies have outperformed former Belgian, Italian or Portuguese colonies. Countries with a high predicted trade share according to Frankel and Romer (1999) have grown faster than their counterparts with low predicted trade shares. Having more natural capital has reduced growth rates. We also checked the robustness of our results to the set of included variables and other factors and find that most of them stand up well.

The rest of the paper is organized as follows: in Section 2, we discuss possible determinants of economic growth among African economies and introduce the variables used in our growth models. In Section 3 we introduce the procedure for GMM estimation and OLS analysis of how time-invariant factors determine country fixed effects, and we also explore our 2SLS-IV models and their results. Section 4 summarizes and concludes the paper.

2 Determinants of Performance

The countries of sub-Saharan Africa occupy a distinctive place in the world economy that emerged hand in hand with the modern nation-state, industrial technology, and the organizational forms of modern commerce and finance. Sub-Saharan Africa was the birthplace of humanity and still exhibits more genetic, cultural, ethnic, and linguistic diversity than any other region of similar size. However, its burden of tropical climates and disease, and its isolation from the other continents by oceans to the West and East and the desert to the north, meant that until recent times, foraging and nomadic peoples coexisted in it with agriculturalists who, in the main, worked small plots of land without the benefit of plows, draught animals, and fertilizer. Their societies were often knit together mainly by small or decentralized tribes, interspersed among which were various small kingdoms and in a few cases (e.g. Mali and Ghana), larger empires. While part of the "Old World," sub-Saharan Africa had such limited contact with the civilizations of the Mediterranean and Asia that the source of the Nile in East Africa was still unknown to Europeans more than three centuries after the voyages of Columbus and Magellan. It was only after Europeans had learned of the malaria-inhibiting powers of quinine that colonial administrations, the production of tropical export crops, modern mining, and the nation state in its modern form came to the region. European colonial presence, though in most countries extending less than seventy years, dramatically affected African political and economic structures. Decolonization left

fragile modern infrastructures, oriented mainly toward serving primary export industries, with states initially manned by thin cadres of educated citizens, funded disproportionately by export taxes and foreign aid. These infrastructures became highly susceptible to clientalist corruption, ethnic conflict, and change of government by military coup.[6]

We expect differences in economic performance among Africa's countries to be explained by the same types of geographic and historical factors that account for the region's uniqueness in international terms. Some of these factors can be treated as ultimate and hence exogenous causes, including equatorial location, landlocked geography, an ecology conducive to the spread of malaria, and early historical realities shaped by these factors (i.e. the late appearance of states, their ethno-linguistic diversity, and the arrival of European colonizers). Others, including the level of corruption in government and the occurrence of civil wars, will be treated as endogenous, that is as heavily influenced by the exogenous variables. The following paragraphs discuss the explanatory variables used by us under the headings geographic, social and historical, and institutional and policy.[7]

A first geographic factor accounted for in our study is proximity to the equator. A dummy variable for tropical climate is one of the key explanatory variables in Sachs and Warner (1997), but since such a dummy has less variation within our sample than the absolute latitude measure later used by Gallup, Sachs and Mellinger (1999) and others, it is the latter that we adopt to control for this factor. The second included variable relates to costs and ease of access to international trade. Sachs and Warner (1997) argued that being landlocked is one of the major causes of slow growth in many African countries. It's not clear, however, that coastal access has been beneficial in Africa, where ports are underdeveloped. Also, Nunn (2008) suggests that the slave trade has had lingering effects on growth

[6] Analyzing cross-national and sub-national data, Lorentzen, McMillan and Wacziarg (2005) argue that high adult mortality, exacerbated to some extent by the ongoing AIDS epidemic, explains almost all of Africa's growth tragedy. A good survey of proposed explanations of African economic performance is provided by Collier and Gunning (1999). Data from the World Bank and other sources indicate that most sub-Saharan African economies attained positive growth in the 1960's and 1970's and reached their peak per capita GDP in the latter decade. 41% of the countries in our sample had a per capita income in 1995 that was less than its 1960's level, 35% a 1995 income below their 1970 level, 56% a 1995 income below their 1980 level, and 62% percent a 1995 income below their 1990 level. Only six percent of sub-Saharan Africa's population live in nations with higher per capita income in 1995 than they had ever achieved (Rodrik, 1999). However, 42 of 47 African countries have returned to democratically elected governments between 1990 and 2000 (Barkan, 2002), growth has resumed and accelerated in many countries during the past few years, and some of the conflicts of the past, like those in Mozambique, Angola and Liberia, have been put to rest.

[7] Of course, it is not possible to control for every possible factor, so we focus on what we see as core variables in the general cross-country empirical growth literature, making sure to include the key Sachs-Warner geographic and the key Easterly-Levine social and historical variables, and avoiding variables for which past data are limited for our African sample. We use the secondary enrolment ratio rather than the schooling attainment variables used by Easterly-Levine because more African observations are available for it. We use the investment to GDP ratio whereas Easterly-Levine use the ratio of financial system assets to GDP. While not separately controlling for the Black Market Premium like Easterly-Levine, we use the Sachs-Warner Years Open variable which incorporates the size of that premium in its definition. For manageability, we choose one only from sets of closely related variables (for example, absolute latitude instead of a tropical dummy). We leave out the Easterly-Levine assassinations measure but study another indicator of political stability, Civil Wars. A list of all included variables, their definitions, and the data sources, appears in Appendix 1.

via its effects on social structure and cohesion, and we note that coastal areas were more affected by it than those further inland. We tried both a dummy variable for being landlocked and the measure by Gallup, Sachs with Mellinger (1999) of the proportion of the population living within 100 kilometers of an ice-free coast; we present results with the latter (called Coast Pop. Shr.), which were more frequently significant. A third geographic variable is included to test the hypothesis that having more natural resources constitutes, however surprisingly, a "curse" (perhaps because it leads to rent-seeking rather than investment promoting policies, or because it contributes to civil wars and other forms of political instability). Sachs and Warner (1997) included for this purpose the share of primary product exports in GDP, but this seems inadequate, since a high primary export share is as likely to be a consequence as a cause of underdevelopment. We use instead the measure of natural capital developed by the World Bank (1997), which is more exogenous. A fourth variable relates more directly to disease and in particular malaria. Using malaria incidence measures is inadequate because economic development exerts reverse causal influence upon the incidence of malaria, so we instead use the malaria ecology measure from Kiszewski et al.(2004).[8] Finally, we included a measure of the degree to which geography, as opposed to policy, favors trade: the trade share predicted by a gravity model that uses a country's population and geographical features (Pred. Trd. Shr.) only, from Frankel, Romer and Cyrus (1996)—sometimes called "natural openness."[9]

Our models include several potential social and historical determinants of country economic performance that can be treated as exogenous when looking at post-1960 growth. We have noted Easterly and Levine's (1997) attribution of Africa's "growth tragedy" to ethnic heterogeneity, but other papers have suggested that high degrees of heterogeneity may be associated with less, not more, inter-ethnic conflict (Reynal-Querol, 2002), and heterogeneity creates opportunities for specialization, competition, and trade that are potentially beneficial. We considered several alternative measures of ethnic heterogeneity, fragmentation, or polarization, ultimately settling on the principal measure from Easterly and Levine (1997), which is the average of five different indices of ethno-linguistic heterogeneity.[10] Religious conflicts may also be important in some countries, for example Nigeria and the Sudan. We include two alternative religious measures–religious fractionalization and religious polarization—used by Reynal-Querol

[8] Malaria ecology provides an instrument for malaria risk that controls for the fact that causation may run not only from malaria to income but also from income to malaria. According to Kiszewski et al. (2004), the basic formula for ME includes temperature, species abundance, and vector type. "Because ME is built upon climatological and vector conditions on a country-basis, it is exogenous to public health interventions and economic conditions".

[9] Frankel and Romer (1999) and Frankel et al.(1996) point out that openness, as a policy variable, matters for economic development. They use the country's natural propensity to trade, based on the gravity model, as instrument for openness. In the gravity model, predicted trade between two countries goes up with the area and population size of the trading partner and down with the distance between two countries.

[10] We decided against the simultaneous inclusion of alternative indicators of the ethnic structure, such as including both an ethnic heterogeneity and an ethnic polarization measure, because of their relatively high correlations with one another.

(2002). In addition, following Sala-i-Martin (1997) and others, we use shares of the population classified as adherents of major religions, for purposes of our sample using share Muslim and share Catholic.[11] Another potential historical determinant of growth that we included, following Bertocchi and Canova (2002), is the colonizing power, grouped as Eng. Col. (English colony dummy), Fr. Col. (French colony dummy), or other Col. (Other colony dummy).[12] We take from Hall and Jones (1999) a measure of the fraction of the population speaking one of the five primary Western European languages (including English) as mother language (Eur. Lng. Shr.), and the fraction of the population speaking English (Eng. Lng. Shr.) as a first language.[13] Finally, we include a measure of the early development of societies proposed by Bockstette, Chanda and Putterman (2002), an index of the depth of experience with state-level polities since 1 C.E. (Statehist01).[14]

We consider five main indicators of institutional quality, political stability, and policy. We anticipate that these factors may significantly affect economic performance, but they may also be endogenous to some or all of the geographic and social-historical factors mentioned above. The first two measures concern the concentration of power and the level of political freedom. These are the Political Openness variable from the Polity IV dataset,[15] and the Political Rights measure compiled by Freedom House.[16] The third variable is a political stability indicator. Because the economies of a number of African polities are well known to have suffered severely from civil wars, we include the civil wars indicator from Collier

[11] Although not all of the remainder of Africans are considered Protestant, we tried specifications that include the shares of all three major religions simultaneously and found them to perform poorly, perhaps because the three are so nearly exhaustive for so many countries. We note that among twenty-two variables found to significantly predict economic growth in Sala-i-Martin's cross-country regressions, "fraction Confucian" and "fraction Muslim" are numbers 3 and 5, respectively, with "fraction Protestant," "fraction Buddhist" and "fraction Catholic" also making the list.

