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Tropics, germs, and crops: how endowments influence economic development

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Abstract

Does economic development depend on geographic endowments like temperate instead of tropical location, the ecological conditions shaping diseases, or an environment good for grains or certain cash crops? Or do these endowments of tropics, germs, and crops affect economic development only through institutions or policies? We test the endowment, institution, and policy views against each other using cross country evidence. We find evidence that tropics, germs, and crops affect development through institutions. We find no evidence that tropics, germs, and crops affect country incomes directly other than through institutions, nor do we find any effect of policies on development once we control for institutions.

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1. Introduction

Burundi today has a per capita income of \$200, which is one-third lower than 4 decades ago. Burundi is poor despite a lush agricultural endowment that has three

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growing seasons, abundant rainfall, fertile volcanic soils, and suitability for cash crops such as coffee, tea, cotton, bananas, palm oil, and rice.¹

Burundi has other geographic endowments that place it at a disadvantage, however, according to some stories of economic development summarized below. It is virtually on the equator, is landlocked, is far from rich trading partners, and has a disease environment that has left life expectancy today at only 47 years. During the colonial period, mortality among the European settlers was a frightful 280 per 1000 per year. The Belgian colonialists thus did not settle but exploited the colony through forced labor on coffee and other cash crop plantations and compulsory food crop quotas.² The Belgians ruled indirectly through Tutsi chiefs, to whom they spuriously attributed “racial superiority” over the Hutu.³ Even the cash crops that could generate high export revenue are thought to be adverse for political economy and institutional development according to some studies.

Three Tutsi military dictators from the same commune in Bururi province have ruled Burundi for 32 out of the 38 years since independence, which has been marred by massacres of civilians, recurrent civil war, and as noted, economic decline.⁴ Institutions have disastrously failed to protect the citizens’ lives or to establish any resemblance of the rule of law. [Ndikumana \(1998\)](#) describes how the elite “privatized” the state and enforced their control through violence. [Nkurunziza and Ngaruko \(2002\)](#) show how the rulers have systematically looted the economy, using mechanisms such as state subsidies to public enterprises controlled by the rulers, severe taxation of cash crops, lucrative civil service positions for the ruling clan (the mean government wage puts the civil servant in the richest 6% of the economy), acquiring consumer goods at controlled prices and reselling them on the black market, and acquiring foreign exchange at the official rate and reselling it at the much higher black market rate.

Canada today has a per capita income 107 times higher than Burundi’s. Canada is rich today despite being marginal for much of the colonial period. In the peace negotiations between Britain and France following the Seven Years War in the 18th century (which Voltaire described as “fighting over a few acres of snow”), the British

¹ Burundi may well have been relatively rich compared to other African countries at some point in the past because of these endowments, but we lack data on African incomes before 1950 or 1960. Our focus is on the long run outcome, which is clearly relative poverty.

² See [Mamdani \(1996, p. 148–149\)](#) and [McDonald et al. \(1969, p. 13\)](#).

³ The nature of the pre-independence ethnic division between the Hutu and Tutsi, which undoubtedly was politically explosive after independence, has been hotly debated. The traditional European view was that the Tutsi were a Nilotic group of tall cattle-herding nomads who migrated into the region and became feudal lords over the short Bantu agricultural Hutus (see [McDonald et al., 1969](#)). More recent scholars deem this a myth and describe a much more fluid and complex traditional society. [Gahama et al. \(1999\)](#) describe the Tutsi “feudal aristocracy” as a racist invention of the Belgians dating from the 1930s. [Ndikumana \(1998\)](#), on the other hand, describes how the post-independence (Tutsi) governments blamed ethnic divisions on the Belgians as a device to suppress discussion of real ethnic discrimination.

⁴ The civil war has been between the Hutus and Tutsis, with other more subtle conflicts between the Bururi Tutsis and non-Bururi Tutsis and also clashes between the Bayanzi and the Bashingo clans of Bururi Tutsi. See [Nkurunziza and Ngaruko \(2002\)](#).

seriously debated taking the island of Guadeloupe instead of Canada as reparations for the war.⁵

Yet Canada has geographic endowments that some stories of economic development argue give it advantages. It is far from the tropics, has a long border with a rich trading partner, has access to the sea, and has a disease environment that gives it a life expectancy of 79 years. During the colonial period, mortality among European settlers was only one-seventeenth of Burundi's. While Canada lacks lucrative cash crops like coffee, cotton, and tea, it is one of the world's premier grain producers—and some studies suggest grain endowments are better for political economy and institutional development than tropical cash crops.

Canada has long been a democracy with the rule of law, has never had a civil war, and has one of the world's best ratings on freedom from corruption.⁶ Canada's boring rulers have perpetrated few of the egregious interventions in the economy seen in Burundi.

How much of Canadians' 107-fold income advantage over Burundians is due to more favorable geographic endowments? How much is due to better institutions? How much is due to better policies? Do the alleged geographic advantages of Canada over Burundi directly affect income, or do they work through institutions or policies?

The purpose of this research is to assess empirically different theories of how geography, institutions, and policy influence economic development.

The *geography/endowment hypothesis* holds that environment directly influences the quality of land, labor, and production technologies (Machiavelli, 1519; Montesquieu, 1748). For example, compared to temperate climates, tropical environments tend to have poor crop yields, more debilitating diseases, and endowments that cannot effectively employ production technologies developed in more temperate zones (Kamark, 1976; Diamond, 1997). Similarly, particular geographical circumstances—whether a country is landlocked and therefore not open to trade—will permanently limit the country's ability to access a large economic market, hinder its ability to exploit economies of scale, and therefore lower its production efficiency (Sachs and Warner, 1995a, b, 1997). Resource endowments like minerals or ecological conditions favoring cash crops may also influence income. According to the geography hypothesis, the environment shapes economic development directly by influencing the inputs into the production function and the production function itself (i.e. certain endowments could make production technologically more difficult).

The *institution view* holds that the environment's main impact on economic development runs through long-lasting institutions. For example, environments where crops are most effectively produced using large plantations will quickly develop political and legal institutions that protect the few landholders from the many peasants and may even feature slavery (Engerman and Sokoloff, 1997; Sokoloff and Engerman, 2000). Even when agriculture recedes from the economic

⁵Sokoloff and Engerman (2000), p. 217.

⁶Of course, this reflects the viewpoint of the majority. The indigenous and French Canadian populations might take a less benevolent view of Canadian history.

spotlight, enduring institutions will continue to thwart competition and hence economic development. Similarly, many countries' institutions were shaped during colonization, so that examining colonies is a natural experiment (Acemoglu et al., 2001, 2002). European colonialists found different disease environments around the globe. In colonies with inhospitable germs and climates, the colonial powers established extractive institutions, so that a few colonialists could exploit natural resources. In colonies with hospitable climates and germs, colonial powers established settler institutions. According to this view, the institutional structures created by the colonialists in response to the environment endure even with the end of colonialism. Thus, the institution view argues that the major impact of the environment on economic development runs through its long-lasting impact on institutions.⁷ Technology in this story is endogenous to the institutions that make adoption of better techniques of production likely.

Finally, the *policy* view—which is really a collection of many different approaches—questions the importance of tropics, germs, and crops in shaping economic development today. This view is embedded in the approach of multilateral development institutions. The policy view holds that economic policies and institutions reflect current knowledge and political forces. Thus, changes in either knowledge about which policies and institutions are best for development or changes in political incentives will produce rapid changes in institutions and economic policies. In this view, history does not play a large role—any adverse historical legacy can be quickly reversed. According to the policy view, while tropical environments, disease, and specific crops may have influenced production and institutions, understanding environmental forces is not crucial to understanding economic development today.

The purpose of this research is to assess which of these three views of the role of the environment in economic development enjoys the most empirical support. There may be overlap and interactions among these theories of economic development. In motivating the analysis, however, we highlight the distinctions.

2. Literature review

2.1. Geography/endowment hypothesis

Some studies argue for direct effects of tropics, germs, and crops on development. Many authors have noted the association between tropical location and underdevelopment, going at least as far back as Montesquieu (1748). People long ago gave a racist interpretation to the climate theory of underdevelopment, including Montesquieu, which helps explain why economists have been reluctant to revive it:

You will find in the climates of the north, peoples with few vices, many virtues, sincerity and truthfulness. Approach the south, you will think you are leaving

⁷North's (1990) classic work treats colonial institutions as exogenously inherited from Europe and attributes the comparative success of the United States and Canada to the inheritance of better institutions and cultural norms from England.

morality itself, the passions become more vivacious and multiply crimes... The heat can be so excessive that the body is totally without force. The resignation passes to the spirit and leads people to be without curiosity, nor the desire for noble enterprise.⁸

Still guilt by association is not sufficient reason to discard the tropics hypothesis, or to ignore the strong correlation between latitude and income. [Sachs and Warner \(1995a, b, 1997\)](#) suggest that tropical location, landlocked location, and commodity dependence directly inhibit development or growth. [Bloom and Sachs \(1998\)](#) point to Africa's tropical location as a large hindrance to development. [Bloom and Sachs \(1998\)](#) and [Sachs \(2001\)](#) argue that tropical location leads to underdevelopment through mechanisms such as (1) the fragility and low fertility of tropical soils, (2) high prevalence of crop pests and parasites, (3) excessive plant respiration and lower rate of net photosynthesis, (4) high evaporation and unstable supply of water, (5) lack of a dry season, cold temperatures, or long enough summer days for temperate grain crops,⁹ (6) ecological conditions favoring infectious diseases for humans, (7) lack of coal deposits, and (8) high transport costs.

