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ABSTRACT

Long-term growth in developing countries has been explained in four frameworks: 'extractive colonial institutions' (Acemoglu et al., 2001), 'colonial legal origin' (La Porta et al., 2004) 'geography' (Gallup et al., 1998) and 'colonial human capital' (Glaeser et al., 2004). In this paper we test the 'colonial human capital' explanation for sub-Saharan Africa, controlling for legal origins and geography. Utilizing freshly collected data on colonial-era population density and education, we find that in sub-Saharan Africa, high European population mortality did not lead to low European population densities, contra Acemoglu et al., (2001). Further, we find that instrumented human capital explains long-term growth better, and shows greater stability over time, than instrumented measures for extractive institutions. We therefore suggest that the impact of the disease environment on African long-term growth runs through a human capital channel rather than an extractive-institutions channel. The effect of education is robust to including variables capturing legal origin and geography, which have additional explanatory power. We also find some evidence that institutions are endogenous to education.

JEL codes: O11, P16, P51

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1. Introduction

This paper is an empirical examination of the colonial origins of Africa's economic growth. Developments in growth theory suggest that explanations should be located in the broad areas of geography, institutions and human capital. Whereas the geography school examines factors where one-way causality with growth is beyond reasonable doubt, - including location, precipitation, sunshine and natural endowments - empirical studies on institutions need to address an endogeneity problem. Recent studies have done so by employing variables that precede modern economic growth in the developing world, including the legal systems used by colonising powers (La Porta et al., 2004) and settler mortality (Acemoglu et al., 2001).

This paper extends this approach to the study of human capital's impact on long-run growth. We utilise newly collected data on colonial human capital, instrumenting them with

settler mortality. As noted by Acemoglu et al. (2001), and in contrast to their global-sample findings, we find that colonial extractive institutions do not explain subsequent growth in Africa. Our main positive finding is that instrumented colonial-era education did cause long-term growth. This finding is robust to inclusion of additional effects of legal origin and geography. Our education measure explains growth better and shows greater stability over time than measures for extractive institutions used by Acemoglu et al. (2001). We also find some evidence that institutions are endogenous to education, as suggested by Glaeser et al. (2004).

The next section briefly reviews the four main schools of thought in the current debate on the roots of long-term growth. Section 3 introduces our data and presents the analysis and results. Section 4 concludes with a summary and discussion of our findings.

2. Explanations of Long-Term Growth

2.1. Extractive Institutions

Institutions are broadly defined as the written and informal rules, beliefs, norms and habits that 'constrain and liberate human action' (North, 1990). Any empirical study on institutions and growth must come to terms with the pervasive and often elusive nature of institutions – particularly, their manifold manifestations, and the endogeneity of institutions to growth. A milestone study is by Acemoglu et al. (2001) who address both problems by studying a large number of former European colonies and defining their colonial-era institutions generically as 'extractive' or 'constructive'. The authors suggest that where the disease environment was favourable to European settlers, they settled in larger numbers and built societies with economic institutions akin to those in Europe. These would typically include many checks and balances on state power, fostering private entrepreneurship, trade and innovation. In contrast, where the disease environment was not favourable - as indicated by high settler mortality - Europeans created 'extractive institutions', i.e. legal constructs endowing the state with large powers and few constraints, and which were designed to effectively transfer natural resources to the colonisers while stifling private initiative and commercial development (Acemoglu et al., 2001: 1375). The authors presume these institutional frameworks (if not concrete institutions) to be persistent, so that settler mortality would be a robust proxy for the quality of both early and current institutions.

One gap in the Acemoglu et al. (2001) analysis is that the two steps in the argument (high European population mortality led to low European population densities, which led to extractive institutions) are not separately tested. Also, they do not examine whether their result was driven mainly by the gap in economic performance between *settler* economies such as the US, Australia and New Zealand and *colonies* in Africa and Asia. This begs the question if extractive institutions explain performance also within a solely African context? We return to both these issues in the empirical section 3.

2.2. Legal Origins

Djankov et al. (2002), Glaeser and Shleifer (2002) and La Porta et al. (1998) address the endogeneity problem besetting institutions by creating a measure of early, colonial-era institutions, which preceded developing-country current growth performance. Their measurement distinguishes between colonial institutions originating from different national legal systems. Again, the presumption is that once introduced, these systems do not change fundamentally and hence legal origin determines the qualities of also current institutions (Glaeser and Shleifer 2002). In our context, the differences between Africa's most active colonisers are relevant. Under French civil law, 'professional judges, legal codes, and written records' are typical while British common law is characterised by 'lay judges, broader legal principle and oral argument' (Glaeser and Shleifer 2002:1193). In the above studies, such differences are successfully linked to measures for present-day institutions including market regulation, property rights, quality of government, political freedom and financial development. These concrete institutions, in turn, are shown to systematically relate to growth.

2.3. Geography

Yet another group of scholars links differences in economic development patterns to geographical factors. An important analytical advantage is the absence of serious endogeneity problems: geographical factors plausibly have some impact on economic growth, while growth has no or very little direct effect on geography. The four broad areas often cited relate to natural endowments, productivity, diseases and transport costs (Sachs and Warner, 1997; Gallup et al. 1998; Bloom and Sachs, 1998; Diamond, 1999; Sachs, 2001).

