# *Does* Money Grow on Trees? How Institutions and Policies Shape Economic Growth

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**Abstract**

This analysis considers the recent progress made in cross-country growth modeling. It uses threshold regressions to reveal three possible nonlinear trees to describe the growth data, and uses BART to test for parameter heterogeneity. The analysis uses model averaging techniques, including both Bayesian and non-Bayesian methods to account for model uncertainty. The major findings include the significant impacts of several economic policies, including the rule of law and the regulations placed on credit, labor, and business, the insignificance of political institutions on economic growth, and a difference in partial effects of several variables conditional on level of democracy.

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# 1 Introduction

Economic growth has long been a hot-button topic for economic research. The neoclassical growth model of Solow (1956) theorized that diminishing returns to capital would lead to an economic phenomenon known as conditional convergence. His model showed that, holding all else equal, countries with a low level of GDP would grow faster than countries with a high level of GDP due to diminishing returns. However, this belief could not be extended to a theory of absolute convergence, as cross-country evidence showed that there was no correlation between GDP level and economic growth. Motivated by the desire to explain and expand growth, economists have turned to cross-country regressions in an effort to uncover the underlying causes of economic growth. In the past 20 years, these efforts have produced a plethora of different models, theories, and methods for estimating the effects of a given input on economic growth. As one can imagine, this has produced a jumbled soup of conclusions and policy recommendations, with one paper's conclusion often contradicting another's. However, cross-country growth modeling is extremely relevant to domestic and foreign policy alike. With greater knowledge about how to achieve economic growth, a nation can better organize its political infrastructure and its government can better institute public policy to increase the well-being of its citizens. This knowledge can also help international organizations to better target their resources and policies to best impact the well-being of the world's citizens. For these reasons, this paper will aim to explain which political institutions and economic policies are robust determinants of economic growth.

## 1.1 Cross-Country Growth Overview

In order to understand the need for cross-country growth research today, it is important to review the findings and evolution of previous research. Barro (1991) analyzed the economic growth of about 100 countries from 1960-1985 and found that, indeed, the cross-country evidence appeared to be inconsistent with the absolute convergence hypothesis. However, when Barro held measures of human capital, namely the primary and secondary school enrollment rates, constant, countries with a lower initial per capita GDP would grow faster than those with a higher initial per capita GDP. This provided empirical evidence of conditional convergence. Barro also took the next step in cross-country growth regressions by finding that growth was positively related to measures of political stability and inversely related to a measure of market distortions. Barro's findings were supported by similar findings by Mankiw, et al. (1992), in which the group found that an augmented Solow model that accounted for human and physical capital was an accurate description of cross-country growth rates. Hall and Jones (1998) found that productivity differs across nations due to differences in rates of investment in physical and human capital. They determined that differences in social infrastructure across countries cause large differences in capital accumulation, educational attainment, and productivity, not to mention income.

## 1.2 Institutions and Growth

### 1.2.1 Theory

Political scientists have long examined the impact of different political structures on economic growth. Lipset (1959) studied the causal effects of democracy and economic growth. Lipset suggested that democracy did not lead to growth, as the popular post-WWII thought process would predict, but rather economic growth led to better education, which in turn led to a social desire for more political freedoms. Lipset theorized that instead of democracy causing growth, it was the initial economic growth that caused the desire for democracy. Olson (1993) attempted to further limit the role of democracy in growth. Olson theorized that Democratic competition does not give leaders the incentive an autocrat has to extract the maximum attainable social surplus. He suggested that monarchies with long-living kings should do better, because the king has a longer horizon to plan for. Olson did partially disagree with Lipset, however. He suggested that democracy establishes itself due to power struggles, i.e. nobody is strong enough to conquer, so factions face a decision between democracy and needless fighting. Property rights and civil liberties follow, which give people confidence about contracts being enforced, which results in economic growth. Przeworski and Limongi (1993) compiled a survey of 18 papers relating democracy and growth published between 1966 and 1992. They found that 8 analyses reported that authoritarian states grow faster than democracies, 8 reported that democracies grow faster than authoritarian states, and 2 reported there was no measurable difference between the two regimes.

### 1.2.2 Empirical Problems in Measuring Freedom

The need to empirically test the theories of Lipset and Olson was clear. The problem facing economists and political scientists alike was that it was difficult to find a suitable proxy variable capable of measuring democracy and freedom. A large number of models were created in order to show the effects democracy had on economic growth. Most used indicators of democratic and economic freedoms, which would otherwise be unobservable. Helliwell (1992) used the Bollen index of political democracy and the Gastil index of political freedom in order to determine that countries with a higher income are likely to have more democracy, but higher levels of democracy lead to slower growth. Rodrik (1997) found that democracies provide more stable growth rates than non-democracies. He also found that democracies tended to deal with external shocks better than non-democracies. Perhaps the biggest problem with these types of analysis is that the Bollen index and the Gastil index (now known as the Freedom House's "Freedom in the World" publication) both clump all of policies and political structures that make a democracy free into one composite index.

Mauro (1995) indicated that there might be a need for one composite index, due to the levels of multicollinearity in disaggregated variables. Nonetheless, it is impossible to differentiate what aspects of democracy actually have an effect on growth. The only conclusion we can draw from papers that utilize such indexes is that democracy, on the aggregate, has an inverse effect on growth.

A number of papers recognize the problem of aggregating many factors into a single index. Carlsson and Lundstrom (2001) show that choosing one measure of economic freedom does not allow for the complexity of economic freedom, but an index makes it hard to draw policy conclusions. For this reason, several papers have attempted to use more specific variables. Barro (1996) used disaggregated measures of political and economic freedom, including measures of government consumption ratio, black market premium, rule of law index, and the terms of trade change. Barro found that growth is enhanced by better maintenance of the rule of law, smaller government consumption, and lower inflation.

### 1.2.3 Does Regime Matter?

Another question in the cross-country growth literature is the importance of the political regime. One interesting question that Barro (1997) raises deals with different types of authoritarian states. Barro supposes that there are two kinds of dictators—the first that is preoccupied with personal ambitions, and a second that is preoccupied with the economic performance of his country. This may make sense, since there is no reason a dictator can not choose to manage his economy as a democracy would. However, Barro mentions that there is not, as of yet, any theory in place to determine which kind of dictatorship will prevail between the two.

Acemoglu (2008b), in a paper entitled "A Theory of Military Dictatorships," states that military dictatorships face high costs for military repression, since they must pay efficiency wages to prevent coups. Acemoglu also mentions that repression during a nondemocratic era can have important effects on the economic and political success of later democratic regimes. For example, Acemoglu mentions that a dictator that chooses to keep a strong military in order to suppress the political voice of his subjects creates a very hazardous situation for any democratic regime attempting to take over power after him. This is because it is in the military's best interest to overthrow the fledgling democratic regime before they reform the military and take power away from those military leaders. On the other hand, if a military dictator chooses to focus on economic growth and keep his subjects happy as opposed to quiet, then he probably creates a much more peaceful transition period. However, since greater economic growth leads to the desire for civil liberties and political freedoms, the dictator will eventually lose his power if the country grows too fast. Acemoglu notes three kinds of nondemocracies—oligarchies, military dictatorships that have gained power over democracies, and military democracies that have gained power over oligarchies. However, he notes that there is a need for empirical analysis of policy and economic performance differences between these regimes. Other papers have taken the actual regime as unimportant to economic growth. This might make sense, since an authoritarian regime could choose to adopt most policies that a democracy might have (except, of course, for free elections). This was shown by Mulligan et al. (2004). In comparing democracies and non-democracies, the group found that democracy has little effect on many economic and social policy variables, and, in fact, are not that different in terms of introducing economic and social policy.

However, Acemoglu, Johnson, and Robinson (2004) argue that institutions are the fundamental cause of long-run growth. In comparison to geographic and cultural factors, the trio find that institutions, both political and economic are what really determine long-run economic growth. They suggest that political institutions determine de jure political power, while the distribution of resources determines de facto power. These, in turn, determine economic institutions and the next period's political institutions, which determine economic performance and the next period's distribution of resources. This model suggests that growth can be generated solely through choosing the right political institutions. As evidence, they examine the paths followed by North and South Korea, nations divided only by their choice in institutions. Since 1948, South Korea has maintained a system of property laws and allowed the market to drive economic conditions. Conversely, North Korea adopted the Soviet system of socialism, outlawing private ownership of property and directing economic conditions via state planning. The result, of course, was South Korea becoming one of the most rapidly growing countries in the world throughout most of the late $20^{th}$ century, while North Korea hardly grew at all.

## 1.3 Other Explanations for Growth Differences

Several writers have also appealed to the notion that efficiency is the deciding factor in growth, not necessarily political regime. Mauro (1995) found that an increase in bureaucratic efficiency leads to a growth in the GDP growth rate. He also found that corruption has more of a negative effect on investment than it does on growth rate. Similarly, Acemoglu (2008a) finds that inefficient bureaucratic structures retard growth and coincide with limited amounts of public good provision and redistribution to the poor. Acemoglu says that the political elite captures inefficiencies so as to limit redistribution, since it is in their best interest not to redistribute. Finally, Acemoglu theorizes that inefficient states create their own constituency and therefore tend to persist over time.

Rivera-Batiz (1999) suggested that the quality of governance matters more to growth than the actual nature of the government. He noted that the quality of governance is much higher in democracies than it is in non-democracies, because democracies often constrain corruption much better than authoritarian regimes. Similarly, LaPorta, et al. (1998) also found that the quality of governance mattered. LaPorta mentions that rich nations have better governments than poor ones, ethnolinguistically homogenous societies have better governments than otherwise, countries with a code of law that derives from the English Common Law have better governments than French Law, and Protestant nations are better off than Catholic or Muslim nations. LaPorta also notes that better governments are bigger and collect higher taxes.

Collier (2000) hypothesized that the risk of civil war is related to low national income and dependence on primary commodity exports. Collier showed that countries that have a substantial amount of their income coming from the export of primary commodities have a much higher risk of civil strife (about 23% for a country whose exports of primary commodity dependence is 26%). Collier believes that this is because the extortion of primary commodity exports (i.e. diamonds in Sierra Leone) is a viable source of funding a rebellion. Thus a country with a dependence on primary commodity exports is subject to greater political volatility, and thus subject to more volatile, and typically lower growth rates.

Easterly and Levine (1997) found that nations with a more homogenous society had greater economic success. They use the ethnolinguistic fractionalization rate, the probability that two randomly selected residents of the country will be of different ethnolinguistic groups, to measure the homogeneity of a given country. They find evidence that nations with a higher ethnolinguistic fractionalization rate more frequently observe "growth tragedies." This notion was also supported by Alesina, et al. (1999), in which the authors showed that increased ethnolinguistic fragmentation in many American metropolitan areas led to a lower amount of spending on public goods, including schools and roads, and a higher level of careless spending by local governments. This evidence supports the theory of heterogeneity having a negative impact on economic growth.