[Landes \(1998, p. 5\)](#) says the tropics inhibit work: "few manage to work at full capacity when hot and wet." He quotes a Third World diplomat as saying "in countries like India, Pakistan, Indonesia, Nigeria, and Ghana I have always felt enervated by the slightest physical or mental exertion, whereas in the UK, France, Germany, or the US I have always felt reinforced and stimulated by the temperate climate" (p. 15). A related idea with an ancient lineage is that it is easy to gather food crops in the tropics (the opposite of the [Bloom and Sachs \(1998\)](#) idea), which reduces the need to work hard and produce: "fertile countries ... are apt to making men idle and unable to exercise any virtue" ([Machiavelli, 1519](#)).¹⁰

[Diamond \(1997\)](#) does not stress tropics, but instead suggests that germs and crops directly affected the technological development of societies in the very long run. First, some people developed some resistance to germs like smallpox and measles that they got from their farm animals (like Europe), while other peoples lacked farm animals and did not develop this resistance, with the catastrophic results once Europeans arrived (the Americas after Columbus, later the Pacific islands). Draft animals also conveyed a direct productivity advantage (Eurasia), while other regions suffered technological disadvantages from the lack of draft animals (Africa, where germs carried by tsetse flies restricted the distribution of cattle). Second, some regions happened to have wild plant species that lent themselves to domesticated high-yielding food crops (or importantly, were on the same landmass and latitude as someone else who developed the crop), while others had much less promising plant species. [Olson et al. \(2000\)](#) point out that of the 56 heaviest-seeded wild grasses on

⁸<http://www.geocities.com/ru00ru00/racismhistory/18thcent.html>.

⁹The disadvantages of tropical agriculture were also stressed by a former chief economist of the World Bank, [Kamarck \(1976\)](#).

¹⁰The quotation is from <http://www.geocities.com/ru00ru00/racismhistory/18thcent.html>. This is the backward bending labor supply curve idea, in modern parlance. Of course, bad institutions could also reduce the supply of effort, and this is only one of the several possible mechanisms by which some authors believe there is a direct effect of tropical location on development.

earth, 33 occurred naturally in western Eurasia, while only 4 grew in sub-Saharan Africa, and only 2 grew in South America. Again, this seems contrary to the traditional idea that the tropics are naturally abundant in food, but tropical crops are mainly not grains—and the Diamond view argues grains are key. Regions with a more promising endowment of grain species and that which developed a resistance to germs, in the Diamond story, developed a technological lead that was never overcome.

2.2. *Institutions hypothesis*

Other studies trace the effect of tropics, germs, and crops through institutions. [Hall and Jones \(1999\)](#) are one example of the “tropics” view of institutions. They use institutional quality as one component of their “social infrastructure” (which explains productivity), with distance from the equator (along with European language) as instruments.¹¹ Their reasoning is that Western Europeans have historically been associated with high quality institutions, and Western Europeans settled in climates similar to Western Europe. [Kaufmann et al. \(1999b\)](#) also use this reasoning by using percent speaking English and percent speaking a European language as instruments for their institutional variables, getting a strong effect on per capita income. Hall and Jones’ other component of social infrastructure reflects government policy—openness as measured by [Sachs and Warner \(1995a, b\)](#)—which is also related to Western European influence. Note that Hall and Jones specify institutions and government policy as perfect substitutes.

[Acemoglu et al. \(2001\)](#) (AJR) also suggest institutional quality as a fundamental determinant of economic development, but they have a “germs” theory of institutions. AJR base their theory on three premises. First, AJR note that Europeans adopted different types of colonization strategies. At one end of the spectrum, the Europeans settled and created institutions to support private property and check the power of the State. These “settler colonies” include the United States, Australia, and New Zealand. At the other end of the spectrum, Europeans did not aim to settle and instead sought to extract as much from the colony as possible. In these “extractive states,” Europeans did not create institutions to support private property rights; rather, they established institutions that empowered the elite to extract gold, silver, cash crops, etc. (e.g., Congo, Burundi, Ivory Coast, Ghana, Bolivia, Mexico, Peru). Although AJR do not emphasize it, slavery was a way for Europeans to capture a labor force for extractive states, such as in the Caribbean and Brazil.

The second component of AJR’s theory holds that the type of colonization strategy was heavily influenced by the feasibility of settlement. In areas where “germs” created high mortality among potential settlers, Europeans tended to create extractive states. In areas where “germs” favored settlement, Europeans tended to form settler colonies. For instance, AJR note that the Pilgrims decided to settle in the American colonies instead of Guyana partially because of the high mortality rates in Guyana (similarly, [Sokoloff and Engerman \(2000\)](#) note that a Puritan colony on

¹¹ [Easterly and Levine \(1997\)](#) and [Mauro \(1995\)](#) suggested ethnic fractionalization led to poor institutional outcomes.

Providence Island off the coast of Nicaragua did not last long). Moreover, [Curtin \(1964, 1989, 1998\)](#) documents that the European press published colonial mortality rates widely, so that potential settlers had information about colonial “germs.” Thus, according to the endowment theory, the disease environment shaped colonization strategy and the types of institutions established by Europeans colonizers.

The final piece of the AJR theory of institutional development stresses that the institutions created by European colonizers endured after independence. As we discuss below in greater detail, post-independent regimes tended to resemble pre-independent regimes. Settler colonies tended to produce post-colonial governments that were more democratic and more devoted to defending private property rights than extractive colonies. In contrast, since extractive colonies had already constructed institutions for effectively extracting resources, the post-colonial elite frequently assumed power and readily exploited the pre-existing extractive institutions, sometimes making them even more extractive. According to the endowment theory, differences in endowments shaped initial institutions and these initial institutions have had long-lasting repercussions on private property rights protection and other institutions.

In a subsequent paper, [Acemoglu et al. \(2001\)](#) provide further evidence that it is institutions rather than tropics per se that matter. They point out that among colonized regions of the world, societies with higher urbanization or population density in 1500 have worse institutions and lower income today. Since urbanization and population density are a good proxy for income, this suggests a reversal in income ranking between 1500 and today. The tropics hypothesis would predict persistence in income ranking, since latitude does not change. AJR (2002) argue that it was the introduction of extractive institutions in high urbanization places (which turned out to be places with dangerous “germs”), contrasted with the introduction of “settler institutions” in low urbanization places (which were places with less dangerous “germs”), that explains the reversal in incomes.

The “crops” hypothesis is due to [Engerman and Sokoloff \(1997\)](#) and [Sokoloff and Engerman \(2000\)](#) (henceforth ES). ES argue that the land endowments of Latin America lent themselves to commodities featuring economies of scale and/or the use of slave and indigenous labor (sugar cane, rice, silver) and thus were historically associated with power concentrated in the hands of the plantation and mining elite. In contrast, the endowments of North America lent themselves to commodities grown on family farms (wheat, maize) and thus promoted the growth of a large middle class in which power was widely distributed.¹²

Once power was concentrated, the elite in Latin America created institutions that preserved their hegemony, like a narrow franchise for voting, restricted distribution of public lands and mineral rights, and low access to schooling. In countries like

¹²[Easterly \(2002\)](#) found cross-section evidence compatible with the ES story going from commodity endowments through inequality to institutions, openness, and human capital. [Woolcock et al. \(2001\)](#) found that institutions are worse in resource-rich than in resource-poor economies, and that “point-source” and coffee and cocoa resources were associated with worse institutions compared to “diffuse” resource economies. [Isham et al. \(2001\)](#) find worse institutions in resource-rich relative to resource-poor countries.

Mexico, Chile, and Peru up through the early 20th century, land was redistributed away from indigenous populations towards a small group of landowners. In Mexico in 1910, 2.4 percent of household heads owned land (compared to about 75 percent of farmers in the US around the same time).¹³ The favoritism towards the elite also showed up in Latin American laws regulating establishment of corporations, financial institutions, patents, and industrial policies. Grants of new charters for banks and corporations were controlled in favor of insiders in Latin America. Patent fees in the late 19th century in Argentina, Brazil, British Guiana (today's Guyana), Mexico, Peru, Uruguay, and Venezuela were over \$400 (Khan and Sokoloff, 2002), which is between 2.5 and 9.5 times their annual per capita incomes in contemporaneous dollars.

In contrast, North America above the Rio Grande enjoyed a larger middle class with a less powerful elite so that the United States and Canada created more open, egalitarian institutions. For instance, these regions adopted earlier a broad franchise for voting, equal protection before the law, widespread distribution of public lands and mineral rights, cheap patent fees (\$35 in US in the late 19th century), relatively easy entry for new banks and corporations, and a big government push on schooling.¹⁴ The work of ES follows a long history literature that postulates domination by the elite owners of *encomiendas* (land grants for plantations and mines from the crown, accompanied by feudal rights over the indigenous population) as the “original sin” of Latin American underdevelopment (Chasteen, 2000).¹⁵

ES suggest that the elite in Latin America opposed democracy and other institutions promoting equality before the law because they were afraid of the poor majority gaining power. The elite feared in particular that the majority would use power to redistribute income and rents away from the elite towards the majority. ES note that even when Latin American nations were nominal democracies, they imposed literacy or wealth requirements for voting that sharply restricted the franchise well into the 20th century. Through 1940, the US and Canada had proportions of the population voting that were 5–10 times higher than Bolivia, Brazil, Chile, and Ecuador.

Like AJR, ES note that European migration was much larger to North America than to tropical Latin America. They attribute the difference in part to colonial institutions that discouraged European immigration in Latin America (because the elite wanted to preserve their exclusive position), but encouraged it in North America (where abundant land for family farms made new immigrants less threatening). In short, the ES story goes from particular crop endowments to the creation of a privileged elite, who in turn created institutions restricting opportunities to the elite;

¹³ Correspondence with Kenneth Sokoloff.

¹⁴ Slavery in the southern United States, and post-Reconstruction restrictions on black civil rights, is an obvious exception to these statements. ES suggest that the American South is a kind of middle ground between North America and Latin America, lagging behind North America but ahead of Latin America (where African slavery in Brazil and the Caribbean covered a larger share of the population than in North America, and where the violation of rights of indigenous people also covered a larger share of the population than in North America).

