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Institutions, Geography, and Trade: A Panel Data Study

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Abstract: *This paper employs a panel data approach to examine the impact of institutions, trade and geography on economic development. Our approach enables us to account for unobserved heterogeneity across countries, an issue that cannot be addressed in the cross-section framework. Moreover, employing the Hausman and Taylor approach allows us to obtain direct parameter estimates of the time invariant explanatory variables like geography or some institutional measures. Our findings are that institutions, economic integration, and geography are valid determinants of economic development with regard to statistical significance and robustness but differ substantially in terms of their economic impact.* JEL Codes: O1, F1; Keywords: development, institutions, openness, geography, panel data

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1 Introduction

A cursory look at the national income data suggests that the income gap between the rich and the poor nations of the world has been widening. According to data from the Penn World Table Mark 6.1 (Heston *et al*., 2002), the per capita GDP of Sierra Leone in 1961 was 9 percent of that of the United States. By 2000, it had fallen to 2 percent of the U.S. level. This trend is true for many less developed countries. And while the United States remains one of the highest per capita income countries in the world, a few countries were able to pull ahead of the United States. Luxembourg's per capita income in 1961 was almost the same as that of United States, but it exceeded it by about 37 percent in 2000. The persistence of large disparities in income levels between rich and poor countries is a matter of concern for both developing and developed countries, and the issue of what determinants matter most for development has been at the core of a large number of studies in the growth and development literature.

Since this literature is too extensive to be adequately reviewed here, we focus instead on some of the more recent contributions. For the last decade or so, attention has shifted to the study of the "deeper" determinants of economic development as coined by Rodrik *et al*. (2004). According to this approach, factors which affect economic development can be classified into two tiers. While inputs in the production function such as labor, physical and human capital directly affect income and thus economic development, they are themselves determined by deeper and more fundamental factors. And although it remains an open question what exactly constitutes a "deeper" determinant of development, three broad categories have emerged in the literature: geography, institutions, and international trade (integration).[1]

Geographical factors typically characterize the physical location of a nation such as distance from the equator, access to sea, agro-climatic zone, disease environment, soil type, and natural resources. Geography may matter for development through its impact on transaction costs. For example, a country's size, access to sea and topography can crucially affect transport costs and the extent of its integration with the world market. Latitude and climate are also related to disease environment which directly impacts labor productivity and life expectancy, among others.

Geography can also impact economic development through institutions. Climate and soil affect the types of crops planted. This, along with the availability of natural resources, can dictate whether the early institutions were extractive or productive. In fact, some authors like Gallup *et al*. (1999) and Sachs (2003) argue that geography is the most important variable of interest for development, even after controlling for the quality of institutions.

The importance of institutions was emphasized in the work of Douglass North (1993, 1994a, 1994b, 1994c). His motivation to consider institutions can be linked to his view that the neo-classical growth theory is unable to explain widespread differences in economic performances across countries. If only factor accumulation led to progress, then all countries would do so, provided there was a high-enough payoff involved. Differences in income thus require differences in "payoffs" which is where institutions come in (North, 1994a). Institutions are the rules of game which a society lays down for itself and which determine the incentives people face and thus the choices they make. Another way of looking at institutions is through their impact on transaction costs. Well defined rules and their smooth enforcement, i.e. better institutional quality, greatly reduce transaction costs economic agents face and thus lead to more efficient outcomes (North, 1993, 1994a, 1994). Knack and Keefer (1995) and Hall and Jones (1999) were one of the first empirical studies to examine the impact of institutions on economic development. Unlike geography, however, there is a potential problem with institutions—endogeneity. Hall and Jones use a measure of language fractionalization as an instrumental variable for institutions. The search for appropriate instruments for institutions was pushed further by Acemoglu *et al*. (2001). They argue that current institutions are manifestations of past institutions which have prevailed over time. Since past institutional quality can be linked to settler mortality, they use that variable as an instrument for current institutions. The importance of institutions was further developed by Clauge *et al*. (1999) and Acemoglu and Johnson (2005) who show that good institutions, by fostering productive investments lead to favorable economic outcomes.

The argument for economic integration as a fundamental determinant of development is based on the gains from trade literature. Next to the classic case of comparative advantage gains are more modern approaches that stress the importance of trade in the transfer of new technologies and ideas, which in turn enhance productivity. Moreover, supplying to a larger international market allows higher degrees of specialization and thus entails productivity gains. There are many empirical studies on the link between international trade or integration and economic development. One of the more influential ones is Sachs and Warner (1995) who constructed an index of openness and found that greater openness leads to higher growth. As with institutions, trade variables are likely to be endogenous with regard to income. Frankel and Romer (1999) examine this issue in detail. They construct a predicted trade share for countries based on their geographic and size characteristics. This variable is used as an instrument for actual share and their findings point to a positive link between integration and income.