### 1.4 Nonlinear Growth Models

Krieckhaus (2006) identified a need to not pool all countries into a single dataset, since he found that democracy had a different effect in different areas of the world. Krieckhaus found that democracy had a positive impact in Africa, but a negative effect in Asia and Latin America. Several papers have begun to consider a world in which not every country is subject to the same growth model. One such nonlinear model is presented by Durlauf and Johnson (1995). They find that using a linear model is incorrect, since different regimes follow different linear paths based on their initial conditions. Thus their analysis uses a threshold on initial GDP per capita, then a threshold on literacy rate, and then a threshold on initial GDP again. Durlauf and Johnson show how the resulting four groups each have a stable equilibrium. Ray (2002) determined that OLS estimators used to predict growth rates in cross-country regressions are often biased due to sample selection bias. He also warns that a lot of the data provided by countries may not be completely accurate, further biasing the OLS estimates. Ray suggests using a two-equation system with the growth regression estimated jointly with a selectivity equation that specifies the influence of a set of variables on the probability of selection into the sample. Abdelkafi and Derbel (2008) also followed a multiple equilibria model to show that the presence of threshold variables rejects the linearity of the relation between variables. The thresholds tested are GDP per capita and secondary school enrollment. They find that countries with higher GDP per capita and secondary school enrollment (above the threshold) do not benefit from reducing the size of government, in support of LaPorta's findings.

### 1.5 Problems with Cross-Country Models

Despite all of these findings, the legitimacy of cross-country growth regressions has frequently been called into question. Many argue that while particular studies can highlight the importance of any given variable, few to none analyses actually provide robust results. Levine and Renelt (1992) questioned the validity of growth models by testing a large sample of variables using a modification of Leamer's (1985) extreme bounds test. Levine and Renelt found that the only robust relationships in cross-country analyses were between investment share of GDP and growth, investment share and trade share of GDP, and initial GDP and growth. This would essentially suggest that prior research could not make robust predictions on what factors determine economic growth.

The extreme bounds analysis drew the criticism of many econometricians following Levine and Renelt's analysis. Sala-I-Martin (1997) explained that the extreme bounds analysis is not an appropriate test, because it is too strict. In replicating the extreme bounds analysis of Levine and Renelt, Sala-I-Martin found only one variable to be robustly correlated with growth. In his own analysis, Sala-I-Martin used the cumulative distribution function evaluated at 0 ($CDF(0)$) to find that a lot more relationships are actually more significant than the extreme bounds analysis claims.

In light of these discrepancies, Brock and Durlauf (2001) determined that empirical practice in growth is not policy-relevant, because the current methods are not good predictors of robustness. They identified theory and parameter uncertainty as two major criticisms of cross-country growth regressions. In order to better account for model uncertainty, Brock and Durlauf suggested using Bayesian averaging, which they used to strengthen Easterly and Levine's (1997) ethnolinguistic diversity model. Model averaging frameworks can be used to average across many probable models. This is very helpful in cross-country growth regressions, since the open-ended nature of the field lends itself to generating many models considering many different regressors. Sala-I-Martin, et al. (2004) used a variant of Bayesian averaging, the Bayesian Averaging of Classical Estimates (BACE) approach to estimate economic growth and found that 18 of 67 possible regressors were robustly partially correlated with economic growth rates in cross-country regressions, a significant increase over the findings of Levine and Renelt (1992).

There is also the potential problem of endogeneity in cross-country growth models. Endogeneity arises when one or more of the explanatory variables is correlated with the error term. Imagine a regression in the form:

$$y = \beta_0 + \beta_1 x_1 + ... + \beta_K x_K + u \tag{1.1}$$

where $E(u) = 0$ and $Cov(x_j, u) = 0$ for $j = 1, 2, ..., K-1$, but $Cov(x_K, u) \neq 0$. This shows a potential case of endogeneity. It can be caused by an omitted variable, measurement error, or simultaneity. Although the last two causes are certainly possible (with simultaneity being likely probable), the case of omitted variables seems to be of particular interest in a field where each new model contains several variables not seen before. Therefore, endogeneity is an extremely relevant problem to cross-country growth models.

To account for endogeneity, there is a need for economists to build models using instrumental variables. In the past literature such instruments have been hastily defended. In several papers, instruments are said to be appropriate because they are correlated with the endogenous variable. However, a strong instrument must be *partially* correlated with the endogenous regressor. This means that a strong instrument is correlated with the endogenous regressor *conditional on* $\{x_1, ..., x_{K-1}\}$. A strong instrument must also be uncorrelated with the error term, $u$. Finally, a strong instrument must not be a determinant of growth itself. In order to prevent the endogeneity problem, it is important to use strong instruments to capture any effects that may affect cross-country growth. Unfortunately, the nature of the growth data makes it extremely difficult to find such instruments. Brock and Durlauf (2001) discuss the search for valid instruments and conclude that the open-endedness of growth theory makes endogeneity almost inevitable in every context.

Regardless of these recent findings, there is still no clear consensus on the validity of cross-country growth regressions. With less than 200 countries in the world, there is not an extremely large sample size to examine. Sample selection bias in a cross-country regression is extremely difficult to avoid due to the small number of countries for which reliable data exists. Model uncertainty is also a problem, although the aforementioned model averaging scheme may provide some relief. The uncertainties surrounding cross-country growth regressions are vast. All uncertainties mentioned in this paper must be taken into consideration in order to build valid results. Model averaging should be implemented in order to avoid putting too much weight on poorly constructed models. Following these suggestions will produce more policy-relevant results from cross-country growth models.

This paper will adhere to these guidelines in an attempt to generate a valid, robust analysis of the effect of political institutions and economic policies on cross-country growth. While a number of papers have attempted this in the past, this analysis will provide a more comprehensive exploration and comparison of results from different nonlinear methods and different model averaging frameworks. Analyzing the results in light of these comparisons will allow for a more robust picture of the determinants of economic growth. There are two hypotheses to be tested in this analysis. The first is the belief that political institutions and economic policies have an impact on economic growth against the null hypothesis that both have no significant effect on growth. The second is that democracies and nondemocracies receive different benefits from adopting the same institutions and policies against the null hypothesis that there is no statistical difference between the effects to both groups.

In Section 2, this paper will discuss relevant methods used for analysis. Section 3 explores the data used for the analysis, including all variables and data set construction. Section 4 will examine the results of running the methods described in Section 2 on the data described in Section 3. Section 5 will look at some specific case studies from the country sample and use the results in Section 4 to explain growth differences. Finally, Section 6 will extrapolate conclusions based on the analysis and make suggestions for future research.

# 2 Methodologies

There are a number of methodologies that have been used in cross-country growth literature that influence this analysis. This section will provide a discussion of these methods and explain how they are utilized in the analysis. A number of problems discussed in the introduction jeopardize the validity of cross-country growth regressions, including model and parameter uncertainty. Several of the following methods are used to identify these uncertainties, while the rest are used in an effort to eliminate the problems created by these uncertainties.

## 2.1 Sensitivity Analyses

Sensitivity analyses are used to verify the robustness of a model's findings.

### 2.1.1 The Extreme Bounds Analysis

One such sensitivity analysis is Edward Leamer's (1985) extreme bounds analysis (EBA), implemented in the 1992 study by Levine and Renelt. The EBA uses the basic equation:

$$\boldsymbol{\gamma} = \boldsymbol{\alpha}_j + \boldsymbol{\beta}_{yj}\boldsymbol{y} + \beta_{zj}z + \boldsymbol{\beta}_{xj}\boldsymbol{x}_j + \varepsilon \tag{2.1}$$

where $\boldsymbol{\gamma}$ is a vector of growth rates, $\boldsymbol{y}$ is a vector of variables always included in the model, including the initial level of income, the investment rate, the secondary school enrollment rate, and the population growth rate, $z$ is the parameter being tested, and $\boldsymbol{x}_j$ is a vector of up to 3 variables selected from the pool of variables for each model $j$. The regression is run for every possible combination of $\boldsymbol{x}_j$ in order to find $\beta_{zj}$ and $\sigma_{\beta_{zj}}$. According to the EBA, the upper extreme bound is found by selecting the highest value of $\beta_{zj} + 2\sigma_{\beta_{zj}}$, and the lower extreme bound is found by selecting the lowest value of $\beta_{zj} - 2\sigma_{\beta_{zj}}$. Using Leamer's method, the variable $z$ can only be said to be robustly positive if both, the upper extreme bound and the lower extreme bound are above zero. Similarly, $z$ is only robustly negative if both the upper and lower extreme bounds are below zero. If one extreme bound falls on both sides of zero, then the variable $z$ is not robust. This is an extremely strict test that essentially only allows the binary possibilities of being robust or not robust.

### 2.1.2 Cumulative Distribution Functions

The strictness of the EBA meant that almost no analysis could produce meaningful results. This pushed Xavier Sala-I-Martin (1997) to develop a way to work with confidence levels that are less strict than the EBA. In his test, Sala-I-Martin uses the cumulative distribution function evaluated at 0 ($CDF(0)$) and claims that any variable that has a weighted $CDF(0) > 0.95$ is probably robustly related to growth. This framework allows the economist to extrapolate more meaningful conclusions, though does not fundamentally change anything about the data. It essentially introduces a way to use confidence to determine robustness. In order to find the $CDF(0)$ with a normal distribution of $\hat{\beta}_z$, he starts by using equation (1) to find $M$ estimators of $\beta_z$, where $M$ is the total number of models $j$. He then constructs a weighted estimate of the mean of $\beta_z$:

$$\hat{\beta}_z = \sum_{j=1}^{M} \omega_{zj}\beta_{zj} \tag{2.2}$$

where

$$\omega_{zj} = \frac{L_{zj}}{\sum_{i=1}^{M} L_{zi}} \tag{2.3}$$

where $L_{zj}$ is the likelihood that $j$ is the true model, which is calculated using goodness of fit indicators. Next, Sala-I-Martin estimates the weighted variance to be $\hat{\sigma}_z^2 = \sum_{j=1}^{M} \omega_{zj}\sigma_{zj}^2$. Once he knows the mean and variance, he can compute the $CDF(0)$ using the normal distribution. In the case that $\beta_z$ is not distributed normally, he finds the $CDF(0)$ for each of the regressions, $\Phi_{zj}(0; \hat{\beta}_{zj}, \hat{\sigma}_{zj}^2)$ (denoting the $CDF(0)$ for each individual model), and then finds an aggregate $CDF(0)$:

$$\Phi_z(0) = \sum_{j=1}^{M} \omega_{zj}\Phi_{zj}(0; \hat{\beta}_{zj}, \hat{\sigma}_{zj}^2) \tag{2.4}$$

Sala-I-Martin admits that one problem created by calculating weighted averages is that it is very possible that the goodness of fit is not a great indicator of model $j$ being the true model, due to endogeneity. In those cases, he suggests using an unweighted approach.