[12] Like Bertocchi and Canova, we assign former colonies to the country that ruled them longest. The former German colonies – Burundi, Rwanda, Tanzania, Cameroon and Togo – were divided among the countries that took them over after WWI. Burundi and Rwanda are assigned to Belgium, while Tanzania goes to Britain. Though Cameroon and Togo were jointly mandated by France and Britain, we list Togo and Cameroon under France alone since the British part of Togo was annexed to Ghana, and Cameroon is currently in the CFA-franc zone; while Somalia is placed under Italy. One country in our sample, Liberia, is listed as never colonized and accordingly none of the three colonial power dummies is applied to it.

[13] We take care not to use both variables in the same specification.

[14] Some African countries, for example Zambia, were apparently without kingdoms, states or empires until the 19^{th} century, while others, for example Nigeria, contained kingdoms as early as the 8^{th} century. Statehist01 sums values for half centuries, ranging from 0 for no state to 50 for an indigenous polity covering most of the present territory, and uses a discount rate of 1% per half century before the most recent included period, 1901-1950. Bockstette et al. (2002) interpret statehist as an indicator of pre-modern development and find in a global sample that countries with higher statehist values grew more rapidly from 1960 to 1995 (See also Putterman and Weil, forthcoming.). We use a revised and expanded version of their data set (see Putterman, 2004).

[15] Polit. Open. measures directly the limits of executive power. It was provided by the Polity IV data set and used by Azam and Hoeffler (2002). The score ranges from 0 to 10, where 10 denotes a highly open regime. We also tried the ICRG80 and Kaufman et al.(1999) variables as measures of political institutions but due to poor coverage of our sample, the results were not reliable and are not shown in the paper.

[16] The index of political freedom around the world has been published by Freedom House since 1972. The survey consists of a series of questions grouped under political rights and civil liberties, and each country or territory is given a numerical score for each category. The average scores are used to assign each country the status of "free", "partially free", or "not free". A score of 7 corresponds to countries enjoying the greatest freedom and a score of 1 to those enjoying the least freedom.

and Hoeffler (2002). Fourth, as an indicator of quality of institutions we use an index for corruption (Mauro, 1995), measuring the abuse of office for private gain. Fifth, anticipating that trade openness may be an important determinant of economic growth as found by Sachs and Warner (1995, 1997), we adopt their Years Open measure, treating it as a quasi-institutional or policy variable and using our estimates to investigate the influence that geography and history have exerted upon it.[17]

Although factors explaining relative growth outcomes may be expected to operate much the same way within Africa as in the world as a whole, the values of some of the main variables included in our study are distributed rather differently for African countries than for countries in the world as a whole. To see this, we found the highest and lowest values of our focal variables for samples of up to 154 countries including the 39 in our African sample. We then divided the observed ranges into ten bands of equal width. We found that while 29 of the 39 African countries are situated in the top four bands for Ethnic Heterogeneity, the same is true for only 25 of 115 non-African countries for which that measure is available. For Coastal Population share, while the rest of the world's countries have a bi-modal distribution with modes in both the 0 – 10% and the 90 – 100% bands, the distribution among African countries is uni-modal, with the only mode at 0 – 10% and with only one country in our African sample having 70% or more of its population near a coast. For Absolute Latitude, when we treat maximum observed country latitude world-wide as 100% and break the distances from the equator to that latitude into ten bands of equal width, we see that all African countries, being located within 40^o north or south of the equator, fall into the first five bands, with 38 of the 39 sample countries being in the first four bands. The world sample naturally exhibits a broader range, with 56 of the 113 non-African countries for which we have data falling in the top five bands. The Openness, Corruption, and per capita GDP measures all have broader distributions in the non-African than in the African countries. Histograms of the respective distributions can be seen in Part I of our Supplemental Appendix (available on request). These differences in distribution will be pertinent to our explanation for at least one of the anomalies that turn up in our analysis.

We study the determinants of economic growth in the framework of models in which the growth rate of per capita GDP is the dependent variable, and the set of explanatory variables includes initial GDP per capita (iGDPpc), average investment ratio (I/GDP), and a measure of human capital, the secondary school enrollment ratio (Sec. Enrol.).[18] To address the fact that some important explanatory variables

[17] The Sachs-Warner index measures the fraction of years during the period 1960 to 1994 that the economy has been open. A country was open if (i) non-tariff barriers covered less than 40 percent of trade, (ii) average tariff rates were less than 40 percent, (iii) the black market premium was less than 20 percent during the 1970s and 1980s, (iv) the country was not classified as socialist, and (v) the government did not monopolize major exports. Sala-i-Martin (1997) used the Openness variable to check for robustness, and found that the Sachs-Warner measure of openness is among the variables which are robust and correlated with growth. The variable is also used by Hall and Jones (1999).

[18] The three variables are treated as core explanatory variables in the sensitivity analysis of Levine and Renelt (1992).

are time-invariant, Section 3 uses a two-step procedure, estimating a GMM growth regression with the time-varying variables, then estimating OLS regressions in which the time-invariant variables explain that regression's residuals. Section 4 addresses a different distinction among the explanatory variables, estimating a set of two-stage least squares models that take into account the fact that institutional variables like corruption and civil wars may be endogenous to historical and geographical variables like proximity to the equator and colonizing power. Commonality of major findings across the estimates based on these different procedures helps to validate the robustness of our results.

3 GMM and IV Models

3.1 GMM and Residuals Analysis

We have data for all or most of the variables used in this study for up to 33 out of 43 sub-Saharan African countries for all or part of the period from 1960 to 2000.[19] We organize our data on growth rates and on the other variables for which measures are available into eight half-decade observation periods, for 1960-64, 1965-69, etc. (Appendix 2 reports summary statistics of our data.). With some country observations missing for some sub-periods, this gives us up to a maximum of 200 observations in total, with between 5 and 8 observations for most countries (see Appendix 3). Rather than simply pooling these observations, we have made precise estimates of the explanatory variables' effects by controlling for country and period specific effects. But some variables, including most of the geographic and historical factors, do not vary with time. We deal with this by means of a two step GMM: first, we use the generalized method of moments to estimate variants of the growth equation, including some additional time-variant factors, and then we estimate OLS regressions in which the extracted fixed effects for each included country are dependent variables and various sets of time-invariant factors are explanatory variables. Our core results (as in Caselli et al.(1996) and Hoeffler (2002)) are based on the following specification:

$$g_{i,t} = \alpha + \beta y_{i,t-1} + \gamma x_{i,t} + \delta w_i + \varphi \tau_t + \eta_i + \upsilon_{i,t}. \tag{3.1.1}$$

The fixed effects (which may contain both time-and country [observed and unobserved]- specific components) is extracted as[20]

$$\hat{\upsilon}_{it} \equiv (g_{i,t} - \hat{\alpha} - \hat{\beta} y_{i,t-1} - \hat{\gamma} x_{i,t} - \varphi \tau_t) = (\delta w_i + \eta_i) + \upsilon_{i,t}, \tag{3.1.2}$$

[19] We study sub-Saharan Africa, thus excluding countries bordering the Mediterranean due to their different histories and cultures. Because of its domination by its white minority until the mid-1990s and the resulting differences between its economy and those of other sub-Saharan countries, we also excluded South Africa from our study. These decisions were taken for conceptual reasons before we began our research, and we do not investigate whether results differ for a differently defined region (for instance, Africa as a whole, continental Africa without island nations, etc.).

[20] The two step procedure was also applied in Hoeffler (2002), Blanchlower, Oswald and Sanfey (1996) and Battese and Coelli (1995).

where $g_{i,t}$ is the average growth rate in country i during five year period t, $y_{i,t-1}$ denotes the log of income per capita at the beginning of each of these periods, and $x_{i,t}$ is the subset of exogenous explanatory variables that vary over time. A further ingredient accounted for in all our regressions is the set of time dummies, τ_t.[21] η_i accounts for the unobserved country specific effects, w_i represents measured time-invariant country characteristics and $\upsilon_{i,t}$ is the error term. In panel estimation, consistent estimation of the structural coefficients depends crucially on the stochastic properties of the error term, i.e., whether they are serially correlated or not.

In this paper we follow Caselli et al.(1996) and Gyimah-Brempong et al. (1999) and we apply the Arellano-Bond (1991) panel data estimation procedure.[22]In particular, Caselli et al.(1996), Knight et al.(1993), and Islam (1995) estimated a neoclassical growth model using panel data methodology and concluded that single equation models, used to study the determinants of long-run growth, were misleading as they produced biased and inconsistent estimates. They argued that the endogeneity of some of the regressors and the unobserved country specific effects problems were not addressed when single equations and cross-country data were used.[23] In addition, with endogenous regressors and country characteristics, the Arellano and Bond (1991) dynamic panel estimator performs better.[24]

Since the measured country characteristics w_i may be correlated with the unobserved country-specific effects η_i and/or the error term $v_{i,t}$, the model given by equation (3.1.1) reduces to:[25]

$$g_{i,t} = \alpha + \beta y_{i,t-1} + \gamma x_{i,t} + \varphi \tau_t + \eta_i^* + v_{i,t}, \tag{3.1.3}$$

where $\eta_i^* = \eta_i + \delta w_i$, and $v_{i,t}$ is i.i.d. with mean zero and a constant variance and, in particular, $E(v_{it}) = E(v_{it}v_{is}) = 0$ for $s \neq t$. Equation (3.1.3), because of its endogenous regressors and/or its dynamic nature, implies correlation of error term with regressors, thus violating the orthogonality condition. The differenced GMM procedure allows one to obtain a consistent estimator $(\hat{\beta}, \hat{\gamma}, \hat{\varphi})$ for β, γ and φ.[26] These

[21] We have one dummy for each five-year period. The estimated coefficients from time dummies will not be shown in our tables to save space.

[22] Arellano and Bond's (1991) estimation requires that the variables be measured as deviations from their period means and that the equations be estimated in differenced form. Because of the endogeneity and the correlation with the error term, an instrumental variable estimator is called for. In fact, the Arellano-Bond first-differenced GMM is an IV estimator that uses past values of the explanatory variables as well as all strictly exogenous variables as instruments.

