The Colonial Origins of Comparative Development: New Settler Mortality Data

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To my family, who have given me every reason and opportunity to be happy at every stage of my life. And especially to Tia, who has always had so much more faith in me than I ever gave her reason to have.

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Introduction

The fundamental question of development economics remains, “Why are some countries rich and others poor?” What can account for the more than 100-fold income difference between Luxembourg and Burundi — the world’s richest and poorest countries, respectively, in terms of per capita GDP? Some theorize that a country’s geography is the ultimate determinant of a country’s economic outcome. Others point to sound macroeconomic policies, especially a country’s ability and willingness to trade, as the most consequential factor. A third group emphasizes the role of culture, or social capital, and the importance of values such as trust and belief in the power of the individual. Finally, a fourth group argues for the primacy of a country’s institutions. The term “institutions,” as it is used by economists, refers to the incentives that a country’s legal and political environment creates for the economic activity of firms and individuals. The more individuals, secure in the possession of their physical and intellectual property, are encouraged to invest, innovate and acquire skills, the more likely an economy is to prosper, according to the theory. Recently this view—that institutions have a very strong role in explaining differences in economic outcome—has become very popular.

In 2000, Daron Acemoglu, Simon Johnson and James Robinson (henceforth AJR) published a paper attempting to measure the effect of institutions on economic performance. Initially, they came up against a very basic problem with institutions. Not only is the strength of a country’s institutions very difficult to measure (rendering any cross-country estimation of institutional strength somewhat inaccurate), but analysts may also be biased in seeing better institutions in richer countries. Further, it is statistically
very difficult to isolate the effect that institutions have on income when income also has a potentially large effect on institutions.

AJR, therefore, sought a source of exogenous variation, i.e., variation that is not related to the level of income, in institutions. They came up with European settler mortality. The theory was that European powers adopted very different colonization strategies, leading to very different early institutions. In some colonies, the colonizers created strong institutions that protected private property and constrained government power. In others, they formed “extractive” institutions, which had little regard for private property and whose only purpose was to transfer resources from the colony back to the colonizing country. Early institutions, they said, persisted after independence into modern times. Finally, AJR argued that it was the Europeans’ mortality experience that determined their colonization strategy: where Europeans were dying from disease at higher rates, they settled in fewer numbers and created weaker institutions; where they were safer, they set up stronger institutions. As a result, AJR claimed that European settler mortality was a viable instrument for institutions. Using mortality rates faced by soldiers, bishops and sailors between the 17th and 19th centuries, the authors concluded that differences in colonial experience provided a viable source of exogenous differences in institutions, and that their results—that institutions have a strong effect on long-run levels of income—were robust after controlling for various factors such as climate, current disease environment, religion, natural resources and current race composition.

David Alouby has been among the loudest critics of the paper, claiming that AJR’s data set, while a valiant attempt at compiling such extensive settler mortality data, is flawed. He finds that of the 64 countries in AJR’s sample, only 36 distinct mortality
rates are used, with only 28 countries as the source of their own mortality rate. Further, he asserts that as 16 countries have their rates imputed from bishops, 4 from laborers, and the rest from soldiers, the mortality rates are not necessarily comparable. Albouy finds a handful of other inconsistencies with how the data set is put together, such as AJR not differentiating fully between mortality rates of soldiers who are on campaign versus soldiers in the barracks, and finally claims that, after all these problems are resolved, the current data on settler mortality do not support its use as an instrument for institutions. In their two, detailed rebuttals to Albouy, AJR find that his revisions to their data are highly selective themselves, and that many of his revised estimates are without foundation.

One way of shedding new light on this debate is to turn to alternative and arguably better sources of data on settler mortality. The original data used by AJR were compiled by a historian, Philip Curtin, mainly from 19th century military records that were far from complete. For this thesis, I have compiled a new data set, partly from the British life insurance industry and partly from a French treatise on endemic diseases worldwide, in order to better test AJR’s theory. The insurance data have a few hypothetical advantages. Insurance measures of mortality are market-based, i.e., they are used to write real life insurance policies, and this fact in itself carries some weight. Second, the mortality rates from insurance were forward-looking in that potential travelers could compare relative safety in different countries. The previous data were constructed in hindsight. Finally, the insurance rates were often put together by tracking the mortality of European civilians in foreign countries, rather than soldiers, which makes them arguably more representative of ‘settler’ mortality.
Using the new data, I create three data sets on relative mortality: the first contains only the countries for which I have insurance data on mortality. The second data set I call my “Best Estimate of Settler Mortality”: along with data from the French source (a non-insurance measure), AJR and Albouy, I add mortality rates for countries that are not contested by Albouy to the core insurance data set. The third data set attempts to mediate the debate between the two sides, by supplementing AJR’s data with mine for most of the 22 countries whose mortality rates Albouy revises. Running my new data through AJR’s model, I find that settler mortality is, in fact, a strong predictor of institutional strength. When only the countries with insurance data are used, the use of settler mortality as an instrument for institutions is generally significant at the 5 percent level. In both the other series, however, when insurance data are used in conjunction with other mortality rates, I find the instrumentation consistently significant at the 1 percent level. Using settler mortality as an instrument, my results point to a strong and robust effect of institutions on income, and they show that once institutions are accounted for, geography has little effect on a country’s wealth.

The rest of the paper is organized as follows. Section two reviews the literature covering the major hypotheses on the causes of economic development. Section three explains in more detail the criticisms of AJR’s settler mortality paper, as well as AJR’s response. In section four I describe my new mortality data and how they compare to both AJR’s and Albouy’s data. Section five outlines the statistical model used in my regressions, while section six presents the regression results and an analysis of their findings. Section seven concludes.
Review of the Literature

The vast literature of development economics can be roughly grouped into four camps: those who believe geography explains most of the income differences today; those who view a country’s policies, such as openness to trade, as the fundamental determinant of long-run development; those who see institutions as playing the strongest role in shaping a country’s economic outcome; and those who see culture, or social capital, as an alternative to institutions. Giving any of these theories the entire credit for shaping cross-national income levels is clearly unrealistic, given the overlap and interplay between them, as well as hundreds of other factors not mentioned. The purpose of this debate, then, is to try to assign each its own share of the story. For example, can geography alone explain the staggering differences in income level around the world? Or did it put in motion other forces, such as colonial heritage, institutional development or regional integration, which can more fully explain today’s huge wealth inequalities?

Geography

Geography is a key determinant of a country’s climate, agricultural productivity, disease environment, natural resources, diffusion of technology, and transport costs, among many other factors. As such, the idea that it might have a direct effect on a country’s income level is a basic one. Easterly and Levine (2003) disaggregate geography into its three main components—climate, disease environment, and agricultural productivity—using the terms “tropics,” “germs,” and “crops” to stand for each one, respectively. Studies arguing for the “tropics” hypothesis, that a country’s climate and proximity to the sea has a very strong bearing on its economic outcome, include Bloom and Sachs (1998) and Gallup, Sachs, and Mellinger (1999). Bloom and
Sachs (1998) find that the economic development of tropical regions around the world lags far behind that of temperate regions, and thus attribute Africa’s impoverishment to the fact that 93 percent of sub-Saharan Africa lies between the tropics. This location creates obstacles for growth, such as low agricultural production—especially food production—due to the low fertility of tropical soils, high disease burdens for humans, and large transportation costs. Gallup, Sachs, and Mellinger (1999) similarly argue that it is primarily due to a temperate climate that the parts of the United States, Western Europe and Northeast Asia that lie 100 kilometers from the coast contain just 3 percent of the world’s inhabited land mass, and only 13 percent of the world’s population, but account for 32 percent of global economic output.