## 2.2 Accounting for Model Uncertainty – Model Averaging

### 2.2.1 Least Squares Model Averaging

Bruce Hansen (2007) suggests the possibility of using a least squares model averaging (LSMA) approach, which he calls the Mallows Model Average. Given a sequence of approximating models $m = 1, 2, ...$, where the $m$th model uses the first $k_m$ elements of the vector of independent variables,

$x_i$, Hansen defines a model in matrix notation:

$$\boldsymbol{Y} = \boldsymbol{X}_m \boldsymbol{\Theta}_m + \boldsymbol{b}_m + \boldsymbol{e} \tag{2.5}$$

where $\boldsymbol{X}_m$ is the $n \times k_m$ matrix of explanatory variables in model $m$, $\boldsymbol{\Theta}_m$ is the vector of coefficients associated with the vectors of $\boldsymbol{X}_m$, $\boldsymbol{b}_m = \sum_{j=k_m+1}^{\infty} \boldsymbol{X}_j \boldsymbol{\Theta}_j$ is the vector of approximation error, and $\boldsymbol{e}$ is the vector of random error, such that $E[e_i \mid x_i] = 0$ and $E[e_i^2 \mid x_i] = \sigma^2$. Hansen then claims that the least squares estimate of $\boldsymbol{\Theta}_m$ is:

$$\hat{\boldsymbol{\Theta}}_{\boldsymbol{m}} = (\boldsymbol{X}_m^T \boldsymbol{X})^{-1} \boldsymbol{X}_m^T \boldsymbol{Y} \tag{2.6}$$

Then, with a weight vector $\boldsymbol{W}$ such that $\boldsymbol{W} \in [0,1]^M : \sum_{m=1}^{M} w_m = 1$, the model average estimator of $\boldsymbol{\Theta}_M$ is:

$$\hat{\boldsymbol{\Theta}} = \sum_{m=1}^{M} w_m \begin{pmatrix} \hat{\boldsymbol{\Theta}}_{\boldsymbol{m}} \\ 0 \end{pmatrix} \tag{2.7}$$

The weight vector can be determined by minimizing the Mallows Criterion, which Hansen shows is an unbiased estimator of the expected squared error. The Mallows Criterion, equal to:

$$C_n(\boldsymbol{W}) = \boldsymbol{W}^T \bar{\boldsymbol{e}}^T \bar{\boldsymbol{e}} \boldsymbol{W} + 2\sigma^2 \boldsymbol{K}^T \boldsymbol{W} \tag{2.8}$$

where $\bar{\boldsymbol{e}}$ is the residual vector and $\boldsymbol{K}$ is the $M \times 1$ vector of the number of parameters in the $M$ models. $\hat{\boldsymbol{W}}$ is determined by finding the argument $\boldsymbol{W}$ that minimizes (2.8). To do this, an estimate must be made for $\sigma^2$. Hansen suggests

$$\hat{\sigma}_K^2 = (n-K)^{-1} (\boldsymbol{Y} - \boldsymbol{X}_k \boldsymbol{\Theta}_k)^T (\boldsymbol{Y} - \boldsymbol{X}_k \boldsymbol{\Theta}_k) \tag{2.9}$$

where $k_K = K$ refers to a particularly large model.

One problem with LSMA is that it requires homoskedasticity in order to provide the optimal estimators. It may be a leap to assume such homoskedasticity exists in the cross-country data.

### 2.2.2 Bayesian Averaging

Using Bayesian averaging is an intuitive way of accounting for model uncertainty, since it accounts for the likelihood of each model, $M_1, M_2, ..., M_K$ being the true model. Hoeting, et al. (1999) explain how to use Bayesian model averaging (BMA) to account for model uncertainty. To use

BMA, one must find the posterior distribution of the parameter in question, $\beta_z$ , given data, $D$. In this case, the posterior distribution is:

$$P(\beta_z \mid D) = \sum_{k=1}^{K} P(\beta_z \mid M_k, D)P(M_k \mid D) \tag{2.10}$$

where

$$P(M_k \mid D) = \frac{P(D \mid M_k)P(M_k)}{\sum_{l=1}^{K} P(D \mid M_l)P(M_l)} \tag{2.11}$$

and where

$$P(D \mid M_k) = \int P(D \mid \theta_k, M_k)P(\theta_k \mid M_k)d\theta_k \tag{2.12}$$

where $\theta_k$ is the vector of parameters of $M_k$, $P(\theta_k \mid M_k)$ is the prior density of $\theta_k$ under model $M_k$, $P(D \mid \theta_k, M_k)$ is the marginal likelihood, and $P(M_k)$ is the prior probability that $M_k$ is the true model. With this information, the posterior mean and variance can be determined as follows:

$$E[\beta_z \mid D] = \sum_{k=1}^{K} \hat{\beta}_{zk} P(M_k \mid D) \tag{2.13}$$

$$Var[\beta_z \mid D] = \sum_{k=1}^{K} (Var[\beta_z \mid D, M_k] + \hat{\beta}_{zk}^2) P(M_k \mid D) - E[\beta_z \mid D]^2 \tag{2.14}$$

where $\hat{\beta}_{zk} = E[\beta_z \mid D, M_k]$. This method of estimation accounts for model uncertainty, which makes it an attractive choice for estimating growth equations.

The Bayesian Averaging of Classical Estimates (BACE) approach to estimate economic growth, used by Sala-I-Martin, et al. (2004) is closely related to BMA. Since finding prior distributions of each of the model parameters conditional on each possible model can be computationally difficult, the group proposes a method that averages across many models, but only relies on ordinary least squares (OLS) estimation. They define the weighted probability of a given model being the true model conditional on the data as:

$$P(M_k \mid D) = \frac{P(M_k)T^{-j_k/2}SSE_k^{-T/2}}{\sum_{l=1}^{2^J} P(M_l)T^{-j_l/2}SSE_l^{-T/2}} \tag{2.15}$$

where $T$ is the sample size and $2^J$ is the total number of possible linear models created with $J$ regressors. The $P(M_k)$ is set according to the model size, $\bar{j}$. Each variable is then said to have a probability of $\frac{\bar{j}}{J}$ of being included in the model. The posterior mean is actually the same as in 2.13, except that it is summed over $2^J$ terms:

$$E[\beta_z \mid D] = \sum_{k=1}^{2^J} \hat{\beta}_{zk} P(M_k \mid D) \tag{2.16}$$

Similarly, the variance becomes:

$$\begin{aligned} Var[\beta_z \quad &\mid \quad D] = \\ \sum_{k=1}^{2^J} P(M_k \quad &\mid \quad D)(Var[\beta_z \mid D, M_k] + \sum_{k=1}^{2^J} P(M_k \mid D)(\hat{\beta}_{zk} - E[\beta_z \mid D])^2 \end{aligned} \tag{2.17}$$

### 2.2.3 Weighted-Average Least Squares

Magnus, et al. (2010) suggests that BMA is not an adequate framework for cross-country growth empirics, because it deals with prior distributions too lackadaisically and is too computationally complex. They suggest using a weighted-average least squares framework (WALS) in order to avoid unbounded risk. To make their model more simplistic, they first orthogonalize the columns of the matrix containing the independent variables to be tested in the model averaging framework. This makes the required time to compute linear, as opposed to the exponential time required by BMA. They also suggest using a Laplace prior instead of a normal prior, since it has finite risk. The Laplace prior suggested by Magnus, et al. is defined:

$$\pi(\eta) = \frac{\log 2}{2} \exp(-(\log 2) \left|\eta\right|) \tag{2.18}$$

so that the prior median of $\eta$ is 0 and the prior median of $\eta^2$ is 1 (to mimic ignorance).

The basic unrestricted model in WALS is:

$$y = X_1\beta_1 + X_2\beta_2 + \varepsilon \tag{2.19}$$

where $y$ is an $(n\text{x}1)$ matrix of the dependent variable, $X_1$ is the $(n\text{x}k_1)$ matrix of $k_1$ dependent variables that are mandatory in every model to be averaged (whether it be for theoretical or empirical reasons), $X_2$ is the $(n\text{x}k_2)$ matrix of $k_2$ regressors to be tested in the model averaging framework, and $\varepsilon\tilde{\ }N(0, \sigma^2)$ is the normally distributed random error term. The orthogonalization occurs by setting $X_2^T M_1 X_2 = I_{k_2}$, where $M_1 = I_n - X_1(X_1^T X_1)^{-1} X_1^T$. Thus there exists a $(k_2\text{x}k_2)$

orthogonal matrix, $P$, and a diagonal matrix, $\Lambda$, such that:

$$P^T X_2^T M_1 X_2 P = \Lambda \tag{2.20}$$

Then we can define a new regressor matrix and parameters: $X_2^* = X_2 P \Lambda^{-1/2}$ and $\beta_2^* = \Lambda^{1/2} P^T \beta_2$, which implies that $X_2^* \beta_2^* = X_2 \beta_2$ and $X_2^{*T} M_1 X_2^* = I_{k_2}$. This permits the use of $X_2^*$ and $\beta_2^*$ in place of $X_2$ and $\beta_2$, which makes the following computations much simpler. (It will also be simple to recover $\beta_2$ after computations by recognizing that $\beta_2 = P\Lambda^{-1/2}\beta_2^*$.)

Once the regressors have been orthogonalized as such, one must compute $\hat{\beta}_2^* = X_2^{*T} M_1 y$ to find the parameter estimates. Next, letting $\eta = \frac{\beta_2^*}{\sigma}$, compute $\hat{\eta} = \frac{\hat{\beta}_2^*}{\sigma}$, where $\sigma^2$ can be approximated by $s^2$, the least squares estimator of the variance in the unrestricted model, if $\sigma^2$ is unknown. Then, for $j = 1, ..., k_2$, compute the Laplace estimator $\tilde{\eta}_j = E(\eta_j \mid \hat{\eta}_j)$ and its variance, $\omega_j^2 = Var(\eta_j \mid \hat{\eta}_j)$. Then set $\tilde{\eta} = (\tilde{\eta}_1, ..., \tilde{\eta}_{k_2})^T$ and $\Omega = diag(\omega_1^2, ..., \omega_{k_2}^2)$. This means that $\beta_2 = \sigma P \Lambda^{-1/2} \eta$, so the WALS parameter estimates are:

$$b_2 = \sigma P \Lambda^{-1/2} \tilde{\eta} \text{ and } b_1 = (X_1^T X_1)^{-1} X_1^T (y - X_2 b_2) \tag{2.21}$$

We can also define the variance of these estimates:

$$Var(b2) = \sigma^2 P \Lambda^{-1/2} \Omega \Lambda^{-1/2} P^T \tag{2.22}$$

and

$$Var(b1) = \sigma^2 (X_1^T X_1)^{-1} + Q Var(b2) Q^T \tag{2.23}$$

where $Q = (X_1^T X_1)^{-1} X_1^T X_2$.