[23] Other studies have employed cross-section procedures to study the determinants of long run growth (Mankiw, Romer and Weil (1992), Barro (1997), Levine and Renelt (1992), Sala-i-Martin (1997) and King and Levine (1993)); Hoeffler (2002), Ojo and Oshikoya (1995) observe that there is a loss of information associated with the use of a single (average) observation; Caseli et al.(1996) indicate that Cross-country estimator is only consistent under restrictions that individual fixed-effects are uncorrelated with the other right-hand-side variables.

[24] A large number of techniques including GLS, the within group estimator (FE), and the GMM estimator (Chamberlain, 1983) have also been proposed.

[25] We assume that $y_{i,t-1}$ and x_{it} are predetermined for v_{it} in the sense that $E(v_{it}\,|y_{i,t-1}, x_{it}) = 0,\ \forall t$.

[26] A problem with the original Arellano-Bond (1991) estimator is that lagged levels are often poor instruments for first differences, especially for variables that are highly persistent, such that the data series have near unit root properties. In such cases, as one of our referees pointed out, a possible response is to implement system GMM (Blundell and Bond,

consistent estimates are plugged into equation (3.1.2) to extract the residuals of the growth regression. These residuals are then regressed on the time-invariant country characteristics, w_i, as:[27]

$$g_{i,t} - \hat{\alpha} - \hat{\beta} y_{i,t-1} - \hat{\gamma} x_{i,t} - \varphi \tau_t = \delta + \delta_1 w_i + \xi_{i,t}. \tag{3.1.4}$$

3.1.1 First Stage Regressions for GMM Models

Table 1 presents the results of the first-stage dynamic GMM estimator. The growth rate of per capita income is the dependent variable and independent variables are conventional time-variant economic variables (iGDPpc, I/GDP, Sec. Enrol.), institutional variables (including an indicator of civil wars and institutional quality index), and time dummies. We present four alternate specifications, three of which drop one or another of the last three explanatory variables to check the robustness of results and to allow for the inclusion of country observations otherwise excluded due to missing data.[28] Table 1 also presents a first – and a second – order serial correlation test, as well as the Sargan test of over-identifying restrictions. It additionally presents Wald test statistics for the significance of the regressors. These tests determine the correctness of the dynamic GMM estimator used here. A key condition exploited in this analysis is the absence of serial correlation among the error terms. After examining our results, we found negative first order correlation in the residuals. The M1 statistic rejects the null hypothesis of lack of first order-serial correlation between error terms, validating our conjecture that the error term contains country specific effects.[29] However, the M2 statistic in Table 1 fails to reject the null of lack of second-order autocorrelation in the first-difference residuals in all specifications.[30]

1998). Following Gindling, et al., (2008) we regressed the growth rate of GDP per capita on its lagged value, controlling for country fixed effects, to assess whether our data suffer from this problem. With a coefficient on the lagged variable of 0.196 (significant at the 1% level), we found no indication that our data are highly persistent nor that the Arellano and Bond (1991) estimator is biased. We conclude that system GMM is not called for.

[27] We assume that the errors are independent across countries and serially uncorrelated for the coefficients on country characteristics to be consistent.

[28] Perhaps due to the modest sample size and the small number of observations for some countries, the maximum number of lags for independent variable which gives good results in this model is one.

[29] The fact that the error term contains country specific characteristics is a strong argument for the use of the second-stage GMM procedure. The Sargan tests of over-identifying restrictions are rejected in all four specifications that use the dynamic GMM estimation.

[30] Test statistics and p-values for the first and second order autocorrelation in residuals are given by M1 and M2 respectively and are distributed as standard normal. The M2 statistic tests for lack of second-order serial correlation in the first-difference residuals. This is the case if the errors in the model in levels are not serially correlated, but also if the errors in levels follow a random-walk process (Arellano and Bond 1991). The M1 statistic however tests for lack of first-order serial correlation in the differenced residuals. Since $(v_{it} - v_{it-1})$ is the first difference of serially uncorrelated errors, M1 need not be statistically zero; but the consistency of the GMM estimators hinges heavily upon the assumption that M2=0.

Table 1: **First Stage Regressions for GMM Models**

Dependent variable: Growth rate of GDP per capita (Gr(GDPpc))

Indep. Var.	**1**	**2**	**3**	**4**
Log. (iGDPpc)	-3.808**	-3.436**	-3.390**	-3.401**
	(1.563)	(1.594)	(1.519)	(1.408)
Log. (I/GDP)	5.231***	5.399***	5.259***	4.496***
	(0.954)	(0.968)	(0.950)	(0.886)
Civil Wars	-2.036**		-1.364*	-1.161
	(0.884)		(0.842)	(0.838)
Polit. Open.	0.159**	0.261*		0.079
	(0.162)	(0.158)		(0.150)
Sec. Enrol.	-0.461	-0.527	-0.760	
	(0.671)	(0.684)	(0.659)	
Constant	-0.083	-0.051	-0.059	-0.276**
	(0.243)	(0.247)	(0.227)	(0.124)
Wald χ^2	69.80	62.40	65.90	56.60
Sargan χ^2	25.79	28.24	27.83	19.02
	(0.17)	(0.10)	(0.11)	(0.52)
# Obs.	136	136	141	190
# Countries	24	24	24	33
M1	-3.07***	-2.86***	-3.47***	-4.67***
P-value	(0.002)	(0.004)	(0.001)	(0.000)
M2	-1.35	-1.52	-0.72	-1.34
P-value	(0.17)	(0.12)	(0.47)	(0.18)

Note: Entries for variables in this table are estimated coefficients followed by standard errors, in parentheses, and *, **and *** indicate significance at the 10, 5 and 1% levels respectively.

Turning to the estimates, the coefficients on the initial GDP per capita are negative and significant at the 5 percent level in all four specifications. The estimated speed of convergence is about 3.5 percent per annum. The investment share of GDP is highly significant ($p < 0.001$) and positive in all specifications, with an average coefficient of 5.09. The coefficient on secondary enrollment is negative and quite insignificant in all three specifications that include it, and since data for it are missing for a large number of countries, we drop the variable both from the final specification of Table 1 and from the 2SLS estimates of section 3.2. Civil wars is significant at the 5 and 10 percent level with the anticipated signs in two of the three regressions in which it is included. The coefficient on political openness is of of the expected sign and is significant at the 5 and 10 percent level in columns 1 and 2, respectively. The coefficient on civil wars implies that an increase of one standard deviation in civil wars directly decreases economic growth by 0.24 standard deviations, a 0.60% change in growth rate when political

openness and schooling are controlled for in our GMM specification, and by 0.16 standard deviations, a 0.40% change in growth rate, when only schooling is controlled for in our GMM specification. This is a relatively large effect compared to the average growth for the sample period $(1960-2000)$ of about 0.73%.[31] These results provide support for the view that institutional problems, especially civil wars, were important proximate causes of slow growth in Sub-Saharan African countries.[32]

3.1.2 Second Stage Regressions for GMM Residuals

In the second stage, we estimate OLS regressions, with clustered standard errors at the country level, on the time-invariant variables in our set of potential growth determinants. The dependent variable is the residual from the column 4 GMM regression, a version chosen because dropping secondary schooling—which is not significant in the other regressions—permits a significant gain in sample size without major change in other coefficients. The results are shown in Table 2.[33] Since the GMM regressions of Table **2** include multiple observations for the same country in different periods, the country-specific error terms extracted from the column 4 regression are in fact country-and-period terms, which we analyze in two alternatives ways.

[31] See Tahari et al. (2004). Estimates of the growth rate vary among the columns of Table 1 due to changes in country coverage, but all are within the narrow range from 0.71% to 0.76%.

[32] A growing literature on civil wars and economic performance, including recent books by Clement (2005) and by Fosu and Collier (2005), confirms the negative effects of civil wars on growth in sub-Saharan Africa. Prior to the 1990s, other forms of political instability, especially coups d'etat, were a more common disrupter of political and economic life, with harm to economic growth shown by scholars including Fosu (2002).

[33] We need to stress that the coefficients on the fixed effects regression are consistent if and only if all the country characteristics are uncorrelated with the unobserved county specific effects. This is, however, a strong restriction, which would hold only in very rare cases. We shall thus regard these results with caution, as in Hoeffler 2002.

Table 2: Second Stage Regressions for GMM Residuals

Dependent Variable: GMM Residuals

Indep. Var.	**1**	**2**	**3**	**4**
Latitude	-0.341**	-0.365**	-0.592***	-0.926***
	(0.164)	(0.147)	(0.151)	(0.173)
Latitude_sq	0.020**	0.020***	0.035***	0.054***
	(0.008)	(0.007)	(0.007)	(0.010)
Coast Pop. Shr.	-3.791***	-4.318***	-3.996***	-2.731***
	(1.232)	(1.131)	(0.764)	(0.919)
Pred. Trd. Shr.	2.344***	2.387***	2.742***	3.136***
	(0.656)	(0.512)	(0.426)	(0.513)
Statehist01	9.637***	10.251***	6.736***	10.890***
	(2.424)	(1.965)	(2.035)	(1.639)
% Muslim	-0.037***	-0.036***	-0.028***	-0.043***
	(0.013)	(0.010)	(0.007)	(0.010)
Eth. Heter.	4.328***	3.732***	3.825***	5.696***
	(1.116)	(0.904)	(0.682)	(1.261)
Malaria Ecol.	-0.008	-0.009		0.062
	(0.036)	(0.033)		(0.044)
English Col.				0.695**
				(0.285)
Natural Cap.			-0.0001*	
			(0.00006)	
Polit. Rights		0.448*		
		(0.248)		
Yrs. Open			3.124*	
			(1.733)	
Abs. Corruption				-0.346
				(0.395)
Constant	-9.907***	-10.689***	-10.049***	-13.010***
	(2.728)	(2.487)	(1.672)	(1.638)
R^2	0.32	0.34	0.43	0.47
# Obs	173	167	140	117
# Countries	30	29	24	20

Note: Entries for variables in this table are estimated coefficients followed by standard errors, in parentheses, and*, **and *** indicate significance at the 10, 5 and 1% levels respectively.

