Disease, Institutions and Underdevelopment

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Abstract

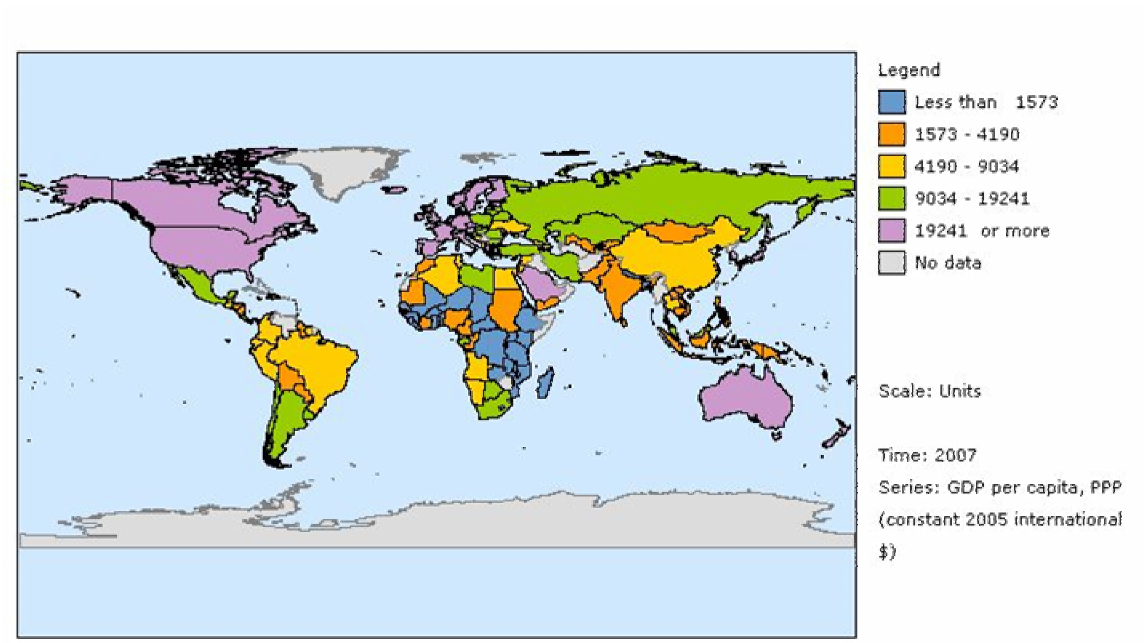
What explains poverty of Sub Saharan Africa and South Asia? One view holds the disease environment of these regions as the primary culprit. Others see it as a typical symptom of growth retarding institutions. We test validity of these competing assertions for a cross section of countries. Our results indicate that institutions are the prime determinant of economic performance of countries. Disease does not play a significant role in determining outcomes. On the contrary, we find support for the indirect effect of disease via institutions, as asserted by the 'institutions school'. Interestingly, the 'institutions school' contention about geography having *no direct effect* on income is also not validated. Our results show that being land locked can pose significant disadvantage for a country. Endowment of hydrocarbon, however, is beneficial for economic outcomes.

Key words: Economic Performance, Institutions, Disease.
JEL Classification: I10, O43,

I. Introduction

World poverty has a geographical milieu. It is specifically concentrated in certain parts of the world, namely Africa and Southern Asia. Of the 36 countries having average per capita income less than 1573[1], 30 are in Sub-Saharan Africa (SSA), two are in South Asia [World Development Indicators 2007]. [2] Countries in the lowest 10th percentile of the world income distribution, with the exception of Myanmar, are all in SSA.