When compared with BMA, Magnus, et al. found that the WALS estimates fell in line with BMA estimates, while requiring only negligible time for computations. This method, although extremely new and fairly untested, provides yet another way to implement model averaging to account for model uncertainty.

## 2.3 Accounting for Nonlinearities

One of the most basic ways of accounting for nonlinearities in a regression analysis is to use interaction terms and polynomial terms to describe the nonlinear effects. A model using interactions with $n$ terms would be in the form:

$$\boldsymbol{Y} = \beta_0 + \boldsymbol{\beta X} + \sum_{j=1}^{n} \boldsymbol{\beta}_{ij}(i_j \boldsymbol{X}) \tag{2.24}$$

where $\boldsymbol{X}$ is the vector of independent variables, and $i_1, ..., i_n$ are the interaction terms. A nice thing about using interaction terms or polynomial terms is that they allow for a smoothed, continuous effect provided that the two regressors in question are, themselves, continuous (i.e. not binary). This means that the data will not suggest that adding some marginal amount to a particular variable will cause a nation's growth to "jump" to another level.

The problem with this type of model is that if there are $p$ independent variables, then there are $2^{(1+n)p}$ possible combinations of regressors, since there are $p$ regressors that can either be included or not, and $n * p$ interaction terms that can also either be included or not. For example, if this analysis were to compare all possible combinations of independent variables and interaction terms, we would need to run $2^{650}$ regressions. While this would be possible, albeit *extremely* time-consuming and cumbersome, it would *actually* be impossible to include all possible combinations of polynomial terms, since each variable could have infinite polynomial terms. While one can guess which variables and interactions should be included in the true model, the sheer number of possibilities highlights the model uncertainty surrounding cross-country growth regressions.

### 2.3.1 Threshold Regressions

Another way to account for nonlinearities in the data is to highlight them using threshold regressions. A simple threshold model would have one variable on which the threshold is placed, splitting the data into two parts. Then a linear regression is run on both parts, allowing for cross-group comparisons. With a binary variable, the threshold is already set. For example, a wage model could exhibit a simple threshold on a binary variable, $female$, equal to 1 if the worker is a female. To do this, one would just need to run a regression on all the observations for which $female = 0$, and then on all the observations for which $female = 1$. This should yield the same exact results as running the aforementioned interaction model with each of the regressors interacted with $female$, albeit in two distinct regression results. For continuous variables, decisions must be made as to what qualifies as a legitimate threshold.

The basic framework for threshold regressions is to build a regression tree. A regression tree, $T$, tests the partial effects of $p$ regressors, $(x_1, ..., x_p)$, on a dependent variable, $y$. A tree contains a set of $v$ decision rules for splitting, $b$ terminal nodes (where $b = v+1$), and a set of parameters associated with the terminal nodes, $M = (\mu_1, ..., \mu_b)$. For example, in the model employed by Durlauf and Johnson (1995), the duo placed a decision rule on initial per capita GDP. Those countries with a per capita GDP in 1960 of less than or equal to $800 were deemed "low GDP" countries and formed terminal node 1. Those with an initial per capita GDP greater than that threshold went through a second decision rule on the literacy rate at 46%. Those that fell under the decision rule were said to be "intermediate GDP, low literacy" countries in terminal node 2, while those with a higher literacy rate went to the third decision rule. The final decision rule was placed on initial per capita GDP again. The countries remaining in the analysis with an initial per capita GDP less than or equal to $4850 were said to be "intermediate GDP, high literacy" countries in terminal node 3, and those who had an initial per capita GDP of greater than $4850 were deemed "high GDP, high literacy" countries in terminal node 4. Durlauf and Johnson found that the partial effects in the four terminal nodes were significantly different from one another using a Wald test.

Durlauf and Johnson chose their thresholds by employing a regression tree methodology that essentially searches across a subset of possible splits of the data and determines a set of rules and terminal nodes by taking OLS estimates across those possible decision rules and finding the set that minimizes the sum of squared residuals. One problem with this method, as pointed out by Hansen (2000), is that the regression tree methodology employs an ad hoc estimation procedure, which does not incorporate any distributional theory. In its place, Hansen proposes a statistical theory for threshold estimation and develops an asymptotic distribution theory for the regression estimates. In doing so, he develops a useful asymptotic approximation to the distribution of the estimate of the threshold parameter, which yields a practical method for confidence intervals to be constructed without the nuisance parameters required by previous methods.

First, define two equations representing the regression results with a threshold of $\gamma$ on variable $q$. (Note that $q$ could be in the set of regressors, $x$, but does not need to be.)

$$y_i = \theta_1^T x_i + \varepsilon_i, \quad q_i \leq \gamma \tag{2.25}$$

$$y_i = \theta_2^T x_i + \varepsilon_i, \quad q_i > \gamma \tag{2.26}$$

where $\varepsilon_i \tilde{} N(0, \sigma^2)$ is the random error term. However, one can define a binary variable, $b_i(\gamma) = \boldsymbol{I}_{(-\infty,\gamma]}(q_i)$, where $\boldsymbol{I}_A(x)$ is the indicator function. This binary variable can then be used to unite

(2.25) and (2.26) into one equation:

$$y_i = \theta^T x_i + \delta^T x_i(\gamma) + \varepsilon_i \tag{2.27}$$

where $x_i(\gamma) = x_i b_i(\gamma)$ and $\delta^T = \theta_1^T - \theta_2^T$. This is easily stacked into matrix notation, yielding:

$$Y = X\theta + X_\gamma \delta + \varepsilon \tag{2.28}$$

The LS estimates of $\theta$, $\delta$, and $\gamma$ jointly minimize the sum of squared errors, $S_n(\theta, \delta, \gamma)$, where

$$S_n(\theta, \delta, \gamma) = (Y - X\theta - X_\gamma \delta)^T (Y - X\theta - X_\gamma \delta) \tag{2.29}$$

Assuming $\gamma$ is restricted to a bounded set, $\Gamma$, one can condition on $\gamma$, leaving (2.28) linear in $\theta$ and $\delta$, which means a simple OLS regression will yield $\hat{\theta}(\gamma)$ and $\hat{\delta}(\gamma)$. This means the sum of squared errors only depends on $\gamma$:

$$S_n(\gamma) = S_n(\hat{\theta}(\gamma), \hat{\delta}(\gamma), \gamma) = Y^T Y - Y^T X_\gamma^* (X_\gamma^{*T} X_\gamma^*)^{-1} X_\gamma^{*T} Y) \tag{2.30}$$

Then, a threshold value, $\hat{\gamma} = \arg\min S_n(\gamma)$, for $\gamma \in \Gamma$. The slope estimates then become $\hat{\theta} = \hat{\theta}(\gamma)$ and $\hat{\delta} = \hat{\delta}(\gamma)$.

To test if the hypothesized threshold value, $\gamma$, is the true threshold, $\gamma^*$, Hansen suggests using the likelihood ratio (LR) test. The LR statistic is defined:

$$LR_n(\gamma) = n \frac{S_n(\gamma) - S_n(\hat{\gamma})}{S_n(\hat{\gamma})} \tag{2.31}$$

The LR test says to reject the null hypothesis $H_0 : \gamma = \gamma_0$ when $LR_n(\gamma_0)$ is large. The p-value to reject $H_0$ is easy to compute if homoskedasticity is assumed. Then the p-value is defined:

$$p_n = 1 - \left(1 - e^{-\frac{1}{2} LR_n(\gamma_0)^2}\right)^2 \tag{2.32}$$

If the data contains heteroskedasticity, a nuisance parameter, $\eta^2$, must be estimated. A scaled LR statistic can then be generated:

$$LR_n^*(\gamma) = \frac{LR_n(\gamma)}{\hat{\eta}^2} \tag{2.33}$$

The estimation of $\eta^2$ is a complex process. First, let $r_{1i} = (\delta_n^{'} x_i)^2 (e_i^2/\sigma^2)$ and $r_{2i} = (\delta_n^{'} x_i)^2$. Then

$$\eta^2 = \frac{E(r_{1i} \mid q_i = \gamma_0)}{E(r_{2i} \mid q_i = \gamma_0)} \tag{2.34}$$

But this requires estimates of $r_{1i}$ and $r_{2i}$, so let $\hat{r}_{1i} = (\hat{\delta}_n^{'} x_i)^2 (\hat{e}_i^2/\hat{\sigma}^2)$ and $\hat{r}_{2i} = (\hat{\delta}_n^{'} x_i)^2$. Then a polynomial regression can predict the ratio of conditional expectations in (2.34). Let

$$\hat{r}_{ji} = \hat{\alpha}_{j0} + \hat{\alpha}_{j1} q_i + \hat{\alpha}_{j2} q_i^2 + \hat{\varepsilon}_{ji} \tag{2.35}$$

This allows a prediction of $\eta^2$, namely:

$$\hat{\eta}^2 = \frac{\hat{\alpha}_{10} + \hat{\alpha}_{11}\hat{\gamma} + \hat{\alpha}_{12}\hat{\gamma}^2}{\hat{\alpha}_{20} + \hat{\alpha}_{21}\hat{\gamma} + \hat{\alpha}_{22}\hat{\gamma}^2} \tag{2.36}$$

In general, the best choice for $\gamma$ on a given variable will be the argument that minimizes the LR statistic, thus granting the lowest possible p-value.

An advantage of using this type of methodology is that it creates a statistical model for choosing thresholds that is consistent with distributional theory. This makes statistical justification for threshold choice extremely easy. However, there are also disadvantages to using this method, as many different thresholds may be found in the data. This creates a complex model with many different possible trees, and little knowledge about which of those is the true regression tree.