First, columns 1 – 4 of Table **2** report regressions in which a given country can be represented by several observations because the dependent variable—an error term from the GMM estimate—differs across periods, although the explanatory variables do not. We provide four separate regression estimates because variables added, by turns, in columns 2, 3 and 4 cause reductions in sample size, due to missing

values. Second, in regressions not reported in Table **2** we run a cross section version of our fixed effects OLS regression, in which the single observation per country uses as dependent variable the average of the error terms for that country from the period-specific observations in Table **1**.[34] The results are similar, although the standard errors on the cross-section regressions were somewhat larger. In both the Table **2** regressions and its cross section variant, we find that coefficients on many of the variables representing time invariant characteristics are significant at the 1% level, with a few others being significant at the 5% or 10% levels.

The estimates for two of the geographic measures deserve particular attention. First, after experimenting with both a linear and a quadratic specification, we find that the latter performs best for latitude, and that the significant coefficients and their signs reverse findings, based on world samples, that countries further from the equator grow faster. In particular, the significant positive coefficients on latitude means that all else equal, growth slows as a country's latitude increases to about 9° north or south of the equator. Although the negative coefficients on latitude squared eventually predominate, the predicted growth rate becomes higher than at the equator only for countries located at at least 17 - 19 degrees latitude, which means that latitude is disadvantageous to growth over most of the tropical zone. Second, the surprising negative and significant coefficients ($p < 0.01$) on the Coast Pop. Shr. variable are contrary to Sachs and Warner (1997)'s finding (see also Gallup, Sachs and Mellinger, 1999) that countries in the vicinity of an ocean or an ocean-navigable river tend to grow faster than landlocked countries. Our result suggests that, among African countries, those close to the ocean did not grow any faster than those further from it, and indeed, performed worse. The size of the coefficient implies that Coast Pop. Shr. would have a large impact on economic development.

Turning to other geographic variables, the coefficient on log of predicted trade share (Pred. Trd. Shr.) is positive and significant in the country effect estimates that include it. Malaria ecology is included in three of the regressions but is never significant and has inconsistent signs. The natural capital measure, inclusion of which reduces the sample size somewhat, is included in regression 3 and obtains a negative coefficient significant at the 10% level, consistent with a now familiar finding for global samples.

Turning to the social and historical variables, we find positive and significant coefficients on state-hist01, indicating that countries with long histories of polities above the tribal level tended to have faster growth than those without such histories, all else being equal. The coefficients on ethno-linguistic fractionalization (Eth. Heter.) are all highly significant, and their sign contrary to that found by Easterly and Levine (1997) for the related ethnic fractionalization measure.[35] The included religion variable

[34] See Hoeffler, 2002 for a detailed discussion on these issues.

[35] We also estimated versions of the four regressions in which we include both ethnic heterogeneity and its square. Because both terms obtained significant coefficients in only one of the specifications of Table 2 where it was still not significantly

indicates that countries with a large proportion of Muslims achieved significantly lower levels of growth than did other African countries.[36] We tried including our English, French, and Other Colony dummy variables in each equation and found that only the English Colony variable ever obtained a significant coefficient, which is a positive one in column 4.

Finally, of our five institution or policy measures, three lack time series variation over the period studied, and thus appear as explanatory variables in the second stage regressions. We include only one in a given regression because of their related natures and unavailability for different sub-sets of countries. Political Rights and Years Open show weakly significant positive relationships with the residuals in columns 2 and 3 respectively. Absence of Corruption has an insignificant negative coefficient in equation 4.

3.2 2SLS and IV Regression

One of the drawbacks of the method used in the previous section is that it fails to distinguish between variables that are clearly exogenous to the current policy environment and the current performance of institutions and the economy, and variables that may be influenced by them. While a country's latitude, its ethnic makeup, and the power that colonized it in the nineteenth century cannot possibly have been influenced by its adoption of trade openness or experience of civil wars in recent times, the reverse could easily be the case.

In this section we reanalyze our data, taking as the pivot of our methodology a distinction between endogenous and exogenous variables, rather than between time-variant and time-invariant variables. We estimate a set of two-stage least squares regression models in which geographic and historical variables are used as instruments to predict civil wars, trade openness, political rights, political openness, and corruption, presenting only those results that pass tests for both the endogeneity of the latter variables and for over-identifying restrictions.

3.2.1 Identification Methodology

Assuming that the unobserved country characteristics, η_i, are not significant and using measured geographical and social-historical factors as instruments, our 2SLS-IV regression systems follow this system

preferred at the 5% level according to a Ramsey test, and to maintain comparability across our estimates and with those of others, we show estimates with the level term only (but these alternate estimates and test statistics are shown in Appendix 4). A quadratic specification for ethnic heterogeneitiy that allows us to make inferences about the range of values over which its effect is positive is included among our 2SLS estimates, below.

[36] This result contrasts with Sala-i-Martin (1997)'s finding that the proportion of Muslims is positively correlated with growth of GDP per capita in regressions using world samples. We also tried including % Catholic but found that it obtained insignificant coefficients.

of equations:

$$g_{i,t} = a_o + a_1 Y_{i,t} + a_2 X_{i,t} + v_{i,t},$$
$$Y_{i,t} = b_o + b_1 Z_{i,t} + b_2 X_{i,t} + \varepsilon_{i,t}, \tag{3.2.1}$$

where X is a set of exogenous controls, which act directly on the outcome, and Y is a vector of endogenous institutional and policy variables, while Z is a vector of time-variant and time-invariant exogenous instruments, and $\varepsilon_{i,t}$ is an error term. In this specification, the Z vector is being used to instrument for the set of endogenous variables contained in the Y vector.[37]

Our identification methodology includes the assumptions that the instruments should be uncorrelated with the error term, $E(Z_{i,t}v_{i,t}) = 0$, should not influence the independent variable by themselves, $E(Z_{i,t}g_{i,t}) = 0$, but can influence the growth rate through their effect on institutions and policies, $E(Y_{i,t}Z_{i,t}) \neq 0$. Under these assumptions, we can use instrumental variable estimation, provided that there is at least one instrument for each endogenous variable**.**

Our 2SLS systems are specified by first dividing the potential determinants of the rate of growth of GDP per capita (which is the dependent variable of our 2nd stage regressions) into three sets: (a) direct determinants of the growth rate, consisting of initial GDP per capita, I/GDP, the coastal population share, natural capital, and malaria ecology, (b) endogenous institutional and policy variables (civil wars, years open, political rights, political openness and absence of corruption), and (c) potential instruments, which we hypothesize may be determinants of the endogenous variables but not direct determinants of growth, consisting of predicted trade share, latitude, latitude squared, ethnic heterogeneity and in one instance its square, state history, colonizing power (Britain, France, or Other), religious fractionalization, European language share, and two religious affiliation variables–% Muslim, and % Catholic.[38] We then attempted to estimate a separate 2SLS regression system for each of the five endogenous variables

[37] A drawback of the 2SLS approach adopted in this section is that it is difficult to control for country fixed effects when some of the instruments, other explanatory variables, and even some of the instrumented institutional and policy variables take only one value for each country (i.e., are time invariant). Such variables drop out if values are taken as differences from country means, and manual inclusion of country dummy variables proved impossible without dropping some elements of the model. We therefore proceed on the assumption that relevant country characteristics are adequately captured by the values of the time-invariant measures, which include latitude, ethnic heterogeneity, and coastal population share.

[38] We experimented with a quadratic specification for ethnic heterogeneity including both level and square terms, adopting the quadratic specification whenever the joint significance of the coefficients on the two terms is 5% or less, a Ramsey test indicates an improvement of specification over the alternative with only ethnic heterogeneity (level term) at the 5% level or less, and the test results for instruments (over-identification and endogeneity) for the 2SLS equation system are satisfactory. These criteria were met in all cases by the quadratic specification for latitude. The first two criteria were also met in the first-stage regressions for Political Rights and Political Openness. However, the third criterion is met by a specification without ethnic heterogeneity squared but not when the square term is included, so in Table 3 we show a quadratic specification for Ethnic heterogeneity in the first stage regression for Political Openness only, although the coefficients in the quadratic first stage estimate are mentioned in our later remarks about a possible convex effect of ethnic heterogeneity and the estimates are displayed in Appendix 4. Coastal population share, natural capital, and malaria ecology, although potentially as exogenous as the variables in set (c), were grouped in set (a) because tests showed them to have direct effects on the growth rate in numerous specifications.

(b), selecting an appropriate specification for each two-equation system by investigating which set of the potential instruments satisfies the criteria that (i) the instruments successfully predict the relevant endogenous variable, as indicated by passing Wu-Hausman and Durban-Wu-Hausman tests of endogeneity, (ii) the instruments also pass the Cragg-Donald weak instruments test, and (iii) the instruments can be excluded from the 2nd stage regression, as indicated by the system passing the Sargan and Basmann tests of over-identifying restrictions.[39] The procedure followed in each case was to first estimate the relevant two-equation system including all potential instruments (c), then if one or more test results were unsatisfactory, repeat the procedure dropping in turn each of the potential instruments, and continuing to drop additional potential instruments until satisfactory results were obtained on all tests.[40] When tests (iii) suggested that one or more potential instruments could not in fact be excluded from a 2^{nd} stage regression, we re-estimated the system with that variable included in both the 1^{st} and the 2^{nd} stage regression, resulting in two variables that are instruments in most of the 2SLS systems being included in both regressions when political rights is the included endogenous variable.[41]

3.2.2 2SLS Regression Results

Tables 3a and 3b show pairs of 1^{st}- and 2^{nd}-stage regressions for our five endogenous institutional and policy variables, beginning with Civil Wars. The first equation of each pair is the predicting equation

[39] In principle, all five endogenous variables could be included in a single growth regression. However, correlations between them and the problem of selecting a few identifying instruments for each of them make this quite difficult. We therefore include only one endogenous variable in each 2SLS system. To be sure, the claim that a given instrumental variable affects economic growth only through a particular institutional or policy variable, as is required by any one of the 2SLS systems, may be thrown into question by the appearance of that same variable as an instrument in another of our 2SLS systems. For this reason, we interpret each 2SLS system as a free-standing attempt to understand how different exogenous and institutional variables have affected economic growth in Africa. Put differently, each of the five institutional and policy variables is treated as one of several alternative indicators of the quality of the institutional environment in the sample countries, and the relationships among these five variables is not explored here. We briefly summarize provisional tests of the relative importance of the five variables in a final footnote of this subsection.