Fig. 1: Geographic Distribution of the Per Capita Income of the World

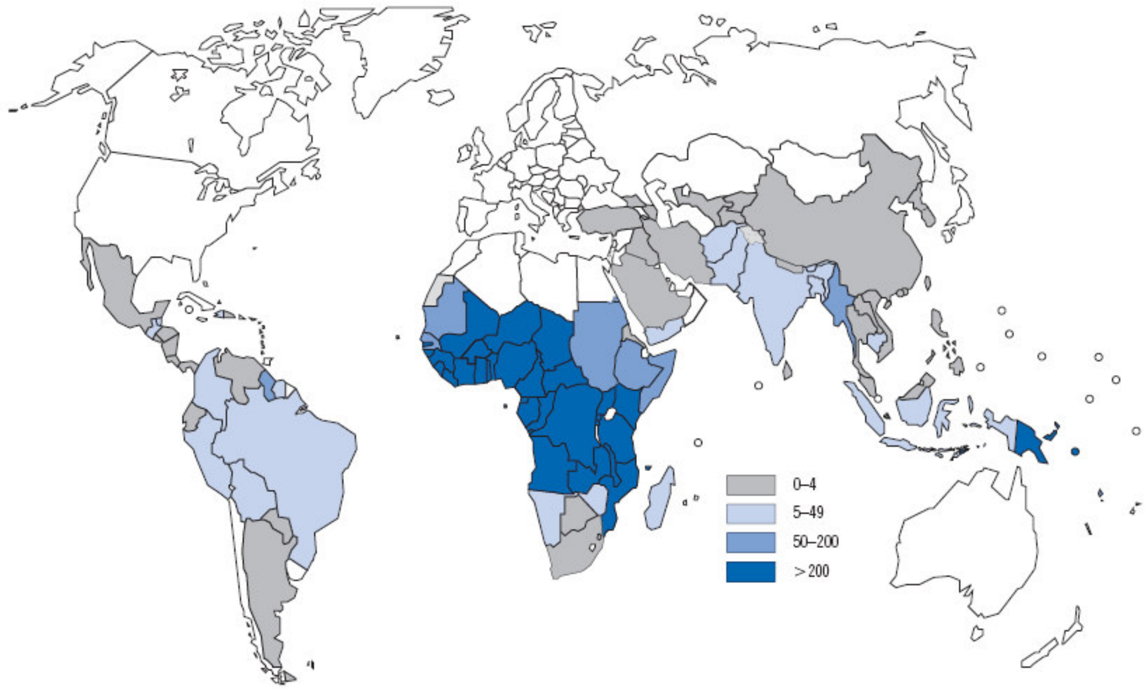


Source: World Development Indicators, World Bank (2007)

These regions are also burdened with high incidence of epidemic diseases. Take, for example, the case of Malaria[3]. Of the 30 high burden countries in the world, 20 are in SSA, 3 are in SA [WHO (2008)]. The richest countries in the world are all Malaria free.

[1] This cut off point is based on World Development Indicators classification.
[2] The other four countries are Myanmar, Haiti, Cambodia [East Asia and Pacific] and Tajikistan.
[3] According to World Malaria Report 2008, almost 3 billion people are at risk of infection. About 250 million cases are reported annually, causing one million deaths annually.

Fig. 2: Estimated Incidence of Malaria per 1000 Population, 2006



Source: World Malaria Report, WHO (2008)

Is this a mere coincidence or could disease ecology be one possible explanation behind the vast differences in the economic performance of regions? An influential school of thought argues that this indeed is the case[4]. Countries afflicted with intensive malaria are on average poorer than countries without malaria [Gallup and Sachs (2000)].[5]

This view is contested by an equally eminent school of thought who considers institutions as the prime determinant of economic performance. They argue that disease ecology has no direct effect on incomes; rather, its effect operates through institutions. Specifically, Acemoglu *et al* (1999) provide evidence that disease affects income only

[4] See Bloom and Sachs (1998), Gallup, Sachs and Mellinger (1999), Gallup and Sachs (2000), Sachs (2003), Chakraborty, Papageorgiou and Perez-Sebastian (2005), Gundlach (2004), Presbitero (2006), Gollin and Zimmermann (2007) for evidence of malaria on economic growth. This line of thinking belongs to a larger body of literature which treats 'geography as destiny' and argues that economic prosperity is strongly correlated with geographical and ecological measures [Sachs (2003)]. These regions are poor because they are endowed with resources (disease ecology, soil, water) which impede growth. See Hasan (2007) for a review of 'geography school of thought'.

[5] The average income of countries with malaria was $1526 in 1995 as compared to an average income of $8268 for countries without malaria (*ibid*).

indirectly via its effect on institutions.[6] This paper tests these alternative theories about differences in economic performance of regions. It is structured as follows. Section II gives an overview of underdevelopment. Section III discusses methodology. Section IV presents results. We conclude in the final section.

II. Understanding Underdevelopment: Disease Ecology versus Institutional Environment

Why is poverty concentrated in Africa and South Asia? Are these regions poor because of their location? This peculiar spatial distribution of poverty has encouraged researchers to focus on the role of geographic factors in economic performance of regions. Disease ecology is cited as one reason why certain regions lag behind others. Disease affects economic growth through a number of channels. Firstly, reduced life expectancy incurs enormous economic losses to the society due to shortened lives.[7] Second link operates through the low human capital formation due to under-investment at household level.[8] Third is the depressing effect of morbidity on individual productivity. Moreover, sickness in early childhood causes absenteeism from school, attention deficiency and hence affects cognitive skills [Commission on Macroeconomics and Heath].

A number of research studies confirm the effect of disease on incomes. Gallup and Sachs (2000) contend that countries with intensive malaria had 33 percent lower incomes than countries without malaria.[9] In a cross-country regression for the period 1965-90, they found that countries with intensive malaria grew 1.3% less per person per year, and a reduction in malaria by 10% increased growth by 0.3% [Gallup and Sachs (2000)].

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[6] Using colonisation of countries as a natural experiment, they argued that countries where European colonizer could not settle because of hostile disease environment resulting in high settlers mortality experienced extractive institutions. Whereas countries where they could settle in large numbers owing to more adaptable living conditions saw development of efficient institutions.

[7] Endemic fatal diseases like malaria strike scores of individuals in the prime of their working life, reducing over all economic growth.

[8] High rates of infant and child mortality induces parents to have large family (to compensate for the death of children) leaving them with little resources to invest on their surviving children.