Diamond (1997) argues instead that it was a region’s “germs” and “crops” at the dawn of civilization that fated its long-run development. He attributes Europe’s economic success to the availability of plant and animal species for domestication that it enjoyed. Not only was this a constant supply of food, which he deems critical to the formation of cities, but also of immunity to germs like smallpox and measles that Europeans got from farm animals. By contrast, none of the 14 domesticated large mammal species worldwide, and only 4 of the 56 heaviest-seeded wild grasses on earth, are endemic to sub-Saharan Africa (Easterly and Levine (2003), p. 6). Eurasia’s very large, east-west landmass also made transportation easy because of the unchanging latitude, allowing for faster trade and more rapid technological advancement than in the rest of the known world.
**Institutions**

Those who argue for the primacy of institutions in determining long-run growth and income levels do not discount the importance of geography, but point out that geography has in part shaped the development of long-lasting institutions around the world, and that its effect on economic development is therefore indirect.\(^1\) It is worth mentioning that studies on institutions generally trace modern institutional development back to the colonial era, between the 17\(^{th}\) and 19\(^{th}\) centuries, drawing a distinct line between the Old World and the New World and giving European expansion most of the credit for shaping the modern institutional landscape.\(^2\) As with the geography theorists, different studies on institutions point to the different ways that geography has shaped them. Hall and Jones (1999) are of the “tropics” view of institutions, reasoning that Western Europeans settled in areas with climates similar to Western Europe, bringing with them their high-quality institutions. In trying to determine the effect of “social organization,” or institutions, on output per worker—which they find to be strongly positive—they use distance from the equator and percent of the population speaking a Western European language as instruments.\(^3\)

Engerman and Sokoloff (1997) contend that it was “crops” that had the biggest effect on institutions, and highlight the different factor endowments between North America and the rest of the Americas to illustrate their theory. The soils and climates of

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\(^2\) There has been a dramatic reversal in income positions in the world over the past 500 years. Countries that were poor prior to colonization are now rich, such as the United States and Australia, while countries that were rich prior to colonization like India and Mexico, have since fallen behind. This is evidence against the argument linking geography to economic development. This phenomenon is often called the Great Reversal. For more information, see AJR (2002).

\(^3\) Both Hall and Jones (1999) and AJR (2000) argue that colonization plays a role in explaining institutional development, but whereas Hall and Jones give importance to ‘who’ went where, and in what proportion, AJR argue that it was the subsequent experience of the colonizer, not their identity, that matters.
Latin and South America gave them a comparative advantage in lucrative commodities such as rice and sugar, whose production was subject to tremendous economies of scale on large slave plantations. The resulting slave trade drastically changed the demography of these regions, leading to extreme inequality between the small ruling elite and the rest of the population. In turn, this ruling elite created institutions to protect themselves, restricting the masses from access to economic opportunities and investing very little in schooling. In comparison, North American soils were ideal for farming grains and livestock, which exhibited much smaller economies of scale. Without the need for mass slave labor, and given the relatively light populations of Native Americans on the east coast to begin with, a more homogenous population developed. This led to the formation of more democratic institutions with higher rates of human capital investment.

Accordingly, Engerman and Sokoloff’s “endowment” hypothesis holds that the abundance and type of a colony’s resources determined the level of inequality pervasive in its society and thus the type of institution established by its colonizer. Similar studies of more recent times have also shown that natural resource abundance—such as crude oil in Nigeria and Saudi Arabia—can lead to slower growth by stunting institutional development.4

The “germs” hypothesis of institutions can be attributed to AJR. As mentioned earlier, this hypothesis rested on three premises. First, that Europeans adopted very different colonization strategies: in some colonies they set up “extractive states” where the institutions served mainly to transfer resources from the colony to the mainland, with little or no protection for private property and no constraints on government power. Alternatively, in other colonies, they tried to model European institutions that had great

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respect for private property and significant checks on government power. Second, AJR argue that the type of institution adopted was determined by the feasibility of settlement. Where Europeans died at higher rates from disease, they settled in fewer numbers and created worse institutions, and, conversely, where they were safer to settle, they created stronger institutions. The third premise is that pre-independence institutions persisted after independence. Where political power had been concentrated in the hands of a few, and rent-seeking had been institutionalized, the ruling elite after independence had little trouble taking over from the colonizers. Similarly, once democratic institutions had been established before independence, later change would have proved very difficult and very costly for anyone who attempted it.

**Social Capital**

Social capital, or culture, has also been put forth as a determinant of growth. Knack and Keefer (1995) claim that institutions affect growth by increasing levels of trust and civic cooperation in society. Others, on the other hand, have argued that history affects economic development through culture, and it is a society’s culture that shapes its institutions. In contrasting the societal organizations of the Maghribi traders of the 11th century with the Genoese traders of the 12th century, Grief (1994) theorizes about the importance of cultural beliefs—the ideas and thoughts common to several individuals that govern their interactions—in shaping institutional development. Similarly, Tabellini (2006) looks at different regions of Europe, rather than different countries, to show that cultural indicators such as trust, respect for others, and confidence in the link between individual effort and economic success, are highly correlated with economic development.
Using data from the World Value Surveys from the 1990s, he finds that history affects economic development not through institutions but through culture.

A related strand of literature argues for the primacy of human capital—a measure of education, skills and wealth. Glaeser et al. (2004) find that human capital is a more basic cause of growth than institutions, and posit that what European colonizers brought with them to the New World was not so much their institutions but their human capital. They find that both initial levels of human capital and the average level of institutional quality in a country during a certain time period predict its economic growth over that period. So while initial levels of human capital are strong predictors of growth, the authors argue that the causality between institutions and growth runs predominantly from the latter to the former.

**Government Policies**

The last major development hypothesis is that a country’s macroeconomic policies, regardless of its climate and initial endowments, will affect its long-run development. While geography may influence production technologies and institutions, a country’s economic success depends more on whether or not it enforces policies promoting low inflation, openness to trade, and responsible capital account controls. Frankel and Romer (1999) take up this view by estimating the effect of trade on income. Having to instrument for trade, due to the obvious dual causality between trade and income, they construct a model that uses geographical determinants to predict a country’s natural propensity to trade. They find that trade has a very significant impact, both economically and statistically, on income, meaning that many developing countries suffer

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5 In their model, natural propensity to trade between two countries increases with factors such as area and population of the trading partner, and decreases with factors such as distance between the two countries and whether either country is landlocked.
from their physical distance to major trading markets. Sachs and Warner (1997) provide evidence that only part of Africa’s slow growth can be attributed to limited access to the sea and an unfavorable tropical climate, because weak basic economic policies, such as a lack of openness to trade and historically high government savings rates, have had an even larger impact on economic growth.

3 The Settler Mortality Debate

Since 2004, the debate over the settler mortality data has gone back and forth thrice between Albouy and AJR.⁶ In his two papers criticizing the construction of the data, Albouy makes three points: AJR are inconsistent in applying their own selection criteria for data; mortality rates from soldiers, bishops and laborers are not necessarily comparable; and AJR use questionable methods for coding, or assigning, one country’s mortality rate to another (Albouy (2006), p. 2). He finds that after making several adjustments to the data, settler mortality, as it is used, is a weak instrument for institutions. AJR, in turn, have responded that the criticisms themselves are very selective, and that making the necessary adjustments to Albouy’s new data leads to very much the same results put forth in the original settler mortality paper. The details of the actual debate are not in themselves very relevant to my paper, so I will focus on only a few major points of disagreement.

Albouy claims that AJR stray from their policy of always taking the first available mortality rate for a country. Curtin, the source of AJR’s data, reports mortality rates in Sudan of 0, 10.9 and 88.2 for 1884, the first half of 1885 and the second half of 1885, respectively. In this case, Albouy argues that AJR should choose 0, or 10.9, whereas

AJR (and I) disagree on the grounds that this would imply Sudan was as healthy as many parts of Europe. Table 1 of Albouy (2006) shows the 14 countries for which Albouy makes similar adjustments. He makes a second set of adjustments (in Appendix Table A2) based on new data that he gathers from Curtin, Alexander M. Tulloch—one of the first people to keep careful records on the health of the British armed forces in the mid-19th century—and various other sources. In one of his specifications, Albouy also uses only those countries which are the source of their own mortality rate, leading to a sample size of 27. While some of AJR’s coding can be questioned—such as assigning a rate of 280 from a campaign in Mali to Burkina Faso, Cameroon, Gabon, Angola and Uganda—some is very legitimate, and dropping all countries that do not have their own data points shrinks the sample to an excessive extent. Most of the points of contention revolve around Africa, and the 22 countries whose mortality rates Albouy makes tangible changes to, mostly from Africa, are presented in Table 3. AJR claim in response that their results regarding the positive effects of institutions on income per capita are just as strong without African data, and that after correcting for Albouy’s highly selective edits, settler mortality remains a viable instrument for institutions. Whether the debate between the two sides is over or not remains to be seen, but one can certainly see why new data on settler mortality might be very helpful.