Endowments of 'point resources' (principally oil, gas, diamonds and precious metals) provide a growth potential which may be successfully exploited to raise income sustainably; but they also

are notorious for leading to a 'resource curse' of political and economic instability related to rents. In contrast, endowments with non-point, widespread natural resources such as sunshine, rainfall and soil fertility have historically constituted the most common geographical basis for broad-based and sustainable growth. This may account partly for Africa's growth problems, as its location in the tropics implies that production conditions, particularly in agriculture, are less favourable and more variable than in temperate zones, due to fragile soils and little or infrequent rainfall. Third, plagues and pests affect plants and animals (and thereby agricultural productivity) as well as the productivity of human labour. Such diseases (particularly, malaria) are unusually widespread in Africa and their impact is more harmful than in most other parts of the world. Fourth, lack of access to seaports or navigable rivers increases local transport costs; a third of all African countries are landlocked, comprising a quarter of its population (Sachs and Warner 1997, Gallup et al. 1998). Also, large distances to world markets increase the transport costs of trade.

Over time, powerful feedback mechanisms may reinforce these barriers to economic development. Low agricultural productivity inhibits an 'agricultural transformation', which historically has been the basis for industrialisation, economic diversification and rising income levels in all now-developed countries (Timmer, 2002). Harsh living conditions lead to thinly settled countries and low incomes, which then constitute an endogenous drag on further growth, e.g. through demand limitations and larger costs (and lower returns) in infrastructure construction. Small domestic markets also inhibit scale-sensitive technological innovation, widening the 'ecological divide' with developed countries that hinders the adoption of innovations via technology diffusion (Sachs, 2001:22).

2.4. Human Capital

The human capital angle on growth in former colonies has recently been argued by Glaeser et al. (2004) and Djankov et al. (2003), based on work by Schultz (1961), Lipset (1959, 1960), Dewey (1916) and others. As it is the focus of this paper, we discus it in some detail. The key observation here is not that settlers took 'institutional fundaments' with them, but that they took themselves and thus their human capital. Where settler mortality was high, fewer settlers went to stay and less human capital was brought and developed via schools, hospitals and other human-capital proliferating institutions. This initial human capital endowment in turn laid the foundation for institutional and economic development.

The relevance of education in agrarian societies (as most colonies were) has sometimes been questioned by observing that the returns to education are typically low relative to its return in

more diversified economies (Galor et al. 2006, Pritchett 2000, Bennel 1996). But the human capital school has emphasised that the benefits of human capital are 'not technological but political' (Glaeser et al. 2004:282). Early writers argued that education 'broadens man's outlook, enables him to understand the need for norms of tolerance, restrains him from adhering to extremist doctrines, and increases his capacity to make rational electoral choices' (Lipset 1960:39). Educated people are purportedly more aware of governments actions, more actively participating in society, and better able to organise themselves politically and to resolve their conflicts 'through negotiation and voting rather than through violent disputes' (Glaeser et al. 2004:272; also, Lipset 1960, Bourguinon and Verdier 2000, Tilly 1998). Education is also a precondition for a functioning judicial and administrative system.

Colonial education is thus hypothesised to foster long-term growth via two channels: both by causing present education levels, and via its effect on institutions, fostering stability, 'voice', and good governance (especially, secure property rights and law and order). In support, Lipset (1960) found that the least educated societies are never stable democracies, whereas highly educated societies generally are. This was updated and confirmed by Glaeser et al. (2004), who also find a strong effect of initial education on institutional changes.

The main contribution of this paper is to test the effect of colonial human capital on subsequent growth in former African colonies, in a comparison to the better publicised effects of legal origins, extractive institutions and geography. In Appendix A we therefore provide some background on the role of education in Africa's two major colonial systems, which motivates both its continuing effect on present education and its effect on the quality of institutions. In summary, *French* officials looked upon indigenous leaders as agents of administration and objects of assimilation, and were primarily interested in their potential adherence to French standards, more than their indigenous legitimacy. The *British* were mainly interested in indigenous leaders' legitimacy while maintaining and using traditional leadership selection procedures. French assimilation dictated that all education be conducted in French, whereas the British left it to the missionaries to educate also in the vernacular (Crowder 1964). The British did not try to create a Europeanised African elite or to deprive educated non-ruling class Africans from local recognition and power. The French intentionally created an educated elite assimilated into the colonial administration. The French relied on, but also restricted, missionary activity, while the British left education largely to church-based organisations. The Anglican and other Protestant missionaries who thus ran the British colonial education system strove for broad-based literacy. The aims of their Catholic counterparts were more limited. French education was also more restricted by reticence about imposing colonial education on traditionally Muslim populations.

These differences in educational development have shown great stability over time and, if anything, have increased (Brown 2000). If we correlate the spread of education in colonial times[1] with educational achievements in 1995[2], we find an R^2 of nearly 0.7. Explanations as to why these educational distributions have been so persistent remain rather tentative. Clignet and Foster (1964) argue that 'there has been a great deal of talk about Africanization [after independence], but very little real attempt has been made to transform the curricula or the educational structure' (Clignet and Foster 1964: 197). This is confirmed by Ntiri (1993), who states that the elites who inherited power after independence often continued policies initiated in colonial times. Another explanation is the persistence effect, where the advantages in coverage and literacy that the British created generated the relatively high educational achievements of later years (Brown 2000). In our empirical analysis below we take this persistent difference between former French and British colonies into account.