[9] Zimmerman and Gollin (2007) suggest that about half of this income gap can be explained by the disease alone.

Bloom and Sachs (1998) argue that people living in the tropics have lower life expectancies at birth, which is "highly predictive of slow economic growth" [Bloom and Sachs (1998): 228].[10] Based on several cross-country studies, Commission on Macroeconomics and Heath suggests that a 10 percent improvement in life expectancy at birth increases growth rate by 0.3 to 0.4 percent per annum [Commission on Macroeconomics and Heath: 24]. Masters and Sachs (2001) estimated a simultaneous equation model to test the impact of physical geography on economic growth. Their estimates suggest a very strong impact of disease (malaria) prevalence, which lowers incomes by 74%. The effect remains significant even after controlling for other diseases. Chakraborty, Papageorgiou, and Sebasti´an (2005) conclude that the effects of disease are significant and health interventions are needed to put countries with high disease burden on a path of high-growth. In India, malaria eradication increased literacy and primary school completion rates by 12 percentage points [Cutler *et al* (2007)]. Finlay (2007) also reports significant indirect effect of health on growth. McCarthy, Wolf and Wu (2000) suggest relationship between growth and disease is robust to inclusion of other control variables as well as controlling for reverse causation.

Malaria Ecology

Malaria has complex epidemiology. Its transmission requires interaction among humans, mosquitoes and parasites. It is caused by the family of Plasmodium parasites, which has four species: *P. falciparum*, *P. Malariae*, *P. ovale* and *P. vivax*. Among these, *P. falciparum* is the deadliest. The parasite is transmitted to human body by means of a mosquito vector (host). The malaria vector includes about a hundred species of genus *Anopheles*. The distribution of *Anopheles* mosquitoes varies greatly across the world. The most efficient vectors for transmitting malaria to humans are *An. gambiae and An. funestus*. Unfortunately Africa has the most efficient mosquito vector *Anopheles gambiae s. s.* and the most fatal malaria strain *P. falciparum.* This explains why Africa suffers from most severe malaria. The most efficient mosquito vector in Western Europe feeds on cattle and is not anthropophilic.
Source: Bloom and Sachs (1998), Gallup and Sachs (200), Sachs (2003) and Gollin and Zimmermann (2007).

This emphasis on disease as a *prime* reason behind poverty of nations does not enjoy universal support. A large body of literature exists that links economic performance of countries to the prevailing institutional environment [rule of law, constitutional government, impartial courts, security of life, property, and contract], contending that

[10]They further argue that effect runs through disease ecology (and nutrition) as the burden of vector-born infectious diseases (e.g. malaria) is much higher in the tropics.

"*Good institutions, it appears, can overcome geographical constraints and lousy initial conditions*" [Rodrik (2003): 12].

Acemoglu, Johnson and Robinson (2007) and Acemoglu and Johnson (2003) hold disease environment (and health conditions) as important for economic performance. Their point of departure from the 'geography school' is in their assertion that disease has no direct impact on incomes; rather, its effect operates indirectly via institutions. Earlier, they presented the 'germs theory' of institutional development according to which European colonizers established efficient institutions in places where they found favourable disease environment and extractive institutions where high mortality rates rendered areas as unsuitable for settlement [Acemoglu, Johnson, and Robinson (2001)]. Their results suggest that institutions explain a large [about three quarter] part of differences in economic performance of regions; geography variables had no effect on income in their specification.

Looking at the anecdotal evidence – differences in the economic performance of North and South Korea despite sharing same geography; economic growth of Singapore, Mauritius, and Australia (having a large area in the tropics) despite their location; the success story of Botswana despite unfavourable disease environment and being land locked – all point to the fact that ''Geography is not destiny' [Rodrik (2003): 12]. Birdsall comments, 'Africa is caught in an institutional trap, signaled and reinforced by the small share of income of its independent middle strata' [Birdsall (2007): 575].

The evidence about the effect of disease and institutions on incomes is at best mixed. While this discussion about the 'fundamental' causes of development continues, studies suggest that both disease ecology and institutions may be important for growth [Gundlach (2006)], and that disease, despite its direct effect on incomes, may not be destiny [McCarthy, Wolf, and Wu (2000)].[11] Funke and Zuo (2003) suggest further work into the inter-relationship is needed.

III. Methodology

[11] McCarthy, Wolf, and Wu (2000) found statistically significant impact of disease on growth. They suggest that tropical location is not destiny; healthcare access and income equality affects malaria morbidity.

Most empirical on studies on growth rely on the 'proximate' causes [human and capital accumulation, productivity] to explain enormous differences in economic performance across countries. More recently, a strand of research has emerged that explains these differences in terms of the 'deeper determinants' of growth [Rodrik, *et al.* (2004), Bloch and Tang (2004), Przeworski (2004), and Woods (2004)]. The argument being that accumulation of human and physical capital and their productivity is dependent on the deeper, more fundamental sources of development. These deeper determinants include institutions and geography, though trade is also included occasionally. These studies employ a simple model whereby income levels [measures of economic development] are regressed upon institutions and geography variables to discern their individual effect. A particular model is represented by the equation below:

$$Income = \mu + \alpha Institutions_i + \beta Geography_i + X_i'\gamma + \varepsilon_i \qquad (1)$$

Where X_i' represents other control variables.