¹⁵ Of course, pre-colonial institutions in the Aztec and Inca empires also featured elite domination.

other crop endowments led to diffused distribution of power, which created institutions giving fairly equal opportunities to all. According to ES, the institutional restriction of opportunities in Latin America was not conducive to a development strategy, like industrialization, that requires the participation of the majority of society; the generally inclusive institutions in North America facilitated industrialization.

2.3. *Policy hypothesis*

The policy hypothesis is an amalgam of views that stress the importance of major national policies and de-emphasize the importance of endowments in determining economic development. The policy view holds that sound macroeconomic policies, openness to international trade, and the absence of capital account controls will tend to foster long-run economic success. This perspective is clearly imbedded in the policy recommendations adopted by major multilateral institutions. Indeed, a motivating factor for creating international financial institutions is to facilitate the adoption of sound national policies that foster economic development. According to the policy hypothesis, while tropics, germs, and crops may influence production technologies and institutions, the adoption of policies that foster low inflation, openness to international trade, and unchecked international financial flows will promote economic development.

Some economists have taken a notably sophisticated view of the role of policies in economic development. Frankel and Romer (1999) and Frankel et al. (1996) argue that geography matters for economic development through government policy, specifically trade openness. They argue that openness per se has a strong causal effect on per capita income, instrumenting for openness with a country's natural propensity to trade based on the gravity model. 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. Trade also goes down with higher population size of the home country (more trade takes place within borders relative to across borders) and goes down if the country is landlocked.¹⁶ They construct "natural openness" by summing up the predicted bilateral trade shares of each country with all the other countries in the world. According to this line of research, geography matters for many poor developing countries because they are far from markets and thus less likely to realize benefits from trade.

3. Data and summary statistics

To assess different theories regarding the potential mechanisms via which tropics, germs, and crops influence economic development, we need measures of the

¹⁶ Bilateral trade also goes up with per capita incomes of the trading partners. Because of concerns about endogeneity, Frankel and Romer use the factor accumulation of trading partners to predict per capita income. However, they also have a "pure geography" measure that includes only the factors mentioned in the text, which is what we use in the empirical work below.

underlying endowments and indicators of the possible institutions via which endowments may influence output. We also need measures of national policies since the policy hypothesis questions the importance natural endowments and instead emphasizes the impact of macroeconomic policies on economic development. This section defines the variables, presents simple graphs, and discusses the sample of countries on which we focus our investigation. The next section presents the regression results.

3.1. *Endowments*

We focus on four different measures of endowments, but experimented with others to assess the robustness of the results.

3.1.1. *Settler mortality*

Settler mortality equals the logarithm of annualized deaths per thousand European soldiers (with each death replaced with a new soldier) during the early 19th century, for 72 former colonies. AJR (2001) compiles data. The raw data come from British, French, and United States governments during the period 1817–1848 (Curtin, 1989). AJR (2001) argue that these early 19th century mortality rates among soldiers are good proxies for long run mortality by comparing it to (i) Curtin (1998), who examines similar data on soldier mortality from disease during the second half of the 19th century and (ii) Gutierrez (1986), who uses Vatican records to construct estimates of the mortality rates of bishops in Latin America from 1604 to 1876. As in AJR (2001), logarithms are used to diminish the impact of outliers.

Settler mortality exhibits both high cross-country variability and a strong positive connection with the level of economic development. First, there is enormous variability in the settler mortality data, ranging from 8.5 annualized deaths per thousand to well over a thousand deaths per thousand in Gambia, Nigeria, and Mali (recall the rates are computed with replacement). Second, Table 1 and Fig. 1 document the negative relationship between settler mortality and the logarithm of real per capita GDP in 1995. The correlation is significant at the one-percent level and illustrates that higher levels of settler mortality are associated with lower levels of economic development.¹⁷

We use settler mortality as an indicator of endowments to assess both the geography and institutions hypotheses. The geography hypothesis stresses that the disease environment directly influences productivity. Settler mortality measures the disease environment as European settlers arrived and thereby provides an exogenous indicator of “germs.” The AJR (2001) institution hypothesis, instead, stresses that (i) initial endowments shape the long-lasting institutions created by European conquerors and (ii) these long-lasting institutions continue to shape economic development today. Settler mortality provides information on whether

¹⁷These historical mortality rates are correlated with mortality rates today (AJR, 2001), which are themselves correlated with per capita income today.

Table 1
Correlations and summary statistics: selected variables

Log(GDP per capita) is the logarithm of real GDP per capita in 1995. The Institutions Index averages (1) the six Kaufman, Kraay, and Zoido-Lobaton (1999a, b) measures: (i) voice and accountability, (ii) political instability and violence, (iii) government effectiveness, (iv) regulatory burden, (v) rule of law, and (vi) graft, and (2) one of the three policy variables: inflation, trade openness, or real exchange rate overvaluation. Settler mortality is the logarithm of annualized deaths per thousand of European soldiers. Latitude is absolute value of each country's latitude. Landlock equals one if the country is landlocked and zero otherwise. Inflation equals the average annual inflation rate 1960–1995. Openness equals years that the country has been open to trade, and Real Exchange Rate Overvaluation equals the average real exchange rate overvaluation, 1960–1995.

	Log(GDP per capita)	Institutions Index	Settler Mortality	Latitude	Landlock	Inflation	Openness	Real Exchange Rate Overvaluation
<i>A. Correlations</i>								
Log(GDP per capita)	1							
Institutions Index	0.79 (0.000)	1						
Settler Mortality	−0.68 (0.000)	−0.57 (0.000)	1					
Latitude	0.47 (0.000)	0.48 (0.000)	−0.43 (0.000)	1				
Landlock	−0.38 (0.001)	−0.35 (0.002)	0.31 (0.007)	−0.15 (0.195)	1			

Table 1 (continued)

	Log(GDP per capita)	Institutions Index	Settler Mortality	Latitude	Landlock	Inflation	Openness	Real Exchange Rate Overvaluation
Inflation	0.05 (0.718)	-0.16 (0.196)	0.07 (0.571)	-0.05 (0.682)	0.06 (0.626)	1		
Openness	0.64 (0.000)	0.65 (0.000)	-0.54 (0.000)	0.19 (0.120)	-0.19 (0.103)	-0.07 (0.588)	1	
Real Exchange Rate Overvaluation	-0.33 (0.007)	-0.33 (0.007)	0.40 (0.001)	-0.17 (0.185)	0.10 (0.429)	0.28 (0.021)	-0.21 (0.082)	1.00
<i>B. Summary statistics</i>								
Mean	7.18	-0.09	4.64	0.18	0.14	0.17	0.26	122.36
Median	6.99	-0.17	4.36	0.15	0	0.08	0.14	112.19
Maximum	10.28	1.59	7.99	0.67	1	1.42	1	381.94
Minimum	4.69	-1.33	2.15	0.01	0	0.03	0	69.19
Std. Dev.	1.42	0.68	1.24	0.13	0.35	0.23	0.32	47.08
Skewness	0.43	0.57	0.18	1.08	2.09	3.56	1.23	2.73
Kurtosis	2.30	2.90	3.04	4.58	5.36	17.08	3.39	15.47
Observations	72	72	72	72	72	66	70	64

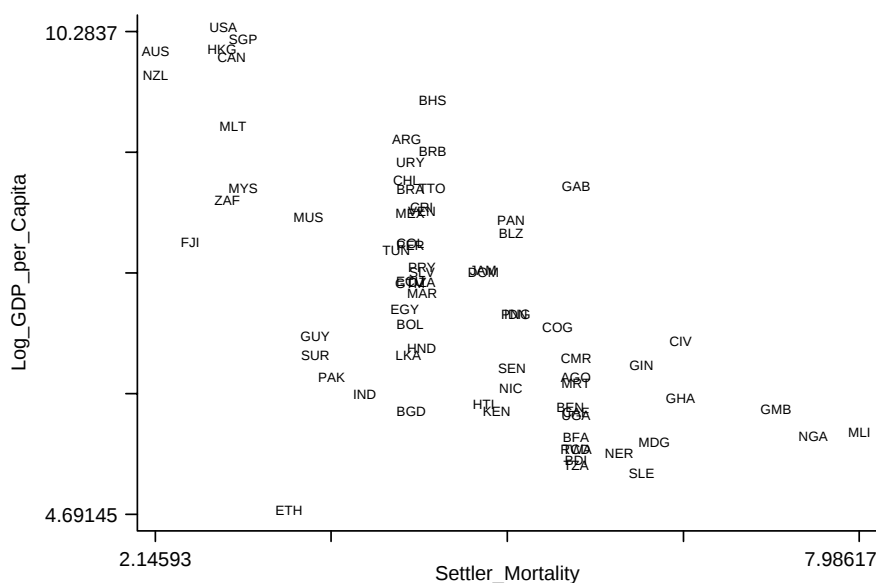


Fig. 1. Logarithm of GDP per capita in 1995 vs. settler mortality.

initial endowments tended to favor the creation of “extractive colonies” or “settler colonies” as defined above.

3.1.2. Latitude

Latitude equals the absolute value of the latitude of the country. We take the data from [La Porta et al \(1999\)](#). Countries that are closer to the equator will tend to have a more tropical climate. Tropical endowments may directly hinder production ([Kamarck, 1976](#); [Crosby, 1986](#); and [Gallup et al., 1999](#)). Alternatively, tropical endowments represent an inhospitable disease environment for colonialists, which may foster “extractive” institutions according to the institutions hypothesis ([AJR, 2001](#); [2002](#)).¹⁸

The data indicate a strong positive association between latitude and economic development. As shown in [Table 1](#) and [Fig. 2](#), countries with higher absolute latitude tend to have higher levels of real per capita GDP.¹⁹ Thus, we use latitude as an objective measure of “tropics.” We experimented with other measures of endowments. In particular the World Bank global economic indicators produces a zero-one dummy variable of whether the country is tropical. Using this measure does not change this paper’s conclusions.