3. **Data and Analysis**

We use collected education data taken from the colonial yearbooks[3] on the last years of African colonialism between 1945 and 1950 (Sudan was the first sub-Saharan country to gain independence in 1956) but before the European influence on the economic system started to decline (Hazlewood 1972, Giblin 1980). Three variables from this new data set are relevant to the present analysis:

(i) and (ii) the percentage of Europeans per total population and the number of Europeans per square mile. A salient feature of this newly compiled data are that in the 1940s, British colonies were on average about five times more densely populated than French colonies (28 as compared to 5 persons per square kilometre), but with 1 % of the total population, the British presence was still about twice as large as the French who formed 0.5 % of the population. Acemoglu et al (2001) and Engerman and Sokoloff (2002) suggest that the relative size and the numbers of the ruling elite indicated how 'extractive' institutions were[4]. We test this below.

[1] Total number of pupils divided by total population. See appendix C for sources.
[2] Average years of primary schooling in the total population over age 15, taken from the Barro and Lee data set (Barro and Lee 2001).
[3] See Appendix C for sources.
[4] We also attempted to capture extractiveness more directly, by measuring extraction of resources and products by trade flows, terms of trade and taxation, following Persson and Tabellini (2000) and Acemoglu et al. (2002). This stranded on missing data on trade and differences in colonial taxation systems.

(iii) the number of primary and secondary pupils per 1,000 population, which proxies investment in educational institutions following e.g. Easterlin (1981). As already noted in section 3, the ratio of total pupils to the population were clearly higher in British colonies[5].

We apply our newly compiled data to the question of Africa's long-term growth in two ways. First, we explicitly check the two intervening steps in the Acemoglu et al. (2001) argument that higher settler mortality led to colonies being more thinly settled by Europeans; and, second, that a lower density of Europeans in the population led to different institutions, worse for long-term growth. Acemoglu et al. (2001) argue this based on the literature but without primary empirical evidence. We collected the primary data and in Table 1 show that both these relations cannot be detected for sub-Saharan Africa. This then leads us to explore an alternative explanation for Africa's long-term growth in an instrumental-variable estimation.

In Panel A of table 1 we report results from regressions of settler mortality on the density of Europeans in the population and density of Europeans per surface measure. Neither regression gives statistically significant results, and the negative R^2 indicate that models A1 and A2 perform worse than a constant-only model. In Panel B we regress the two index measures for colonial institutions used by Acemoglu et al. (2001)[6] on the density of Europeans in the population, and again fail to find a relation. The same qualitative results (not reported here) obtain when taking Europeans per surface area as the independent variable in Panel B.

[5] We present an overview of key statistics in the data Appendix B.
[6] As proxies for colonial-era institutions Acemoglu et al. (2001) used a democracy index at the first year of independence, varying between the 1950's and 1975, an index measure for constraint on the executive at first year of independence, where more constraints reflect better institutions.

Table 1: African Settler Mortality, Population Density of Europeans and Institutions

Dependents	*Panel A – independent: log European settler mortality*			*Panel B – independent: Europeans/population*	
	Model A1	*Model A2*		*Model B1*	*Model B2*
Constant	0.828***	0.769***		3.003***	2.078***
	(0.198)	(0.195)		(0.495)	(0.709)
Europeans/population	7.903				
	(14.191)				
Europeans/km2		2.754			
		(2.474)			
'Constraints on executive'				52.350	
				(37.606)	
'Democracy'					88.665
					(53.862)
# obs	18	18		24	24
R2	-0.06	-0.06		0.04	0.07

Source: Settler mortality: Acemolgu et al. (2001), institutional variables: Polity IV, and authors' calculations. Standard errors are in parentheses.

These results in our African sample differ from those reported by Acemoglu et al. (2001) in a global sample of former colonies, results which support their claim about the link between settler mortality and early institutions. This leads us to question that claim for the African context. Indeed, in further analyses we found that in an African sample there is no detectable relationship between settler mortality and early institutions, proxied either as a democracy index at the first year of independence (varying between the 1950s and 1975) or as an index for constraint on the executive at first year of independence, where fewer constraints on the executive are presumed to represent extractive institutions[7]. So while Acemoglu et al. (2001, footnote 21) report that there is a 'weaker relationship between settler mortality and institutions in a sole Africa sample', we actually find no relationship in an African sample, using identical data. We conclude that African colonial-era institutions are not well proxied by settler mortality[8].

[7] Full results from these analyses are available on request from the authors.

[8] An important reason underlying this result may be that the stability over time of institutions assumed in Acemoglu et al. (2001) should be questioned in the Afrian context. African colonial-era institutions do not correlate well with current institutions (which cause current GDP). Twenty-four of the 44 African countries included in the Polity IV data[8] experienced shortly after independence an (often sharp) decline in the democracy index used here and in Acemoglu et al. (2001). Of the 14 countries with a low initial measure for 'constraint on the executive', 6 countries showed an appreciable improvement subsequently. This volatility links in with a cross-country analyses of institutional indices by Glaeser et al.