While there are a large number of empirical studies that investigate the link between a single deep determinant and development, only a few consider all three deep determinant categories at the same time, and those that do work almost exclusively within a cross-section framework. The findings from these cross-section studies point in different directions. Dollar and Kraay (2003) examine this issue and find that it is difficult to disentangle the effects of geography, trade and institutions on economic development in a cross section setting. They then exploit the time variations in trade and institutions to study impact of these two variables on economic growth in a panel data context. They find that in explaining the changes in decadal growths rates, trade share changes play a relatively bigger role than changes in institutions. While Sachs (2003) argues that it is mostly geography that matters for development, the findings in Rodrik *et al*. (2004) emphasize institutions as the most important overall determinant. Alcala and Ciccone (2004) examine the determinants of the average labor productivity. They show that when the standard trade share variable is replaced by alternative summary measures such as real openness and tradable GDP openness, its coefficient estimate remains highly significant even when controlling for institutional quality and geographic factors.

With the exception of Dollar and Kraay (2003), our empirical approach differs from the aforementioned studies in that we examine the link between the three deep determinants and development within a panel data framework. Using a panel data framework instead of the standard cross-section approach has several advantages. First and foremost, we can control for unobserved, time-invariant cross-country heterogeneity through the use of a fixed-effect (FE) estimator. Unfortunately, using the FE estimator will cause all time-variant variables such as all geography measures as well as many institutional measures to be excluded from the regression. However, an estimator that is closely related to the FE estimator but allows the estimation of time-invariant covariates is available: the Hausman and Taylor estimator (1981). This is the precisely the estimator we use extensively throughout this paper. The HT model however does not account for simultaneity bias between the dependent and independent variables. One approach that has been used in the literature in dealing with endogeneity in the panel data model is the Arellano-Bond (1991) estimator. The disadvantage of the Arellano-Bond estimator in our context is that it requires the transformation of the model from levels to growth rates, thereby preventing a comparison between the cross-section and panel data estimates. To control for the endogeneity caused by the contemporaneous correlation between the time-varying endogenous variables and the idiosyncratic error term, we use lagged values of these variables. Furthermore, to neutralize the impact of short-term (business cycle) effects on income we use ten-year as well as five-year averages for all time-varying variables.

Using data from over 90 countries over the 1961 to 2000 period, we find that institutions and international linkages have a positive and statistically significant impact on economic development, while the adverse impact of geography is typically smaller in magnitude. This result thus provides an interesting as well as encouraging outlook: determinants that can be influenced by public policies (institutions and trade relations) matter for development and their joint, positive impact may help to overcome any exogenous, geographical disadvantage a developing country may have.

The rest of the paper is organized as follows. Section 2 contains the empirical model and a discussion of the estimation methodology. We describe the data in Section 3. In Section 4, we derive and interpret the main estimation results. Section 5 concludes. Appendix A consists of variable definitions and summary statistics. The estimation results are given in Appendix B. An online appendix contains a number of robustness checks.

2 Empirical Model

Following Rodrik *et al*. (2004), the starting point of our empirical investigation is the following linear cross-section specification:

(1) $Inc = \theta_1 + \theta_2 + \theta_3 Intg + \theta_4 Geog + \varepsilon$

where *Inc* is the log of income per capita and *Inst*, *Intg* and *Geog* are measures of institutions, integration and geography, respectively. Estimation of (1) poses a number of difficulties that need to be addressed. First, institution and integration measures are likely to be endogenous due to measurement error, survey bias, and/or reverse causality.[2] Consequently, appropriate instruments are needed for both measures. Of the various instruments found in the literature, two stand out due to their widespread use: settler mortality (see Acemoglu *et al*., 2001) and predicted trade shares (see Frankel & Romer, 1999).

The first stage regressions for the two institutions and integration are:

(2a) $Inst = \alpha_1 + \alpha_2 SM + \alpha_3 Geog + \alpha_4 FR + \eta$

(2b) $Intg = \beta_1 + \beta_2 FR + \beta_1 SM + \beta_1 Geog + \nu$

where *SM* is log settler mortality (Acemoglu *et al*., 2001), *FR* is the Frankel-Romer (1999) predicted trade share and *Inst*, *Geog* and *Intg* are as defined above. A shortcoming of the above model is that it ignores unobserved cross-country heterogeneity. Using a panel data approach enables us to exploit the time dimension of the data to account for unobserved country-specific heterogeneity.

A panel data extension of the above model is, however, not completely straightforward since some of the right-hand side variables in Equations. (1–2) are time invariant. Thus, when using mean- or first-differencing to remove country-specific effects, time invariant covariates would be removed from the estimation equation as well. An alternative approach that allows parameter estimation of time-invariant regressors within the panel data framework is the random effects specification. However, random effects models assume independence between the individual error terms and the explanatory variables, an assumption that is often violated in economic applications, and is not likely to hold in the above model as well.