¹⁸ The literature has given little attention to some of the *advantages* of tropical location, like greater biodiversity, tourism potential, less discomfort and need for protection from cold temperatures, other intangible quality of life aspects, etc.

¹⁹ Naturally, there is some cut-off at extremely high latitudes where little settlement is feasible.

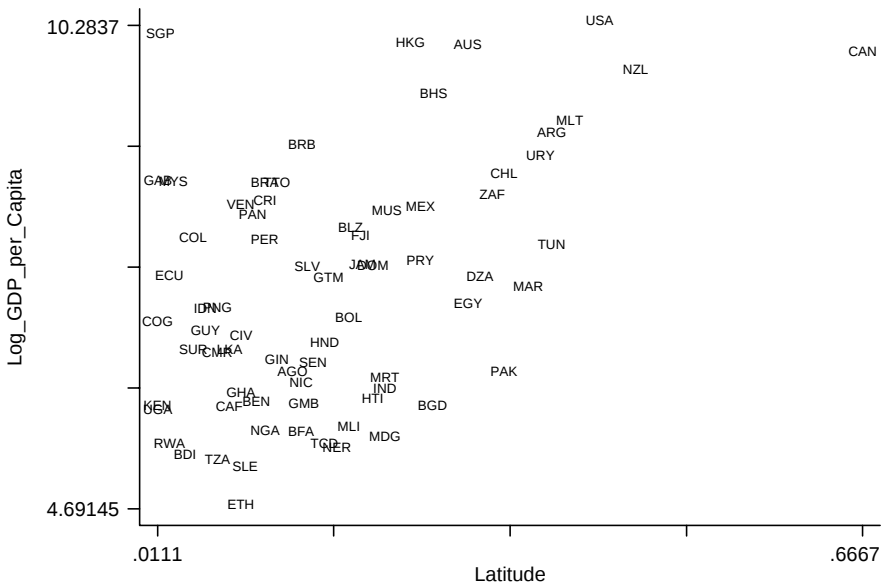


Fig. 2. Logarithm of GDP per capita in 1995 vs. latitude.

3.1.3. *Crops/minerals*

Our measures of “crops/minerals” are dummies for whether a country produced any of a given set of leading commodities in 1998–1999. For example, the dummy WHEAT takes on the value 1 if the Food and Agriculture Organization (FAO) records the country as producing any wheat in 1998–1999 and 0 otherwise. We adopt the same convention for mining commodities, with the data on production coming from the World Bureau of Metal Statistics. These dummies are arguably exogenous since they reflect simply whether the land endowment makes it possible to produce or mine a particular commodity. Harlan (1992, pp. 53–60) discusses the botanical mechanisms by which different ecological zones are compatible with some types of crops and not with others. The quantity of wheat produced would endogenously respond to price incentives, institutions, and other country characteristics, but whether ANY wheat is produced is more likely to reflect exogenous characteristics like soil and climate. These characteristics have thus remained constant over time, and hence reflect historical agricultural endowments, which in turn reflects historical conditions for institutions.

We use the crops/minerals dummy variables to assess the ES hypothesis. ES argue that certain commodities lent themselves to economies of scale and the use of slave labor. These types of commodities naturally produced long-lasting extractive institutions that protect the elite and stymie overall economic development. Other types of commodities, however, lent themselves to production by middle class family farmers. These types of commodities, then, tended to produce long-lasting inclusive institutions that foster economic growth. Thus, we use commodity endowments to test the ES hypothesis.

The crops/minerals dummies are bananas, coffee, copper, maize, millet, oil, rice, rubber, silver, sugarcane, and wheat. We chose the particular list of commodities (from the more than a hundred possible primary commodities in the data) based on our random priors as to what were important commodities in many countries' economic history, either because they were mentioned by ES or because of our knowledge of country case studies. We did not do any specification searches to choose the basket of commodities.²⁰

3.1.4. *Landlocked*

Landlocked is simply a dummy value that takes one the value 0 if the country has coastal territory on the world's oceans, and 1 otherwise. There are 40 landlocked countries in the world according to this definition. In our sample of 72 countries (restricted by the Settler Mortality variable), ten are landlocked.

3.1.5. *Natural openness*

We do not feature this endowment variable in our main regressions, but we substitute it for landlocked as a robustness check (it will turn out the results below are unchanged). Frankel and Romer (1999) define natural openness as the trade share built up from an equation predicting bilateral trade with other countries. The bilateral trade equation that we use from Frankel and Romer includes only purely geographic variables: the home country's population and area, the trading partner's population and area, the distance between the two countries, whether the countries share a common border, and whether the home country is landlocked. Natural openness for the home country is the predicted trade share summing up all the predicted bilateral trade with all potential trading partners. The most "naturally open" countries in the world are Belize, Malta, and Luxembourg.²¹ The most "naturally closed" countries are China, the United States, and Brazil.

3.2. *Institutions*

Since theories by AJR (2001) and Engerman and Sokoloff (1997) stress that endowments influence economic development through their impact on institutional development, we need measures of institutional development to assess these theories. We focus on Kaufman et al.'s (1999a) six measures of institutional development, but confirm our results using a measure of private property rights protection (Holmes et al., 1997).

3.2.1. *Institutions index*

Institutions index equals the average of the six Kaufman et al. (1999a, b) measures of institutional development, where larger values signify better institutional

²⁰ These are the same commodities that are used in Easterly 2001, who found that commodity dummies helped explain differences in inequality across countries in a way consistent with the ES hypothesis.

²¹ Although Luxembourg is landlocked, it is located next to the dense population concentrations in trading partners. Note that country size is an important determinant of natural openness.

development. Although we focus the analysis on the Institutions Index, we confirm the findings with each of these six underlying measures. These measures are based on an unobserved components model that aggregates over 300 indicators, ranging from ratings by country experts to survey results. The underlying measures are defined as follows:

- (1) *Voice and accountability*—the extent to which citizens can choose their government, political rights, civil liberties, and an independent press.
- (2) *Political stability and absence of violence*—a low likelihood that the government will be overthrown by unconstitutional or violent means.
- (3) *Government effectiveness*—quality of public service delivery, competence of civil servants, and the degree of politicization of the civil service.
- (4) *Light regulatory burden*—relative absence of government controls on goods markets, government interference in the banking system, excessive bureaucratic controls on starting new businesses, or excessive regulation of private business and international trade.
- (5) *Rule of law*—protection of persons and property against violence or theft, independent and effective judges, contract enforcement.
- (6) *Freedom from graft*—absence of the use of public power for private gain, corruption.

The method used to calculate the index gives it approximately a unit normal distribution, with an increase always meaning better quality institutions.

The institutions index is positively associated with both economic development and better endowments. First, many rich countries, such as Australia, Canada, New Zealand, Singapore, and the United States, all have institutions index values of greater than 1.0, where the sample mean is -0.1 . Similarly, very poor countries, such as Angola, Burundi, Haiti, Niger, Nigeria, and Rwanda, all have institutions index values of less than -1.0 . More formally, [Table 1](#) and [Fig. 3](#) demonstrate the strong positive relationship between the logarithm of GDP per capita and the institutions index. Second, [Table 1](#) and [Figs. 4 and 5](#) show that the institutions index is positively correlated with latitude and negatively correlated with settler mortality. For instance, Australia, Canada, New Zealand, Singapore, and the United States all are of settler mortality rates of less than 20 per thousand, and all have institutions indexes greater than 1.0. Similarly, Angola, Burundi, Haiti, Niger, Nigeria, and Rwanda all have settler mortality rates of greater than 100 per thousand, and all have institutions indexes of less than -1 .

3.3. Macroeconomic policies

To measure the macroeconomic environment, we use three indicators of macroeconomic policies over the last four decades that capture the historical emphasis on openness to trade, capital, and sound fiscal and monetary policies. We assess whether these macroeconomic policy indicators explain cross-country

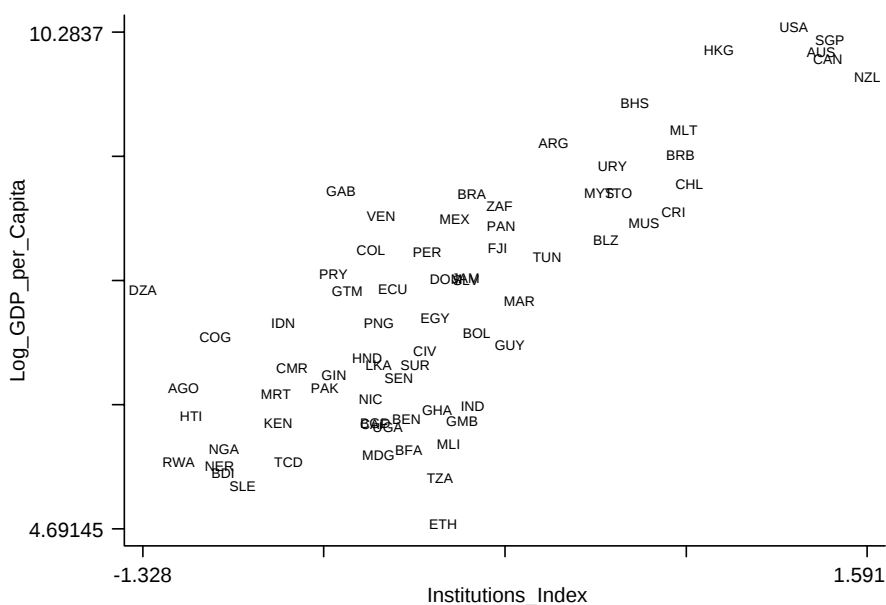


Fig. 3. Logarithm of GDP per capita in 1995 vs. institutions index.