This is not to say that there cannot be a link between settler mortality and African growth, or that institutions are irrelevant in this relation; only that the account of this link presented by Acemoglu et al. (2001) finds no support in the African data. Alternatively, settler mortality may have influenced colonial institutions in other aspects than its extractiveness, and in ways unrelated to the density of colonists. We noted in section 2 above that one candidate for an alternative channel is colonial human capital, rather than colonial extractive institutions. Glaeser et al. (2004), Djankov et al. (2003) and Lipset (1959, 1960) suggested that colonial human capital may cause both colonial institutions and current human capital, and – through either or both of these channels – it may cause present GDP levels. It is this explanation of Africa's long-term growth that we will now explore empirically, using our newly collected data.

This analysis faces the same endogeneity challenges as the Acemoglu (2001) account, and we therefore instrumented the colonial-era education measure PUPILS (the percentage of pupils in the population) with settler mortality SETTMORT around 1800, as in Acemoglu et al. (2001). We then regress this instrumented human capital variable on PPP per capita GDP levels in 1995[9]. Panel A in table 2 presents the second stage IV regression[10]. Panel B reports the corresponding first stage results. Panel C shows OLS results of human capital variables on 1995 p.c. GDP. We test robustness to other explanations by adding in the second stage a legal-origin variable (COLONISER, which takes value 1 for British and 0 for French colonies) and five geographical variables: MALARIA (index of 1994 malaria prevalence), COASTPOP (the share of the population living within 100 km from the coast), LANDLOCK (absence of overland access to sea), TROPICS (the share of territory located in the tropics)[11] and HYCROCARBONS (proven reserves of natural gas and crude oil in 1993, BTUs per person). In selecting these variables, we follow La Porta et al. (2004) and Gallup et al. (1998). Similarly, in the first stage we also include COLONISER, COASTPOP, LANDLOCK[12] and TROPICS, but omit HYDR0CARBONS - which was arguably irrelevant to 1940s human capital investments - and a malaria measure (since the disease

(2004) who note that these index measures tend to reflect short-term changes (e.g. election results) rather than the stabler, underlying institutions.

[9] We chose 1995 to allow comparison to Acemoglu et al (2001).

[10] We combine an instrumental variable approach with generalized least squares, which accounts for the correlation structure in the disturbances across equations. This procedure, also known as 'three stage least squares', results in consistent estimates that are more efficient than 2sls without using the information contained in cross-equation correlations of disturbances. We estimated our equations also without GLS (i.e. 'simple' 2sls), which produces qualitatively identical, but less significant estimates, as expected. See Kmenta (1977) and Greene (2003) for more detail.

[11] TROPICS has little variation within Africa, with many values equal or close to 100 %. Excluding it improves the significance of findings, without qualitatively changing them.

[12] Note that we include both COASTPOP and LANDLOCK since they are quite different variables. There are countries with coastlines (COASTPOP=1) such as Kenya, but with coastal populations of only 6 percent. Compare also Mozambique (40 %), Sudan (2%) and Tanzania (16%)(Gallup et al. 1998:31)

environment is already captured by settler mortality)[13]. For both stages of the IV regression and for OLS, we present model (1) without controls, model (2) with a legal-origin control, and model (3) with both legal-origin and geographical controls.

Panel B shows that settler mortality caused colonial education levels (also when controlling for geography and legal origin), supporting the panel A specification[14]. Panel C suggests that colonial education can be linked to 1995 per capita GDP in simple OLS regressions with and without controls (but this relation is likely to be partly endogenous). The PUPILS coefficients are of the right sign, but just above a significance cut-off point of p=0.10 in models (1) and (3). When PUPILS is instrumented by European settler mortality in Panel A, thus solving the endogeneity problem, instrumented colonial education is found to cause 1995 per capita GDP, in models with and without controls.

[13] Alternatively, including a malaria measure also in the first stage might be considered if the 1940s disease environment is thought to have an effect on education not already captured in settler mortality, which reflects the 19th century disease environment. Including as a proxy the incidence of malaria in 1966 (as used in Gallup et al., 1998) does not change the sign and significance of the second stage estimates, but (as expected) in the first stage it does reduce the significance of the coefficient for settler mortality.

[14] Instrumenting colonial human capital with other (legal-origin or geographical) exogenous variables did not yield statistically significant explanations of 1995 GDP. Although colonial education correlates with several of the exogenous variables considered here, only settler mortality is a suitable instrument for human capital variables in an equation explaining 1995 GDP. Results from these additional analyses are available on request from the authors.

Table 2: IV regression of Log GDP per capita in 1995: education, legal origin and geography

	(1)	(2)	(3)
Panel A: Two-Stage Least Squares for colonial education (instrument: settler mortality) and controls			
Constant	6.385***	5.943***	2.686
	(0.432)	(0.489)	(2.257)
PUPILS	24.941*	31.504***	18.727**
	(12.897)	(11.759)	(9.466)
COLONISER		0.593*	0.587***
		(0.302)	(0.210)
MALARIA			-0.983***
			(0.378)
COASTPOP			0.228
			(0.661)
LANDLOCK			-0.206
			(0.335)
TROPIC			4.558*
			(2.457)
HYDROCARBONS			0.021
			(0.035)
Panel B: First stage for colonial education (independent: settler mortality) and controls			
Constant	0.104***	0.100***	0.067
	(0.031)	(0.028)	(0.105)
SETTMORT	-0.012***	-0.011**	-0.009**
	(0.005)	(0.005)	(0.004)
COLONISER		-0.013	-0.009
		(0.009)	(0.009)
COASTPOP			0.036*
			(0.020)
LANDLOCK			-0.001
			(0.012)
TROPIC			0.012
			(0.100)
Obs	28	24	24
R2	-0.37	0.19	0.64
Panel C: Ordinary Least Squares for colonial education and controls			
Constant	7.025***	6.838***	6.733***
	(0.176)	(0.285)	(0.784)
PUPILS	4.550	7.679**	6.442
	(3.138)	(3.708)	(4.065)
COLONISER		0.246	0.258
		(0.283)	(0.257)
MALARIA			-1.197**
			(0.467)
COASTPOP			0.942
			(0.677)
LANDLOCK			0.179
			(0.434)
TROPIC			0.976
			(0.824)
HYDROCARBONS			0.053
			(0.039)
Obs	35	30	29
R2	0.03	0.07	0.29