## 2.4 Bayesian Additive Regression Trees (BART)

The model uncertainty that arises from numerous regression trees can also be accounted for using model averaging techniques. Chipman, George, and McCulloch (2008) provide a methodology for averaging across regression trees. The basic linear model is defined:

$$Y = f(x) + \epsilon, \qquad \epsilon \tilde{} N(0, \sigma^2) \tag{2.37}$$

where $Y$ is the output to be predicted by a function of a $p$-dimensional matrix of regressors, $x = (x_1, ...x_p)$. An approximation of $f(x)$ is given by the sum of $m$ regression trees (each with its own set of decision rules and terminal nodes), $f(x) \approx h(x) = \sum_i^m g_i(x)$, where each $g_i$ is an individual regression tree. Letting $T = (T_1, ..., T_m)$ denote the tree space and $M_i = (\mu_1, ..., \mu_b)$ denote the parameter values associated with each of the $b$ terminal nodes in $T_i$, we can redefine the linear equation as a sum of trees:

$$Y = \sum_{i=1}^{m} g(x; T_i, M_i) + \epsilon \tag{2.38}$$

Given this setup, if $m = 1$, each $\mu_{1j}$ ($j = 1, ..., b$) represents $E(Y \mid x)$. When $m > 1$, each $\mu_{ij}$ represents only an addend of $E(Y \mid x)$. Additionally, each $\mu_{ij}$ will represent a main effect when $g(x; T_i, M_i)$ relies only on one variable in $x$, and will capture an interaction effect when $g(x; T_i, M_i)$ relies on multiple components of $x$. Thus BART yields the additional bonus of capturing all main and interaction effects. (Note that trees can be of varying order, thus making the captured interaction effects of varying orders, as well.)

In order to average across multiple trees, a regularization prior must be specified. This regularization prior is also used to keep large trees from dominating the final results. To simplify the process of finding priors, Chipman, et al. suggest restricting attention to priors for which:

$$P((T_1, M_1), ..., (T_m, M_m), \sigma) = \left[\prod_i P(T_i, M_i)\right] P(\sigma) \tag{2.39}$$

$$= \left[\prod_i P(M_i \mid T_i) P(T_i)\right] P(\sigma) \tag{2.40}$$

and

$$P(M_i \mid T_i) = \prod_i P(\mu_{ij} \mid T_i) \tag{2.41}$$

This ensures that the trees and their associated parameters are independent of each other and of $\sigma$. Thus there is only a need to specify three components: $P(Ti)$, $P(\mu_{ij} \mid T_i)$, and $P(\sigma)$. The first, $P(Ti)$, is specified by three aspects. The first is the probability that a node at depth $d$ is non-terminal, which Chipman, et al. specify as:

$$\alpha(1 + d)^{-\beta}, \qquad \alpha \in (0, 1), \beta \in [0, \infty) \tag{2.42}$$

They suggest setting $\alpha = 0.55$ and $\beta = 2$. The second aspect of $P(Ti)$ is the distribution on the splitting variable assignments at each interior node, specified by a uniform prior. The third is the distribution on the splitting rule assignment in each interior node conditional on the splitting variable, also specified on a uniform prior. This setup gives the highest weights to trees ending in 2 or 3 terminal nodes, but does allow for more or less if the data suggests.

The second component, $P(\mu_{ij} \mid T_i)$, is specified by the conjugate normal distribution, $N(\mu_\mu, \sigma_\mu^2)$, which yields a prior on $E(Y \mid x)$ of $N(m\mu_\mu, m\sigma_\mu^2)$ due to the fact that each $\mu_{ij}$ is i.i.d. Therefore it is optimal to choose $\mu_\mu$ and $\sigma_\mu^2$ such that $m\mu_\mu - k\sqrt{m}\sigma_\mu = y_{\min}$ and $m\mu_\mu + k\sqrt{m}\sigma_\mu = y_{\max}$. The default value for $k$ is 2, since it yields a 95% chance that $E(Y \mid x) \in (y_{\min}, y_{\max})$. Then it is best to center the prior at 0, so set $\mu_\mu = 0$ and $\sigma_\mu = \frac{1}{2k\sqrt{m}}$, which means $\sigma_\mu = \frac{1}{4\sqrt{m}}$ in the default case. This component ensures that large trees do not over-influence the final results by keeping the tree parameters small.

Finally, $P(\sigma)$ is specified by a inverse chi-square distribution, $\sigma^2\tilde{}\nu\lambda/\chi_\nu^2$, where $\nu$ and $\lambda$ can be calibrated using $\hat{\sigma}$, which is either the standard deviation of $Y$ or the residual standard deviation of $Y$ on the original set of regressors. The parameter $\nu$ should be chosen from the set $(3, 10)$ to give the distribution the appropriate shape, and the parameter $\lambda$ should be chosen such that for some desired value, $q$, $P(\sigma < \hat{\sigma}) = q$. The defaults are set at $\nu = 3$ and $\lambda = 0.90$.

The choice of $m$ determines how many trees will be averaged in the Bayesian process. The effectiveness of the method increases rapidly when $m$ grows from a very small number to a somewhat large number, but then levels off as $m$ grows very large, not to mention the time to compute rises with $m$. The default value for $m$ is 200. Given this number of trees to be averaged, the posterior distribution is too difficult to calculate. Therefore, Chipman, et al. suggests using a Bayesian backfitting Markov Chain Monte Carlo (MCMC) algorithm. The posterior distribution, $P((T_1, M_1), ..., (T_m, M_m), \sigma \mid y)$, can be approximated through this MCMC process by first setting $T_{(i)} = \{T_1, ..., T_{i-1}, T_{i+1}, ...T_m\}$ and $M_{(i)} = \{M_1, ..., M_{i-1}, M_{i+1}, ...M_m\}$. Next, take $m$ successive draws of $(T_i, M_i)$ conditionally on $(T_{(i)}, M_{(i)}, \sigma, y)$, then $m$ successive draws of $\sigma$ conditionally on $(T_1, ..., T_m, M_1, ..., M_m, y)$, which is just a draw from an inverse gamma distribution. However, $(T_i, M_i)$ relies on $(T_{(i)}, M_{(i)}, y)$ only through the vector of partial residuals, i.e. $R_i = y - \sum_{j \neq i} g(x; T_j, M_j)$, which means that those $m$ draws are equivalent to $m$ draws from $[(T_i, M_i) \mid R_i, \sigma]$. Due to the fact that $M_i$ is specified to have a conjugate normal prior, these draws can be carried out through first a draw of $[T_i \mid R_i, \sigma]$ and then a draw from $[M_i \mid T_i, R_i, \sigma]$.

Using this framework, the sequence of functions defined by:

$$f^*(x) = \sum_{i=1}^{m} g(x; T_i^*, M_i^*) \tag{2.43}$$

converges to the posterior distribution of the true function, $f(x)$. Several iterations of this should be run to ensure accuracy to the true function $f(x)$. To estimate $f(x)$ at a particular set of variables,

$x$, one can calculate the mean of a sample of $K$ iterations, $f_1^*, ..., f_K^*$:

$$\hat{f}(x) = \frac{1}{K}\sum_{k=1}^{K} f_k^*(x) \tag{2.44}$$

or simply use the median of $f_1^*, ..., f_K^*$, which should approximate the median of the true $f(x)$. This framework also allows for the estimation of partial effects of the components of $x$. This is integral to the analysis of cross-country growth regressions. Given the variable of interest, $x_s$, and letting its complement, $x \backslash x_s = x_c$, we can define $f(x) = f(x_s, x_c)$. Then the partial dependence function is defined:

$$f(x_s) = \frac{1}{n}\sum_{i=1}^{n} f(x_s, x_{ic}) \tag{2.45}$$

Then a draw from the posterior distribution of $[f(x_s) \mid y]$ at a given value of $x_s$ is given by computing $f_k^*(x_s) = \frac{1}{n}\sum_{i=1}^{n} f_k^*(x_s, x_{ic})$ and the average across $f_1^*, ..., f_K^*$ will generate an estimate of $f(x_s)$. A plot of this partial dependence can grant a lot of insight to the existence (or lack thereof) nonlinearities in the growth data.

# 3 Data

This analysis considers data from 86 different countries from 1970 to 2007. The data come from a variety of sources. In order to avoid endogeneity caused by omitted-variable bias, more than just political institution variables and economic policy variables are considered. A number of key economic indicators are reported in the Penn World Tables (PWT) (Heston, Summers, & Aten, 2009). Among these variables is the dependent variable in our analysis, *growth*, which is the growth rate of real GDP per capita. The independent variables are broadly grouped into five separate categories. There are the Solow variables, political institution variables, geographic variables, economic policy variables, and cultural variables.

## 3.1 Solow Variables

The first group of variables, the Solow variables, reflect the seminal work by Robert Solow (1956) and extensions of the Solow model, such as Mankiw, Romer, and Weil (1992). All of these variables, except for *maleschooling*, are derived from data provided in the PWT. The first of these variables is *initialGDP*, which represents the natural log of real per capita GDP in the first year of the period in the analysis. This variable is used to show conditional convergence, as suggested by many other papers. Conditional convergence refers to the phenomenon by which countries with lower levels of GDP are able to grow faster, and, in effect, "catch up" with higher GDP countries. An example of this is the four "Asian Tigers" (Hong Kong, Singapore, South Korea, and Taiwan), which were able to sustain high growth rates throughout the late 20th century.

The next variable, $n$, represents the natural log of the sum of the population growth rate, growth of total factor productivity (TFP), and depreciation. As a standard, the sum of the growth of TFP and depreciation is set at 0.05, as suggested by Mankiw, et. al (1992). This variable captures the effect of changes in the labor supply, which Solow proved to have a significant impact on economic growth.

Finally, the last two variables in this category deal with changes in the supply of capital. The first is a measure of human capital, which a number of papers, including Kendrick (1976) and Lucas (1988), emphasized as an important determinant of growth. To measure human capital, this analysis follows previous works by measuring the average years of schooling attained by a 25 year old or older male in the given country (*maleschooling*). Education is commonly used as a measure of human capital due to its ease of measuring. The data for schooling was obtained from Barro and Lee (2000). To measure changes in physical capital, we use the natural log of the investment share of real GDP per capita (*ishare*).

### 3.2 Political Institution Variables

One of the key questions to be answered in this analysis is the effect of political institutions on economic growth. These political institution variables come from the Polity IV data set, which is collected on a yearly basis on most countries of the world (Marshall & Jaggers, 2008). The following measures of several important political institutions are divided into three groups. First are the regime variables, which in this analysis only includes one variable–*durability*. The variable *durability* measures the natural log of the number of years since the most recent regime change or the end of a transition period defined by the lack of stable political institutions. While this variable does not discern between "good" regime durability and "bad" regime durability, one would expect to see a positive correlation between *durability* and *growth*, due to the stability offered by a long-tenured regime.

The second group, the executive variables, contains four variables. The first of these, *execreg*, measures the effective regulation of chief executive recruitment. A value of 0 indicates that the chief executive is recruited only through forceful seizure of power. A value of 0.5 indicates that the chief executive is hand-picked by the political elite without a formal competition, such as in a one-party system. A value of 1 indicates that the chief executive is recruited in a well-regulated manner, whether it be by free election or hereditary succession.