[40] If dropping only one variable proved insufficient, we tentatively removed whichever variable had shown the largest improvement in the criteria and tried each possible second variable, and so on. When following this procedure, we treated latitude and latitude squared as one variable, always dropping either both or neither of the two.

[41] A referee suggested that three factors treated as exogenous in our IV estimates—ethnic heterogeneity, late appearance of states, and colonizing power—may be influenced by other explanatory variables such as latitude and coastal population share, and thus themselves may be endogenous within the setting of our 1st stage regressions. We investigated this by estimating a set of regressions in which a colonizer dummy, Ethnic Heterogeneity, or Statehist01 is the dependent variable and the explanatory variables are malaria ecology, natural capital, % Muslim, and absolute latitude. The only significant coefficients we found were for % Muslim, which is positive and significant at the 5% level in the equation for Statehist01, and Malaria Ecology, which is positive and significant at the 5% level in the equation for Ethnic Heterogeneity. These correlations are of some interest in their own right: the appearance of states and of Islam were historically connected in the Sahel zone, while prevalence of malaria may have been related to low population density and absence of state building which tend to go along with the survival of numerous distinct linguistic identities. However, it is not feasible to treat 1st stage regressors as instruments, the correlations are not so strong as to cause severe multi-colinearity problems, and state history and ethnic heterogeneity are certainly exogenous to the contemporary institution and policy variables that we study. Moreover, they possess independent causal impact. For example, in the 1st stage regression for Absence of Corruption, both Statehist01 and % Muslim have significant coefficients, but of opposite sign despite the positive correlation between the two variables. Accordingly, we continue to treat them as instruments when they pass the tests described in the text.

for the endogenous variable and the second is the growth equation that includes its predicted value.

Table 3a:First and Second Stage Regressions for IV Models

	Dependent Variable.					
Indep. Var.	Civil Wars	Gr(GDPpc).	Yrs. Open	Gr(GDPpc).	Polit. Rights	Gr(GDPpc).
Pred. Trd. Shr.			0.148***		0.345	
			(0.022)		(0.357)	
Latitude			-0.029***		-0.229***	-0.336
			(0.005)		(0.083)	(0.344)
Latitude.sq			0.002***		0.017***	0.005
			(0.0002)		(0.004)	(0.021)
Eth. Heter.	0.040				1.624***	
	(0.144)				(0.595)	
Statehist01	-0.237		0.510***		0.431	5.766*
	(0.321)		(0.077)		(1.377)	(3.355)
Other. Col.	0.381***		-0.052*		0.210	
	(0.095)		(0.026)		(0.463)	
Relig. Frac.	0.004		0.002***		-0.011	
	(0.003)		(0.001)		(0.012)	
Eur. Lng. Shr.	1.406		0.607			
	(1.818)		(0.492)			
% Muslim	0.002		-0.0002		-0.012	
	(0.002)		(0.0004)		(0.009)	
Civil Wars		-4.454**				
		(2.039)				
Yrs. Open				15.896***		
				(3.033)		
Polit. Rights						2.523**
						1.080
Log. (iGDPpc)	0.050	-1.062	-0.013	-1.112*	0.261	-2.552**
	(0.085)	(0.663)	(0.019)	(0.573)	(0.335)	(1.005)
Log(I/GDP)	-0.206***	1.887***	-0.002	2.215***	-0.397	3.456***
	(0.061)	(0.655)	(0.036)	(0.486)	(0.254)	(0.741)
Coast Pop. Shr.	-0.379***	-1.643	-0.02	-1.561	0.458	-2.203
	(0.135)	(1.186)	(0.035)	(0.980)	(0.575)	(1.639)
Natural Cap.	-2.39e-06	-0.0001	5.11e-06*	-0.0001	-0.0001**	0.0001
	(0.00001)	(0.00008)	(2.80e-06)	(0.00007)	(0.00004)	(0.0001)
Malaria Ecol.	0.002	-0.042	0.003***	-0.046*	0.045**	-0.059
	(0.004)	(0.028)	0.001	(0.024)	(0.018)	(0.071)
Constant	0.191	4.845	-0.473***	2.131	1.259	1.909
	(0.592)	(4.914)	(0.137)	(3.605)	(2.351)	(5.163)
Adjusted R^2	0.16	0.02	0.45	0.22	0.38	-0.06
# Obs.	191	191	191	191	138	138
# Countries	24	24	24	24	23	23

Table 3b:First and Second Stage Regressions for IV Models

	Dependent Variable.			
Indep. Var.	Pol. Open	Gr(GDPpc).	Abs. Corruption	Gr(GDPpc).
Pred. Trd. Shr.	3.083***		0.563***	
	(0.654)		(0.107)	
Latitude	-0.540***		-0.343***	
	(0.141)		(0.027)	
Latitude.sq	0.043***		0.023***	
	(0.007)		(0.002)	
Eth. Heter.	-7.846***		2.537***	
	(1.034)		(0.356)	
Eth. Heter.Sq.	11.847**			
	(4.671)			
Statehist01			3.020***	
			(0.348)	
Other. Col.	-0.785			
	(0.902)			
Relig. Frac.	-0.012		-0.015***	
	(0.021)		(0.004)	
Eur. Lng. Shr.	1.875			
	(14.712)			
% Muslim	-0.026*		-0.032***	
	(0.013)		(0.003)	
Pol. Open		0.574***		
		(0.131)		
Abs. Corruption				1.405***
				(0.260)
Log. (iGDPpc)	0.324	-1.105*	-0.460***	-1.585**
	(0.468)	(0.569)	(0.103)	(0.690)
Log(I/GDP)	-0.945**	2.662***	0.087	2.874***
	(0.417)	(0.510)	(0.080)	(0.608)
Coast Pop. Shr.	-3.419***	-0.880	1.151***	-0.697
	(1.136)	(1.024)	(0.264)	(1.293)
Natural Cap.	-0.0001	-0.0001*	-7.84e-06	-0.00009
	(0.00008)	(0.00008)	(0.00001)	(0.00009)
Malaria Ecol.	0.098***	-0.0007	0.093***	-0.039
	(0.031)	(0.025)	(0.008)	(0.031)
Constant	-5.533	-0.109	2.024	0.146
	(3.749)	(3.492)	(0.759)	(4.063)
Uncentered R^2	0.41	0.23	0.88	0.35
# Obs.	193	193	136	136
# Countries	25	25	17	17

Note: Entries for variables in this table are estimated coefficients followed by standard errors, in parentheses, and*, **and *** indicate significance at the 10, 5 and 1% levels respectively.

Each of the institutional and policy variables is well predicted by its instruments, and each proves

to be a significant determinant of growth at either the 5% or the 1% level. Of the five variables, Civil Wars is a negative while Years Open, Political Rights, Political Openness and Absence of Corruption are positive determinants of growth.

Although each pair of equations constitutes a separate 2SLS system and is estimated independently of the others, it's convenient to discuss the results as a group, noting how each explanatory variable affects growth either directly or via one or more of the endogenous variables. To begin with, the three major "sub-Saharan growth surprises" of the previous section are all found again in the 2SLS regression systems. As in Table 2, latitude proves to be detrimental to growth, in this case by negatively impacting four of the endogenous variables that increase growth.[42] Ethnic heterogeneity has a positive coefficient where it appears in level term only, being insignificant in the Civil Wars regression but showing highly significant positive effects on Political Rights and Absence of Corruption. In the regression for Political Openness, both Ethnic heterogeneity and its square obtain significant coefficients, with the positive coefficient on the square term becoming dominant and implying a positive relationship between ethnic heterogeneity and growth for values of the former above 0.33, a range in which just over three quarters of the included countries fall. Coastal population share, which cannot be excluded from any of the 2^{nd}-stage regressions, has negative and non significant coefficients in all of them. However, it also has two indirect effects that seem inconsistent with these findings: although not an instrument in the proper sense in either regression, Coastal Pop. Share has a negative and significant effect on Civil Wars and a significant positive effect on Absence of Corruption.

Turning to other variables, a positive effect of a long state history on growth is indicated either directly or indirectly in three of the five equation systems: a positive direct effect, significant at the 10% level, in the Political Rights system, and positive effects on Years Open and Absence of Corruption, both significant at the 1% level. Predicted Trade Share is a positive predictor, significant at the 1% level, of Years Open, Political Openness, and Absence of Corruption. Of the three colonizing power dummy variables, only Other Colony showed any significance and so was included, having significant detrimental effects by increasing Civil Wars and decreasing Yrs Open. Of the religious affiliation share variables, likewise, only % Muslim survived tests for inclusion in the systems, displaying unhelpful indirect effects via all five endogenous variables, but significant ones only via Political Openness and Absence of Corruption. European Language Share passes tests for inclusion in three equation systems, but its coefficient is never significant. Religious Fractionalization is included as an instrument in all five systems, showing a significant positive indirect effect on growth by increasing Years Open but a

[42] In the 2SLS system that includes Political Rights, our tests indicated that latitude and its square could not be excluded from the 2nd-stage equation. Although not instruments in the proper sense, they are nevertheless significant negative predictors of Political Rights, with latitude showing a negative but insignificant effect on growth itself.

significant negative indirect effect by reducing Absence of Corruption.[43]

Like Coastal Population Share, the Natural Capital and Malaria Ecology variables are included, as dictated by test results, in all 2^{nd}-stage regressions, which makes their inclusion also in the 1^{st}-stage regressions as a control conventional. In these cases, the coefficients in both stages are potentially of interest, since there is no economic reason to rule out effects via the endogenous variables. Natural Capital obtains the now-expected negative coefficient in four of the five 2^{nd}-stage regressions, but is significant at the 10% level in only one.[44] Malaria Ecology has negative coefficients in all five 2^{nd}-stage regressions, but is significant at the 10% level in one only. Contrary to expectations, Malaria Ecology appears to have significantly positive indirect effects on growth by increasing Absence of Corruption.