4 Data

My new data on settler mortality come almost exclusively from two sources. The insurance portion comes from Assurance Magazine and the Journal of the Institute of Actuaries, a British journal begun in 1848 covering all matters relating to insurance.
With the development of the life insurance industry in the early 19th century, the journal first tracks mortality rates and insurance premiums in England and Scotland, then in British colonies where life insurance agencies were established for British settlers, and, by the late 19th century, in countries around the world where European soldiers or missionaries might have been traveling to. The non-insurance portion of my data comes from *Traité de Géographie et de Statistique Médicales et des Maladies Endémiques* (referred to as TGSMME), a French treatise published in 1857 which attempts to explain the varying geography and incidence of endemic disease in all known parts of the world. Only one non-insurance data point, for Argentina, is from a third source: a French pamphlet on infant mortality in Buenos Aires published in 1886 that also makes reference to overall adult mortality. Like AJR, the main gap in my data is for South America as the life insurance industry was only later to develop in Spain and Portugal, and both the Spanish and Portuguese militaries did not keep very strong mortality records. All mortality rates are reported in the standard measure of annual deaths per thousand at risk.

I try to stay as close as possible to AJR’s rules of always taking the earliest data point when several are available and only taking an average value when a given sample is small. For example, the French source lists the mortality of British troops in Hong Kong for the years 1842-1845 as 320, 407, 291 and 154 (all per 1,000) with sample sizes of 711, 845, 949 and 1,000 soldiers, respectively. Having no reason to believe that one year would be more indicative of the true mortality than another and the year-to-year changes in mortality quite possibly being due to small sample sizes, it seems most appropriate to use the average, 293 per 1,000, as Hong Kong’s mortality rate. Appendix Table A5 presents the new data.
My assignment of mortality rates from one country to a neighboring one with a similar disease environment, however, is less ambitious than AJR’s—one of Alouby’s biggest criticisms of the original work—resulting in a smaller sample of countries for which I have mortality data. For example, I assign Ghana’s rate of 72.7 per 1,000 to Burkina Faso and Togo, and Honduras’s rate of 26.68 per 1,000 to five of its neighbors in Latin America. AJR, as previously mentioned, go a little further. Along with the West African coding mentioned earlier, they also use a benchmarking system based on the theory that countries with similar median temperatures would have similar mortality rates, to assign Mexico’s rate of 71 per 1,000 to Guatemala, Colombia, Ecuador, Bolivia, Brazil and Uruguay. Thus AJR’s data set of 64 countries is comprised of only 36 mortality rates with only 28 countries being the source of their own mortality rate. My insurance data set of 46 countries has only 21 distinct mortality rates, the non-insurance data cover 39 countries from 26 data points, and together I have mortality rates for 57 countries.

Theoretically, there are several reasons to believe that my new data may offer a plausible alternative to AJR’s data set, and at the very least, a check of their results. For one, insurance companies put real money behind the mortality rates they came up with in different parts of the world. Therefore, side by side with any 19th century military record, one would be hard pressed not to choose the insurance data. Though mortality rates from insurance companies may be biased upward, as insurance companies have an incentive to charge higher premiums, there is no reason to believe that this should affect the relative premiums between countries, which is what we are interested in. Another problem that insurance data eliminate, since they are not derived from soldiers, is the distinction between mortality rates from soldiers on campaign and soldiers in the barracks—a point
that Albouy devotes much time to, claiming that “campaign rates are more likely to be used in countries with high risk of capital expropriation and low GDP per capita,” causing measurement error. By taking mortality rates of European settlers rather than soldiers and removing this distinction, not only do we eliminate this measurement error, but we also capture more fully what was originally intended as “settler mortality.”

My non-insurance data also have a few advantages over AJR’s. It appears very likely that both my French source and Curtin’s work are based on the same reports by Tulloch. While Curtin uses much of this information to track the history of the African conquest campaign by campaign, never really assigning one mortality rate to any particular country—and it is in deciding which rate to select for which country from which campaign that leads to disagreement between AJR and Albouy—my source assigns a mortality rate to each individual country in attempting to give the reader a sense of relative mortality around the world. This is again more truly representative of “settler mortality.”

The last potential advantage that my data would seem to have over AJR’s is that I have taken timing into account. Originally trying to capture mortality rates faced by European settlers “at the time of colonization” using mortality rates of soldiers, bishops and sailors stationed in the colonies between the 17th and 19th centuries (AJR 2000, p. 1), AJR’s data actually span the years 1817-1928. Since we are using mortality rates then to explain variations in institutions now, comparing the mortality rates of South Africa between 1818 and 1836 with that of Madagascar in 1895, and of the Democratic Republic of Congo in 1928, may be somewhat tenuous. The timing of the data is

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7 Most of AJR’s observations lie in the mid to late 19th century, but a few data points are taken from early in the 20th century.
important for two reasons. Ideally, as AJR state, one would obtain settler mortality data from the moment of colonization because anything later does not take into account any improvement in health that may have occurred from institutional development. For example, mortality rates for the United States in the 1830s are not truly representative of the challenges faced by the original British settlers in the early 17th century who began the process of institutional development. This could mean that countries that were colonized earlier faced lower mortality rates by the time data were collected, thereby biasing the data in favor of the theory. Second, exogenous factors such as medical breakthroughs and the rate at which these were spread to different parts of the world may greatly affect mortality rates, whether in absolute terms or relative from country to country, and would make the data collection even more sensitive to timing.

Though the data I find are also scattered throughout the 19th century, I employ rates of mortality decline discussed by Curtin to move the data to similar time periods (these declines are charted in Appendix Table A6). He writes, “In the nineteenth century, death rates not only dropped in Europe; they dropped even more dramatically among Europeans who went overseas” (Curtin 1989, p. 1). Curtin claims that in the middle of the 19th century a “mortality revolution” took place due to advances in military medicine, causing mortality rates to fall much more rapidly in the two middle decades of the century than before 1840 or after 1860. Only when the germ theory of disease was discovered by Western microbiologists in the 1880s did mortality rates once again begin to decline very quickly (Curtin 1989, p. 80). For example, in British India, Curtin suggests that mortality rates fell by about 0.85 percent per year between 1820 and 1840, by 2.5 percent per year between 1840 and 1860, by 0.92 percent between 1860 and 1890,
and by nearly 5.5 percent between 1890 and 1913. In comparison, Curtin claims that, in French Algeria, mortality fell by 0.92 percent per year between 1820 and 1840, by 3.18 percent per year between 1840 and 1860, by 1.31 percent per year between 1860 and 1890, and by 2.56 percent per year between 1890 and 1913. Using similar formulas for rates of decline in different parts of the world, I move the scattered data to a few benchmarked points in time (1820, 1840, 1860 and 1890) in order to better compare apples with apples.\(^8\)

A closer inspection of the data, however, yields surprising results. Comparing the insurance data with AJR’s data, first without taking timing into account, I find that not only are there very large differences for several data points, but the insurance data are almost always lower—only Australia and New Zealand have higher mortality rates. Figure 2 plots the relationship between the two data sets. The countries whose mortality rates have the largest discrepancies between insurance and AJR values, Nigeria and the Gambia, are almost three-and-a-half log points, or 350 percent, lower with the new data. Figure 3 shows that this result is not driven by timing, i.e., that the insurance data for 1840 are also lower than AJR’s data for 1840, and again, by significant amounts. Interestingly, in both cases, most of the countries for which insurance mortality rates are similar to, and higher than, the AJR values are “neo-Europes”—a term coined by historian Alfred Crosby for places to which Europeans emigrated and brought with them their culture, technology and agriculture—such as the United States, Canada, Australia and New Zealand. One explanation for this might be that both historical and insurance records in these countries may have been more accurate, owing to their relationships with

\(^8\) Moving data points forward and back over extended periods of time is undoubtedly not a perfectly accurate practice, given that rates of decline are rough estimates and may differ greatly from one region, or country, to the next. Further research in the area of relative mortality declines would certainly be helpful.
continental Europe, and so not only would there be the least discrepancy between the two
data points for these countries but also, as we predicted earlier, insurance mortality rates
would be higher than military records of mortality rates. Table 1 uses 1840 mortality
rates to show the countries that have the biggest differences between their insurance and
AJR data points, such as Nigeria and the Gambia.