To circumvent both problems—accounting for unobserved, time invariant country-specific effects and obtaining estimates of the observed time-invariant variables—we use the estimation method proposed by Hausman and Taylor (1981), referred to as HT hereafter. A HT model can be represented by the following specification:

$$(3)\ y_{it} = X_{1it}\beta_1 + X_{2it}\beta_2 + Z_{1i}\gamma_1 + Z_{2i}\gamma_2 + \nu_i + \mu_{it}$$

for $i = 1,2\ldots N$ and $t = 1,2\ldots.T$, where X and Z are vectors of time-varying and time-invariant variables, respectively, ν_i is the country specific fixed effect, μ_{it} is the idiosyncratic error and subscript 1 (2) represents variables independent of (correlated with) the individual specific error term.[3]

To choose the appropriate estimation technique for the panel data model, we follow the approach suggested in Baltagi *et al*. (2003). First, we test whether we need to use panel data methods by carrying out the Breusch-Pagan (BP) test for error components. Second, if panel data methods are warranted, we check the exogeneity of *each* time-varying variable by testing whether the variable of interest is correlated with the individual country-specific error term. This is done through a Hausman specification test between random and fixed effect specification. The resulting classification of the time-varying explanatory variables is given in the top half of Table A3.[4] Third, we check the appropriateness of the random effect (RE) versus the fixed effect (FE) estimator of our panel specification using a Hausman test.

Finally, we test the HT estimator (Equation 3) against the chosen model from the previous step, again using a Hausman test. We report the selected estimation model (HT, RE, or FE) at the bottom of each table.

Though the HT approach enables us to account for the potential correlation between the explanatory variables and country-specific time invariant unobservables, there may still be simultaneity between the dependent variable and some of the observed right-hand side variables, in particular certain measures of trade and institutions. For the time varying variables, we account for the existence of this contemporaneous endogeneity by using the average values of these variables from the previous decade. The identifying assumption here is that while previous decade's institutional and trade variables would not be affected by current decade's per capita GDP, they are strongly correlated with the current levels of the respective variables.

3 Data

The data set covers the four decades from 1961 to 2000. Time varying variables are averaged over ten years to smoothen out temporary shocks and business cycle fluctuations common across countries. As a result, the time dimension of the sample is four. The cross-section dimension varies between the various specification of the baseline regression model, ranging from N = 65 to N = 125. Summary statistics are given in Appendix A, Table A2, and correlation coefficients can be found in an online appendix (Appendix D, Tables D1–D3).

Economic Development Our measure of economic development (the dependent variable in all regressions) is the log of per capita GDP, expressed in 1996 international dollars, taken from the Penn World Table, Mark 6.1 (Heston *et al*., 2002).

Institutions Our preferred measure of institutions is contract intensive money (CIM), defined as the ratio of non-currency money to total money in an economy, as proposed by Clague *et al*. (1999). The basic argument for such a measure stems from the fact that in societies where the property and contract rights are well defined, even transactions which heavily rely on outside enforcement can be advantageous.[5] Currency in this setting is used only in small transactions. Agents are increasingly able to invest their money in financial intermediaries and exploit several economic gains. Thus, stronger institutions would be manifested by a greater share of CIM.

But is CIM indeed a measure of institutional quality and not just a proxy for financial development? Based on a case study of seven countries, Clague *et al*. (1999) show that CIM tracks major political developments that have little direct impact on the financial sector. They also conduct a principal components analysis to indicate that CIM is predominantly a measure of the property rights environment rather than financial development. In fact Clauge *et al*. (1999) characterize CIM as the "contract-intensive money indicator of property rights enforcement" (p. 186). In this regard, CIM can be seen to be a good proxy for both Acemoglu and Johnson's (2005) property rights measures as well as North's (1994) definition of institutions. Finally, an additional benefit of the CIM measure is that it is more objective and more precisely measured than most organization measures which are often survey-based and thus suffer from biases and measurement errors.

Another important measure of institutions is the "number of veto players," which captures the extent of checks and balances within the government and is obtained from the World Bank's *Data on Political Institutions* database (Beck *et al*., 2001). The motivation here is that countries with multiple decision makers offer greater protection to individuals and minorities from arbitrary government action (Keefer *et al*., 2003). This measure counts the number of decision makers in the government, taking into consideration whether they are independent from each other.

Trade We measure the extent of a country's integration into the world economy by its share of trade (exports plus imports) in GDP, a widely used, but not uncontroversial measure of openness. In addition, we employ direct measures of trade policies such as the average import duty imposed by a country. We also use Sachs and Warner's (1995) openness index (updated and extended by Wacziarg and Welch, 2003). It is an indicator variable based on the years a country is considered open to trade. Specifically, we look at periods of uninterrupted openness. If a country has been open since the 1960s, a score of 4 is assigned, if open since the 1970s, a score of 3, and so on. An economy which was closed to trade throughout the sample period gets a score of 0. Since foreign currency restrictions imposed by the government can stifle trade, we use the black-market premium as a proxy for the extent of foreign currency restrictions.

Geography A measure of geography recently introduced in the literature is disease environment. Gallup *et al*. (1999) constructed a malaria index for two years, 1966 and 1994. This measure has been used in a number of studies involving geography and development. However, Sachs (2003) has argued that the traditional malaria index used in the literature is not a good indicator of the disease environment. Instead, he uses a new measure that combines temperature, mosquito abundance and vector specificity. The new measure is called Malaria Ecology (ME). In contrast to the old malaria index, ME is an ecology-based measure that is predictive of malaria risk. We include both, the traditional malaria index and the ME variable in our study. Additional geographical measures used in our empirical analysis include hydrocarbons per capita, a dummy for landlocked countries, and the percentage of land area in the tropics.

Details on these and several other measures used in this study can be found in Table A1 in Appendix A.