Looking finally at the two core economic determinants of the growth rate, both lagged GDP per capita and the investment share (I/GDP) have their expected signs in all five 2^{nd}-stage regressions, with investment share always increasing the growth rate at the 1% level of significance and lagged GDP per capita having a negative sign, consistent with convergence, and being significant in all 2^{nd}-stage regressions, except that for Civil Wars, at the 10% level or better.

Table 4 presents alternative tests of endogeneity (Wu-Hausman F- test and Durbin-Wu-Hausman χ^2-test), overidentifying restrictions (Sargan N*R-sq test and Basmann test), and of weak instruments (Cragg-Donald F-test). In all five 2^{nd}-stage regressions in which an endogenous variable is instrumented, our results – with the exception of one weak instruments test–pass all the tests mentioned above.[45,46]

[43] Due to concern that the joint presence of Religious Fractionalization and Ethnic Heterogeneity might play a role in the unexpected coefficients on the latter variable, we also re-ran each equation system dropping Religious Fractionalization. The results, not shown, are qualitatively unchanged.

[44] The p-value of the coefficient on Natural Capital in the 2nd stage regression for Civil Wars is 0.102.

[45] The first stage regression for political rights fails the Cragg-Donald F-test of weak instruments, with $p = 0.13$.

[46] Although determining the relative importance of the five endogenous institutional variables analyzed in this section is beyond our objectives for this paper, we undertook some exercises in this vein following the suggestion of one of the referees. For each of the ten possible pairings of endogenous variables, we estimated two 2SLS equation systems treating not one but two variables as endogenous. For example, considering the first two IV equation systems in Table 3a, we estimated a new system of equations that includes two first stage regressions, one for Years Open and another for Civil Wars, and a second stage (growth) regression in which the predicted values of both variables are included as regressors. Two estimates were done for each pairing of endogenous variables: one in which the instrument set is the union of the two sets of instruments used for the relevant endogenous variables in Table 3, the other in which the instrument set is the intersection of those two sets of instruments. We then checked whether one endogenous variable obtained a more significant coefficient than the other in the corresponding second stage regressions (compare Acemoglu and Johnson, 2005). For all pairings of endogenous variables, at least one of the two remained statistically significant with at least one of the two instrument sets, and usually one endogenous variable was significant with both sets of instruments. Using this methodology, we found that the variable Civil Wars was exceeded in significance by all four of the other endogenous variables and that the variable Political Rights was exceeded in significance by each of the three variables other than Civil Wars. There was a less clear-cut relationship among the three remaining variables, with Years Open exceeding in significance Absence of Corruption for both large and small instrument sets but with no clear dominance between Years Open and Political Openness or between Political Openness and Absence of Corruption. As a further exercise, we estimated 2SLS systems that included three first stage equations, one for each of these three variables, again with a maximal (union) and minimal (intersection) set of instruments. In the second stage (growth) regressions based on both sets of instruments, only Years Open had a statistically significant coefficient. The complete results can be viewed in our Supplemental Appendix. A provisional conclusion, therefore, is that Years Open has the most decisive influence on growth among the five institutional variables that we study, while the

Table 4: **Endogeneity and Over-identifying Restrictions Tests**

	Tests	Civil Wars	Yrs. Open	Polit. Rights
Overid.	Sargan (χ^2)	5.45	8.75	4.47
		(0.36)	(0.27)	(0.35)
	Basmann (χ^2)	5.06	8.16	3.98
		(0.41)	(0.32)	(0.41)
Endog.	WH (F)	5.00	12.13	6.03
		(0.03)	(0.00)	(0.02)
	DWH (χ^2)	5.28	12.31	6.50
		(0.02)	(0.00)	(0.01)
Weak Inst. Test	C-D (F)	3.32	18.6	1.72
		(0.00)	(0.00)	(0.13)
Instruments		Statehist01	Statehist01	
		% Muslim	% Muslim, Other Col.	Pred. Trd. Shr.
		Other Col.	Pred. Trd. Shr.	% Muslim
		Eth. Heter.	Latitude, Relig. Frac.	Other Col.
		Relig. Frac.	Latitude. sq	Eth. Heter.
		Eur. Lang. Shr.	Eur. Lang. Shr.	Relig. Frac.

Table 4 continued

	Tests	Polit. Open.	Corruption
Overid.	Sargan (χ^2)	8.72	10.2
		(0.37)	(0.12)
	Basmann (χ^2)	8.081	9.41
		(0.43)	(0.15)
Endog.	WH (F)	7.94	11.00
		(0.01)	(0.00)
	DWH (χ^2)	8.41	11.33
		(0.01)	(0.00)
Weak Inst. Test	C-D (F)	8.24	133.5
		(0.004)	(0.00)
Instruments		Pred. Trd. Shr.	Pred. Trd. Shr.
		% Muslim	% Muslim
		Other. Col.	Other. Col.
		Eth. & Eth. Sq.	Eth. Heter.
		Latitude	Latitude
		Latitude. sq.	Latitude. sq.
		Relig. Frac.	Relig. Frac.
		Eur. Lang. Shr.	Statehist01

Note: Overid. stands for over-identifying restrictions and Endog. stands for endogeneity tests. DWH refers to Durbin-Wu-Hausman χ^2-test, WH refers to Wu-Hausman F-test and C-D refers to Cragg-Donald F-test. Entries in parentheses are p-values.

influences of Civil Wars and Political Rights are least important. Since these exercises are not based on careful consideration of alternative methods, we view them as suggestive, only.

3.3 Consistency of GMM and IV Models, and Robustness

By virtue of the negative and significant coefficients on initial GDP per capita, our dynamic GMM and IV technique estimates both confirm the usual conditional convergence result, i.e. income is growing faster in poorer countries, all else being equal. The effect of the investment/GDP ratio is robustly positive and significant in both sets of estimates, with a 1% change in (I/GDP) leading to a 4.5 to 5.4% change in the GDP growth rate according to the GMM estimates and a 1.9 to 3.5% change in GDP growth rate according to the IV estimates. Findings with regard to geographic, historical, institutional and policy variables also show considerable consistency across methods of analysis. We summarize those findings in Section 4.

Turning to robustness concerns, in all regressions we corrected for heteroskedasticity or implemented regressions with clustered standard errors at the country level.[47] We checked for their robustness to different ways of dealing with the correlation between predicted trade share, coastal population share and trade openness, and found that our results cannot be explained by these correlations.[48]

4 Summary and Conclusions

This paper has explored the role of political, social, and geographic factors in explaining economic performance of countries in sub-Saharan Africa during the years 1960 – 2000. Our findings indicate that initial GDP per capita and the investment share of GDP influence economic growth in the conventional manner in sub-Saharan African countries, providing assurance that the data are adequate and that the laws of economics hold south of the Sahara as elsewhere. But the available measure of human capital (average schooling) is never significant and always has a negative sign. We also confirm that a variety of other variables help to explain performance in sub-Saharan Africa. These include institutional and policy variables (civil wars, economic openness, political rights, political openness and corruption), geographic

[47] The exception with regard to displaying results with cluster standard errors at the country level are the 2^{nd}-stage regressions in Tables 3a and 3b, which do not correct for heteroskedasticity because the endogeneity and over-identifying restrictions tests, which are fundamental to our results, cannot be obtained if we correct for heteroskedasticity there.

[48] We were worried about a possible correlation between predicted trade share, coastal population share and the policy variable "Yrs. Open". It happens that the correlation between the trade share and Coast Pop. Shr. is very large. Predicted trade share and trade openness could also be related to each other in two ways if predicted trade share indicates the natural level of trade. First, a high natural level of trade may make it more likely for the country to adopt more open policies, and second if a country has a high trade potential (predicted trade share), then openness will benefit its growth more than if the country has low trade potential. We included, therefore, (in a set of GMM estimates not shown here) an interaction term, the product of predicted trade share with the openness variable. When using the predicted trade share and the openness variables together with the interaction term, only the predicted trade share is significant while both the openness variable and the interaction term attain insignificant coefficients. When the predicted trade share is used with the interaction term, only the predicted trade share is significant with the correct sign. When the interaction term is used with Yrs. Open., neither one is significant. Finally, when the interaction term is used alone, it gives a large positive coefficient which is significant at five percent level. We found, therefore, no evidence of multicollinearity driving our results.

variables (latitude, coastal population share, natural capital, malaria ecology, and the Frankel-Romer predicted trade share), and social and historical variables (ethnic heterogeneity, the statehist measure of pre-modern development, colonizing power, religion, and proportions speaking Western European languages). Our results, especially those obtained when treating them as endogenous, strongly confirmed that good institutions, avoidance of civil wars, and a more open economy, have had significant positive effects on growth in Africa. We also obtain some confirmation of Bertocchi and Canova's finding that having been colonized by Belgium, Italy or Portugal conferred a worse fate than colonization by England or France, and of the World Bank's 1997 finding that having more natural capital has tended to be harmful to growth.

Our results contained three major surprises. First, having a larger coastal population share has significantly negative effects on the rate of growth in our African country panel, especially according to our GMM models but also based on two of the three indirect effects that are significant in the first stages of our 2SLS models. Thus, we find no intra-African support for Sachs and Warner's contention that one reason Africa's countries have grown slowly is that so many of them are landlocked.