The present paper adopts the above model, using malaria as the geography variable resulting in the following equation:

$$Log(y_i) = \mu + \alpha INST_i + \beta Malaria_i + X_i'\gamma + \varepsilon_i \qquad (2)$$

Where y_i is per capita income in international dollars for country i, $INST_i$ is the measure of institutions and $Malaria_i$ is the measure for malaria prevalence for country i. X_i' is a vector of control variables that affect other variables. Our coefficient of interest are α and β. Since there is no consensus in literature about the direct effect of malaria on income, we test null hypothesis: H_0: $\beta = 0$.

Further, since institutions and malaria cannot be assumed to be independent of income,[12] we employ a two stage least squares method of estimation. Our preferred instrument for institutions variable is fraction of population speaking English

[12] A higher level of income can make better institutions more affordable. It can also make investments in malaria control more viable.

(ENGFRAC), originally used by Hall and Jones (1999). This instrument is widely used in studying impact of institutions on income. Acemoglu *et al* (1999) have used log of settlers' mortality as an instrument for institutions but data on that instrument is limited to 64 countries, which restricts the sample and results in loss of viable information. Secondly, their theory – European colonizer established efficient institution in areas where they could settle in large numbers and extractive institutions in areas where they faced high mortality – works well for countries that experienced colonization but is not relevant for countries that were never colonized. For malaria variable we use ME (malaria ecology) as the instrument. Malaria ecology combines data on temperature, mosquito abundance and vector into a single measure, and is highly predictive of population at risk of malaria [Sachs (2003)]. In the first stage institutions and malaria are regressed on all exogenous variables.

$$INST = \phi + \varphi ENGFRAC_i + \psi ME_i + \theta X_i' + \varepsilon_{INSi} \qquad (3)$$

$$Malaria = \sigma + \delta ENGFRAC_i + \omega ME_i + \upsilon X_i' + \varepsilon_{Malriai} \qquad (4)$$

The study uses cross section data for 207 countries. Log of per capita GDP in 2005 measured in international dollar [PPP] is taken as a measure of income. We use Rule of Law Index for the year 2005 from Kaufmann, Kraay, and Zoido-Lobaton (2007) as our measure of institutions. Rule of Law measures "the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence" [*ibid*: 4]. Malaria refers to proportion of each country's population that live with risk of malaria transmission, multiplied by an estimate of the proportion of national malaria cases that involve the fatal species, Plasmodium falciparum and was developed by Sachs (2003). ENGFRAC, our instrument for the institutions variable, is from Hall and Jones (1999). ME was developed, and used as instrument for Malaria, by Kiszewski *et al.* (2004). Further details about variables and data sources are presented in appendix table 1. Table 1 gives summary statistics. Democratic Republic of Congo has the lowest income and Qatar has the highest in our sample. Iceland has the best score on Rule of Law index while Somalia performs the worst.

IV. Estimation Results

We employ Two Stage Least Squares [2SLS] method to estimate equation (2). Table 2 reports whether our variables of interest (Rule of Law and Malaria) have any effect on income. Column 1 of Table 2 reports 2SLS estimate of regressing income on Rule of Law using ENGFRAC as an instrument. The results indicate that Rule of Law has a direct and strong positive impact on income. F-statistics in panel B confirms that ENGFRAC can be used as an instrument. R-square for first stage however remains low. Column 2 reports that Malaria too has a strong negative impact on incomes, though its explanatory power is less when compared to that of Rule of Law. Nevertheless, it seems obvious that Rule of Law [the institutions hypothesis], as well as Malaria [the geography hypothesis][13], is relevant for explaining cross country variation in incomes. Next we test the strength of these variables when they are included in the regression equation simultaneously. Column 3 reports that both coefficients are significant and have expected signs. Disease ecology not only has a direct effect on income, but also affects it indirectly via influencing institutions [Column 3, Panel B]. Inclusion of malaria ecology [ME] in the first stage for institutions considerably improves explanatory power as R-square jumps three fold. This result suggests that both point of views about causes of development stand validated. In the next couple of tables we include additional control variables to test robustness of these results.