4 Empirical Results

4.1 Cross-section framework

To contrast our empirical results with the existing literature, we first estimate the cross-section specification used by Rodrik *et al*. (2004). As in that study, the measure of economic development in the cross-section model is the log of per capita GDP in 1995, measured in international prices. Openness to international trade is measured as average trade shares over 1961–2000[6] (*trade shares*). For institutions, we use the *Rule of Law* indicator as described in the data appendix. The measure of geography used is absolute distance from the equator[7] (*Dist Equator*). Like Rodrik *et al*. (2004), we estimate the model for two sample sizes due to the use of different instruments for institutions. The first instrument—settler mortality—allows for a sample size of 70, while the second—language fractionalization—permits a sample size of 123. Both instruments are used in Rodrik *et al*. (2004). Hall and Jones (1999; hereafter HJ) used language fractionalizations as an instrument for institutions, while Acemoglu *et al*. (2001; hereafter AJR) introduced settler mortality as an alternative instrumental variable. When trade is added as an additional regressor, the constructed trade share from Frankel and Romer (1999) is used as an additional instrument. After controlling for the endogeneity of trade and institutions, only the latter seems to have a statistically significant impact on development. These results as well additional comments can be found in an online appendix (see section E1 and Table E).

In the next subsection, we reexamine the relationship between the three "deep determinants" and per capita income, but this time within a panel data setting.

4.2 Panel estimations

As explained in section 2, the HT approach to panel data estimation requires the *ex-ante* identification of those covariates that are correlated with the country-specific time-invariant unobservable characteristics. Among the time-varying regressors, we find that only contract intensive money (*CIM*) and number of veto players (*Veto Players*) are uncorrelated with country-specific effects and thus qualify as an exogenous X1(it) variables (see Table A3 in Appendix A). All other time-varying covariates are treated as endogenous X2(it) variables.[8] Moreover, where data permits, we replace the current values of these variables by values from the previous decade to control for possible simultaneity bias between these and the dependent variable. Among the time-invariant covariates, we assume that the multi-dimensional measure of the quality of institutions (*Rule of Law*), the absence of corruption index (*NoCorrupt*), and Sachs and Warner's (1995) openness index (*SW open*) are correlated with country-specific effects and thus considered Z2(i) variables since these variables are typically considered endogenous in the cross-section literature. In implementing the HT model, these variables are instrumented by the means and mean deviations of the exogenous time varying variables. All other time-invariant covariates (i.e., all geography measures, region dummies, legal origin dummies, and language and religious fractionalization measures) are treated as exogenous Z1(i) variables, as is typical in the cross section literature.

4.2.1 Baseline specification

Table 1 in Appendix B contains the panel regressions of our benchmark specifications of Equation (3). The dependent variable in all models is the log of GDP per capita in 1996 international dollars (*ln GDP capita*). In columns 1–4 we use *CIM* as our time-varying measure of institutions. In columns 5–8 CIM is replaced with an alternative measure, *Veto Players*. In the last three columns (9–11), both measures are included in the estimations. We employ two measures of trade. In columns 1–2 and 5–6, we use the traditional measure of the ratio of exports and imports in GDP (*Trade Share*), while in columns 3–4 and 7–8 we use the black market premium (*BMP*) as a proxy for distortions to international trade flows and/or macroeconomic mismanagement. In columns 9–11, both measures are used simultaneously. We employ two measures of geography: *Malaria Ecology* and a malaria incidence measure for the year 1966 (*Malaria Index*, 1966). The latter measure is used in columns 3–4 and 7–8, while *Malaria Ecology* is used in all other specifications. Finally, two time-invariant measures of institutions are considered as well. In columns 2, 4, 6, 8 and 10 we use a measure of the absence of corruption (*NoCorrupt*), while in columns 1, 3, 5, 7 and 9 we use the *Rule of Law*. In the last column (11), both measures are included.

As mentioned in section 2, we use a series of tests to identify the appropriate estimation approach—pooled OLS, random effects (RE), fixed effects (FE) or Hausman-Taylor (HT)—for each specification of the benchmark model. Based on the corresponding p-values for each test (reported in the middle of Table 1), we select the appropriate estimation procedure as shown in the last row of the table. In most cases, the chosen model is HT. Only in columns 4 and 10 RE is preferred. Since the HT model involves carrying out an instrumental variable (IV) regression in step 3 of its estimation procedure, we report the F-values from the first stage of that IV approach as well as the p-values of the over-identification tests from the second stage, when applicable. F-statistics (though not reported in Table 1) indicate that the instruments in all HT specifications are strong and the p-values for both the Basmann and the Sargan test (see footnote to column 9) indicate that the exclusion restrictions of the instruments are valid.[9]

The estimation results show that most regressors have point estimates that are statistically significant at the 5 percent level or higher. In addition, all explanatory variables have the expected sign. In terms of their economic significance, *CIM* and *NoCorrupt* have the strongest impact. The *CIM* elasticity estimates range from 0.39 to 0.71, while the statistically significant *NoCorrupt* elasticities[10] fall into the range from 0.62 to 2.34. The statistically significant *Malaria Index* elasticity estimates range from -0.2 to -0.39, while the similar sized *Trade Share* elasticities range from 0.12 to 0.31. Compared to the *Malaria Index*, the *Malaria Ecology* elasticity estimates are smaller (in absolute values) ranging from –0.08 to –0.2. The average elasticity estimate for *Veto Players* is around 0.07, roughly one-seventh the size of the average CIM elasticity. BMP elasticity estimates are generally small, ranging from –0.03 to –0.06. The other time-invariant measure of institutions, *Rule of Law*, has the lowest elasticity estimates ranging from 0.009 to 0.01 (for statistically significant estimates).