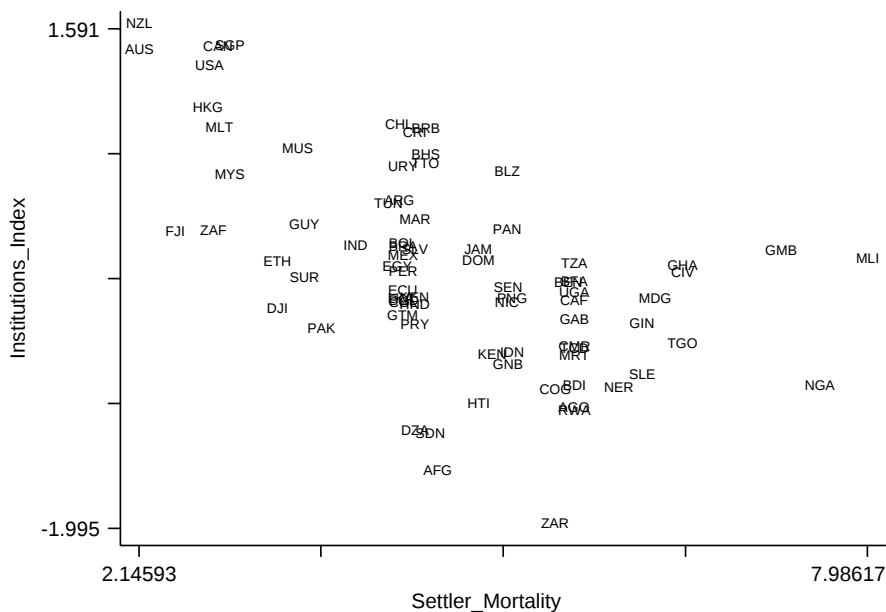


Fig. 4. Institutions index vs. settler mortality.

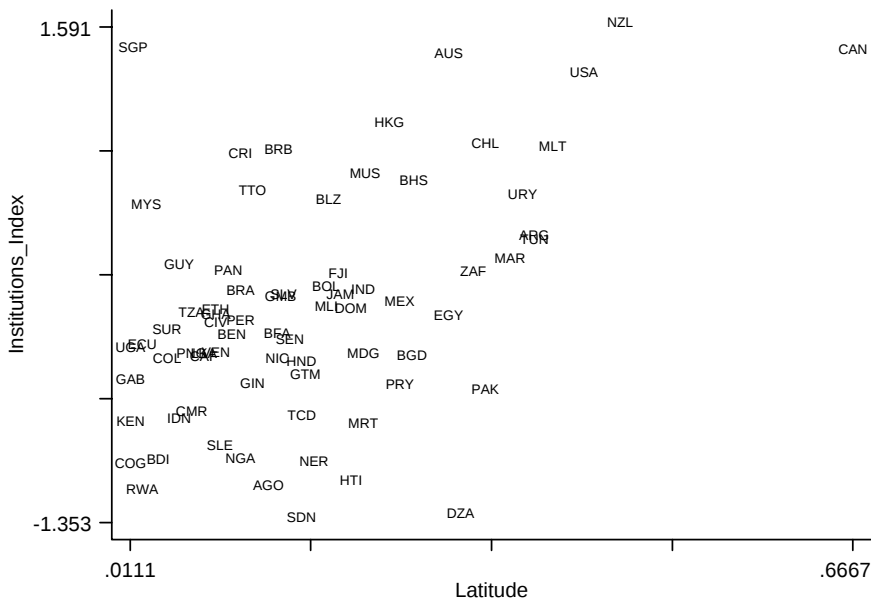


Fig. 5. Institutions index vs. latitude.

variations in economic development after accounting for the explanatory power of natural resource endowments.

3.3.1. Openness

Openness measures the degree to which the country does or does not interfere with foreign trade. More specifically, it is the fraction of years from 1960 to 1994 that [Sachs and Warner \(1995a, b\)](#) classified a country as “open”. They define a country as open if (i) non-tariff barriers cover less than 40 percent of trade, (ii) average tariff rates are less than 40 percent, (iii) the black market premium was less than 20 percent during the 1970s and 1980s, (iv) the economy is not socialist, and (v) the government does not control major exports through marketing boards.

3.3.2. Real exchange rate overvaluation

Real exchange rate overvaluation measures the degree to which the exchange rate is overvalued on average. We start with the index of overvaluation for 1976–1985 that [Dollar \(1992\)](#) calculates. Dollar’s calculation was based on Summers-Heston purchasing power parity comparisons, measuring the extent of general overvaluation controlling for the level of income. He found this to be a significant determinant of growth rates (the more overvaluation, the less growth). We convert this into an annual series by calculating the real exchange rate as $(\text{domestic cpi})/(\text{exchange rate domestic currency per dollar} \times \text{US CPI})$. We benchmark this series for each country by adjusting the level such that the average for 1976–1985 equals Dollar’s calculation. Our overvaluation measure is the average over 1960–1998. An increase

in the index signifies more overvaluation. The index ranges from a minimum of 69 to a maximum of 381, where 100 signifies no under- or over-valuation. Extreme overvaluation usually reflects a situation where the government has kept the official exchange rate constant in the face of high domestic inflation.

3.3.3. *Inflation*

Inflation is the average of the logarithm of the inflation rate over the last four decades. Inflation is meant to capture the consistency of monetary and fiscal policies in that large, structural fiscal imbalances may lead to debt monetization and higher inflation rates. Major international institutions focus on controlling inflation as a mechanism for boosting long-run economic activity.

3.4. *Other explanatory variables*

To assess the robustness of our results, we include several other potential determinants of economic development.

3.4.1. *Ethnolinguistic diversity*

Ethnolinguistic diversity measures the probability that two randomly selected individuals from a country are from different ethnolinguistic groups. Some political economy models predict that as ethnolinguistic diversity rises, countries tend to formulate weaker institutions, weaker public services, and policies that close the economy to foreign interactions (e.g., [Alesina et al., 1999](#)). Recent studies show that in highly ethnically diverse economies, the group that comes to power tends to implement policies that: (a) expropriate as many resources as possible from the ethnic losers, (b) restrict the rights of other groups, and (c) prohibit the growth of industries or sectors that threaten the ruling group ([Alesina et al., 1999](#); [Easterly and Levine, 1997](#)). Thus, ethnolinguistic diversity may directly hinder economic development and indirectly shape the underlying institutions and policies that influence economic development.

3.4.2. *Religion*

Religion may also influence economic development. Many scholars argue that religion shapes national views regarding property rights, competition, and the role of the State. [Putnam \(1993, p. 107\)](#), for instance, contends that the Catholic Church fosters “vertical bonds of authority” rather than “horizontal bonds of fellowship”. Similarly, [Landes \(1998\)](#) argues that Catholic and Muslim countries have tended to develop xenophobic cultures and powerful church/state bonds to maintain control, which hinders institutional and economic development. To measure religious composition, we use the following variables: Catholic, Muslim, and Other Religion, which equal the fraction of the population that is Catholic, Muslim, or of another (non-Protestant) religion. The Protestant share of the population is omitted (and therefore captured in the regression constant). The data are from [La Porta et al. \(1999\)](#).

3.4.3. French legal origin

French legal origin equals one if the country has a French civil law tradition and zero if the country has a British common law tradition as defined by the origin of each country's Commercial/Company law (La Porta et al., 1999). As discussed below, the sample only includes former colonies with either French or British legal origins. We include the legal origin variable in our analyses because there is a growing body of work which argues that the legal tradition implanted in countries by European colonists has profoundly shaped national approaches to property rights protection and the degree to which the State intervenes in the economy. In short, Hayek (1960), La Porta et al. (1998), and Beck et al. (2002b) argue that the French civil law was developed to unify the legal system, prevent jurisprudence, and solidify State control of the courts. In contrast, the British common law evolved to protect private property owners from the Crown. Thus, this view contends that countries with a French legal origin will tend to place greater emphasis on the rights of the State versus the rights of individuals. Beck et al. (2002a) show that countries with French legal origins tend to have lower levels of property rights protection than countries with British legal origins after controlling for many other factors, including natural resource endowments. We include this variable in our analyses to assess the robustness of our results.

3.5. Sample

We focus our analysis on a sample of 72 former colonies. Focusing on former colonies represents a natural experiment for assessing how tropics, germs, and crops influenced subsequent economic development (AJR, 2002). That is, colonizers arrived and faced different environmental endowments. We examine whether these endowments directly influence economic development, or whether these endowments shaped the formation of critical, long-lasting institutions that form the foundation of economic development. Furthermore, we have data on settler mortality only for this sample of 72 former colonies, and as shown graphically above, settler mortality is an informative indicator of future economic and institutional development.

4. Regression results

This section evaluates the following four questions. First, do endowments explain cross-country variations in economic development? Second, do endowments explain cross-country variations in institutional development? If endowments do not explain economic development, then there is no support for the geography hypothesis. If endowments do not explain institutional development, then there is no support for the institutions hypothesis. In fact, we find that endowments explain both economic development and institutional development. Thus, we proceed to the next two questions. Third, do endowments explain cross-country variations in economic development beyond their ability to explain cross-country variations in institutions? If the answer is no, then this provides evidence for the institutions

hypothesis and against the geography hypothesis. If, however, endowments explain economic development beyond the institutional development channel, then this provides support for the geography hypothesis. Finally, after accounting for the impact that endowments have on growth through institutions, do the macro-economic policies pursued by countries over the last four decades help explain current levels of economic development?

4.1. Do endowments explain economic development?

Table 2 presents ordinary least squares (OLS) regressions, with heteroskedasticity-consistent standard errors, of the logarithm of real per capita GDP in 1995 on the various endowment indicators. Specifically, we examine settler mortality, latitude, landlocked, and the full assortment of crop and mineral dummy variables discussed in Section 3. We run a very simple regression of the logarithm of per capita GDP on the endowment variables, taken one-at-a-time and then in groups. However, we examine the 11 crops/minerals variables collectively. Furthermore, we also list the results from a multivariate regression that includes the French legal origin dummy variable, the three religious composition variables (Catholic, Muslim, and Other Non-Protestant religions), and the ethnolinguistic diversity index. We include these control variables to assess the independent link between endowments and the level of economic development.