The second executive variable, *execcomp*, measures the competitiveness of executive recruitment. Competitiveness of executive recruitment refers to the notion of ordinary citizens becoming political leaders. A value of 0 means the chief executive gains power only through forceful seizure, hereditary succession, or designation by some non-competitive method. A value of 0.5 means that there is a dual system of executive recruitment, in which one leader is chosen non-competitively, while the other is chosen through a competitive election, or it means the nation in question is in transition from a non-competitive institution to a more competitive one. Finally, a value of 1 refers to a system where leaders are chosen through competitive elections.

A third executive variable is the openness of executive recruitment, *execopen*. This variable attempts to measure the opportunity for any given politically-active person to gain a leadership position. A value of 0 means that there is no openness in executive recruitment, i.e. leaders are chosen only through hereditary succession. A value of 0.33 means that the system has one leader chosen through hereditary succession and a chief minister selected by the chosen leader or by an executive court. A value of 0.67 means that the system has one leader chosen through hereditary succession and a chief minister selected through democratic election. A value of 1 refers to an open system where the leader is chosen through either designation by the political elite or competitive election.

The last executive variable, *execconst*, captures the constraints placed on the power of the executive. A value of 0 means the executive has unchecked and unlimited power to control and conduct affairs of the state. A value of 0.33 means the system grants great authority to the executive, with only a few checks on power, such as an independent legislature or judiciary with the power to set and change policy. A value of 0.67 refers to a system that levies substantial limitations on the power granted to the executive, including a legislature/judiciary that frequently denies executive requests for funding and/or policy measures or appoints important administrative leaders. A value of 1 refers to a system in which the executive is appointed by the legislature or judiciary and has significantly less authority than the appointing group.

The final group of political variables, the participation variables, describe the intitutions which affect the political participation of the nation's citizens. The first variable is the regulation of participation, *partreg*. This variable captures the regulations placed on participating in the political process, including limitations on expressing political views. A value of 0 refers to a completely unregulated system, in which no long-lasting political organizations exist, and therefore have little to no participation in the political process. A value of 0.25 means the system contains some stable political groups, i.e. parties, that influence politics, but rarely find overlapping interests to affect policy. A value of 0.5 refers to a sectarian system in which active factionalism allows the ruling party to effectively subjugate the opposing party until it loses power, in which the process repeats with the new ruling party. A value of 0.75 describes a system in which some organized activity is allowed, but several groups and certain issues are restricted from involvement in the political process. A value of 1 refers to a system in which political participation is completely regulated, and there are stable, long-lasting political groups that regularly participate in the political process with almost no exceptions.

The last participation variable is the competitiveness of participation, *partcomp*. This variable captures the degree to which one can seek alternative policy or leadership. A value of 0 describes a system in which all activity outside of the ruling regime is repressed. A value of 0.25 means the ruling party allows some opposing activity, but severely limits its form and reach. A value of 0.5 refers to a system where different organizations representing ethnic or religious factions regularly compete for power, and where the regime in power seeks an agenda tailored towards its own followers rather than the common good of the entire nation. A value of 0.75 indicates that a nation is in transition from a non-competitive system of participation to a competitive one, or vice-versa. A value of 1 means that there is a competitive system, where power is regularly and voluntarily transferred between stable political groups.

The final variable in this category, *democracy*, which is an index derived from all the aforementioned political variables. This variable is not included as a main regressor, due to the fact that it is a linear combination of the other variables. However, it will be used while analyzing nonlinear effects, since it can still be used in decision rules governing sample splits.

### 3.3 Economic Policies

In addition to the impact of political institutions on economic growth, this paper also aims to discern the impact of economic policies on economic growth. The following measures of several important economic policies were adapted from the Fraser Institute's Economic Freedom in the World (2009). They each are measured on a scale of 0 to 10, based on an average of several components. The values are reported as the natural log of the score given by the survey. The first policy, *govtsize* refers to the size of government, and is an average of four key measures. The first is government consumption spending as a percentage of total consumption. Countries with a larger proportion of government spending to consumption were given lower ratings, with the highest spending nation earning a 0. The second measure is transfers and subsidies as a percentage of GDP, with countries with a larger proportion of subsidies and transfers again receiving lower scores. The third measure is government enterprises and investment, which refers to the number and share of output generated by state-operated enterprises (SOEs) and the government investment as a share of total investment. Having fewer SOEs and a smaller proportion of investment yields the highest scores. The final measure that factors into *govtsize* is the top marginal tax rate and the income threshold at which the top marginal tax rate applies. Lower top marginal tax rates coupled with high thresholds yield the highest scores. In general, a higher value of *govtsize* refers to a economically smaller government.

The second policy accounted for in this analysis is the rule of law ($ruleoflaw$). This variable has seven components. The first, judicial independence, assigns higher scores to countries that have a judiciary that is completely independent of political influence from government, citizens, and firms. The second, impartial courts, assigns higher values to nations that have a well-regulated court system in which operate through a clear, neutral process. Third, protection of property rights, assigns higher scores to nations that have clearly defined and well-enforced property rights. Fourth, military interference in the rule of law and the political process, assigns higher scores to countries who do not rely on the military to regularly get involved with political functioning. Fifth, integrity of the legal system, gives higher scores to countries that have a strong, impartial legal system coupled with popular adherence to the law. Sixth, legal enforcement of contracts, gives higher scores to the nations that allow firms and individuals to collect clear-cut debts quickly and at a reasonably low cost. Finally, the seventh component is the regulatory restrictions on the sale of real property, which assigns higher scores to countries that allow property transfers to occur with lower time and monetary costs.

The third economic policy in this analysis measures the access to sound money (*soundmoney*). The first of four components, money growth, measures the average annual growth rate of the money supply in the past five years minus the average annual growth rate of GDP over the past ten years, and assigns higher values to those who have a slower growth of money supply. The second component, the standard deviation of inflation, yields higher ratings to those nations who experience a more stable inflation rate over the past five years, i.e. having a smaller standard deviation.The third component measures the inflation in the most recent year, and assigns a higher value to those nations with smaller rates of inflation. The final component measures the freedom to own foreign currency bank accounts, with nations with no restrictions on owning such accounts earning the highest scores.

The fourth economic policy variable, $freetrade$, measures the relative freedom to conduct trade in international markets. It is the average of five components. The first component, taxes on international trade, actually has three components of its own. It assigns higher rankings to those nations who observe lower revenues from trade taxes as a percentage of the trade sector, lower mean tariff rates, and a lower standard deviation of tariff rates. The second component, regulatory trade barriers, assigns higher values to those nations with fewer non-tariff trade barriers and lower non-monetary cost requirements, i.e. time, to import and export goods. The third component, the size of the trade sector, estimates the size of the trade sector based on the population, size, and location and compares that estimate with the actual trade sector. Nations with a larger trade sector than expected receive higher scores. The fourth component of $freetrade$, the black market exchange rates, measures the difference between the official market exchange rate and the black market exchange rate. Countries with the lowest black market exchange rate premium receive the highest scores. The final component, international capital market controls, yields the highest scores to nations which encourage foreign ownership of companies and foreign direct investment, and to those nations who implement fewer capital controls.

The final economic policy, the regulation of credit, labor, and business ($regCLB$) has three components. The first component, the regulations placed on credit markets, has four components of its own. It assigns higher scores to those nations with a higher percentage of bank deposits held in privately owned banks, nations that approved most foreign bank applications and allowed those banks to compete, nations where the private sector consumes a higher percentage of domestic credit, and nations with fewer interest rate controls and regularly positive real interest rates. The second component of $regCLB$, labor market regulations, has six components. The first of these measures, the minimum wage, yields higher scores to nations with a lower minimum wages relative to average value added per worker. The second, hiring and firing regulations, gives higher scores to nations in which firms have the flexibility to hire and fire as they see fit. The third, centralized collective bargaining, gives higher scores to countries in which firms determine their own pay structure, as opposed to some centralized collective bargaining agreement. The fourth, mandated cost of hiring, yields higher marks to countries that have a smaller hiring cost (the sum of social security, payroll taxes, mandated benefits, paid vacation days, etc.) as a percentage of salary. The fifth, mandated cost of worker dismissal, gives higher scores to nations with a lower firing cost (the sum of the cost of advanced notice, severance pay, and any other penalties levied on firing a worker) measured in weeks of wages. Finally, the sixth component of labor regulations, conscription, gives the highest scores to nations with shorter or no military conscription. The final component of $regCLB$, business regulations, has seven of its own components. Highest values are assigned for nations with lower use of price controls, less burdensome administrative requirements, lower bureaucracy costs, lower time and monetary costs associated with starting a business, fewer occurances of undocumented extra payments or bribery, lower time and monetary costs associated with obtaining construction licenses, and lower time costs associated with preparing, filing, and paying corporate taxes.

Finally, there is also an index measure of economic freedom, $EF$, which encompasses all of the economic policy variables. Like *democracy*, it is not included in the models as a regressor, since it is a linear combination of other variables and will likely bias the results. However, it will also be used in the nonlinearities analyses for decision rules.

## 3.4 Geographic Measures

In order to robustly discern the effects of different political institutions and economic policies, there is a need to account for geographic features that may naturally affect the economic growth of a state. The following measures are adapted from a Harvard CID Project data set, *Physical Geography and Population* (Gallup, Mellinger, & Sachs, 2001). The first variable measures the natural log of the mean distance to the coast or a river in km (*distsea*). The second measures the percent of land contained in the geographical tropics (*tropicland*). The third refers to the percent of land that is within 100km of ice-free coast or sea-navigable river (*landsea*). The final geographic variable measures the percent of soil deemed at least moderately suitable for agricultural activity. This variable, *soilquality*, was adapted from Matthews (1983) and although it is possible that the quality may have improved or worsened between the years of analysis and this 1983 benchmark, it is very unlikely that it would have changed too drastically across an entire nation.

## 3.5 Ethnic Division

The next variable in the analysis attempts to capture the ethnic division of a given country. The ethnolinguistic fractionalization rate, $ELF$, is adapted from Roeder (2001). This variable measures the probability that any two citizens of the country, chosen at random, are of different ethnolinguistic backgrounds. It was provided for the years 1961 and 1985. It essentially captures the ethnolinguistic heterogeneity of a nation. This was found to be a significant determinant of growth by Easterly and Levine (1997).

## 3.6 Cultural Variables

The final group of variables consists of regressors that measure the percent of the population that identifies as a certain religion, as measured in 1980 by Barrett (1980). First, *pctcath* measures the percentage of population that identifies as Catholic. Next, *pctmuslim* measures the percentage of population that identifies as Muslim. Finally, *pctprot* measures the percentage of population that identifies as Protestant. Again, while it is possible that these percentages have changed across the years in this analysis, it would be very surprising if any have changed very drastically between the years of this analysis.