Table 3 includes a number of geography variables that are known to affect income [Columns 1-8]. Addition of these variables does not alter the results significantly. Both Rule of Law and Malaria maintain their expected signs and significance. In addition, a number of geography variables – Latitude, Land lock, Tropics, Inland Population Density, Distance from Major Markets and Hydrocarbons – are also significant. The only exceptions are Temperate and Coastal Land, which do not have any significant effect on income; though they have a strong effect on institutions as evident from respective first stage regressions. Many geography variables [Latitude, Tropics, and Distance from Major Markets] have both a direct and an indirect effect [through institutions] on incomes. To make more sense of these results, being either land locked [Column 2] or

[13] We call it the 'geography hypothesis' as this argument belongs to the strand of research advocating a strong and direct effect of geography on incomes.

having a large proportion of population in the inlands [Column 6], as opposed to coastal areas, is not favourable for economic outcomes of countries. It is understandable since limited access limits economic opportunities for large section of populations. Having large endowments of hydrocarbons [Column 8], contrary to resource curse hypothesis, is beneficial. Interestingly, many geography variables influence incomes through their effect on institutions. We can classify these variables in three categories: location [as measured by Latitude], climate [Tropics and Temperate], and access [Coastal Land, Distance from Major Markets]. In Column 1, Panel B we notice that ENGFRAC and Latitude together explain almost 40% of variation in institutions, though the direct effect of Latitude is not very pronounced. Similarly, Tropics, Temperate, Coastal Land and Distance from Major Markets [Column 3, 4, 5 & 7, Panel B] improve first stage estimation of institutions. In contrast, variables that have a strong direct effect on income [Land lock, Inland Population Density and Hydrocarbons] have none on institutions. ME is significant in all, except in Column 1, first stage estimation of institutions. Two things are borne out from the regressions in Table 3. First, most geography variables have a direct effect on incomes, validating the 'geography hypothesis'. Second, many of these variables have only a small direct effect, but a strong indirect effect [via institutions]. This is more in line with the 'institutions hypothesis', though it refutes any direct effect of geography on incomes.

Could it be taken to mean that both institutions and malaria are the fundamental determinants of economic performance? In Table 4 we add some additional control variables that are known to have significant explanatory powers in growth regressions. Inclusion of regional dummies changes the results dramatically. Malaria variable loses its significance in all cases [Columns 1 – 8]. All other geography variables, with the exception of Land lock [Column 3] and Hydrocarbons [Column 7] lose their significance in the second stage of estimation [Panel A]. Rule of Law not only retains its significance, its impact is also little disturbed. It is interesting to note that many geography variables – Latitude, Tropics, and Coastal land continue to effect institutions, confirming the assertion by the 'institutions school' that geography affects income indirectly via its influence on institutions. What conclusion can we draw from here? First, the 'disease hypothesis' is no more valid. Malaria has no direct effect on income. Second, the institutions hypothesis stands verified. Its assertions that: (1) institutions are the fundamental reason for variations in economic outcomes; (2) disease affects incomes only indirectly via its effect through institution; are borne out by empirical evidence provided in Table 4. One caveat, however, remains; some aspects of geography – Land locked and Hydrocarbons – continue to have a first order effect on incomes.

Notice that Latitude, Tropics and Coastal land, along with ME, are relevant for the first stage for institutions even after inclusion of regional dummies. This highlights the need to explore the role of geography [location, climate and access] in shaping institutional environments in greater detail. One cannot overemphasize the importance of this avenue of research since currently used instruments [ENGFRAC] explain only a fraction of variation in institutions.[14] Our results indicate that inclusion of geography variables in the first stage estimation for institutions increases goodness of fit remarkably well. This finding, however, is only preliminary. Further research is needed in this area.

V. Conclusion

The poorest of countries are located in Sub-Saharan Africa and South Asia. These countries also carry a disproportionate burden of endemic diseases like malaria. This geographic concentration of underdevelopment has led many to ascribe it to the disease environment of the country. We test validity of this assertion against the competing hypothesis about primacy of institutions for a cross section of countries. In the most parsimonious specification – regressing income on institutions and disease alone – both coefficients turn out to be significant. However, significance of disease is not robust to inclusion of other control variables, especially regional dummies, though it retains its significance in the presence of other geographic variables. Our results confirm that institutions have a direct effect on the economic performance of countries. Disease does not play a significant role in determining outcomes. On the contrary, we find support for the indirect effect of disease via institutions, as asserted by the 'institutions school'. Interestingly, the 'institutions school' contention about geography having *no direct effect* on income is also not validated. Our results show that being land locked can pose

[14] Log of Settler's Mortality, as expounded by Acemoglu *et al* (2001) has more explanatory power than ENGFRAC, but their theory is only relevant for ex-colonies.

significant disadvantage for a country. Endowment of hydrocarbon is beneficial for economic outcomes, though its effect is very small. One of our main finding is the relevance of geography variables in explaining variations in institutions. This finding is only preliminary and underscores the need to explore this connection further.