The results clearly indicate that endowments explain economic development. Each of the four endowment indicators—settler mortality, latitude, landlocked, and the crops/minerals indicators—significantly explain cross-country variation in the logarithm of GDP per capita. These findings do not change when controlling for legal origin, religious composition, or ethnolinguistic diversity. The signs on settler mortality, latitude, and land locked are consistent with theory. Namely, lower settler mortality, higher latitude, and not being land locked are all associated higher levels of economic development. When we also try Frankel–Romer natural openness, we also find it to be significantly associated with economic development with the predicted sign (not shown). Of the other exogenous control variables, religion and ethnolinguistic diversity are frequently significant but French legal origin is not.²²

When we include all the endowment indicators together, there is clearly some multi-collinearity across the endowment variables. Nevertheless, settler mortality and the crops/minerals variables remain independently linked with economic development even when all the endowment and control variables are included simultaneously. Note that settler mortality alone explains almost *half* of the cross-country variation in GDP per capita. The latitude and landlocked variables are not actually significant. We do not want to make too much of this because of the high collinearity between these variables and the other endowment variables. However, these results do not provide strong support for the idea that

²² The significance of the religion variable varies, but sometimes indicates that the Muslim religion is associated with less institutional quality and development than other religions, particularly Protestant and Other religion.

[illegible]

tropical location and lack of access to the sea inhibit development through channels other than through their effect on human disease and on natural resource endowments.

The sizes of the coefficients suggest that endowments exert an economically big impact on economic development. For instance, Tanzania had very high rates of settler mortality of 5.6 (i.e., 280 death per thousand, where $280 \approx \exp(5.6)$) and has a very low level of per capita GDP of \$182, where the natural log of \$182 equals 5.21. The regression coefficient from the second regression in Table 2 (which controls for legal origin, religion, and ethnic diversity) indicates that if Tanzania had a disease environment that produced settler mortality rates closer to that experienced in India of 3.9, respectively (i.e., 49 deaths per thousand), then Tanzania would enjoy income levels of more than double its current level and even greater than that enjoyed in India now, e.g., about \$415.²³

4.2. Do endowments explain institutional development?

Table 3 regressions indicate that endowments help explain cross-country variation in institutional development. Each of the endowment indicators is significantly associated with the aggregate institutions index. These relationships hold when controlling for legal origin, religious composition, and ethnic diversity. As noted earlier, adding all the endowment variables together induces multicollinearity, such that it is not always possible to identify the independent link between each endowment indicator and institutional development when controlling for all of the other endowment indicators. Settler mortality and natural resources (germs and crops) are again more significant than tropical latitude or lack of coastal access (although only crops remain independently significant when other exogenous variables are included). Note that when settler mortality and latitude are included together, they jointly explain 45 percent of the cross-country variation in the institutions index (when not controlling for legal origin, religious composition, and ethnic diversity).²⁴

²³ Formally, $\Delta(\log \text{GDP per Capita}) = -(0.62) * \Delta(\text{settler mortality})$. Tanzania's settler mortality equals 5.6 and India's equals 3.9. Thus, $\Delta(\log \text{GDP per Capita}) = -(0.62) * \Delta(-1.7) = 1.05$. Since Tanzania's log of GDP per capita equals 5.21 (which equals \$182), its new level would equal 6.27, which equals \$528.

²⁴ Instead of examining 11 individual dummy variables related to crops and minerals, we also constructed an index, "good crops," to examine more narrowly the Engerman and Sokoloff (1997) hypothesis about crops and institutional development using one summary measure. In particular, the good crops index equals $\log(1 + z_{\text{maize}} + z_{\text{wheat}}) / (1 + z_{\text{rice}} + z_{\text{sugarcane}})$, where z_X equals the share of the land area that is judged to be suitable by FAO for growing crop X. We construct this index because ES focus on wheat and maize as crops that foster a large middle class with egalitarian institutions in contrast to rice and sugarcane, which tend to produce a powerful elite and more closed institutions. We find that these good crops index significantly and positively explain institutional development, even when controlling for religion, ethnic diversity, and legal origin. We also find that this good crops index is highly correlated with settler mortality and latitude and does not enter the institution regression significantly when these other endowment indicators are simultaneously included. We also find that when we use this good crops index as an instrumental for institutions, we confirm this paper's findings and the good crops index does not reject the test of the overidentifying restrictions, which again confirms this paper's findings.

The impact is economically substantial. For instance, Chile's settler mortality rate is 4.23 while Singapore's is 2.87 (i.e., 69 and 18 deaths per thousand, respectively). If Chile had the disease endowments of Singapore, the results suggest that this would substantially close the gap between Chile's level of institutional development (0.87) and Singapore's (1.44).²⁵ Consistent with AJR (2001) and Engerman and Sokoloff (1997), endowments importantly shape institutional development.

We reproduced the analyses in Table 3 for each of the six components of the institutions index and the index of private property rights used by La Porta et al. (1998). Specifically, we examine the connections between endowments and (i) voice and accountability, (ii) political stability and absence of violence, (iii) government effectiveness, (iv) relatively light regulatory burden, (v) rule of law, (vi) absence of graft, and (vii) the private property rights index. We confirm the results of Table 3 for each of these indicators of institutional development. In particular, settler mortality, latitude, and crops/minerals are always strongly correlated with institutional development even when controlling for legal origin, religious composition, and ethnic diversity (which are themselves significant in many of the regressions).

4.3. Do endowments explain development beyond institutions?

Thus far, the regression results indicate that endowments influence both economic and institutional development. These findings are consistent with both the geography hypothesis, which stresses that endowments directly influence work effort (Machiavelli, 1519; Montesquieu, 1748; Landes, 1998) and agricultural productivity (Myrdal, 1968; Diamond, 1997; Sachs, 2001) and therefore GDP per capita. The findings are also consistent, however, with the institutions hypothesis, which stresses that endowments influence the formation of long-lasting institutions—such as the application of private property rights protection, the operation of the rule of law, the extent of corruption, and the general degree to which the government produces rules that facilitate private interactions vis-à-vis the extent to which the government protects a small elite—that shape economic development (AJR, 2001, 2002; Engerman and Sokoloff, 1997, 2000). We now conduct regression analyses to distinguish between these two hypotheses.

4.3.1. Econometric specification and methods

To distinguish between the geography and institutions hypotheses, we run two-stage least-squares regressions with heteroskedasticity-consistent standard errors of the following form:

Second Stage : $\text{Logarithm of GDP per capita} = \alpha[\text{Institutions Index}] + \beta X + u$,

First Stage : $\text{Institutions Index} = \delta[\text{Endowments}] + \gamma X + v$.

²⁵ Specifically, $\Delta(\text{Institutions Index}) = -(0.25) * \Delta(\text{settler mortality})$. Chile's settler mortality equals 4.23 and Singapore's is 2.87. Thus, $\Delta(\text{Institutions Index}) = -(0.25) * \Delta(-1.36) = 0.34$. Since Chile's institutions index is 0.87, its new level would equal 1.21, while Singapore's is 1.44.

Table 3
Endowments and institutions: Institutions Index

Dependent variable: Institutions Index. The regressions are estimated using OLS, with heteroskedasticity consistent *P*-values in parentheses, and 72 observations. The constant is not reported. The Institutions Index averages the six Kaufman, Kraay, and Zoido-Lobaton (1999a, b) measures: (i) voice and accountability, (ii) political instability and violence, (iii) government effectiveness, (iv) regulatory burden, (v) rule of law, and (vi) graft. Settler mortality is the logarithm of annualized deaths per thousand European soldiers in the early 19th century. Latitude is the absolute value of each country's latitude, scaled between 0 and 1. Landlocked equals one if the country does not have access to the sea, and zero otherwise. Crops/minerals is a series of 11 one-zero dummy variables of whether the country has ever had the following crops and minerals: bananas, coffee, copper, maize, millet, oil, rice, rubber, silver, sugarcane, or wheat. Religion is a series of three variables, the fraction of the population that is Catholic, Muslim, or a religion that is not Catholic, Muslim, or Protestant. For Crops/Minerals and Religion, we report the *F*-test of joint significance, with the corresponding *P*-value in parentheses. Ethnolinguistic diversity is the probability that two randomly selected individuals in a country will not speak the same language. French legal origin is a dummy variable that equals one if the country has a French civil law tradition, and zero if the country has a British common law tradition.

Endowments			Control variables			R^2
Settler mortality	Latitude	Landlocked	Crops/Minerals (11 variables)	French Legal Origin	Religion (3 variables)	Ethnolinguistic Diversity
-0.34 (0.000)						0.39
-0.25 (0.000)				-0.31 (0.062)	0.62 (0.606)	-0.46 (0.029)
	2.62 (0.000)					0.24
	2.58 (0.000)			-0.35 (0.028)	4.30 (0.008)	-0.39 (0.101)
						0.51

[illegible]

X is a set of included exogenous variables, meaning they are exogenous variables that are included in the second-stage regression (i.e. French legal origin, religion, ethnic fractionalization). In some regressions, X is omitted. The error terms in the first and second-stage regressions are v and u , respectively. Endowments are considered excluded exogenous variables in that they are used as instrumental variables to extract the exogenous component of the Institutions Index but they are excluded from the second-stage regression.

Consider first the case where there are no X variables, then the regression addresses the question: does the component of the Institutions Index explained by exogenous endowments explain cross-country differences in the logarithm of GDP per capita? If α is significant, then this suggests that endowments influence economic development through institutions, which is consistent with the institutions hypothesis.

Continuing with the case where there are no X variables, the test of the overidentifying restrictions (OIR) addresses a key question: do endowments explain economic development *beyond* the ability of endowments to explain institutional development? Specifically, the OIR test has as its null hypothesis that endowments do not explain u , i.e., endowments do not explain the logarithm of GDP per capita beyond the ability of endowments to explain institutions. This produces a Lagrange multiplier test statistic that under the null hypothesis is distributed Chi-squared (m), where m is the number of OIRs. The number of OIRs equals the number of excluded exogenous variables minus the number of endogenous variables included as regressors in the second-stage regression.