Second, contrary to the oft-mentioned idea that proximity to the equator is a disadvantage, in our African panel the relationship between latitude and economic growth is non-linear, with proximity to the equator being good for growth over about half of latitude's observed range, and the estimated growth rate being higher at the equator than in the large majority of the range of latitude observed in the region. In the four IV regression models in which it proved helpful to include latitude, the coefficients are also highly significant and imply that trade openness, political openness, political rights, and absence of corruption, are at first decreasing with latitude. The fact that latitude could be excluded from the 2nd stage regressions in four of our five 2SLS equation systems, which suggests that it affects growth only by influencing institutions or policies, is also of interest.

Third, contrary to Easterly and Levine's hypothesis and their evidence from global regressions to the effect that ethnic heterogeneity may account for "Africa's growth tragedy," the ethnic heterogeneity variable, identical to the main measure of that concept used in their paper, is positively and significantly related to economic growth and to favorable institutional and policy outcomes, at least over the range in which most observations fall, in our Africa-only panel. In all four GMM residual regressions shown, ethnic heterogeneity is positively related to growth residual, significant at the 1% level. Ethnic heterogeneity appears to be a significant positive determinant of lower corruption and of greater political rights and shows a significant convex relationship with political openness with a positive relationship predominant over the range of ethnic heterogeneity levels in which three quarters of sub-Saharan African countries fall. A fourth, more minor, surprise is that in contrast with Sala-i-Martin's finding for global samples,

we find that a larger Muslim population share is associated with lower rates of growth.

The fact that proximity to the equator is not associated with slower growth within sub-Saharan Africa does not necessarily contradict the idea that tropical climate helps to explain the region's poor economic performance relative to other parts of the developing world. Almost all countries in the region lie mainly if not entirely in the tropics, and relatively tropical climates may still help to account for relative performance of SSA as a region, our results notwithstanding. However, our results suggest either that exact degree of proximity to the equator doesn't matter so long as a country is already located within the geographic tropics, or that whatever it is about a tropical climate that makes economic growth more difficult is not well proxied by distance from the equator.

One factor helping to account for the surprising relationship between latitude and growth in sub-Saharan Africa may be the fact that sub-Saharan countries furthest from the equator in a northerly direction are located in or on the margins of the Sahara desert. There are also major deserts, the Kalahari and the Namib, well south of the equator, and serious drought frequently plagues the horn of Africa and other sub-regions of the continent, without obvious correlation with latitude. Temperate climates are also found in highland regions near the equator, in east and central Africa. Our estimates suggest that the worst locations for growth are those about 10° north or south of the equator, home to Mali, Nigeria, Chad, Sudan, and Somalia, in the north and Malawi in the south among countries included in our sample. In sum, being tropical may be a factor in slow African economic growth, but being close to the equator per se is evidently not.

The case of ethnic heterogeneity may be similar to that of latitude in the sense that most sub-Saharan countries are (as seen above) found near a boundary of that variable's distribution, so the conclusion from global studies that ethnic heterogeneity is a factor explaining slower economic growth in Africa versus other regions is not strictly speaking at odds with our finding of a positive correlation between ethnic heterogeneity and growth within the region. A possible explanation for the apparent discrepancy can be found in recent contributions, including Montalvo and Reynal-Querol (2005), which suggest that the true global relationship between ethnic heterogeneity and economic growth is U-shaped because having a few large, competing ethnic groups may be worse than having many small ones. African examples are not hard to come by: compare, for instance, the relative ethnic calm of Tanzania, where none of more than 100 ethnic groups accounts for more than 10% of the population, to the unrest in neighboring Rwanda and Kenya, with two and a few dominant ethnic groups, respectively. Nor is having a single predominant ethnic group a guarantee against political instability and violence, as the case of Somalia tragically illustrates. We found evidence for the same U-shaped relationship in one of our 1st stage regressions in Section 3.2. Our estimated coefficients on Ethnic heterogeneiety and its square in that

regression imply that Political Openness, an institutional condition favorable to economic growth, is an increasing function of Ethnic heterogeneity for values of the latter exceeding 0.33.[49]

Suppose that the true global relationship between GDP growth and ethnic heterogeneity is U-shaped but turns upwards only for the highest third of observed ethnic heterogeneity values. Then there is no contradiction if estimates over a global sample that use a linear specification find a significant negative coefficient on ethnic heterogeneity, while estimates over a sample of African countries using such a specification find a significant positive coefficient. The estimated coefficients on Ethnic heterogeneity and its square in our 1st stage regression for Political Openness imply that Political Openness is lower for ethnically heterogeneous countries until Ethnic Heterogeneity reaches about 0.67, a value above which most sub-Saharan African countries but few other countries globally are found (see the Supplemental Appendix). The practical implication is that it may be African countries with lower not higher levels of ethnic diversity that are most in need of efforts to reduce grievances and increase participation by all groups in the making and implementation of national policies, taking their cue from the success of Tanzania's efforts to mitigate tribalism (Miguel, 2004).

Whereas explanations of the surprise findings regarding latitude and ethnic heterogeneity may be related to the distinctive ranges that African countries occupy with respect to those variables, our finding that larger coastal populations are negatively associated with growth in sub-Saharan Africa requires a qualitatively different kind of explanation. It is often remarked that Africa has the smallest ratio of coastline to area of any continent, and that it is relatively lacking in good natural harbors. Not only does the continent have many landlocked countries, but also in countries with coastlines, population tends to be denser away from the sea, where agricultural conditions are better. Bloom and Sachs (1998) note the absence of large rivers navigable by ocean-going ships and cite Adam Smith's observation that "There are in Africa none of those great inlets, such as the Baltic and Adriatic seas in Europe, the Mediterranean and Euxine (Black) seas in both Europe and Asia, and the gulfs of Arabia, Persia, India, Bengal, and Siam, in Asia, to carry maritime commerce into the interior parts of that great continent." Such natural disadvantages do not, in our opinion, provide a complete explanation of why presence of coastal population fails to register a positive effect on growth, in our sample. Our finding suggests that on the whole, African countries that have coastlines have yet to reap most of the trading advantages that these might one day give them. Exceptionally high costs and low efficiency in African ports are probably

[49] As mentioned in note 38 above, a quadratic specification for Ethnic heterogeneity also performs well (in terms of individual and joint significance and a Ramsey test) in a first-stage regression for Political Rights but was rejected due to failure to meet criteria for good instruments. The estimated coefficients, -7.54 for Ethnic heterogeneity and 9.52 for its square, imply that more Ethnic heterogeneity is better for Political Rights once Ethnic heterogeneity exceeds 0.40, slightly higher than the 0.33 turning point implied by the estimates in the Political Openness regression. Taking into account the slightly different set of countries included in the Political Rights regression, the percentage of included countries in the relevant range (above 0.4) remains almost identical, at 76%.

part of the explanation (Bloom and Sachs, 1998; Clark, Dollar and Micco, 2004). Other problems which have thus far prevented the growth of most export-oriented manufacturing are undoubtedly also at play. Finally, a long-term cost born by African coastal areas as a consequence of the slave trade may also be at work (Nunn, 2008).

Our findings suggest that the message of Sachs and Warner (1997) and Gallup, Sachs and Mellinger (1999) that sub-Saharan Africa's poor growth performance may in part be attributable to having many countries that are landlocked must at a minimum be amended by noting that sub-Saharan countries that have larger coastal population shares have yet to grow faster than those that have little coastal population or are landlocked. That the sub-Saharan region may be the only part of the world in which access by ocean-going vessels has been of little or no benefit stands out as especially noteworthy among our paper's findings.

We introduced a variable not previously focused on in the African context, state history, and we found its inclusion to be statistically warranted and often important in both our GMM and our IV models. In the GMM residual estimates, a longer state history always predicts faster growth, significant at the 1% level. In the IV models, statehist01 was found to be a highly significant predictor of openness and absence of corruption, and in the equation system for political rights it is a direct positive predictor of the growth rate.[50] Its positive association with the growth rate and its negative association with corruption are consistent with the previous findings of Bockstette *et al.* for world samples.[51]

Most of these results were confirmed by both our GMM and residuals approach and our two-stage least squares analysis, but the latter approach suggests a more specific interrelation among the causal factors, namely that policies and institutions like the existence of greater corruption or more frequent civil wars, while often important as proximate causes of which countries make progress and which fail to do so, are to a significant degree caused by longer term processes and more exogenous geographical and demographic facts.[52]

How might we view these results if concerned about the near-term prospects of Africa's economies? On the positive side we count the fact that geographic and demographic factors like equatorial and inland location and ethnic heterogeneity do not seem to be bars to growth in their own rights, and that changing policies on trade and creating greater political openness and lessening corruption appear

[50] Statehist is not included in the predicting of political openness since its inclusion in the set of instruments violates the endogeneity and over-identifying restrictions tests.

[51] See also Chanda and Putterman (2005). Gennaioli and Rainer (2005) find a positive association between the degree of centralization of African tribes before colonization and measures of the success of provision of certain public goods including paved roads and lower infant mortality during the early post-colonial period.

[52] Masanjala and Papageorgiou (2006) have generated evidence that the determinants of growth in Africa and in the rest of the world may be different but have not provided specific estimates of what the relationships in question are. Conducting the same exercises for a world sample and confirming that the coefficients for African countries are significantly different is a desirable further step for our project.

capable of facilitating economic growth. On the negative side, the social, cultural and historical legacies at work in many countries of the region may make the creation of high quality institutions and policies a challenging, though one can hope not impossible, task. Our confirmation of the importance of those institutions suggests to us that studying what does and doesn't work in the area of capacity building in public, private, and civil spheres in Africa is one of the most important directions for future research.

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Appendix 1: Variable definitions and sources

Civil wars: A dummy variable indicating whether the country is at war. It only considers internal wars which resulted in at least 1000 battle related deaths (civilian and military) per year. Data are from Azam and Hoeffler (2002) and were used in Collier and Hoeffler (2002).

Coast Pop. Shr. (Coastal population share): Measures the ratio of population within 100 km of ice-free coast to total population. Calculated using 100 kilometers from ice-free coast buffer (source: Gallup, Sachs with Mellinger (1999)).

Absence of Corruption: Based on the Corruption Perceptions Index (CPI) from Transparency International (2003) (source: www.Transparency.org).