The non-insurance portion of my data is much closer to the AJR data, with about
half the observations being higher than their corresponding AJR values and half lower;
additionally, only a handful of countries are notably different between the two, as shown
in Table A1. Given that all the data seem to come from Tulloch, the proximity of the
data sets is understandable, with the major outliers probably resulting from the fact that
the nature of some of Curtin’s works makes it difficult to extract one mortality rate for
any one country. Table A1 also offers some explanations for countries with large
discrepancies between the two values.

My main data set, which I call the Best Estimate of Settler Mortality, is presented
in Table 2. It is an attempt to pool all available resources, with the insurance data at the
core, and come up with my best guess as to what relative mortality rates were in the 19th
century, with as few assumptions as possible. I first take all the countries for which I
have a mortality rate from insurance data, and add countries for which my non-insurance
rate is very similar to AJR’s—close being a log difference of less than 0.4. I then add
Tunisia and Hong Kong, because my non-insurance rate seems more realistic than AJR’s,
in Tunisia’s case due to the accepted mortality rates of neighboring countries and in Hong
Kong’s case because of corroboration from Albouy’s data. Finally, I add 13 countries
that were a part of AJR’s original data set whose mortality rates Albouy agreed with. This leads to a sample of 66 countries.

Finally, Table 3 compares my new data to both the AJR and Albouy data sets for the countries with which Albouy takes issue. Albouy makes two sets of revisions, which I label Albouy I and Albouy II. The first are countries whose mortality rates he changes to eliminate inconsistencies in the way AJR’s data set was constructed, for example, if the earliest rate for a country was not selected or if AJR used a maximum rather than an average rate over a period of time. The second are revisions that he makes using alternative data sources such as Tulloch, Curtin and AJR (2005). Using Table 3, I construct a new data series which attempts to mediate the debate between the two sides, comprising original AJR mortality rates for all but the 22 countries for which Albouy makes revisions. For these countries I use my new data when they are an intermediary to the AJR and Albouy values, or provide reasons for which of the two makes more sense. For example, AJR’s rate of 14.9 deaths per 1000 in Hong Kong is from a campaign of unknown length that took place mostly in Beijing, leading me to select my non-insurance data point which is very similar to Albouy’s. As a counterexample, Albouy’s suggestion of 10.9 deaths per 1000 for the Sudan would imply that Sudan was as healthy as many parts of Europe, in which case I select my insurance data point which is very similar to AJR’s. Similar explanations are provided in Table 3 for the other 20 countries. In assigning new mortality rates to several African countries, I attempt to simultaneously address two of Albouy’s arguments: that AJR were inconsistent in their data selection and that their coding was overly ambitious.
Empirical Methodology

In testing my new data on settler mortality, I use the same model employed by AJR. Equation (1) describes the relationship between income, Y, and current institutions, R, in country i, while equations (2) – (4) make up the settler mortality theory.9

\[
\log Y_i = \alpha + \beta Y R_i + \gamma R X'_i + \epsilon_i \quad (1)
\]

\[
R_i = \lambda_R + \beta_R C_i + \gamma_R X'_i + \epsilon_i \quad (2)
\]

\[
C_i = \lambda_C + \beta_C S_i + \gamma_C X'_i + \epsilon_i \quad (3)
\]

\[
S_i = \lambda_S + \beta S \log M_i + \gamma S X'_i + \epsilon_i \quad (4)
\]

AJR use a measure of democracy in 1900 as their “early institutions” variable, C, and the fraction of the population of European descent in 1900 as the measure of European settlements, S. The variable M is the mortality rates faced by settlers, while X is a number of control variables that affect all variables, such as distance from the equator, religion, humidity and continent dummies.10 It should be noted that the log of settler mortality is used, not the absolute mortality rate, in order to minimize the distortional effects of countries with very high mortality rates and of possible outliers.

AJR’s preferred measure of institutions is a “risk of expropriation” index from the Political Risk Services’ (PRS) International Country Risk Guide, an annual report on the quality of governance worldwide. In order to maximize the sample of countries for which I have data, I instead use a measure of the “rule of law” from Kaufmann, Kraay, and Zoido-Lobaton (1999) which is scaled on roughly a unit normal distribution, with a

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9 This paper does not estimate equations (2) – (4). In Table 3 of AJR (2000), the authors present OLS regressions of these equations to show that their theory does work through the channels proposed and check for robustness using a number of measures for institutions. They conclude that “institutions persist” and that institutional development was, at least in part, shaped by mortality.

10 Table A1 of AJR (2000) provides a description and the source of each of these control variables.
higher value corresponding to stronger institutions.\textsuperscript{11} Given the high correlation between various measures of institutions, the results should not be sensitive to the choice of institutional variable.\textsuperscript{12} I also use the World Bank’s per capita GDP data adjusted for purchasing power parity from 2000, rather than 1995, to maximize sample size.

As previously discussed, there are a number of potential problems with estimating equation (1) by OLS, such as reverse causality, omitted variable bias, and measurement error. The authors therefore estimate equation (1) by two-stage least squares (2SLS). Though measurement error is now introduced through the combining of data from many sources, the authors claim that it is of the “classical” type, and will not lead to inconsistent instrumental variable (IV) estimates (AJR 2005, p. 6). The instrumentation of institutional quality by settler mortality in the first stage is modeled in the following way:

\[ R_i = \mu + \beta M \log M_i + \gamma X_i + \epsilon_i \]  

(5)

Figure 4 illustrates the inverse relationship between the log of settler mortality and the rule of law index, using the Best Estimate of Settler Mortality series.\textsuperscript{13} The coefficients of interest are therefore \( \beta_M \), which we would expect to be negative and whose robustness indicates the strength of settler mortality as a potential instrument for institutions, and \( \beta_Y \), representative of the share of a country’s economic outcome that can be attributed to institutional quality.

\textsuperscript{11} Kaufmann, Kraay, and Zoido-Lobaton (1999) aggregate over 300 indicators from country experts and survey results to construct six measures of institutional quality: voice and accountability, political instability and violence, government effectiveness, regulatory burden, rule of law, and graft. Easterly and Levine (2003) define the rule of law by the “protection of persons and property against violence or theft, independent and effective judges, contract enforcement.”

\textsuperscript{12} See Appendix Table A3.

\textsuperscript{13} It should be noted that Figure 4 is not a simple scatter-plot, but rather a graphical representation of the model estimated in Column 2 of Table 5.
Results

Tables 4-6 present the basic results of the 2SLS estimations for the three sets of mortality data.\textsuperscript{14} In each table, Panel A reports the estimates of $\beta_M$ from equation (5) while Panel B reports the 2SLS estimates of the coefficient $\beta_Y$ from equation (1).