Source: Geographical data: Gallup et al (1998), Settler mortality data: Acemoglu et al. (2001), Colonizer data: La Porta et al. (2004), pupil data: authors' calculations. Standard Errors in parentheses.

In addition, our estimates offer qualified support for the legal-origin explanation of growth: the coefficient is positive and significant, especially when including geographical controls. However, the significance of this exogenous variable is not robust to an OLS specification, perhaps because LEGALORIGIN captures some other systemic difference between British and French colonies other than legal origin; for instance, the qualitative differences in education systems noted in section 3. Of the geographical variables, MALARIA is a robustly negative influence on growth, both in OLS and IV specifications. The share of land in the tropics has a positive and weakly significant coefficient in the IV estimation, but this is not robust to specifying an OLS.

We conclude that the link between settler mortality and GDP in 1995, which Acemoglu et al. (2001) conjectured to run via 'extractive institutions', in Africa is most likely to run via human capital investments made in the colonial era through education[15]. This conclusion is robust to including controls for geography and legal origin. It connects to the description given by Acemoglu et al. (2001: 1374-1375) of extractive institutions as *inter alia* involving low educational and healthcare investments; but in view of the lack of support for the intervening steps in the Acemoglu et al. (2001) argument, presented in table 1, this interpretation is tenuous for the African setting. A more plausible understanding of the findings is to see them as support for the rival hypothesis that human capital, as distinct from the broader institutional framework, causes long-term growth (Glaeser et al., 2004). This interpretation finds additional support in the lack of significant findings for institutional measures, such as instrumented 'democracy' and 'constraints on the executive' variables, reported in table 1.

We pursue this line of reasoning further by examining the additional hypotheses that (i) colonial education achievements persisted (i.e. that colonial education achievements cause present educational levels) and that (ii) colonial human capital caused colonial institutions. On (i), table 3 shows that instrumented education levels in the 1940s cause present enrolment rates, both primary and secondary[16]. Thus, a first channel through which exogenous, colonial-era investments in human capital have affected present growth is through the 'persistence effect' mentioned above, by durable increases in levels of human capital till the present. It is important to note that human capital persist over time, while institutional measures do not, as discussed above. This is in contradiction to the argument put forward by Acemoglu et al. (2001) on the

[15] Our newly compiled data set allowed us to also consider health, another dimension of human capital. In IV and OLS regressions of HOSPITALS, a measure for colonial healthcare (the number of hospitals per 1000 population health), again using settler mortality as the instrument, on 1995 pcGD, HOSPITAL yields a valid instrumental-variable explanation of present GDP levels. But model performance is very weak, with a negative R2 indicating that a constant-only model would predict better. Also, the relation between colonial health and present pc GDP relation was not robust to introducing controls.

[16] Average years of primary schooling in the total population over age 15, taken from the Barro and Lee data set (Barro and Lee 2001). Using World Development Indicators as the source yields similar results.

durability of institutional quality, but it is in line with the Glaeser et al. (2004:274) argument that human capital is 'the more basic cause of growth'.

Table 3: Colonial Human Capital Persisted

IV regression of colonial human capital on present human capital		
2ND stage dependent:	PRIM95	SEC95
Constant	0.843**	-0.096
	(0.342)	(0.206)
PUPILS	35.634***	15.060***
	(9.246)	(5.561)
first stage dependent:	PUPILS	PUPILS
Constant	0.111***	0.111***
	(0.032)	(0.032)
SETTMORT	-0.013**	-0.013**
	(0.005)	(0.005)
Obs	19	19
R^2	0.63	0.49

Source: education data: Barro and Lee (2001), settler mortality data: Acemoglu et al (2001), pupils data: colonial yearbook and authors' calculations. Standard errors are in parentheses.

Finally in table 4 we explore another channel by examining the influence of instrumented human capital investments on contemporaneous institutional indicators. We consider both the institutional indices on democracy and on constraints on the executive used by Acemoglu et al. (2001), and find positive and significant correlations of PUPILS with both in an OLS framework. These findings are however not robust to using instrumented education (not reported), so that the results may be partly driven by endogeneity of education to institutions.

Table 4: Colonial Education and Contemporaneous Institutions

OLS regression of colonial legal institutions on colonial education levels		
Dependent:	DEMOCRACY75	CONSTRAINT
Constant	1.154	2.641***
	(0.733)	(0.501)
PUPILS	37.990***	19.086**
	(13.346)	(9.133)
Obs	37	37
R^2	0.16	0.09

Source: institutional data: Polity IV, pupil data: author's calculations. Standard Errors in parentheses.