Table 1 yields a number of additional insights. When *CIM* is replaced with *Veto Players*, the point estimates of the trade variables, *Trade Share* and *BMP*, are larger and more significant (see columns 5–8 compared to columns 1–4), a result of the relative weaker explanatory power of *Veto Players*. A similar pattern can be observed for the geography measures. Including all time-varying variables simultaneously (columns 9–11) does not change the results for the most part. *Malaria Ecology* remains negative but is significant in only one case. The time-invariant measures of institutions when entered one at a time (columns 9–10) are significant. However, when both of them are included simultaneously (column 11), none of them is statistically significant, while all time-varying trade and institution measures remain statistically significant and display similar magnitudes.

In terms of economic relevance, we find that a 10 percent increase in *CIM* and the *Trade Share* together will improve per capita income by around 6 percent, while a 10 percent increase in Malaria risk would lower income by 2 percent.[11] Thus, income losses due to unfavorable geographic factors, i.e. a rise in a country's exposure to malaria risk, can be more than offset by an improvement in its institutions combined with a rise in its exposure to international trade.

The above results are both novel and plausible. Institutions, trade and geography turn out to be statistically significant and economically important determinants of economic development. In contrast to the findings in Rodrik *et al*. (2004) that were based on cross-section estimates, we do not find that, within the context of our panel data estimates, the inclusion of several measures of institutions renders the impact of openness to trade and geography statistically insignificant or leads to implausible coefficient signs of those measures. However, we concur with Rodrik *et al*. (2004) that in terms of their economic impact, institutional measures seem to matter more than either openness or geography.

4.2.2 Robustness checks

We also conduct a series of robustness checks on the results reported in Table 1. The robustness check results together with the detailed discussion can be found in an online appendix (see Section E2 and Tables E2 through E8). We tested for sensitivity to changes in the length of the time dimension of the panel (Table E2), to alternative measures of institutions, openness, and geography (Tables E3–E6), to the inclusion of time-effects (Table E7), and to an alternative estimator (Arellano-Bond difference GMM, Table E8). The results from these robustness checks support the main findings from Table 1, namely that institutions, trade and geography are all valid determinants of economic development.

5 Conclusions

Starting with Rodrik *et al*. (2004), a number of papers have questioned an independent role of international trade and geography for development once measures of institutional qualities are included in the empirical model. This paper begs to differ with that conclusion. While we concur with Rodrik *et al*.'s emphasis on the importance of institutions, in particular in terms of their economic significance, we show that across all empirical models—from the baseline to the various alternative specifications—international trade and geography affect economic development on their own. We establish this result by applying the Hausman-Taylor estimator to a panel data set, an approach that allows us to simultaneously account for unobserved time-invariant country-specific heterogeneity as well as identify certain parameters of interest such as geography and other time-invariant variables. Our approach is not without limitations. Clearly, the need to group the explanatory variables into those which are independent of the time-invariant country-specific error term and those which are not is somewhat subjective. However, we have taken great care to minimize a potential subjectivity bias. We also show that by using the Arellano-Bond estimator as an alternative to Hausman-Taylor, we are able to produce estimates of the time-varying regressors (i.e. institutions and international trade) that are very similar to the ones generated by HT.

While our results show that institutions, trade, and geography are all valid determinants of economic development with regard to statistical significance and robustness, they vary in terms of their economic impact. This is especially true if we measure the quality of institutions as the extent of contract intensive money. The various trade and trade policy measures are economically important as well, but typically to a lesser extent than the institution measures. The economic impact of geography, in particular when measured through the malaria ecology index, cannot be ignored but is weaker than the main measures of trade and institutions. Together, our results provide an interesting as well as encouraging outlook: institutions and trade matter for development and their joint, positive, and strong economic impact should help policy makers in developing countries to mitigate of the geographical disadvantages their nations may face.

Endnotes

1 Easterly and Levine (2003) provide a good overview of studies analyzing the three determinants. In this paper geography is defined as physical geography, as opposed to economic geography as discussed in Redding and Venables (2004).

2 See Frankel and Romer (1999), Hall and Jones (1999), Acemoglu *et al*. (2001), and Baier and Bergstrand (2007).

3 See the Appendix C (online) for a description of the HT estimator.

4 The test results are available from the authors upon request. In Table A3, an X1 behind a time-varying variable indicates that this variable can be considered exogenous, while an X2 indicates endogeneity. There is no equivalent test for the time-invariant covariates listed in the bottom half of Table A3. The classification of these variables into exogenous (Z1) and endogenous (Z2) covariates is based instead on practice in the cross-section literature.