\textit{Insurance Data Only}

Table 4 presents the results using only insurance data on mortality rates as the instrument for institutions, yielding a sample of 46 countries. Column 1 displays the strong first stage relationship between the log of settler mortality and the rule of law index, my measure of current institutions. The corresponding second stage, which estimates the impact of current institutions on per capita GDP, shows a coefficient of 0.74 which is significant at the 1 percent level. To illustrate what this means, suppose we had two countries, Guyana and Mauritius for example, which were about one point apart in their rule of law estimates. The coefficient suggests that Mauritius’ per capita income should be about 0.74 log points higher than, or twice as large as, Guyana’s.\textsuperscript{15} Therefore, using insurance data, I confirm AJR’s results that institutions have a causal effect on current income. Column 2 adds distance from the equator, a geographical control, as an independent variable. The first stage is weakened by this addition, but the coefficients for both the log of mortality and distance from the equator remain significant at the 5 percent level. In the second stage, the estimate of the impact of institutions on income actually increases, and remains significant at the 1 percent level. The coefficient for the

\textsuperscript{14} Regression results using only non-insurance data, not presented here in the main findings, are listed in Appendix Table A2.

\textsuperscript{15} $\exp(.74) = 2.1$. 

24
geography variable is insignificant. Column 4 shows that removing Bangladesh, the only major outlier, has little effect on the results.

Continent dummies for Asia and Africa are added in Column 3, and while the dummy for Asia is highly significant in the first stage and insignificant in the second, Africa’s is insignificant in the first and quite significant in the second. This result suggests that the mortality data are a stronger predictor of institutions for non-Asian countries, substantiated by the fact that the coefficient of mortality is higher with the inclusion of the dummy, and that institutions might be a better predictor of income in non-African countries. The significance of settler mortality’s coefficient in the first stage rises with the introduction of continent dummies.

Columns 5 and 6 show that these results are not driven by the timing of the data, the first presenting the findings for mortality data scattered around the 19th century and the second for mortality data benchmarked to 1890. The coefficients of mortality and the rule of law are nearly unchanged from the 1840 findings, as are their significance.

Interestingly, distance from the equator is never significant at the 5 percent level in the second stage, and often enters into the equation with the wrong (i.e., negative) sign, leading me to believe that the “institutionalists” are right: geography’s effect on income is indirect, through the channel of institutions.

Additionally, the estimate of the impact of institutions on per capita income, $\beta_Y$, is consistently higher in the 2SLS estimation than in the OLS estimation, sometimes three times as high, and statistically very robust. This is interesting because we would expect the coefficient in the OLS specification to be biased upward due to reverse causality (the OLS estimate captures both the positive impact of institutions on growth and the positive
impact of income on institutions). The implication is that the bias toward zero, caused by measurement error in the institutions variable, is actually the stronger of the two forces, and by a fair amount.

*Best Estimate of Settler Mortality*

The Best Estimate of Settler Mortality series of 66 countries provides the strongest evidence in favor of the AJR hypothesis. Column 1 of Table 5 again shows the strong relationship between settler mortality and institutions in the first stage, and institutions and income in the second. Both coefficients are significant at the 1 percent level. Adding distance from the equator in Column 2 does little to change their significance, but the new variable is itself significant in the first stage, meaning that not only does geography play an indirect role in shaping institutions through settler mortality, it also has a direct effect on institutional formation. The first stage relationship between the logarithm of settler mortality and the rule of law is shown in Figure 4, and we can see from the figure that Singapore and Hong Kong are the two outliers. The results are almost indifferent to the exclusion of Singapore and Hong Kong, as shown in Column 4.

The inclusion of continent dummies in Column 3 doesn’t change the findings in the first stage relationships, but in the second, the estimate of the rule of law on per capita income is weakened from significance at 1 percent to significance only at 5 percent, and the coefficients for both continent dummies are highly robust. Here again we find that the effect of institutions on economic performance is weaker in Asia and Africa than elsewhere. Columns 5 through 8 show that the timing of the data is of little importance to the relationship between mortality and institutions, as well as that between institutions.

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16 It is possible that the slightly weaker results obtained in using only insurance data are due to the fact that this series contains a smaller sample of countries than does the Best Estimate series.
and income, which both remain significant at the 1 percent level. The direct effect of geography on institutions in the first stage continues to be highly robust.

In Columns 5 and 6, I introduce a dummy variable which is equal to one for countries whose rates do not come from an insurance source. This is done to make allowance for the fact that insurance and non-insurance data may have a significant difference in their levels (i.e., non-insurance data are generally higher given that they come from soldiers rather than civilians), making their measures of mortality somewhat incomparable.\footnote{Additionally, life insurance policies are generally purchased by the wealthier, and therefore healthier, portion of the population, another reason why mortality rates from insurance sources may be lower than those from non-insurance sources.} This is very similar to Albouy’s use of dummies for countries whose mortality rates had been imputed from bishops and laborers, rather than soldiers. However, the unchanged significance of both the first and second stage relationships proves that even though there may be a level difference between the two types of data, the relative differences between countries are the same in both samples.

Columns 7 and 8 again show that the results are not driven by timing. Finally, in Column 9, I drop eight Latin American countries whose mortality rates had been imputed from AJR’s benchmarking system from the sample, to make sure that these countries are not driving the results. Once again, the estimates of mortality and geography are highly significant in the first stage, as is the coefficient of the rule of law in the second.

Much like in Table 4, the estimate of the impact of institutions on income is almost always stronger in the 2SLS estimation than in the OLS estimation.

**Mediating the AJR-Albouy Debate**

The third data series is an attempt to mediate the debate between AJR and Albouy, using AJR data for most countries, and new data for the countries with which Albouy
takes issue. The result is a sample of 69 countries for which I have data. Once again, the results, presented in Table 6, are highly in favor of the AJR hypothesis. The coefficient of log mortality in Column 1 is -0.447 and is significant at the 1 percent level. The corresponding second stage estimate of the effect of the rule of law on per capita income is even stronger. These findings are still very significant in Column 2, when distance from the equator is added as an independent variable in both stages, and get even stronger when Hong Kong is dropped as an outlier in Column 4. Just as in the previous sample, the inclusion of continent dummies for Asia and Africa in Column 3 slightly weakens the coefficients of settler mortality in the first stage and rule of law in the second, though both remain significant at the 1 percent level, and the coefficient estimates for the dummies are themselves highly robust in the second stage.

In Columns 5 and 6, I again introduce a dummy variable to make sure the two types of data, insurance and non-insurance, are comparable. This time, the dummy is equal to one for countries whose rates come from insurance data. The first stage results are virtually unchanged while the second stage estimate of institutional impact on income is actually stronger. The data again find the two sets to be useable together. Columns 7 and 8 present the findings when the timing of the data is changed. For data scattered around the 19th century, the first stage relationship between log mortality and institutions is weakened slightly to significance at the 5 percent level, while the second stage stays highly robust. Data benchmarked to 1890 show nearly the same results as those benchmarked to 1840. In Column 9, I use Albouy’s 1840 mortality rate of 313.76 per 1000 for Guinea and Sierra Leone, rather than mine of 134.12, and this leaves the results
virtually unchanged.\textsuperscript{18} The first stage impacts of log mortality and geography on institutions, as well as the second stage impact of institutions on income, are all significant at the 1 percent level. Yet again, the 2SLS estimate of the impact of institutions on growth is consistently higher than the OLS estimate.

\textit{Robustness Checks}

Appendix Table A4 uses the Best Estimate of Settler Mortality sample to control for two variables that may be correlated with both settler mortality and economic outcomes: the prevalence of malaria in 1994 and percent of the population that was of European descent in 1975. Columns 1 through 8 present regression results where these two variables are added as independent variables in both the first and second stage, in conjunction with distance from the equator and the basic continent dummies. I find that both the first stage relationship between log settler mortality and institutions, and the second stage relationship between institutions and income, are weakened from significance at the 1 percent level, sometimes to significance at the 5 percent level, and sometimes to being insignificant when the malaria variable is added. However, rather than proving that the effect of institutions on income is weakened when current disease environment is controlled for, this result is likely due to malaria in 1994 being a function of institutional quality, i.e. it is a potential outcome of institutions and economic development, and the fact that the equation may be misspecified to begin with: the malaria in 1994 variable is certainly correlated with both distance from the equator and the African dummy, since malaria is much more prevalent between the tropics.