4. Summary, Discussion and Conclusions

Acemoglu et al. (2001) conjecture that high settler mortality led colonising powers to introduce 'extractive 'institutions, which set the economy of a long-term path of low and volatile growth. Low settler mortality, in contrast, supposedly caused colonisers to build institutions more conducive to growth. When we redo this analysis for a sample of only African countries, *both* these correlations disappear. Higher settler mortality did not lead to African colonies being more thinly settled by Europeans, and a lower density of Europeans in the population did not lead to different institutions, worse for long-term growth. We suggest that an alternative explanation involves colonial education rather than extractive institutions. We collect archival material from colonial yearbooks to construct a novel data set on European and total population densities, as well as investments that the colonial powers had been making by the 1940s in schools.

Utilizing these data, we find that African colonial education does possess both properties ascribed to institutions in the global Acemoglu et al (2001) study: they correlate well both with settler mortality and with current measures for human capital. Instrumenting education with settler mortality, we obtain again a robust explanation of long-term development, which does not suffer from endogeneity and which is specific to Africa. We establish the robustness of this explanation by introducing controls for the legal origin of institutional systems and for a number of geographical variables, both of which have additional explanatory power. Further investigation of the channels through which education fostered growth suggests its positive impact on both current education and on colonial institutions, though the causality between colonial institutions

and colonial education seems two-way. These findings are interpreted with arguments and evidence presented by Glaeser et al. (2004) and Lipset (1960), among others, on the importance of human capital on institutions, via the political process.

Our study illustrates the problem of sample sensitivity. The Acemoglu et al. (2001) finding that differences in settler mortality proxy institutions, which explain growth, is widely interpreted as an insight into the causes of contemporary developing-country growth performance. But the relation cannot be detected in an African sample. Another point that this research highlights is the importance of correct inference (in the substantive, not the statistical sense). Acemoglu et al. (2001) infer that high settler mortality leads to more thinly settled colonies, which in turn results in extractive institutions, which in turn leads to lower GDP; but only settler mortality and GDP are actually observed. When we collect the necessary data and examine the intervening steps in the argument, we find no empirical support. Plausible but untested guesses are fruitful ground for follow-up research - as we hope to have shown - but this observation serves to urge some modesty in the presentation of findings and chains of arguments where typically most, but not all, of the links are actually tested.

In conclusion, this study suggested that the absence of sufficient improvements in education during the post-colonial era has been a major factor in the disappointing long-run performance of African economies. And more attention to the human-capital explanation of growth appears a fruitful avenue to be explored in the growth literature.

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APPENDIX A: Education in Colonial Africa

We organise our discussion around the main distinction in our sample, which is the difference between educational policies by the British and the French colonising powers. The spread of European-style education in the territories they colonised was part of the late 19th and early 20th century process of empire building, in which the British and French vied for control over large parts of the African continent: education rates increased rapidly once the 'scramble for Africa' truly began in the 1880s, and indeed spread most quickly in contested areas. For instance Tanzania, added to the British empire only in 1914 and not threatened by the ambitions of rival colonisers, continued to have the lowest primary enrolment rates in all British Africa.

The two major powers operated with distinct styles and educational outcomes. Benavot and Riddle (1988) calculate enrolment rates per school age population for different years before 1940, and find on average considerably higher figures in British Africa compared to French West Africa and Equatorial French Africa (see also Bowman and Anderson 1963). This difference in outcomes can be plausibly linked to the complex interaction, in both the French and British colonies, of their two most powerful institutions: the state, represented by the colonial administration system; and the church, represented by missionary educators.

Colonial Administration

The British exercised 'indirect rule' in Africa (Lugard 1929), where traditional structures and institutions were left intact and colonial rulers attempted to work with traditional chiefs. Within the colonial superstructure, chiefs maintained direct power over their peoples and lands (Lugard 1919). Indirect rule was motivated by pragmatism and by the aim of reducing the costs of colonial administration (Lugard 1929 and Wesseling 1991). One result was that the major aim of schooling was to build administrative capabilities of traditional chiefs (Sutton 1965), and education was not a ticket to upward mobility. Non ruling-class Africans who achieved higher education could not participate in the ruling of the colony (Collins 1970). Since the British wished to avoid an indigenous educated elite, colonial officials discouraged general education beyond the primary level. Cost considerations also played a role in the British administration preferring vocational training over literacy and general education.

Rather than relying on indigenous institutions, the French implemented an assimilation policy with the ultimate goal of providing non-Western peoples with 'cultural characteristics that would make them acceptable as citizens on the same basis as their European fellow at home' (Sutton 1965: 63), while 'degrading or ignoring [traditional] institutions in favour of French customs, culture and civilization' (Collins, 1970: 162). While the French were fearful of unemployed higher educated Africans, most positions within the administration were to be filled

by French nationals, trained in France. Assimilation policies implied the imposition of direct, centralized French control. Newly created administrative units (*cantons*) typically cut through traditional boundaries and chiefs were divested of their power, though they often maintained their positions. They were assigned to cantons on the basis of their education or demonstration of loyalty to the French (Crowder 1964). Education was a tool in the drive for indigenous cultural. The reward to obtaining it was admittance to the lower echelons of the administration system (Collins 1970).