5 A similar point is made by Acemoglu and Johnson (2005) who examine both, "contracting institutions" and "property rights institutions." The former govern contracting relationships between private parties and the latter govern the relationship between private citizens and those with political power. They show that while contracting institutions may be useful for financial intermediation, it is the property rights institutions that have a positive impact on economic growth and development.

6 The GDP and openness measures are taken from the Penn World Table, version 6.1 (Heston *et al*., 2002).

7 We also used relative distance from the equator but the coefficient estimates and t-statistics turned out to be quite different from those reported by Rodrik *et al*. (2004).

8 The test results for democracy index (*Democracy*) and constraints on the executives (*Constraints on Exec*) were inconclusive. In this case, we decided to treat both variables as endogenous.

9 Column 9 and 10 are the only specifications in Table 1 for which the number of exogenous X1 variables exceeds that of the endogenous Z2 variables, a necessary condition for the use of the over-identification tests. No over-identification test are reported for column 10 since RE, not HT, is the preferred model.

10 All parameter estimates of variables that are not in logs are appropriately adjusted to generate elasticity estimates, with evaluations taken at the mean.

11 Based on averages of statistically significant parameter estimates from columns 9–11 in Table 2, with Malaria estimates evaluated at the mean of 3.78 (see Table B6 in the online appendix).

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Appendix A.
Variable Definitions and Summary Statistics

Table A1 (*continues on following pages*): Variable Definitions and Data Sources

Institutions

Name	Definition and Source(s)
CIM	*Contract Intensive Money*: Defined as the ratio of non-currency (M1excluding currency) to total money (M2). From Bittik (2004)
Veto Players	*Number of Veto Players*: This variable counts the number of veto players in a political system, adjusting for whether these veto players are independent of each other, as determined by the level of electoral competitiveness in a system, their respective party affiliations, and the electoral rules. Veto players are defined as the president, largest party in the legislature, for a presidential system; and as the prime minister and the parties in the government coalition in a parliamentary system. (Also see Keefer, 2002.) From DPI2000 (Beck *et al*., 2001), where it is coded as *CHECKS*.
Leg. Comp. Index	*Legislative Index of Electoral Competitiveness*: Scaled as: (1) no legislature (2) unelected legislature (3) elected, one candidate (4) one party, multiple candidates (5) multiple parties are legal, but only one won seats (because other parties did not exist, compete, or win seats) (6) multiple parties competes and won seats (but one party won 75 percent or more of the seats) (7) the largest party received less than 75 percent of the seats. From DPI 2000 (Beck *et al*., 2001) where it is coded as LEIC.
Stability of Tenure	*Stability of Tenure*: Measure of government stability that captures the extent of turnover in any one year of a government's key decision makers. It is calculated by dividing the number of exits between year t and t+1 by the total number of veto players in year t. The variables are therefore on a 0-1 scale, with zero representing no exits and one representing the exit and replacement of all veto players. From DPI 2000 (Beck *et al*., 2001) where it is coded as STABS.

Institutions (cont.)

Name	Definition and Source(s)
Democracy	
	Institutionalized Democracy: Democracy is conceived as three essential, interdependent elements. One is the presence of institutions and procedures through which citizens can express effective preferences about alternative policies and leaders. Second is the existence of institutionalized constraints on the exercise of power by the executive. Third is the guarantee of civil liberties to all citizens in their daily lives and in acts of political participation. The Democracy indicator is an additive eleven-point scale (0-10). From Polity IV dataset (Jaggers & Marshal, 2000), where it is coded as DEMOC.
Constraints on Exec	
	Constraints on Executive: This variable refers to the extent of institutionalized constraints on the decision-making powers of chief executives, whether individuals or collectivities. (1) unlimited authority (2) intermediate category (3) Slight or moderate limitation on executive authority (4) intermediate category (5) Substantial limitations of executive authority (6) intermediate category (7) Executive parity or subordination. From Polity IV dataset (Jaggers & Marshal, 2000), where it is coded as XCONST.
FH Democracy Index	
	Average of Political Rights and Civil Liberty; both indicators from Freedom House (FH), (2004)
LER Fractional.	
	Language, Ethnic and Religious Fractionalization: Denotes the following three variables: • *Ethnic Fractionalization: is the probability that two randomly selected individuals in a country will not belong to the same ethnic group in the 1990s. From Alesina et al. (2003)* • *Linguistic diversity: is the probability that two randomly selected individuals in a country will not speak the same language in the 1990s. From Alesina et al. (2003)* • *Religious Fractionalization: is the probability that two randomly selected individuals in a country will not belong to the same religious group in the 1990s. From Alesina et al. (2003)*
European Lang Fraction	
	European Languages: Fraction of population speaking one of the four major Western European languages (English, French, German, Spanish and Portuguese) at birth. From Hall and Jones (1999)

Institutions (cont.)