\textsuperscript{18} Looking at Table 3, it is not immediately clear which alternate mortality rate to use for Guinea and Sierra Leone. AJR’s rate of 432.99 is from a campaign which included mortality in the Gambia. Albouy disaggregates the mortality for the two countries and assigns Sierra Leone a rate of 313.76. I use both this value, as well as my insurance value of 134.12, to check for robustness.
Therefore, before drawing conclusions about whether or not my findings were robust to this variable, I would need to find a way to instrument for current disease environment.

The second control, fraction of the population of European descent in 1975, is added to show that it was not the number of Europeans that settled in a country that shaped institutions but the mortality experience of those who did so. Columns 6 through 8 show that both the first and second stage estimates are highly robust to this control.

7 Conclusion

A recent paper argues for the primacy of the effect of institutions on a country’s per capita income level, relying on differences in colonial experiences as a viable source of exogenous differences in institutions around the world today. It states that where European settlers faced higher mortality from disease, they settled in fewer numbers and formed weaker institutions, and where they were healthier, they formed stronger institutions. Furthermore, institutions formed in 18th and 19th century colonies are very likely to have persisted till today. Thus, the mortality rate of European settlers is correlated with current institutions and, assuming exogeneity, is a viable instrument. In this thesis, I have compiled new data on settler mortality, mostly from the mid-19th century British life insurance industry. The advantages of such data are that they are market-based, forward-looking rather than compiled in retrospect, and often based on European civilian mortality, rather than soldier mortality. Using my new data, I find that European settler mortality rates are a strong predictor of current institutional strength.

Apart from validating the link between settler mortality and current institutions, my results also show that a country’s geography, apart from shaping a country’s disease
environment, which in turn affects settler mortality and therefore institutions, also plays an independent role in shaping institutions. Going back to section two then, while my paper provides evidence for the “germs” theory of institutions, it does not preclude either the “tropics” or “germs” theories of institutions from also being right. Additionally, I find a very strong impact of institutions on income, and, once institutions are controlled for, I find that geography has almost no direct effect on a country’s economic development.

While this paper is by no means the final say on settler mortality, the new data it provides shows that a reliable data set on settler mortality is certainly not implausible. It also suggests two channels for further research: first, the early insurance industry of other European colonizers—particularly Spain and Portugal, as this would provide much more reliable data on Latin and South America—and second, the relative rates of decline in worldwide mortality during the 19th century. As timing is such an important part of AJR’s theory, more precise rates of mortality decline in certain countries or regions might significantly improve the explanatory power of settler mortality as a predictor of institutions.

References


### Table 1
Insurance Data vs AJR

<table>
<thead>
<tr>
<th>Country</th>
<th>Insurance - 1840</th>
<th>AJR - 1840</th>
<th>log Insurance - 1840</th>
<th>log AJR - 1840</th>
<th>log Difference</th>
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<td>Nigeria</td>
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Notes on countries with large discrepancies:

- Nigeria, Gambia, Angola, Zaire, Congo (French), Niger, Cote d'Ivoire, Burkina Faso, Guinea, Sierra Leone, Ghana, Togo, Central African Fed., Chad, Rwanda, Uganda and Cameroon: AJR's rates for these countries are all imputed from military campaigns of varying sample sizes. The insurance rates for these countries come from measures of European civilian mortality.

- Nicaragua, Panama, Venezuela, Costa Rica, El Salvador, Honduras and Guatemala: AJR's rates all come from their benchmarking system, which, starting with a rate of 71 deaths per thousand for Mexico, assigned rates to other countries in Latin and South America. The insurance rates for all these countries except Venezuela come from an 1861 population census taken in Honduras. Venezuela's rate comes from Guyana's population census of 1861.

- Bangladesh: Both the insurance value and AJR value are coded from Bengal, the nearest Indian province, and both are an average of troop mortality. The insurance value is very likely low, however.

- South Africa: AJR's rate is an average of British troop mortality between 1818-1836. The insurance value is from a sample of people who had life insurance policies in South Africa.

- Mauritius: AJR's rate is again the average mortality of British troops between 1818-1836; the insurance value is from a population census of 1875.

- New Zealand: AJR's value is the average mortality of British troops between 1846-1855, while the insurance value is from a population census of 1964.

### Table 2

**Best Estimate of Settler Mortality**

<table>
<thead>
<tr>
<th>Former Colony</th>
<th>Kariff Insurance (1840)</th>
<th>Kariff Non Insurance (1840)</th>
<th>AJR (1840)</th>
<th>Albouy II (1840)</th>
<th>Best Estimate - 1840</th>
<th>Source</th>
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<td>Algeria</td>
<td>70.17</td>
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Notes:

Hong Kong: AJR's rate is from the China Field Force, a British garrison that fought in 1860. The campaign was of unknown length (AJR 2005, p. 5), and was fought mostly in Beijing, which had very different mortality than Hong Kong, according to Albouy (2006). The non-insurance rate, which is in between the AJR and Albouy values, is used instead.

Bahamas: Albouy's rate is directly from Tulloch, and since the non-insurance value is very similar but in between AJR and Albouy, it is used instead.

Angola, Burkina Faso, Cameroon, Gabon and Uganda: For the sake of consistency (see Albouy 2006, p. A7), Albouy all these countries a rate of 400 deaths per thousand, which had all previously had an AJR rate of 280 per thousand. I therefore apply my insurance data to these countries.

Guinea and Sierra Leone: Albouy disaggregates AJR’s mortality rate for Sierra Leone, which included deaths from the Gambia, using Tulloch. I use my insurance values for the two countries so as not to skew relative mortality within Africa in my main specification, but Columns 9 of Table 6 present the results using Albouy's values instead.

Egypt: Given neighbors' mortality, AJR's rate is more reasonable.

Mali: Albouy's rate is more plausible.

Sudan: Albouy's rate implies health on par with Europe, so AJR used.

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<tr>
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<td>-0.743 (0.126)***</td>
<td>-0.384 (0.181)***</td>
<td>-0.667 (0.281)***</td>
<td>-0.471 (0.180)***</td>
<td>-0.492 (0.239)***</td>
<td>-0.354 (0.169)***</td>
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<tr>
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<td>0.031 (0.014)***</td>
<td>0.034 (0.014)***</td>
<td>0.038 (0.014)***</td>
<td>0.041 (0.014)***</td>
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<tr>
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<td>46</td>
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</tbody>
</table>

Note: Bangladesh is the only outlier in this regression.

Standard errors in parentheses

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively
### Table 5: IV Regressions of log GDP per capita

- **Panel A: First Stage for Rule of Law**
  - Log Mortality: 0.638 (0.110)**
  - Distance from the equator: 0.026 (0.008)***  0.025 (0.009)***  0.028 (0.008)***
  - Asia Dummy: -0.009 (-0.273)
  - Africa Dummy: -0.214 (-0.217)
  - Non-Insurance Dummy: 0.171 (0.143)***
  - Adjusted R-Squared: 0.33
  - Number of Observations: 66

- **Panel B: Two Stage Least Squares**
  - Rule of Law:
    - SM Best Estimate 1840 (1): 0.665 (0.083)***
    - SM Best Estimate 1840 (2): 0.688 (0.124)***
    - SM Best Estimate 1840 (3): 0.433 (0.155)***
    - SM Best Estimate 1840 w/o outliers (4): 0.75 (0.144)***
    - SM Best Estimate 1840 (5): 0.729 (0.170)***
    - SM Best Estimate 1840 (6): 0.514 (0.152)***
    - SM Best Estimate No Timing (7): 0.676 (0.150)***
    - SM Best Estimate 1890 (8): 0.758 (0.145)***
    - SM Best Estimate 1840 w/o SA (9): 0.788 (0.043)***
    - OLS (10): 0.539
    - OLS w/o outliers (11): 0.515
  - Distance from the equator:
    - -0.002 (-0.006)  0.002 (-0.007)  -0.006 (0.008)  -0.005 (-0.008)  -0.005 (-0.008)  -0.005 (-0.008)  -0.006 (0.008)  0.004  0.005 0.004 (-0.004) (-0.005)
  - Asia Dummy: -0.368 (0.138)***
  - Africa Dummy: -0.564 (0.124)***
  - Non-Insurance Dummy: 0.171 (0.143)***
  - Adjusted R-Squared: 0.33
  - Number of Observations: 66

Note: Singapore and Hong Kong are the outliers in this regression. SA consists of Bolivia, Brazil, Colombia, Ecuador, Mexico, Paraguay, Peru and Uruguay.