## 3.7 Problems with Cross-Country Data

When examining cross-country data, there are several problems that any analysis will inevitably run into. First, many variables included in cross-country analysis are extremely slow-moving. For example, the political institutions mentioned above are generally stable, provided there is no military coup or revolution. It is hard to imagine a nation that sees the system of recruiting a leader change significantly every year and yet remain stable enough to provide reliable data for analysis. Furthermore, determining the effects of changes in these slow-moving variables is difficult to see instantaneously. In most cases, if a major political institution changes, it may take several years until the nation acclimates to the new institution. The same applies for new economic policies. Thus there is a need to account for an adjustment period in the analysis. Slow-moving variables also give an illusion of having more degrees of freedom than perhaps is actually suggested by the data. This is more of a characteristic of the data than a true problem with the data, but it does influence how the data is presented.

In order to avoid the illusion of a greater amount of degrees of freedom, it was decided that this analysis could best account for the impact of changes in the data by splitting the data into two periods, 1970-1988 and 1989-2007, and averaging the values assigned to the variables across the given period of analysis. This essentially creates two observations for each country, and helps to yield more robust results. The period from which the observation is from is indicated in the binary variable $per1$. If the observation comes from the earlier period, then $per1 = 1$; otherwise $per1 = 0$. This also reconciled the problem of only having $ELF$ defined in two years. For period 1, the $ELF$ of 1961 was assigned, and the $ELF$ of 1985 was assigned in period 2. The variable $initialGDP$ was set to equal the natural log of real per capita GDP in 1970 for period 1 and the natural log of real per capita GDP in 1989 for period 2. The number of observations in period 1 is 68, while the number of observations in period 2 is 86. A list of countries present in each period can be found in the Data Appendix. There are several reasons why there are more observations in the second period, including the collapse of the U.S.S.R. in 1991 and improvements in methods of gathering and compiling reliable evidence in the past 30 years.

While the number of observations may seem small, the total of 154 observations is comparable to previous growth papers. There is an extremely limited number of countries in the world. Even if reliable data existed for every country in the world, there would still be fewer than 200 observations per year. However, there are always some countries with missing data, whether it be because of political reasons or unreliable data gathering. Therefore, cross-country data usually operates with a fraction of nations excluded from analysis. When a country was only missing a value for a variable in a few years, it was simple to average across all available years, thereby saving some observations. However, for the cases where a nation was missing all years of a particular variable, it was decided that the observation should be dropped from the analysis. This was mostly because when an observation was missing one variable, it was generally missing more, due to the fact that there were several variables coming from the same source, as opposed to each variable coming from a different source.

There is also usually some belief that many of these variables actually move together and depend on one another. Indeed many of the variables are significantly correlated with one another at the 5% level. For this reason, a principal component analysis was run on the data to try to take the principal components of each group of variables. However, after the components were estimated, the Kaiser-Meyer-Olkin measure of sample adequacy came back negative for each component, indicating that the data was not correlated strongly enough to warrant a principal component analysis.

Finally, there have been several arguments to use fixed-effect variables for panel data, such as ones unique to each country or ones unique to a set continent or region of the world to account for unobserved differences across the world. However, using these variables would have several negative effects econometrically. First, it would cut the degrees of freedom in half, making it much more difficult to conduct robust hypothesis testing. Second, there is nothing to indicate that those fixed effects are not determined by the political institutions, economic policies, geography, or culture of a nation. While a fixed-effect variable could certainly pick up on some cultural effects not accounted for in the religion variables, it would be remiss to assume none of the other regressors helped to shape that culture. Were the data not averaged across large blocks of time, it may make sense to capture the fixed effects, since there is probably little change from year to year. However, expanding that time difference to 19 years makes it hard to believe those fixed effects have truly stayed fixed all along. Given the construction of the data set in this analysis, it does not seem optimal to include fixed-effect variables.

# 4 Results

## 4.1 Linear Regression (OLS)

Many linear regressions were run as a part of this analysis. In adherence to prior theoretical papers on economic growth, the base model for analysis will be:

$$growth = \beta_0 + \boldsymbol{X\theta} + \varepsilon, \qquad \varepsilon \sim N(0, \sigma^2) \tag{4.1}$$

where $X$ is the vector of Solow variables, $initialGDP$, $n$, $maleschooling$, and $ishare$, as well as the dummy variable $per1$. The OLS estimator $\hat{\theta}$ reveals the relationship between the Solow variables and economic growth.The OLS results estimate about a 1% (0.97954%) rate of conditional convergence per year on average, holding all else constant. This refers to the coefficient on $initialGDP$, which has a p-value of 0.002 using robust standard errors. This is not surprising, as many previous works have also described this notion of conditional convergence, although it is significantly smaller than the convergence predicted by Barro (1996). In terms of aiding growth, one can see that a 1% increase in the average years of schooling for males age 25 or older in the society predicts about a 1.3% increase in growth rate per year at a p-value of 0.008. Significant at every significance level is the investment share of GDP, for which a 1% increase predicts a 1.9% increase in growth rate of real GDP per capita per year. The dummy variable $per1$ also shows a significantly positive effect, indicating that growth was naturally higher in the earlier period. The coefficient on $n$ was not found to be statistically significant. The significant regressors and their sign can be seen in Table 4.1. For full regression results, please see the Full Regression Results Appendix at the end of this paper.

Table 4.1: Significant Regressors and their Sign from the Base Model (10% significance level)

| Regressor | Sign |
|---|---|
| $initialGDP$ | - |
| $maleschooling$ | + |
| $ishare$ | + |
| $per1$ | + |

### 4.1.1 Political Institutions

Next, (4.1) was extended to incorporate the political institution variables. The model thus became:

$$growth = \beta_0 + \boldsymbol{X\theta}_X + \boldsymbol{Z\theta}_Z + \varepsilon \tag{4.2}$$

Table 4.2: Significant Regressors and their Sign from the Political Institution Model (10% significance level)

| Regressor | Sign |
|---|---|
| *initialGDP* | - |
| *maleschooling* | + |
| *ishare* | + |
| *per*1 | + |
| *durability* | + |

where $\boldsymbol{Z}$ represents the vector of political institution variables, *durability*, *execreg*, *execcomp*, *execopen*, *execconst*, *partreg*, and *partcomp*. Adding this set of variables to the analysis does not significantly change the estimates of the coefficients on the Solow variables. There is still evidence of conditional convergence at the 1% significance level, and *maleschooling* and *ishare* still have significantly positive impacts on economic growth. In terms of political institutions, none of the aforementioned variables had a significant impact on economic growth at the 5% significance level, and only *durability* was statistically significant (and positive) at a 10% level. In fact, the adjusted R-squared value only rose by 0.0008, and the root mean squared error (RMSE) only fell from 1.7668 to 1.7652. Adding the political institution variables to the model only granted a minute amount of predictive ability. This seems to suggest that no political institutions other than having a durable regime in power has any effect on economic growth.

### 4.1.2 Economic Policies

This part of the analysis will again use (4.2), only this time $\boldsymbol{Z}$ will be replaced by the vector of economic policy variables, *govtsize*, $ruleoflaw$, *soundmoney*, $freetrade$, and $regCLB$. When these variables are added to the base model, the Solow variables maintain their signs and significance (although *maleschooling* becomes only significant at the 5% level instead of the 1% level). The coefficients on *govtsize*, *soundmoney*, $freetrade$, and $regCLB$ are all positive, but not statistically significant. However, the coefficient on $ruleoflaw$ (0.38727) was found to be significant at even the 1% level. The interpretation of this variable is that an increase in the rule of law, whether it be by implementation and enforcement of contract laws, introduction of a more impartial judiciary, or some other means, is significantly beneficial towards economic growth. The adjusted R-square is about a tenth greater than that of the base model, and the RMSE falls to 1.6369, indicating adding the economic policies to the analysis increases the predictive capability of the model.

Table 4.3: Significant Regressors and their Sign from the Economic Policy Model (10% significance level)

| Regressor | Sign |
|---|---|
| *initialGDP* | - |
| *maleschooling* | + |
| *ishare* | + |
| *per*1 | + |
| $ruleoflaw$ | + |

### 4.1.3 Geographic Variables

Setting $\boldsymbol{Z}$ equal to the vector of geographic variables, *distsea*, *tropicland*, *landsea*, and *soilquality*, provides a means for checking the significance of geographic factors. When added to the base model, the Solow variables again maintain their sign and significance. The variable *distsea* is the only geographic variable that is not significant at the 10% level. The OLS estimators predict that a 1% increase in the amount of land located in the geographic tropics will correspond with a 1.549% decrease in the growth of real GDP per capita per year on average, all else equal. The coefficient associated with *tropicland* is significant at every level. On the other hand, *landsea* has a significantly positive relationship with growth at the 10% level, and its coefficient has a greater magnitude than that of *tropicland*, which may prove a saving grace for countries locked in the tropics. Interestingly, *soilquality* has a significantly negative relationship with growth at the 10% level. Perhaps this is because some countries with good soil quality may feel little incentive to industrialize or progress past a system of subsistence farming.

Table 4.4: Significant Regressors and their Sign from the Geography Model (10% significance level)

| Regressor | Sign |
|---|---|
| $initialGDP$ | - |
| $maleschooling$ | + |
| $ishare$ | + |
| $per1$ | + |
| $tropicland$ | - |
| $landsea$ | + |
| $soilquality$ | - |

### 4.1.4 Ethnic Division and Cultural Variables

Finally, setting $\boldsymbol{Z}$ equal to the vector of ethnolinguistic fractionalization, $ELF$, and the cultural variables, *pctcath*, *pctmuslim*, and *pctprot*, yields a means to analyze whether these final variables should be included in the model. The Solow variables do not change in sign nor in significance. The ethnolinguistic fractionalization rate is not found to be statistically significant, nor is *pctmuslim*. However, the coefficient on *pctcath* is found to be significantly negative at the 1% level. Furthermore, the coefficient on *pctprot* is also significantly negative at the 1% level, with a coefficient almost twice in magnitude the coefficient of *pctcath*.