Name	Definition and Source(s)
Region: S.S.A.	Dummy variable for countries in *Sub-Saharan Africa*. From World Bank, Global Development Network Database
Region: Latin America	Dummy variable for countries in *Latin America*. From World Bank, Global Development Network Database
Region: E Asia and Pacific	Dummy variable for countries in *East Asia and Pacific*. From World Bank, Global Development Network Database
British Legal Origin	Dummy variable for countries with British legal system. From La Porta *et al*. (1999)
French Legal Origin	Dummy variable for countries with French legal system. From La Porta *et al*. (1999)
Religious Fraction	Denotes the following three variables: Fraction of the population in the 1980s that is Catholic, Muslim, and Protestant, respectively. From La Porta *et al*. (1999)
Rule of Law	Measures the quality of contract enforcement, police and courts, as well as the likelihood of crime and violence, average for 1996, 98 and 2000. From Kaufmann *et al*. (2003)
NoCorrupt	*Index of government corruption*: Low ratings indicate "high government officials are likely to demand special payments" and "illegal payments are generally expected through lower levels of government" in the form of "bribes connected with import and export licenses, exchange controls, tax assessment, policy protection, or loans." Scale from 0 to 10. Average of the months of April and October in the monthly index between 1982 and 1995. Source: *International Country Risk Guide (ICRG)*. From La Porta *et al*. (1999)

Trade	
Name	**Definition and Source(s)**
Trade Share	Imports plus exports relative to GDP; From PWT Mark 6.1 (Heston *et al*., 2002)
ER Overvaluation	*Real Exchange rate overvaluation*: From World Bank, Global Development Network Database
BMP	*Black Market premium*. From World Bank, Global Development Network Database
Import Tariffs	*Imports Tariffs*: Import duties as a percentage of total imports. From World Bank, World Bank (2003); own calculations.
Taxes on Trade	*Total taxes on International trade*: Total taxes on international trade as a percentage of total trade. From World Bank (2003); own calculations.
Openness Index	*Index of Openness*: This index is based on the openness dummy constructed by Sachs and Warner (1995) and updated by Wacziarg and Welch (2003). The Sachs-Warner index takes the value of 1 for each decade in which a country was open to trade. Our openness index is constructed as sum across decades and thus takes values between 0 to 4. From Wacziarg and Welch (2003); own calculations

Geography	
Name	**Definition and Source(s)**
Dist Equator	*Relative Distance from the equator*: Calculated as distance from the equator, divided by 90. From Gallup *et al*. (1998) and Hall and Jones (1999)
Malaria Ecology	A measure of malaria incidence that combines temperature, mosquito abundance and vector specificity. The underlying index is measured on a highly disaggregated sub-national level, and then is averaged for the entire country. Because ME is built upon climatological and vector conditions on a country-by-country basis, it is exogenous to public health interventions and economic conditions. From Sachs (2003)

Geography (cont.)

Name	Definition and Source(s)
Malaria Index (1966)	*Falciparam malaria index, 1966*: A measure of the prevalence of malaria disease environment in the sixties. From Gallup *et al*. (1998)
Landlocked (not C/W Europe)	Dummy variable for non-Western and non-Central European landlocked countries. From Gallup *et al*. (1999)
% of land in tropics	Percentage of a country's surface area located in the tropical region. From Gallup *et al*. (1999)
Hydrocarbons per capita	Amount of fossil fuels per capita in 1993. From Gallup *et al*. (1999)
Good Crops Index	The index equals log(1+%maize+%wheat)/(1+%rice+%sugarcane), where %X equals the share of the land area suitable for growing crop X according to FAO. From Easterly and Levine (2003)

Instrumental Variables for 2SLS Regressions in Table E1

Name	Definition and Source(s)
Settler Mortality	Mortality rate of European colonialists in the 1500s. From Acemoglu *et al*. (2001)
F-R Trade Share	*Frankel and Romer Predicted Trade Shares*: Predicted trade shares obtained from bilateral gravity type equations and controlling for geography. From Frankel and Romer (1999)

Table A2 (*continues on following page*): Summary Statistics of Country Means

Variable	Obs	Mean	Min	Max
GDP per cap	166	8.25	6.26	10.06
Measures of Institutions				
Ln CIM	108	4.29	3.55	4.54
Veto Players	167	2.37	1.00	7.28
Leg. Comp. Index	167	5.08	1.00	7.00
Stability of Tenure	167	0.11	0.00	0.33
Democracy	158	3.66	0.00	10.00
Constraints on Exec	158	3.83	1.00	7.00
FH Democracy Index	171	2.95	0.00	6.00
Language Fractionalization	165	3.19	-1.56	4.52
Ethnic Fractionalization	169	3.53	-1.61	4.53
Religious Fractionalization	174	3.45	-1.47	4.45
% European Language	143	0.27	0.00	1.06
Region: SSA	176	0.27	0.00	1.00
Region: Latin America	176	0.19	0.00	1.00
Region: East Asia	176	0.11	0.00	1.00
British Legal Origin	175	0.31	0.00	1.00
French Legal Origin	175	0.43	0.00	1.00
% Catholic (80s)	157	2.24	-2.30	4.58
% Muslim (80s)	125	1.89	-4.61	4.60
% Protestant (80s)	145	1.21	-2.30	4.58
Rule of Law	174	0.01	-1.83	2.21
No Corrupt	123	5.69	1.01	10.00