Standard errors in parentheses

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
### Table 6

#### IV Regressions of log GDP per capita

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<tr>
<th></th>
<th>Mediating debate 1840 (1)</th>
<th>Mediating debate 1840 (2)</th>
<th>Mediating debate 1840 (3)</th>
<th>Mediating debate w/o outlier 1840 (4)</th>
<th>Mediating debate 1840 (5)</th>
<th>Mediating debate No Timing (6)</th>
<th>Mediating debate 1890 alt. GIN and SLE (7)</th>
<th>Mediating debate 1840 (8)</th>
<th>OLS (10)</th>
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<td>0.84</td>
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<tr>
<td></td>
<td>(0.089)***</td>
<td>(0.155)***</td>
<td>(0.157)***</td>
<td>(0.143)***</td>
<td>(0.149)***</td>
<td>(0.271)***</td>
<td>(0.171)***</td>
<td>(0.155)***</td>
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<td>(0.043)***</td>
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<td>-0.008</td>
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<td>(-0.008)</td>
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<td>(-0.004)</td>
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<tr>
<td></td>
<td>(0.112)***</td>
<td>(0.116)***</td>
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<tr>
<td></td>
<td>(0.131)***</td>
<td>(0.127)***</td>
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<td>(-0.183)</td>
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</table>

#### Panel A: First Stage for Rule of Law

| Log Mortality        | -0.447                    | -0.325                    | -0.274                     | -0.357                               | -0.338                    | -0.29                            | -0.232                                     | -0.321                    | -0.334     |
|                      | (0.076)***                | (0.082)***                | (0.091)***                | (0.079)***                           | (0.084)***                | (0.096)***                       | (0.090)***                                | (0.085)***                | (0.082)*** |
| Distance from the equator | 0.025                    | 0.025                     | 0.022                      | 0.022                                | 0.023                     | 0.033                            | 0.026                                      | 0.024                     |            |
|                      | (0.008)***                | (0.009)***                | (0.008)***                | (0.009)***                           | (0.009)***                | (0.009)***                       | (0.008)***                                | (0.008)***                | (0.008)*** |
| Asia Dummy           | -0.003                    | -0.024                    |                           |                                      |                           |                                  |                                           |                          |           |                     |       |
|                      | (-0.269)                  | (-0.273)                  |                           |                                      |                           |                                  |                                           |                          |           |                     |       |
| Africa Dummy         | -0.265                    | -0.233                    |                           |                                      |                           |                                  |                                           |                          |           |                     |       |
|                      | (-0.199)                  | (-0.207)                  |                           |                                      |                           |                                  |                                           |                          |           |                     |       |
| Insurance Dummy      | -0.255                    | -0.161                    |                           |                                      |                           |                                  |                                           |                          |           |                     |       |
|                      | (-0.262)                  | (-0.28)                   |                           |                                      |                           |                                  |                                           |                          |           |                     |       |
| Adjusted R-Squared   | 0.33                      | 0.4                       | 0.4                       | 0.44                                 | 0.39                      | 0.39                             | 0.33                                       | 0.39                      | 0.41 |
| Number of Observations | 69                       | 69                        | 69                        | 68                                   | 69                        | 69                               | 69                                         | 69                        | 69 |

Note: Hong Kong is the only outlier in this regression.

Standard errors in parentheses.

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
<table>
<thead>
<tr>
<th>Country</th>
<th>Non-Insurance - 1840</th>
<th>AJR - 1840</th>
<th>log Non-Insurance - 1840</th>
<th>log AJR - 1840</th>
<th>Log Difference</th>
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</table>

Notes on countries with large discrepancies:

**Senegal**: AJR's rate is the average mortality between 1819-1838 while the non-insurance rate is the average mortality of French troops between 1838-1851.

**Gambia**: AJR's rate is an annualized rate from a 20-month campaign up the Gambia River which killed 279 soldiers out of a force that was as large as 120 and, at times, as small as 40. The non-insurance rate is taken from Senegal.

**Tunisia**: AJR's rate is from the campaign of 1881 while the non-insurance rate is the average mortality of European civilians between 1837 and 1853.

**Bahamas**: AJR's rate is from the Windward and Leeward islands (Barbados and Trinidad and Tobago) between 1817-1836, while the non-insurance rate is for British troop mortality only in the Bahamas between 1817-1836.

**Hong Kong**: AJR's rate is from the China Field Force, a British Garrison that fought in 1860. The campaign was of unknown length (AJR 2005, p. 5), and was fought mostly in Beijing, which had very different mortality than Hong Kong, according to Albouy (2006). The new non-insurance rate is an average of British troop mortality between 1842 and 1845.

<table>
<thead>
<tr>
<th></th>
<th>Non-Insurance 1840 (1)</th>
<th>Non-Insurance 1840 (2)</th>
<th>Non-Insurance 1840 (3)</th>
<th>Non-Insurance 1840 w/o outliers (4)</th>
<th>Non-Insurance No Timing (5)</th>
<th>Non-Insurance 1890 (7)</th>
<th>OLS (9)</th>
<th>OLS w/o outliers (10)</th>
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<td>0.697</td>
<td>0.712</td>
<td>0.283</td>
<td>0.732</td>
<td>0.695</td>
<td>0.852</td>
<td>0.578</td>
<td>0.558</td>
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<tr>
<td></td>
<td>(0.120)***</td>
<td>(0.240)***</td>
<td>(-0.478)</td>
<td>(0.195)***</td>
<td>(0.256)**</td>
<td>(0.269)***</td>
<td>(0.081)***</td>
<td>(0.084)***</td>
</tr>
<tr>
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<td>-0.002</td>
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<tr>
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<td>(0.343)*</td>
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<td>(0.134)***</td>
<td>(0.138)*</td>
<td>(0.138)*</td>
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<td></td>
<td>(0.013)**</td>
<td>(0.012)**</td>
<td>(0.012)*</td>
<td>(0.013)*</td>
<td>(0.012)**</td>
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Note: Hong Kong is the only outlier in this regression.

Standard errors in parentheses

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
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Note: Number of observations reported below each coefficient. All coefficients are significant at the one percent level.

Table A4

IV Regressions of log GDP per capita

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<td>(0.007)</td>
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Note: Singapore and Hong Kong are the outliers in this regression. SA consists of Bolivia, Brazil, Colombia, Ecuador, Mexico, Paraguay, Peru and Uruguay.

Standard errors in parentheses.