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Table 1: Summary Statistics

Variables	Observatio ns	Mean	Std. Deviation	Min	Max
Income	177	8.64	1.30	5.59	11.17
Institutions	198	-0.03	0.99	-2.21	2.05
Disease	163	0.31	0.42	0	1
Latitude	192	24.65	16.34	.228	64.22
Landlock	206	0.19	0.39	0	1
Coastal Land	158	0.46	0.38	0	1
Tropics	158	0.31	0.41	0	1
Temperate	158	0.29	0.41	0	1
Hydrocarbons	145	0.74	4.58	-4.61	10.59
Distance	147	4081	2429	140	9590
Density	147	67.73	118.70	0	968

Table 2

Panel A: Two Stage Least Squares				
	(1)	(2)	(3)	
Rule of Law	1.15 (6.46)**		0.91 (4.63)**	
Disease		-2.30 (-11.94)**	-1.17 (-3.36)**	
No. of obs.	167	152	152	
R-square	0.60	0.52	0.73	
Panel B: First Stage for Endogenous Variables				
Dependent Var.	Rule	Malaria	Rule	Malaria
Pop. Speaking English	1.16 (3.59)		1.02 (2.91)**	-0.14 -(1.24)
ME		0.05 (13.95)	-0.05 -(4.99)**	0.05 (13.68)**
F-statistics	12.87	194.73	19.03	98.49
R-Square	0.06	0.56	0.19	0.56

Panel A reports the second stage least squares estimates for log GDP per capita (international dollars) in 2005, and Panel B reports the corresponding first stages; t-ratios are in parentheses [** denotes significance at 5%, * denotes significance at 10%]. Column 1 and 2 test whether Rule of Law and Malaria have the ability to explain cross-country variations in income. Column 3 tests the strength of each variable when they are entered into the regression equation simultaneously.

Table 3

Panel A: Two Stage Least Squares				
	(1)	(2)	(3)	(4)
Rule of Law	0.87 (5.54)**	0.77 (4.54)**	0.83 (6.09)**	0.92 (4.83)**
Malaria	-1.46 (-4.37)**	-1.29 (-4.38)**	-1.42 (-5.19)**	-1.25 (-3.98)**
Latitude	-0.01 (-1.91)*			
Land Lock		-0.48 (-3.37)**		
Tropics			0.26 (1.66)*	
Temperate				-0.12 (-0.52)
No. of observations	144	152	147	147
R-square	0.73	0.76	0.74	0.73

Panel B: First Stage for Endogenous Variables								
Dependent Var.	Rule	Malaria	Rule	Malaria	Rule	Malaria	Rule	Malaria
Pop. Speaking English	1.03 (3.41)**	-0.16 (-1.57)	0.96 (2.73)**	-0.14 (-1.22)	1.22 (3.93)**	-0.19 (-1.86)*	0.92 (3.39)**	-0.12 (-1.21)
ME	-0.01 (-0.98)	0.03 (9.12)**	-0.05 (-4.90)**	0.05 (13.60)**	-0.03 (-3.30)**	0.04 (12.10)**	-0.02 (-2.54)*	0.04 (11.88)**
Latitude	0.03 (7.26)**	-0.01 (-6.33)**						
Land Lock			-0.20 (-1.13)	0.002 (0.03)				
Tropics					-0.96 (-5.65)*	0.24 (4.30)**		
Temperate							1.35 (8.91)**	-0.29 (-5.26)**
F-statistics	34.04	89.46	13.13	65.22	27.27	81.72	47.56	89.06
R-square	0.41	0.64	0.19	0.56	0.35	0.62	0.49	0.64

Panel A reports the second stage least squares estimates for log GDP per capita (international dollars) in 2005, and Panel B reports the corresponding first stages; t-ratios are in parentheses [** denotes significance at 5%, * denotes significance at 10%]. Columns 1 – 4 add geography variables [Latitude, Land Lock, Tropics and Temperate] as additional control variables to check the robustness of Rule of Law and Malaria.

Table 3 Continued

Panel A: Two Stage Least Squares

	(5)	(6)	(7)	(8)
Institutions	0.86	0.89	0.90	0.78
	(4.10)**	(5.12)**	(6.01)**	(5.02)**
Malaria	-1.15	-1.36	-1.18	-1.22
	(-3.39)**	(-4.55)**	(-3.93)**	(-4.62)**
Coastal Land	0.30			
	(1.27)			
Inland Population Density		-0.001		
		(-4.89)**		
Distance from Major Markets			-0.00004	
			(-1.69)*	
Hydrocarbons				0.06
				(5.11)**
No. of observations	147	140	140	138
R-square	0.74	0.78	0.78	0.82

Panel B: First Stage for Endogenous Variables

Dependent Var.	Rule	Malaria	Rule	Malaria	Rule	Malaria	Rule	Malaria
Pop. Speaking English	0.85	-0.11	1.33	-0.19	1.31	-0.17	1.36	-0.17
	(2.62)*	(-1.02)	(3.61)**	(-1.54)	(3.70)**	(-1.55)	(3.64)**	(-1.47)
ME	-0.04	0.05	-0.05	0.05	-0.04	0.04	-0.05	0.05
	(-4.13)**	(12..84)**	(-4.33)**	(12.77))**	(-3.38)**	(11.86)**	(-4.63)**	(12.81)**
Coastal Land	0.78	-0.14						
	(4.01)**	(-2.17)**						
Inland Population Density			.001	-0.00004				
			(1.01)	(-0.21)				
Distance from Major Markets					-0.0001	0.00004		
					(-3.74)**	(4.46)**		
Hydrocarbons							-0.01	-0.002
							(-0.83)	(-0.34)
F-statistics	20.49	70.68	13.20	59.20	18.76	74.45	13.18	62.32
R-square	0.29	0.59	0.21	0.56	0.27	0.61	0.21	0.57

Panel A reports the second stage least squares estimates for log GDP per capita (international dollars) in 2005, and Panel B reports the corresponding first stages; t-ratios are in parentheses [** denotes significance at 5%, * denotes significance at 10%]. Columns 5 – 8 add geography variables [Coastal Land, Inland Population Density, Distance from Major Markets, and Hydrocarbons] as additional control variables to check the robustness of Rule of Law and Malaria.