For the case where the regressions include X , i.e., the second-stage includes non-endowment instrumental variables, the OIR test becomes a general specification test of the validity of instruments. We use these regressions with X to assess the robustness of the findings when controlling for other potential exogenous determinants of economic development.

Table 4 presents the two-state least-squares regression results, with the OIR tests, and the first-stage F -test's P -value. The first-stage F -test has as its null hypothesis that the instruments do not explain any cross-country variation in institutional development. Table 4 presents results using the Institutions Index, though also we confirm the findings for *each* of the indicators of institutional development discussed above. There are three pairs of regressions. The first pair of regressions uses Settler Mortality and Latitude as instrumental variables (excluded exogenous variables). In the first of these regressions, no X variables are included.²⁶ The second regression includes the X -variables, i.e., we include legal origin, the three religious composition variables, and ethnic diversity as included exogenous variables. The second pair of regressions adds Land Locked to the instrument set. The OIR test now examines whether Settler Mortality, Latitude, and Land Locked explain economic development beyond their ability to account for cross-country differences in the Institutions

²⁶Thus, in the OIR test, the chi-square statistics has 1 degree of freedom because there is one endogenous variable included as a regressor in the second stage (Institutions Index) and there are two excluded exogenous variables (Settler Mortality and Latitude).

Table 4

Endowments, institutions, and GDP per Capita: instrumental variables

Dependent variable: Logarithm of GDP per Capita in 1995. Regressions are estimated using two-stage least squares, 72 observations, with heteroskedasticity consistent P -values in parentheses. The constant is unreported. The endogenous variable in the regression is the Institutions Index, averages the six Kaufman, Kraay, and Zoido-Lobaton (1999a, b) measures: (i) voice and accountability, (ii) political instability and violence, (iii) government effectiveness, (iv) regulatory burden, (v) rule of law, and (vi) graft. The exogenous variables that are included in some of the second stage regressions are as follows. French legal origin is a dummy variable that equals one if the country has a French civil law tradition, and zero if the country has a British common law tradition. Religion is a series of three variables, the fraction of the population that is Catholic, Muslim, or a religion that is not Catholic, Muslim, or Protestant. Ethnolinguistic diversity is the probability that two randomly selected individuals in a country will not speak the same language. For Religion, the table reports the F -test of joint significance of the individual variables, with the corresponding P -value in parentheses. Oil, which equals one if the country is an oil producer. The instrumental variables, i.e., exogenous variables excluded from the second-stage regressions, potentially include the following variables. Settler mortality is the logarithm of annualized deaths per thousand European soldiers. Latitude is the absolute value of each country's latitude. Landlocked equals one if the country does not have access to the sea, zero otherwise. Crops/minerals is a series of 10 one-zero dummy variables of whether the country has ever had the following crops/minerals: bananas, coffee, copper, maize, millet, rice, rubber, silver, sugarcane, or wheat.

Institutions Index	Second stage (included exogenous)			Test of overidentifying restrictions		First-stage information		First-Stage F -test (P -value)
	French Legal Origin	Religion (3 variables)	Ethnolinguistic Diversity	Oil	P -value reported	Instruments	Settler mortality, Latitude	
2.19 (0.000)					(0.393)	Settler mortality, Latitude		(0.000)
2.10 (0.000)	0.23 (0.513)	2.55 (0.063)	-0.13 (0.720)		(0.097)			(0.000)
2.22 (0.000)					(0.393)	Settler mortality, Latitude, Landlocked		(0.000)
2.14 (0.000)	0.24 (0.487)	2.55 (0.063)	-0.10 (0.782)		(0.066)			(0.000)
2.19 (0.000)				1.56 (0.001)	(0.181)	Settler mortality, Latitude, Landlocked, Crops/Minerals (10 variables)		(0.000)
2.22 (0.000)	0.27 (0.388)	1.79 (0.157)	-0.26 (0.431)	1.47 (0.000)	(0.429)			(0.000)

Index.²⁷ Finally, the last pair of regressions adds eleven Crops/Minerals instruments to Settler Mortality, Latitude, and Land Locked. Here we examine whether endowments—defined very broadly—explain current levels of economic development beyond their ability to explain institutional development. Again, there are two regressions for this last pair of regression: a regression with no X-variables included and a regression with X-included. Note we include Oil in the second stage. We do this because Oil independently explains cross-country differences in the logarithm of GDP per capita beyond any impact on institutions in all of the regressions that we assessed. We recognize this explicitly by including it in the second stage. The phenomenon of states that are rich solely because they have large oil reserves is well known.²⁸ We do not, however, believe that this finding importantly distinguishes between the geography, institutions, or policy hypotheses.

4.3.2. Results

The exogenous component of the Institutions Index significantly explains economic development, which is consistent with the institutions hypothesis. The Institutions Index enters significantly at the one-percent level in *all* of the regressions given in Table 4. The results are robust to controlling for legal origin, religious composition, and ethnic diversity. The strong positive impact of institutional development on economic development is also robust to alterations in the instrumental variable set. Furthermore, the instrumental variables are valid: they are highly correlated with the Institutions Index, as illustrated by the *P*-value of the first-stage *F*-test, and the OIR test does not reject the hypothesis that the instruments can be excluded from the second-stage regression.

The coefficient on the Institutions Index is remarkably consistent across the various specifications in Table 4 and economically large. For instance, the regression coefficients indicate that if Mexico exogenously improved its level of institutional development from about the sample mean (−0.07) to the level in the United States, this would eliminate the huge GDP per capita gap between the two countries.²⁹ While these experiments are for illustrative purposes only, they do provide an empirical sense that the impact of institutional development on economic development is substantial, which supports the institutions hypothesis.

The results given in Table 4 indicate that endowments do not explain economic development beyond the ability of endowments to explain institutional development. Specifically, when considering the regressions that only include endowment indicators—Settler Mortality, Latitude, Land Locked, and Crops/Minerals—as

²⁷ For this second pair of regressions, the OIR test has two degrees of freedom: three excluded exogenous variables minus one endogenous regressor in the second state.

²⁸ We mean here oil states that are so abundantly endowed with oil that it increases their income. There is also a literature on how intermediate levels of oil resources are often squandered and can lead to vicious competition for rents. We do not address this latter literature.

²⁹ Specifically, $\Delta(\log \text{GDP per Capita}) = (2.1) * \Delta(\text{Institutions Index})$ from the second regression in Table 4. Since Mexico's Institution Index is −0.07 and the U.S.'s is 1.29, the $\Delta(\text{Institutions Index})$ equals 1.36. Plugging values in yields the following: $\Delta(\log \text{GDP per Capita}) = (2.1) * \Delta(1.36) = 2.86$. Since Mexico's log of GDP per Capita is 8.13, its new level would equal 10.99, while the U.S.'s is 10.28.

instrumental variables, the data never reject the hypothesis that endowments only explain the logarithm of GDP per capita through their ability to explain institutional development. (Nor do the results change when we use Frankel-Romer natural openness as an endowment variable.) That is, the OIR-test is never rejected at standard confidence levels. Even when including the X-variables, we do not reject the OIR-test at the 5 percent level, which means we do not reject the validity of the instruments. As noted above, Oil helps explain economic development directly: countries that have produced oil have higher levels of economic development beyond the ability of oil to explain institutional development. We do not view this as support for the geography hypothesis relative to an interesting alternative view. The geography hypothesis focuses on the impact of disease and climate on labor productivity and technological change. We do not believe the proponents of the geography hypothesis will be comforted by the observation that oil is positively associated with economic development; moreover, we do not believe that proponents of the institutions hypothesis will view the significance of the Oil dummy as rejecting the institutions hypothesis.

In sum, the results in Table 4 provide strong support for the institutions hypothesis but no evidence for the geography hypothesis. Endowments explain institutions, which in turn explain economic development. The data fail to reject the hypothesis that endowments only explain cross-country differences in the level of economic development through the ability of endowments to explain institutional development.

4.4. Do macro-policies matter after accounting for endowments?

Next, we examine whether major, macroeconomic policies—inflation, trade policies, and impediments to international transactions as reflected in real exchange rate overvaluation—help explain current levels of economic development. We do this in two steps. First, we treat the macroeconomic policy indicators, which are averaged over the last four decades as exogenous. Simultaneity bias may bias these results towards finding a significant statistical relationship between policies and economic development if economic success tends to produce better policies. Second, we treat the macroeconomic policy indicators as endogenous; we use instrumental variables to control for potential simultaneity bias. Using these two methods, we assess whether macroeconomic policies explain cross-country differences in economic development.

The evidence suggests that macroeconomic policies do not help account for economic development after accounting for the impact of institutions on the level of economic development. In Table 5, the policy variables are treated as included exogenous variables. The Institutions Index enters all of the regression significantly. Furthermore, the coefficient size on the Institutions Index is essentially unchanged from Table 4, which did not include policy indicators. Thus, even after controlling for macroeconomic policies, endowments explain cross-country differences in economic development through their ability to account for cross-country differences in institutional development. Furthermore, the data never reject the OIR-test. The

Table 5
Policies, endowments and institutions: policies treated as exogenous

Dependent variable: logarithm of GDP per capita in 1995. Regressions are estimated using two-stage least squares, with heteroskedasticity consistent *P*-values in parentheses. The constant is unreported. The endogenous variable in the regression is the Institutions Index, averages the six Kaufman, Kraay, and Zoido-Lobaton (1999a, b) measures: (i) voice and accountability, (ii) political instability and violence, (iii) government effectiveness, (iv) regulatory burden, (v) rule of law, and (vi) graft. Three policy variables: Inflation equals the average annual inflation rate 1960–1995, Openness equals years that the country has been open to trade, and Real Exchange Rate Overvaluation equals the average real exchange rate overvaluation, 1960–1995. The exogenous variables that are included in some of the second-stage regressions are as follows. French legal origin is a dummy variable that equals one if the country has a French civil law tradition, and zero if the country has a British common law tradition. Religion is a series of three variables, the fraction of the population that is Catholic, Muslim, or a religion that is not Catholic, Muslim, or Protestant. Ethnolinguistic diversity is the probability that two randomly selected individuals in a country will not speak the same language. For Religion, the table reports the *F*-test of joint significance of the individual variables, with the corresponding *P*-value in parentheses. The instrumental variables, i.e., exogenous variables excluded from the second-stage regressions are as follows. Settler Mortality is the logarithm of annualized deaths per thousand European soldiers. Latitude is the absolute value of each country's latitude.