Variable	Obs	Mean	Min	Max
Measures of Trade				
Ln Trade Share	166	4.08	-1.70	5.49
Ln BMP	138	2.39	-2.33	10.84
Ln ER Overvaluation	104	4.68	3.92	5.48
Ln Import Tariff	146	1.58	-5.12	4.49
Ln Taxes on Trade	147	1.11	-5.83	4.21
Index Open	141	1.64	0.00	4.00
Measures of Geography				
Malaria Ecology	163	3.78	0.00	31.55
Malaria Index (1966)	143	0.32	0.00	1.00
Dist. Equator	176	0.29	0.00	0.71
Landlocked (not C/W Europe)	149	0.19	0.00	1.00
% land area in tropics	149	0.16	0.00	1.00
Ln Hydrocarbons per cap	147	0.72	-4.61	10.59
Good Crops Index	64	0.97	0.41	2.44
Instrumental Variables for 2SLS Regressions in Table 1				
Ln Settler Mortality	74	4.65	2.15	7.99
F-R Trade Share	142	2.98	0.83	5.64

Table A3. Classification of Variables for HT Model Estimation

Time Varying			
Institutions		**Trade**	
Name	**Category**	**Name**	**Category**
CIM	X1	Trade Share	X2
Veto Players	X1	BMP	X2
Leg Comp. Index	X2	ER Overvaluation	X2
Stability of Tenure	X2	Import Tariff	X2
Democracy	X2	Taxes on Trade	X2
Constraints on Exec	X2		
Democracy Index (FH)	X2		

Time Invariant			
Institutions		**Trade**	
Name	**Category**	**Name**	**Category**
LER Fractional.	Z1	Index Open	Z2
European Lang Fraction	Z1	**Geography**	
Region: S.S. Africa	Z1	**Name**	**Category**
Region: Latin America	Z1	Malaria Ecology	Z1
Region: East Asia and Pacific	Z1	Malaria Ind (66)	Z1
British Legal Origin	Z1	Dist Equator	Z1
French Legal Origin	Z1	Landlocked	Z1
Religious Fraction	Z1	% area tropics	Z1
Rule of Law	Z2	Ln HC per cap	Z1
No Corrupt	Z2	Good Crop Index	Z1

Note: X1 and Z1 (X2 and Z2) denote variables independent of (correlated with) the country-specific time-invariant unobservables.

Appendix B. Estimation Results

Table 1: Panel Regressions: Benchmark Specification, 10 yr averages. Dependent Variable: Ln GDP per capita

		1	2	3	4
X1(it)	Ln CIM (t-1)	0.499	0.553	0.512	0.711
		(4.71)**	(5.02)**	(5.25)**	(5.94)**
	Veto Players (t)				
X2(it)	Ln Trade Share (t-1)	0.211	0.251		
		(4.33)**	(5.30)**		
	Ln BMP (t-1)			-0.039	-0.049
				(3.36)**	(3.73)**
Z1(i)	Malaria Ecology	-0.021	-0.047		
		(1.69)+	(3.74)**		
	Malaria Index, 1966			-0.79	-1.204
				-0.77	(8.06)**
Z2(i)	Rule of Law	0.941		0.639	
		(5.54)**		-0.51	
	NoCorrupt		0.318		0.11
			(4.19)**		(2.89)**
	Observations	272	244	191	173
	Countries	94	84	71	65
	B-P test of OLS vs EC‡	[0.0000]	[0.0000]	[0.0000]	[0.0000]
	Hausman test of RE vs FE‡	[0.0039]	[0.0004]	[0.0000]	[1.0000]
	Hausman test of HT vs FE‡	[1.0000]	[1.0000]	[1.0000]	
	Hausman test of RE vs HT‡				[1.0000]
	Selected Estimation:	HT	HT	HT	RE

Absolute value of z statistics in parentheses
+/*/**: significant at 10% / 5% /1%, respectively
‡: p values in square brackets
First stage diagnostics including the F stats, not reported here, indicate the absence of weak/under- identification in the HT model

5	**6**	**7**	**8**	**9**	**10**	**11**
				0.392	0.518	0.44
				(3.30)**	(3.91)**	(3.54)**
0.039	0.045	0.044	0.048	0.022	0.033	0.03
(2.61)**	(3.23)**	(2.95)**	(3.26)**	-1.44	(1.98)*	(1.95)+
0.241	0.313			0.136	0.123	0.185
(4.96)**	(6.65)**			(2.49)*	(2.33)*	(3.47)**
		-0.059	-0.062	-0.033	-0.047	-0.032
		(4.66)**	(5.02)**	(2.44)*	(3.41)**	(2.46)*
-0.03	-0.044			-0.013	-0.052	-0.026
(2.77)**	(3.43)**			-0.86	(5.51)**	-0.73
		-0.647	-1.134			
			(3.97)**			
0.89		0.751		1.241		0.775
(7.53)**		(1.86)+		(3.34)**		-0.58
	0.413		0.225		0.149	0.12
	(5.60)**		-0.96		(3.44)**	-0.33
340	291	237	211	200	175	175
122	102	89	79	74	65	65
[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
[0.0000]	[0.0000]	[0.3964]	[0.0106]	[0.0000]	[1.0000]	[0.0000]
[1.0000]	[1.0000]	[1.0000]	[1.0000]	[0.9528]		[1.0000]
					[1.0000]	
HT	HT	HT	HT	HT	RE	HT