Table 4

	(1)		(2)		(3)		(4)	
Panel A: Two Stage Least Squares								
Institutions	0.81 (6.17)**		0.82 (5.86)**		0.73 (5.32)**		0.79 (5.64)**	
Malaria	-0.55 (-0.94)		-0.80 (-0.90)		-0.73 (-1.34)		-0.79 (-0.96)	
Latitude			-0.01 (-0.80)					
Land lock					-0.40 (-2.82)**			
Tropics							0.15 (0.46)	
Asia Dummy	-1.12 (-5.86)**		-1.16 (-6.03)**		-1.09 (-5.90)**		-1.11 (-5.71)**	
Africa Dummy	-0.75 (-1.75)		-0.74 (-1.70)*		-0.67 (-1.65)*		-0.67 (-1.34)	
Latin America Dummy	0.06 (0.41)		0.09 (0.03)		-0.05 -(0.36)		-0.02 -(0.09)	
No. of observations	152		144		152		147	
R-square	0.77		0.77		0.79		0.77	
Panel B: First Stage for Endogenous Variables								
Dependent Var.	Rule	Malaria	Rule	Malaria	Rule	Malaria	Rule	Malaria
Pop. Speaking English	1.14 (3.51)**	-0.07 (-0.69)	1.07 (3.54)**	-0.06 (-0.68)	1.09 (3.35)**	-0.08 (-0.80)	1.20 (3.95)**	-0.10 (-1.19)
ME	-0.03 (-2.03)*	0.02 (5.54)**	-0.01 (-0.75)	0.02 (3.88)**	-0.03 (-2.09)*	0.02 (5.49)**	-0.02 (-1.34)	0.02 (4.43)**
Latitude			0.03 (4.61)**	-0.01 (-6.35)**				
Land lock					-0.21 (-1.29)	-0.05 (-1.02)		
Tropics							-0.68 (-3.45)**	0.30 (5.58)**
Asia Dummy	-0.59 (-1.69)	0.19 (1.85)	-0.31 (-0.93)	0.05 (0.57)	-0.56 (-1.61)	0.19 (1.90)*	-0.38 (-1.17)	0.10 (1.09)
Africa Dummy	-0.74 (-3.28)**	0.49 (7.40)**	-0.33 (-1.45)	0.32 (4.82)**	-0.70 (-3.11)**	0.50 (7.47)**	-0.58 (-2.62)**	0.44 (7.21)**
Latin America Dummy	-0.96 (-4.97)**	0.01 (0.26)	-0.47 (-2.17)*	-0.20 (-3.30)**	-0.98 (-5.07)**	0.01 (0.17)	-0.55 (-2.58)*	-0.17 -(2.82)**
F-statistics	15.32	65.12	18.21	69.29	13.11	54.46	16.25	74.07
R-square	0.32	0.68	0.42	0.74	0.32	0.68	0.39	0.75

Panel A reports the second stage least squares estimates for log GDP per capita (international dollars) in 2005, and Panel B reports the corresponding first stages; t-ratios are in parentheses [** denotes significance at 5%, * denotes significance at 10%]. Columns 1 – 4 add regional dummies, in addition to other geography variables [Latitude, Land Lock, Tropics and Temperate], as control variables to check the robustness of Rule of Law and Malaria.

Table 4 Continued

Panel A: Two Stage Least Squares

	(5)	(6)	(7)	(8)
Institutions	0.78	0.88	0.78	0.91
	(5.20)**	(6.80)**	(5.84)**	(5.91)**
Malaria	-0.69	-0.50	-0.41	-0.43
	(-1.14)	(-0.79)	(-0.69)	(-0.65)
Coastal Land	0.26			
	(1.24)			
Distance from Major Markets		-0.00002		
		(-1.02)		
Hydrocarbons			0.05	
			(4.66)**	
Inland Population Density				-0.0001
				(-1.81)
Asia Dummy	-1.07	-0.95	-1.01	-0.78
	(-5.44)**	(-4.43)**	(-4.92)**	(-2.66)**
Africa Dummy	-0.62	-0.72	-0.82	-0.86
	(-1.36)	(-1.71)	(-1.91)	(-1.93)
Latin America Dummy	0.05	0.23	0.18	0.17
	(0.29)	(1.32)	(1.09)	(0.93)
No. of observations	147	140	138	140
R-square	0.77	0.82	0.84	0.81