Eng. Col. (English Colony dummy): Dummy variable indicating that country was a British colony (source: La Porta et al., (1999)).

Eth. Heter. (Ethnic heterogeneity): The average of five different indices of ethno-linguistic fractionalization. Gives the probability of two random people in a country not speaking a same language.

Eth. Heter. sq. (Ethnic heterogeneity squared): See Ethnic heterogeneity.

Eur. Lng. Shr. (European language share): Measures the fraction of the population speaking one of five major Western European languages, including English, as mother tongue (source: Hall and Jones (1999)).

Gr(GDPpc) (Growth rate of GDP per capita): Measures the annual percentage growth rate of GDP per capita based on constant local currency (source: World development indicators).

Latitude: Measures the absolute value of the latitude of the country, where zero is the equator (source: La Porta et al (1999)).

Latitude. sq (Latitude squared): See Latitude.

Log(I/GDP) (Investment share of GDP): Measures the natural log of investment-to-GDP ratio (source: World development indicators).

Log iGDPpc (Log of initial GDP per capita): Measures the natural log of real gross domestic product per capita in the first year of the five year period under observation (source: Own computations based on data from World development indicators).

Malaria Ecol. (Malaria Ecology): A measure of ecological factors associated with the risk of contracting malaria, used in place of actual malaria incidence in order to eliminate possible influences of country income on it. The basic formula for ME includes temperature, species abundance, and vector type (source: Kiszewski et al. (2004)).

Natural Cap. (Natural Capital): Measures the value of a country's agricultural lands, pasture lands, forests and subsoil resources including metals, minerals, coal, oil and natural gas (source: World Bank, Environmentally Sustainable Development Studies and Monographs Series, #17, June (1997)).

Other Col. (Other Colony dummy): Dummy variable indicating that country was a Belgian, Italian, Portuguese or German colony. Germany is not represented in our data due to missing observations and the coding of former German colonies under whichever power controlled them after World War I. (source: La Porta et al., (1999).

Percent Muslim: Measures the percentage of the population that belonged to the Muslim faith in 1980 (or 1990-95 for countries formed more recently) (source: La Porta et al., (1999)).

Polit. Open. (Political Openness): Measures the general openness of political institutions. This index ranges from 0-10, where 10 denote a highly open regime. It is the variable that is called "democracy" in the Polity IV data set and is also referred to as "democracy" by Collier and Hoeffler (2002) and is used by Azam and Hoeffler (2002).

Polit. Rights (Political Rights): An average of an index of political rights and an index of civil liberties from Freedom House (2003), www.freedomhouse.org. Political rights include the right to vote, the right to compete for a public office; while civil liberties include the freedoms of expression and belief, associational and organizational rights, rule of law and personal autonomy without interference from the state. Data are from an annual survey and are available since 1978 for 198 countries.

Pred. Trd. Shr. (Log of Predicted Trade Share): Measures the natural log of the Frankel-Romer predicted trade share. The predicted trade share is computed from a gravity model based only on population and geography (source: Frankel, Romer and Cyrus (1996)).

Relig. Frac. (Religious fractionalization index): Ranges from 0 to 100. A value of zero indicates that the society is completely homogenous whereas a value of 100 would characterize a completely heterogeneous society (source: Collier and Hoeffler (2002)).

Sec. Enrol (Secondary School Enrollment Ratio.): Average years of schooling for those 25 years old and over (source: Barro and Lee(2000)).

Statehist01 (State history index): Measures the proportion of years from 1 to 1950 C.E. in which there were one or more state level polities, whether they were indigenous or imposed, and the proportion of the territory they encompassed, discounting backward at a 1% rate for each half century. An updated version of the index used in Bockestette et al., 2002 (source Putterman, (2004)).

Yrs. Open (Years Open): Measures the fraction of years during the period 1950 to 1994 that the economy has been open according to criteria proposed by Sachs and Warner, which include (1) average tariff rate below 40%, (2) less than 40% of imports covered by quotas and licensing, (3) black market premium below 20%, (4) absence of extreme controls on exports, and (5) absence of a socialist economy. It is measured on a scale from 0–1 (source: Sachs and Warner, (1997)).

Appendix 2: Summary statistics.

Variable	Number Obs.	Mean	Standard deviation	Minimum	Maximum
Civil Wars	272	0.20	0.40	0.00	1.00
Coast Pop. Shr.	264	0.21	0.23	0.00	0.67
Absence of Corruption	184	2.74	0.93	1.60	6.00
Eng. Col.	272	0.41	0.49	0.00	1.00
Eth. Heter.	272	0.61	0.28	0.00	0.87
Eth. Heter. sq.	272	0.45	0.26	0.00	0.76
Eur. Lng. Shr.	272	0.02	0.10	0.00	0.57
Gr(GDPpc)	272	0.82	3.41	-10.90	17.20
Latitude	264	11.12	7.25	0.23	29.59
Latitude. sq.	264	175.89	200.88	0.05	875.86
Log iGDPpc	272	6.77	0.58	5.42	8.83
Log(I/GDP)	262	2.79	0.45	1.07	3.96
Malaria Ecol.	272	14.96	9.12	0.00	32.20
Natural Cap.	216	3958.1	2614.9	880	12340
Other Col.	272	0.12	0.32	0.00	1.00
Percent Muslim	272	29.54	33.01	0.00	99.80
Polit. Open.	258	1.70	2.85	0.00	10.00
Polit. Rights	198	2.74	1.35	1.00	6.50
Pred. Trd. Shr.	272	2.96	0.51	2.16	4.04
Relig. Frac.	272	55.38	16.72	1.00	74.00
Sec. Enrol	198	2.38	1.51	0.00	6.28
Statehist01	264	0.20	0.18	0.01	0.81
Yrs. Open	264	0.11	0.20	0.00	1.00

Note: Includes all observations that enter the regressions of section 3.1 and/or 3.2.

Appendix 3: Country Inclusion by Regression

Tables/ Columns/ Countries

	Table 1				Table 2				Table 3a						Table3b			
	1	2	3	4	1	2	3	4	1	2	3	4	5	6	1	2	3	4
#	24	24	24	33	28	28	25	20	24	24	24	24	25	25	26	26	17	17
Benin	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Botswana	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Burkina F.				υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Burundi				υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Cameroon	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Centr. A. R.	υ	υ	υ	υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Chad				υ		υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Congo	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
D. R. Congo	υ	υ	υ	υ														
Gabon				υ	υ	υ		υ										
Gambia	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Ghana	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Guinea-Bis.	υ	υ	υ	υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Madagascar				υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Ivory Coast				υ											υ	υ		
Kenya	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Liberia	υ	υ	υ	υ	υ								υ	υ	υ	υ		
Malawi	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Mali	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Mauritania				υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Mauritius	υ	υ	υ	υ		υ												
Niger	υ	υ	υ	υ			υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Nigeria				υ	υ	υ		υ										
Rwanda	υ	υ	υ	υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Senegal	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Sierra Leone	υ	υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Somalia				υ	υ	υ												
Sudan	υ	υ	υ	υ	υ	υ		υ										
Swaziland	υ	υ	υ	υ	υ	υ	υ											
Togo	υ	υ	υ	υ	υ	υ	υ		υ	υ	υ	υ	υ	υ	υ	υ		
Uganda	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Zambia	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ
Zimbabwe	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ	υ

Note: # refers to the number of countries in a column of a particular table. υ indicates that an observation for the country listed in the row heading is included in the designated regression. Countries are excluded from regression if data are not available for some of the variables included.

Appendix 4: Second Stage Regressions for GMM Residuals with Quadratic Ethnic

Dependent Variable: GMM Residuals

Indep. Var.	**1**	**2**	**3**	**4**
Latitude	-0.438***	-0.454***	-0.594***	-0.918***
	(0.158)	(0.157)	(0.186)	(0.273)
Latitude_sq	0.022***	0.022***	0.034***	0.053***
	(0.007)	(0.007)	(0.009)	(0.017)
Coast Pop. Shr.	-2.757*	-3.368**	-3.766**	-2.940
	(1.432)	(1.449)	(1.485)	(2.599)
Pred. Trd. Shr.	2.091***	2.161***	2.605***	3.230**
	(0.687)	(0.681)	(0.899)	(1.299)
Statehist01	9.216***	9.929***	6.397***	10.941***
	(2.211)	(2.272)	(3.932)	(3.067)
% Muslim	-0.034***	-0.034***	-0.027**	-0.043**
	(0.011)	(0.011)	(0.012)	(0.018)
Eth. Heter.	11.893***	10.731**	5.736	4.507
	(4.508)	(4.538)	(4.840)	(10.130)
Eth. Heter. Sq.	-8.495*	-7.789	-2.396	1.054
	(4.872)	(4.856)	(5.781)	(8.529)
Malaria Ecol.	-0.020	-0.019		0.063
	(0.037)	(0.037)		(0.071)
English Col.				0.725
				(0.672)
Natural Cap.			-0.0001	
			(0.0001)	
Polit. Rights		0.410*		
		(0.214)		
Yrs. Open			3.616	
			(4.079)	
Abs. Corruption				-0.350
				(0.683)
Constant	-9.456***	-10.232***	-9.733***	-13.011***
	(2.524)	(2.542)	(3.169)	(3.308)
R^2	0.336	0.350	0.429	0.479
Ramsey F-Test	3.047	2.581	0.173	0.000
	[0.082]	[0.110]	[0.678]	[large]
# Obs	173	167	140	117
# Countries	30	29	24	20

Note: Entries for variables in this table are estimated coefficients followed by standard errors, in parentheses, and*, **and *** indicate significance at the 10, 5 and 1% levels respectively. In brackets are P-values for the Ramsey Test. According to the estimates, for all or most values of ethnic heterogeneity (for columns 1 and 2, values up to 0.7), the rate of economic growth is increasing as ethnic heterogeneity increases, and for all estimates, the rate of growth is higher at maximum ethnic heterogeneity value 1.0 than at minimum ethnic heterogeneity value 0.