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.
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<th>Abbreviated Name</th>
<th>Continent Dummy</th>
<th>New Mortality</th>
<th>Insurance?</th>
<th>Date and Source (AM = Assurance Magazine and the Journal of the Institute of Actuaries, TGSMME = Traité de Géographie et de Statistique Médicales et des Maladies Endémiques)</th>
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<td>Average mortality of French troops, French civilians and other European civilians between 1840 and 1853</td>
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<td>from one mention of mortality experience of the Cape of Good Hope Mutual Life Assurance Society in 1874 - AM, v20, p359</td>
<td>from 2,855 members of the society (people with life insurance) over two years 1873-1874, avg. 37 deaths per year</td>
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<td>(1875) Hygiène Infantile: Causes de la Morbidité et de la Mortalité de la Première Enfance a Buenos-Ayres, p53</td>
<td>6,751 deaths/230,000 total population</td>
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<td>Hong Kong</td>
<td>HKG</td>
<td>3</td>
<td>293</td>
<td>(1842-1845) TGQMME, p196 Mortality of British soldiers, sample size of 3,505 soldiers over four years</td>
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<tr>
<td>India</td>
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<td>3</td>
<td>54.67</td>
<td>(1825-1844) TGQMME, p195 average of Madras (101,218 troops), Bengal (88,380) and Bombay (50,987 troops) - all British troops</td>
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<td>28.43</td>
<td>average of Madras (39.2) [AM v11, p18 - 1800-1827], Bengal (23) [AM v11, p15 - 1800-1847] and Bombay (23.1) - AM v19, p285 - 1865 Bombay: 265,019 deaths/11,454,958 population / Madras: Madras Military Fund 1808-1827 / Bengal: Bengal Army (incl. retired) 1800-1847</td>
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<td>41</td>
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<td>Antigua and Barbuda</td>
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<td>(1871) AM, v19 p277 population census of ages 20-80</td>
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<td>(1858) AM, v19 p277 deaths/population</td>
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<td>(1871) AM, v19 p.275 from 1871 population census of island - pop. 162,042</td>
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<td>(1817-1836) TGQMME, p79 Mortality of white troops of British Army, no sample size given</td>
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<td>24.8</td>
<td>(1866-1870) AM, v19 p277 total death 1866-1870/population over that period</td>
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<td>26.68</td>
<td>(1861) AM, v19 p277 population census of ages 20-80</td>
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<td>(1875) AM, v19 p.276 population census of ages 0-60</td>
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<td>71</td>
<td>(1817-1836) TGQMME, p216 Mortality of British Army, no sample size given</td>
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<td>St. Lucia</td>
<td>LCA</td>
<td>4</td>
<td>123</td>
<td>(1817-1836) TGQMME, p79 Mortality of white troops of British Army, no sample size given</td>
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<td>St. Vincent and the Grenadines</td>
<td>VIN</td>
<td>4</td>
<td>52</td>
<td>(1817-1836) TGQMME, p79 Mortality of white troops of British Army, no sample size given</td>
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<td>Trinidad and Tobago</td>
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<td>(1817-1836) TGQMME, p79 Mortality of white troops of British Army, no sample size given</td>
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<td>Trinidad and Tobago</td>
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<td>27.61</td>
<td>(1846-1876) AM, v21 p158 mortality experience of Scottish Amicable Life Assurance Society over 30 years - 23 deaths/833 at risk</td>
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<td>Canada</td>
<td>CAN</td>
<td>5</td>
<td>18.75</td>
<td>(1818-1836) TGQMME, p78, p156, p158 Mortality of British Army, no sample size given</td>
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<td>Country</td>
<td>Code</td>
<td>Sample Size</td>
<td>Average Mortality</td>
<td>Notes</td>
<td></td>
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<tr>
<td>Canada</td>
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<td>5</td>
<td>10.62 Y</td>
<td>weighted average of Conn. Mutual (11.27) [1846-1878] and Mutual Life Ins. Co. of NY (9.32) [1843-1874]</td>
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<tr>
<td>Mexico</td>
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<td>10.47 Y</td>
<td>mortality of British Army, no sample size given</td>
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<td>USA</td>
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<td>6</td>
<td>9.48 N</td>
<td>insurance premiums taken from H^I^ table for Britain as H^I^ mortality from 1797-1863 used - AM, v20 p378</td>
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<tr>
<td>Australia</td>
<td>AUS</td>
<td>8.51 N</td>
<td>(1848-1851) TCBRMME, p152</td>
<td>Mortality of British Army, no sample size given</td>
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<tr>
<td>New Zealand</td>
<td>NZL</td>
<td>5</td>
<td>17.3 Y</td>
<td>(1864) AM, v19 p290</td>
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</tbody>
</table>

**Other Countries and Repeated Mentions**

- Aruba: 77.8 Y (1871) AM, v19 p277 population census of ages 20-80
- Grenada: 24.8 Y (1866-1870) AM, v19 p277 total deaths 1866-1870/poeration over that period
- "Other Islands" in the W.I.: 22.51 Y (1846-1876) AM, v21 p159 mortality experience of Scottish Amicable Life Assurance Society over 30 years - 6 deaths/266.5 at risk
- Jamaica: Y (1846-1876) AM, v21 p158 mortality experience of Scottish Amicable Life Assurance Society over 30 years - 30 deaths/3926 at risk
- British Guiana: Y (1846-1876) AM, v21 p159 mortality experience of Scottish Amicable Life Assurance Society over 30 years - 30 deaths/3926 at risk
- "Central Africa": 77.81 Y (1897) AM, v33 p288 654 missionaries sent by a number of Missionary Societies - 47 deaths/604 years of life
- "West Coast" of Africa: 56 Y (1878-1890) AM, v29 p342 grouping of Lagos, Gold Coast, Gambia and Sierra Leone data
- "West Coast" of Africa: 47 Y (1897) AM, v33 p288 654 missionaries sent by a number of Missionary Societies - 90 deaths/1926 years of life
- "K.W. Coast" of Africa: 35 Y (1897) AM, v33 p288 178 employees of a Dutch Trading Company - 43 deaths/1223 years of life
- Sierra Leone: >103 Y (1879-1885) AM, v25 p439 "still more unhealthy [than the Congo]" no mention
- Sierra Leone: 27.85 Y (1879-1888) AM, v29 p543 European residents and European "floating population [i.e. On ships in the harbour]" - 75 deaths/2730 years of life
- Sierra Leone: 42 Y (1879-1888) AM, v32 p64 "average death rate over 10 years"
- Gambia: 10 Y (1879-1888) AM, v32 p64 "average death rate over 10 years"
- Gambia and Sierra Leone: 27.6 Y (1856-1906) AM, v33 p518 54 deaths/1957 years of assured European life (study over 40 years)
- Ghana: 10 Y (1879-1888) AM, v32 p64 "average death rate over 10 years"
- Congo: 80 Y (1879-1888) AM, v32 p68 "average death rate over 10 years"
- Congo: 25 Y (1879-1888) AM, v32 p69 "average death rate over 10 years"
- Congo: 94 Y (1897) AM, v33 p288 971 employees of the Belgian government on the Congo - 198 deaths/2096 years of life

**Table A6**

**Mortality Declines from Curtin**

<table>
<thead>
<tr>
<th>Period</th>
<th>Africa</th>
<th>South America</th>
<th>Asia</th>
<th>L America + Caribbean</th>
<th>N America</th>
<th>Oceania</th>
</tr>
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<tbody>
<tr>
<td>1820-1840</td>
<td>0.92%</td>
<td>0.98%</td>
<td>0.85%</td>
<td>0.98%</td>
<td>0.92%</td>
<td>0.92%</td>
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<tr>
<td>1840-1860</td>
<td>3.18%</td>
<td>3.82%</td>
<td>2.50%</td>
<td>3.82%</td>
<td>2.50%</td>
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<tr>
<td>1860-1890</td>
<td>1.51%</td>
<td>1.46%</td>
<td>0.92%</td>
<td>1.46%</td>
<td>0.90%</td>
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<tr>
<td>1890-1913</td>
<td>2.56%</td>
<td>1.50%</td>
<td>5.50%</td>
<td>3.88%</td>
<td>3.88%</td>
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</tr>
</tbody>
</table>

Note: All declines in mortality are expressed in percent per year
Figure 1 - Income and Institutions
Figure 2 - Insurance Data vs AJR
Timing not included
Figure 3 - Insurance Data vs AJR

Benchmarked to 1840
Figure 4 – Log Settler Mortality vs Institutions

The diagram shows a scatter plot with countries represented by points. The x-axis is labeled as $e(\text{logkarti\_bestguess\_1840} | X)$, and the y-axis is labeled as $e(\text{rule} | X)$. The line of best fit is included with the equation:

$$\text{coef} = -0.46871554, \text{se} = 0.11785825, t = -3.98$$