Panel B: First Stage for Endogenous Variables

Dependent Var.	Rule	Malaria	Rule	Malaria	Rule	Malaria	Rule	Malaria
Pop. Speaking English	1.02	-0.06	1.34	-0.13	1.38	-0.12	1.30	-0.12
	(3.38)**	(-0.67)	(3.90)**	(-1.24)	(4.04)**	(-1.25)	(3.77)**	(-1.17)
ME	-0.03	0.02	-0.03	0.02	-0.03	0.02	-0.03	0.02
	(-2.33)*	(5.53)**	(-2.16)*	(5.17)**	(-2.07)*	(5.24)**	(-1.82)	(4.94)**
Coastal Land	0.71	-0.02						
	(3.82)**	(-0.44)						
Distance from Major Markets			-0.0001	0.00001				
			(-1.57)	(1.34)				
Hydrocarbons					-0.03	0.003		
					(-1.95)mar	(0.74)		
Inland Population Density							0.001	-0.0001
							(1.21)	(-0.65)
Asia Dummy	-0.47	0.18	-0.50	0.10	-0.78	0.16	-1.00	0.19
	(-1.47)	(1.78)	(-1.27)	(0.81)	(-2.10)*	(1.49)	(-2.18)*	(1.41)
Africa Dummy	-0.48	0.49	-0.40	0.44	-0.76	0.53	-0.65	0.50
	(-2.14)*	(7.11)**	(-1.42)	(5.23)**	(-3.29)**	(7.84)**	(-2.79)**	(7.32)**
Latin America Dummy	-0.93	0.01	-0.75	-0.05	-0.96	0.002	-0.82	-0.02
	(-5.21)**	(0.12)	(-3.48)**	(-0.70)	(-4.78)**	(0.04)	(-4.00)**	(-0.35)
F-statistics	16.96	56.45	12.10	51.66	12.95	56.06	11.85	50.92
R-square	0.40	0.70	0.32	0.69	0.34	0.71	0.32	0.68

Panel A reports the second stage least squares estimates for log GDP per capita (international dollars) in 2005, and Panel B reports the corresponding first stages; t-ratios are in parentheses [** denotes significance at 5%, * denotes significance at 10%]. Columns 5 – 8 add regional dummies, in addition to other geography variables [Coastal Land, Inland Population Density, Distance from Major Markets, and Hydrocarbons] as control variables, to check the robustness of Rule of Law and Malaria.

Appendix 1: Data

Africa	Dummy variable taking value 1 if a country belongs to Africa, 0 otherwise
Asia	Dummy variable taking value 1 if a country belongs to Asia, 0 otherwise
Coastal Land	The proportion of a country's total land area within hundred kilometres of ice-free coast or ocean navigable river. Source: Gallup, Sachs, and Mellinger (1999). Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Engfrac	Fraction of population speaking English. Source: Hall and Jones (1999).
Distance from Major Markets	The log of the minimum Great-Circle (air) distance in kilometers to one of the three capital-goods-supplying regions: the U.S., Western Europe, and Japan, specifically measured as distance from the country's capital city to New York, Rotterdam, or Tokyo. Source: Gallup, Sachs, and Mellinger (1999). Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Hydrocarbons	Hydrocarbon deposits are the log of total BTUs per person of proven crude oil and natural gas reserves in 1993 from WRI (1996). Source: Gallup, Sachs, and Mellinger (1999). Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Income	Log of per capita GDP [constant 2005 international dollar]. Source: World Development Indicators, World Bank (2007)
Inland Population Density	Interior Population/Interior = (Population * (1-Pop100km))/ (Land Area * (1-Lt100km)). Units: persons per square kilometre. Source: CID dataset physical factors. Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Landlock	Dummy variable taking value 1 if a country does not have access to sea, 0 otherwise
Latin America	Dummy variable taking value 1 if a country belongs to Latin America, 0 otherwise
Latitude	Absolute value of distance from equator of capital city. Gallup, Sachs, and Mellinger (1999). Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Malaria	Proportion of each country's population that live with risk of malaria transmission, multiplied by an estimate of the proportion of national malaria cases that involve the fatal species, Plasmodium falciparum, as opposed to three largely non-fatal species of the malaria pathogen (P. vivax, P. malariae, and P. ovale). Source: Sachs (2003), taken from http://www.earth.columbia.edu/about/director/malaria/index.html#datasets.

ME	Malaria Ecology combines climatic factors and specific biological properties of the regionally dominant malaria vector into an index of the stability of malaria transmission. Source: Kiszewski *et al*. (2004). Data taken from http://www.earth.columbia.edu/about/director/malaria/index.html#datasets.
Temperate	% land area in Koeppen-Geiger temperate zones. Source: CID dataset kgzones. Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Tropics	% land area in Koeppen-Geiger tropics. Source: CID dataset kgzones. Data taken from http://www.cid.harvard.edu/ciddata/ciddata.html
Rule of law	Rule of Law Index for 2005. Source: Kaufmann, Kraay, and Zoido-Lobaton (2007).