Missionary Education

The British desire to contain the cost of colonial administration was a factor in their leaving virtually all educational efforts to missionaries (Berman 1975). In contrast, the French Third Republic (1870-1940) enshrined the separation of state and church in its constitution. While this was reflected in widespread antipathy towards missionary education in the colonies, in practice, this resentment was tempered by the government's recognition of the valuable role of the missionary in assimilation. This led to a dual church-state educational system, where missionary schools received state funding and functioned alongside state schools.

Both the Catholics working in education in French Africa and the predominantly Protestant (Anglican, but also other) missionaries in British Africa realised, in the words of Bishop Joseph Shanahan, 'that those who hold the school hold the country, hold its religion, hold its future' (as cited by Berman 1975: 22). This led to a rapid spread of educational work, with enduring results. In those former French colonies where the missionary school system was more developed (Madagascar, Central African Republic, Cameroon, the Congo and Gabon), the overall post-colonial enrolment rates were highest (Debeauvais 1964; and Benavot and Riddle, 1988). Missionary activity was even more determining to long-term educational achievements in British Africa, were education was largely the domain of the churches.

If the role of the churches within colonial education was markedly different between French and British Africa, so were the missionaries. Unlike Catholic educators, Protestants missionaries generally considered their presence temporary since they envisioned independent, self-reliant indigenous churches. This vision required a relatively high standard of fairly broad-based education, from which a future African church leadership could emerge. Also, due to the larger emphasis on individual bible study in Protestant theology, Protestant missionaries placed more value on spreading the key skill of reading among the whole population.

Both the colonial administration and the missionaries responded to most Africans' initially hostile reaction to Western education differently, but depending on local religion. In Muslim areas animosity to Western education was usually respected and educational efforts restricted or abandoned. Large parts of Western Africa were Islamic already before the French arrival, and the

French did not replace Islamic education with their own system. In contrast, peoples with animistic religions were nearly all Christianised eventually. This policy had long-term consequences. As illustration, the animistic southern part of Nigeria was Christianised, while Christian missionary activity in the Muslim areas of Northern Nigeria was forbidden (Sutton 1965). In consequence, by 1958 over 90 percent of the southern children were enrolled in primary schools, in contrast to only 9 percent in the northern part (Ogunsheye 1965, Morgan and Armer 1988). Colonial education in French Africa, more of which covers traditionally Muslim areas than was the case in British Africa, would seem to have been more restricted by this policy. If one compares the educational figures of French West and Equatorial Africa, predominantly Muslim West Africa shows lower formal educational achievements compared to formerly animistic Equatorial Africa (see also Benavot and Riddle 1988, Daun 2000, Hanson II 1989 and Harrison 1988).

Appendix B: Geographical and Institutional Data

We thank Acemoglu for kindly providing the data on which the Acemoglu et al. (2001) results are based; and Gallup, Sachs and Mellinger for making their data on which the Gallup et al. (1998) results are based available on the Internet.

Data description

Variable	Year	Source
Settler Mortality	1800-1850	Acemoglu et al, 2001
Settler mortality is potential settler mortality measured in terms of deaths per annum per 1000 'mean strength' (raw mortality numbers are adjusted to what they would be if a force of 1000 living people were kept in place for a whole year).		
Democracy at first year of independence before 1975	Various years	Polity IV
Democracy indicator based on the competitiveness of political participation, openness and competitiveness of executive recruitment and constraints on the executive. Scale between 0 and 10, where higher scores indicate more democracy. Year of observation is the first year of independence as long as that is before 1975, otherwise the country gets a score of 1 (in line with Acemoglu et al 2001).		
Constraint on the executive before 1975	Various years	Polity IV
Measure of the extent of institutionalised constraints on the decision making powers of chief executives, whether individuals or collectivises. Scale between 0 and 7, where higher scores indicate more constraints. Year of observation is the first year of independence as long as that is before 1975, otherwise the country gets a score of 1 (in line with Acemoglu et al 2001).		
PopCoast	1994	Gallup et al 1998
Proportion of the population living within 100 km of the coastline.		
Landlocked dummy		Gallup et al 1998
A binary dummy, with a value one indicating landlockedness		
Malaria index	1966, 1994	Gallup et al 1998
Index of Malaria prevalence based on a global map of extent of malaria in 1966 (WHO 1967), and the fraction of falciparum malaria. 'The index is the product of the fraction of land area subject to malaria times the fraction of falciparum malaria cases'. (Gallup et al 1998)		
Life expectancy 1965	1965	Gallup et al 1998
Data Gallup et al took form the United Nations		
Tropic	1996	Gallup et al 1998

The proportion of a country's land area within the geographical tropics		
LEGALORIGIN		
Binary dummy, where value one indicates a former British colony.		Authors
Hydrocarbons	1993	Gallup et al 1998
Hydrocarbon deposits are total BTU's per person of proven crude oil and natural gas reserves in 1993, which Gallup et al collected from World Resource Database (1996-1997)		

Appendix C: Newly Collected Colonial Data

Our newly constructed date set is comprised of data on former British and French colonies in Africa. Based on colonial yearbooks of the years 1945-1955 (detailed sources are below), we calculated variables that could serve as proxies for the general institutional environment between 1945 and 1950. The data set consists of four modules:

a) population density and European presence (calculated as density per squared kilometre and as the proportion of Europeans to total population) in countries is collected.

b) human capital: school pupils as a proportion to total population.