Endogenous Institutions Index	Second-stage results (included exogenous variables)							Test of overidentifying restrictions	Obs.
	Policy variables			Other exogenous variables					
	Inflation	Openness	Real Exchange Rate Overvaluation	French Origin	Legal	Religion (3 variables)	Ethnolinguistic Diversity		
2.11 (0.000)	0.50 (0.158)							(0.495)	66
2.03 (0.000)	0.06 (0.883)			0.23 (0.538)		2.21 (0.097)	−0.15 (0.705)	(0.135)	66
2.20 (0.000)		−0.22 (0.743)						(0.269)	70
1.95 (0.000)		0.22 (0.663)		0.15 (0.643)		2.59 (0.061)	−0.15 (0.690)	(0.097)	70
2.09 (0.000)			0.00 (0.934)					(0.461)	64
1.95 (0.000)			0.00 (0.225)	0.24 (0.556)		2.35 (0.082)	−0.08 (0.827)	(0.181)	64
2.05 (0.000)	0.55 (0.129)	−0.11 (0.855)	0.00 (0.744)					(0.384)	64
1.78 (0.000)	0.25 (0.493)	0.27 (0.582)	0.00 (0.174)	0.23 (0.545)		2.42 (0.076)	−0.16 (0.676)	(0.194)	64

policy indicators never enter the regressions significantly. Inflation, Openness, and Real Exchange Rate Overvaluation never enter with a P -value below 0.10. Moreover, even when they are included together, the data do not reject the null hypothesis that the three policies all enter with coefficients equal to zero, which is shown using the F -test on the three policy variables.

When using instrumental variables for the policy indicators, we again find that macroeconomic policies do not explain economic development. Specifically, we fail to reject that hypothesis that macroeconomic policies have zero impact on economic development after accounting for the impact of endowments and institutions. In Table 6, we add an additional excluded exogenous variable to the set of instruments. We use ethnolinguistic diversity since Easterly and Levine (1997) and La Porta et al. (1999) find that ethnolinguistic diversity helps explain cross-country differences in government policies. As noted earlier, the instrumental variables explain a significant amount of the cross-country variation in the Institutions Index. In the first-stage regressions for policy, we find that the instruments explain a significant amount of the cross-country variation in Openness and Real Exchange Rate Overvaluation at the 0.01 significance level. However, the instruments do not do a very good job of explaining cross-country variation in Inflation, i.e., we fail to find evidence that the instruments explain average inflation rates over the last four decades at the 0.01 significance level. As shown, the policy variables never enter significantly. While the exogenous component of the Institutions Index (i.e., the component defined by endowments) continues to significantly account for international differences in the level of GDP per capita, the macroeconomic policy indicators do not add any additional explanatory power.

5. Conclusions

In sum, measures of tropics, germs, and crops explain cross-country differences in economic development through their impact on institutions. To answer some of the questions in the introduction, if Burundi's endowments had been like those of Canada, it would have increased Burundi's income per capita *through institutions* by a factor of 38.³⁰ Recalling the 107-fold difference between Canada and Burundi's income, we can say that a variation of 38 times is explained by our story, while variation by a factor of 2.8 (107/38) is unexplained. (In log terms, 78 percent of the log income difference between Canada and Burundi is explained.)

Consistent with AJR (2001) and ES (1997), tropics, germs, and crops do not explain economic development beyond their impact on institutions. These findings are consistent with the institutions hypothesis and inconsistent with the geography hypothesis. Furthermore, policies do not explain cross-country differences in GDP per capita once one controls for the impact of endowments on institutions and on economic development. Thus, the results are inconsistent with the policy hypothesis

³⁰ We do this exercise using only settler mortality and latitude as endowments for institutions, using the regression coefficients discussed above.

Table 6
Policies, endowments and institutions: policies treated as endogenous

Dependent variable: logarithm of GDP per capita in 1995. The endogenous variables in the regression are: (1) the Institutions Index, which averages the six **Kaufman, Kraay, and Zoido-Lobaton (1999a, b)** measures: (i) voice and accountability, (ii) political instability and violence, (iii) government effectiveness, (iv) regulatory burden, (v) rule of law, and (vi) graft, and (2) one of the three policy variables: inflation, trade openness, or real exchange rate overvaluation. Three policy variables: Inflation equals the average annual inflation rate 1960–1995, Openness equals years that the country has been open to trade, and Real Exchange Rate Overvaluation equals the average real exchange rate overvaluation, 1960–1995. The exogenous variables that are included in some of the second-stage regressions are as follows. French legal origin is a dummy variable that equals one if the country has a French civil law tradition, and zero if the country has a British common law tradition. Religion is a series of three variables, the fraction of the population that is Catholic, Muslim, or a religion that is not Catholic, Muslim, or Protestant. For Religion, the table reports the *F*-test of joint significance of the individual variables, with the corresponding *P*-value in parentheses. The instrumental variables, i.e., exogenous variables excluded from the second-stage regressions, are as follows. Settler Mortality is the logarithm of annualized deaths per thousand European soldiers. Latitude is the absolute value of each country's latitude. Ethnolinguistic diversity, is the probability that two randomly selected individual in a country do not speak the same language.

Institution	Second-stage results				Test of overidentifying restrictions		Obs.
	Policy Variables			Included exogenous variables		<i>P</i> -value reported	
	Inflation	Openness	Real Exchange Rate Overvaluation	French Legal Origin	Religion (3 variables)		
2.21 (0.000)	4.14 (0.231)					(0.677)	66
1.92 (0.000)	−7.10 (0.493)			0.11 (0.831)	1.59 (0.201)	(0.597)	66
1.83 (0.002)		1.13 (0.491)				(0.126)	70
1.51 (0.007)		2.24 (0.166)		0.27 (0.418)	3.97 (0.012)	(0.627)	70
2.10 (0.001)			0.00 (0.983)			(0.083)	64
1.42 (0.025)			−0.02 (0.318)	0.51 (0.394)	2.36 (0.081)	(0.633)	64

Dependent variable: logarithm of GDP per capita in 1995. The endogenous variables in the regression are: (1) the Institutions Index, which averages the six Kaufman, Kraay, and Zoido-Lobaton (1999a, b) measures: (i) voice and accountability, (ii) political instability and violence, (iii) government effectiveness, (iv) regulatory burden, (v) rule of law, and (vi) graft, and (2) one of the three policy variables: inflation, trade openness, or real exchange rate overvaluation. Three policy variables: Inflation equals the average annual inflation rate 1960–1995, Openness equals years that the country has been open to trade, and Real Exchange Rate Overvaluation equals the average real exchange rate overvaluation, 1960–1995. The exogenous variables that are included in some of the second-stage regressions are as follows. French legal origin is a dummy variable that equals one if the country has a French civil law tradition, and zero if the country has a British common law tradition. Religion is a series of three variables, the fraction of the population that is Catholic, Muslim, or a religion that is not Catholic, Muslim, or Protestant. For Religion, the table reports the *F*-test of joint significance of the individual variables, with the corresponding *P*-value in parentheses. The instrumental variables, i.e., exogenous variables excluded from the second-stage regressions, are as follows. Settler Mortality is the logarithm of annualized deaths per thousand European soldiers. Latitude is the absolute value of each country's latitude. Ethnolinguistic diversity, is the probability that two randomly selected individual in a country do not speak the same language.

but consistent with a view that stresses the role of endowments in shaping long-lasting and defining institutions.

There is a large literature that relates cross-country differences in per capita *growth rates* to economic policies. How do we relate our present findings on income *levels* to this literature? It could be that episodes of bad policies are associated with a temporary decrease in income, which shows up in the growth rate over a limited period, but leave no long run impact on the income level (Bruno and Easterly, 1998, made this argument for inflation and output).

It could also be that bad policies are proxying for poor institutions, in those cases where they are not included in the growth regression. The policy implication of this latter explanation is that bad policies are only symptoms of longer-run institutional factors, and correcting the policies without correcting the institutions will bring little long-run benefit. Bad policies would be like a kind of high fever from a bacterial infection. Packing the patient in ice would bring down the fever but does not cure the infection. This kind of story could help explain the disappointing results in developing countries to the wave of macroeconomic policy reforms in the 1990s (Hausmann and Rodrik, 2002; Easterly, 2001).

We acknowledge the caveats that one should not put all one's weight on a failure to reject a zero coefficient or an exclusion restriction. Nor does the kind of general indicator of institutional quality we use, while representing a valuable contribution by Kaufmann et al. (1999a) provide much actual guidance to officials making real laws and regulations. This kind of result should be tested and illumined further with detailed historical case studies of institutional development like those conducted by Engerman and Sokoloff (1997) and coauthors, studies of the links between colonial experiences and later developments (Mamdani, 1996), and contemporary case studies like those in Rodrik (2002). These kind of cross-country results are only a beginning to telling the story of colonial experiences, political conflict and consensus, institution-building, and economic development for each unique case. Still, we are struck by the way that endowments and policies have no independent effect once we control for institutions, contrary to a number of stories, and that institutional quality seems to be a sufficient statistic for accounting for economic development.

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