Sources

French West Africa (Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal)	Annuaire Statistique de L'Afrique Occidentale Francaise, 1949 Volume 4, and 1950 à 1955 Volume 5
French Equatorial Africa (Central African Republic, Chad, Congo Republic, Gabon)	Annuaire Statistique de L'Afrique Equatoriale Française, 1936-1950 Volume 1, 1951 à 1955 Volume 2
Madagascar	Annuaire Statistique de Madagascar, 1938 - 1951, Vol. 1
Botswana	Official Year Book of the Union [of South Africa] and of Basutoland [Lesotho], Bechunanaland Protectorate [Botswana] and Swaziland, 1950 no 26.
Ghana	Economic and Statistical Bulletin of the Gold Coast, April 1952, Vol 1.
	Digest of Statistics, November 1953, No. 4
Kenya	Statistical Abstract, 1955
Lesotho	Official Year Book of the Union [of South Africa] and of Basutoland [Lesotho], Bechunanaland Protectorate [Botswana] and Swaziland, 1950 no 26.
Malawi	Federation of Rhodesia and Nyasaland: Census of Population 1956
	Monthly Digest of Statistics, April 1955, Vol 2, No. 1
Mauritius	Final report on the Census Enumeration made in the Colony of Mauritius and its Dependencies on 11th June, 1944
	Blue Book of the Colony of Mauritius and its Dependencies, 1946/1947
	Yearbook of Statistics, 1959 No. 14.
Nigeria	Blue Book for the year ending 31st December, 1938.
	Digest of Statistics, Vol. 2, October 1952, No. 1 and 4.
	Digest of Statistics 1956
Sudan	Foreign Trade Report (with some internal statistics), 1949
	First population census of Sudan 1955/56, Final Report, vol. 1

Swaziland	Official Year Book of the Union [of South Africa] and of Basutoland [Lesotho], Bechunanaland Protectorate [Botswana] and Swaziland, 1950 no 26.
Tanzania	Statistical Abstract, 1938-1952 (Tanganyika)
Uganda	Statistical Abstract, 1957
Zambia	Federation of Rhodesia and Nyasaland: Census of Population 1956
	Monthly Digest of Statistics, April 1955, Vol 2, No. 1
	Economic and Statistical Bulletin (Northern Rhodesia), Februari 1953, Vol 5, No. 11
Zimbabwe	Federation of Rhodesia and Nyasaland: Census of Population 1956.
	Monthly Digest of Statistics, April 1955, Vol 2, No. 1 Official Year Book of Southern Rhodesia, 1952, No. 4
Additional data on Education	Mitchell, B.R. (2003) 4th edition The Stateman's Year-Book (1946, 1948, 1955).

Variable description and availability

Variable	Description	Year	Source
Population Density	Total population per squared kilometre	1948-55	French West Africa (Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal)
		1950-55	French Equatorial Africa (Central African Republic, Chad, Congo Republic, Gabon)
		1946-51	Madagascar
		1948-53	Ghana
		1947-51	Kenya
		1946-51	Malawi
		1946-47	Mauritius
		1938-50	Nigeria
		1936,46,50	Botswana
		1936,46,50	Lesotho
		1949-55	Sudan
		1936,46,50	Swaziland
		1947-52	Tanzania
		1947-51	Uganda
		1946-51	Zambia
		1946-51	Zimbabwe
European density	Total European population per squared kilometre	1948-55	French West Africa (Benin, Burkina Faso, Cote d'Ivoire,

			Guinea, Mali, Mauritania, Niger, Senegal)
		1950-55	French Equatorial Africa (Central African Republic, Chad, Congo Republic, Gabon)
		1946-51	Madagascar
		1948-53	Ghana
		1947-51	Kenya
		1946-51	Malawi
		1946-47	Mauritius
		1938-50	Nigeria
		1936,46,50	Botswana
		1936,46,50	Lesotho
		1949-55	Sudan
		1936,46,50	Swaziland
		1947-52	Tanzania
		1947-51	Uganda
		1946-51	Zambia
		1946-51	Zimbabwe
European pop	Total European population as percentage of total population	1948-55	French West Africa (Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal)
		1950-55	French Equatorial Africa (Central African Republic, Chad, Congo Republic, Gabon)
		1946-51	Madagascar
		1948-53	Ghana
		1947-51	Kenya
		1946-51	Malawi
		1946-47	Mauritius
		1938-50	Nigeria
		1936,46,50	Botswana
		1936,46,50	Lesotho
		1949-55	Sudan
		1936,46,50	Swaziland
		1947-52	Tanzania
		1947-51	Uganda
		1946-51	Zambia
		1946-51	Zimbabwe
Education	Total students in primary and secondary education to total population	1948-1950/51	French West Africa (Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal, Togo)
		1950-52	French Equatorial Africa (Central African Republic, Chad, Congo Republic, Gabon)

1947-49	Madagascar
1945	Gambia
1945-47	Ghana
1947-49	Kenya
1947-50	Malawi
1947-49	Mauritius
1949-50	Nigeria
1947-49	Botswana
1947-49	Lesotho
1947-49	Sudan
1948-50	Swaziland
1947-49	Tanzania
1949-51	Uganda
1948-51	Zambia
1948-50	Zimbabwe
1947-49	Angola
1948-50	Cameroon
1947-49	Mozambique
1947-49	Sierra Leone
1947-49	Congo DM
1950-52	Liberia
1945-51	Burundi
1945-51	Rwanda
1950	Guinea-Bissau