Table 4.5: Significant Regressors and their Sign from the Ethnic Division and Cultural Model (10% significance level)

| Regressor | Sign |
|---|---|
| $initialGDP$ | - |
| $maleschooling$ | + |
| $ishare$ | + |
| $per1$ | + |
| *pctcath* | - |
| *pctprot* | - |

### 4.1.5 Building a More Complete Model

While it would be easy to accept the previous results as fact, in reality, these variables would not always be measured separate from each other. In fact, to find the true partial effects of the variables, they really need to all be included in one cohesive model. First, $\boldsymbol{Z}$ will be set to include the political institution variables and economic policy variables. When these two groups are added to the base model, the Solow variables maintain their signs and significance, except that the p-value of *maleschooling* rises to 0.089, so it is only significant at the 10% level. Again, none of the political regressors have a significant impact on growth, and *ruleoflaw* is the only economic policy to have a statistically significant coefficient. The adjusted R-squared of the model is 0.6572, which is only 0.004 larger than the adjusted R-squared of the model containing only the economic policy variables. Furthermore, the RMSE actually rises to 1.6572 compared to 1.6369 when only the economic policy variables are included.

Table 4.6: Significant Regressors and their Sign from the Full Model (10% significance level)

| Regressor | Sign |
|---|---|
| *initialGDP* | - |
| *ishare* | + |
| *per*1 | + |
| *ruleoflaw* | + |
| *regCLB* | + |
| *soilquality* | - |
| *pctprot* | - |

Adding the geographic factors into $\boldsymbol{Z}$ causes a loss in significance of *maleschooling*. However, *initialGDP*, *ishare*, and *per*1 are unaffected. There is somewhat of a loss in significance of *ruleoflaw*, as it becomes only significant at a 5% level, but *tropicland* is significantly negative at a 1% level. Soil quality loses its significance when measured along with the political institution and economic policy variables.

Finally, adding the ethnic division and cultural variables to $\boldsymbol{Z}$ and thereby regressing growth on the full set of regressors yields some interesting results. The significant regressors and their sign can be seen in Table 4.6. The initial real GDP per capita, investment share of GDP, and *per*1 are all unaffected. The average years of schooling for a male aged 25 or older just missed being significant at the 10% level with a p-value of 0.102. The rule of law index remains significantly positive at the 5% level, and the index measuring the regulation7 of credit, labor, and business becomes significant at the 10% level. Soil quality becomes significantly negative at the 10% level, but *tropicland* is no longer significant at the 10% level, as its p-value rises to 0.101. In terms of cultural variables, only *pctprot* remains significant, and it is significantly negative at every level. The adjusted R-squared is raised to its highest level at 0.6877, and the RMSE falls to its lowest value, 1.4764. However, this is probably not the best linear model, since so many of the included variables are insignificant and probably skewing the results.

Reducing the size of included variables by repeatedly dropping the component of $\boldsymbol{Z}$ with the highest p-value and repeating the regression until only significant regressors exist in $\boldsymbol{Z}$ yields a model with six components in the set of auxiliary regressors. The remaining variables are *ruleoflaw*, *regCLB*, *tropicland*, *landsea*, *soilquality*, and *pctprot*. The significant regressors and their sign can be seen in Table 4.7. All but *landsea*, which is significant at the 10% level, are significant at the 5% level, with *ruleoflaw*, *tropicland*, and *pctprot* significant even at the 1% level. Additionally, *initialGDP* remains significantly negative at all levels, indicating conditional convergence of about 1.78% per year on average. The investment share of GDP also remains significant at all levels, as does *per*1. Schooling, serving as a proxy for human capital, regains its significance at the 5% level. This model indicates that, in a linear framework, there is evidence that increased rule of law and a decerase on the regulations placed on credit, labor, and business (recall that *regCLB* rises with fewer regulations) have a beneficial effect on economic growth. It also indicates that geography is very important. The initial endowment of land in terms of location and waterways, as well as soil quality help to determine a nation's natural rate of growth. It would also appear that protestantism has a negative impact on growth. This is surprising, since previous research, including that of Acemoglu, Johnson, and Robinson (2004), suggests that the values exemplified in the Protestant lifestyle often promoted capitalism and helped to cause expanded economic growth. It is possible that both models are correct. While Protestantism may have caused economic growth throughout previous centuries, it may simply just be outproduced by other ideologies in the modern world, such as those religions and ideologies included in the omitted group. Among the ideologies in the omitted group are Hinduism, Buddhism, Confucianism, and other Eastern religions that are extremely common among some of the observed high growth nations, such as the Asian tigers. While this is not necessarily a bad model (adjusted R-squared equal to 0.6972 and RMSE equal to ), it would be brash to consider this the "true model."

Table 4.7: Significant Regressors and their Sign from the Full Model, Excluding Irrelevant Regressors (10% significance level)

| Regressor | Sign |
|---|---|
| *initialGDP* | - |
| *maleschooling* | + |
| *ishare* | + |
| *per*1 | + |
| *ruleoflaw* | + |
| *regCLB* | + |
| *tropicland* | - |
| *landsea* | + |
| *soilquality* | - |
| *pctprot* | - |

### 4.1.6 Problems with a Linear Model

Finding the "true" model becomes increasingly difficult with the inclusion of more variables. This analysis, limited to just 25 variables, still has $2^{25} = 33,554,432$ possible linear models. We can simplify that somewhat by requiring that the base model always be included. That shaves the total number of possible regressions to $2^{20} = 1,048,576$, which is still too large to feasibly test all of them. Of course, finding the "true" model also assumes that the "true" model actually is a linear combination of these variables. The likelihood of that is probably even smaller than the odds of picking the correct model from these variables. This creates a lot of model uncertainty in the growth data.

Furthermore, choosing a linear framework implies that there are no nonlinearities in the data. This means that all variables follow a strictly independent linear path. However, this seems unlikely in the growth data. It would not be inconceivable for a nation to only reap the benefits of a well-defined and enforced rule of law if it has sufficiently surpassed a specific threshold, such as fully recognized property rights and an independent judiciary. It is also unlikely that increasing average schooling from 11 to 12 years would have the same effect of increasing schooling from 1 to 2 years. In light of these problems, further analysis must be done to limit the amount of model uncertainty and test for the existence of nonlinearities in the data.

## 4.2 Testing for Nonlinearities

### 4.2.1 Interaction Effects

Several tests were run to test for nonlinearities. First, there was an attempt to identify which variables may have significant interactions with the data. The first natural choice was *democracy*, which is the composite score measuring democracy with regards to the political institution variables. While the linear regressions suggested political institutions may not have an impact on economic growth, it is entirely possible that those regressors found significant affect growth differently for democracies than they do nondemocracies. The new model became:

$$y = \beta_0 + \boldsymbol{X}\boldsymbol{\theta}_X + \boldsymbol{Z}\boldsymbol{\theta}_Z + democracy * \boldsymbol{X}\boldsymbol{\delta}_X + democracy * \boldsymbol{Z}\boldsymbol{\delta}_Z + \varepsilon \tag{4.3}$$

For each of the interaction variables used in this part of the analysis there are three models run. The first is (4.3) with $\boldsymbol{Z}$ equal to the empty set. Thus the interaction is tested only on the Solow variables. Second, it will be run with $\boldsymbol{Z}$ equal to the complete set of variables. Finally, it will be run with $\boldsymbol{Z}$ equal to only those variables and interaction terms found to be significant by the same iterative process described above in the linear framework. This process will change (4.3) to:

$$y = \beta_0 + \boldsymbol{X}\boldsymbol{\theta}_X + \boldsymbol{Z}\boldsymbol{\theta}_Z + democracy * \tilde{\boldsymbol{X}}\boldsymbol{\delta}_X + democracy * \tilde{\boldsymbol{Z}}\boldsymbol{\delta}_Z + \varepsilon \tag{4.4}$$

where $\tilde{\boldsymbol{X}}$ refers to those Solow variables with a significant interaction term and $\tilde{\boldsymbol{Z}}$ refers to those auxiliary regressors with a significant interaction term.

In the first regression with democracy interactions, with $\boldsymbol{Z}$ and $\tilde{\boldsymbol{Z}}$ equal to the empty set, conditional convergence holds at the 5% significance level, and *ishare* maintains its sign and significance. The period 1 dummy and schooling both lose their significance. None of the interaction terms are significant, indicating that the partial effects of the Solow variables are not impacted by the level of democracy. In the second regression, the full set of variables, *initialGDP*, *tropicland*, and *pctprot* are the only main effects found to be statistically significant at a 10% level. Furthermore, the only interaction term found to be statistically significant at the 10% level is *democracy* ∗ *soundmoney*, which has a significantly negative coefficient, suggesting that democracies pay a premium for higher scores in *soundmoney*. To see if these effects remain significant in a less clouded model, regressors were dropped by p-value one by one until only significant effects remained. The result left $\tilde{\boldsymbol{X}} = \varnothing$, $\boldsymbol{Z}$ = {*execreg*, *execcomp*, *execconst*, *partreg*, *distsea*, *tropicland*, *landsea*, *ruleoflaw*, *soundmoney*, *regCLB*, *pctcath*, *pctmuslim*, *pctprot*}, and $\tilde{\boldsymbol{Z}}$ = {*execconst*, *partcomp*, *distsea*, *landsea*, *soundmoney*, *pctcath*, *pctprot*}. Including interaction terms has added 8 regressors to $\boldsymbol{Z}$, while eliminating one, *soilquality*. The signs on the interaction terms indicate that democracies benefit from having a higher percentage of Catholics and Protestants, as well as allowing for the existence of several stable political groups that voluntarily transfer power to one another (having a higher *partcomp* score) than nondemocracies do. They also suggest that democracies pay a premium for levying constraints on the executive power, and enacting stable monetary policy and keeping inflation low (a higher *soundmoney* score). It also suggests that nondemocracies benefit much more from having more of their land close to navigable waterways, perhaps reflecting that nondemocracies rely more heavily on seafaring trade than democracies do. This model has an adjusted R-squared value of 0.7612 and a RMSE of 0.01291. This indicates that the interaction effects captured in this model have granted the growth model more predictive power.

Table 4.8: Significant Regressors and their Sign from the *democracy* Interaction Model, Excluding Irrelevant Regressors (10% significance level)

| Main Effects | | ∗*democracy* | |
|---|---|---|---|
| Regressor | Sign | Regressor | Sign |
| *initialGDP* | - | *execconst* | - |
| *ishare* | + | *partcomp* | + |
| *per*1 | + | *distsea* | - |
| *execreg* | - | *landsea* | - |
| *execcomp* | + | *soundmoney* | - |
| *execconst* | + | *pctcath* | + |
| *partreg* | - | *pctprot* | + |
| *distsea* | + | | |
| *tropicland* | - | | |
| *landsea* | + | | |
| *ruleoflaw* | + | | |
| *soundmoney* | + | | |
| *regCLB* | + | | |
| *pctcath* | - | | |
| *pctmuslim* | - | | |
| *pctprot* | - | | |

However, there could also be significant interaction effects between other variables in the data. The next model will be the same as (4.3), but *democracy* will be replaced with *EF*, the index measuring economic freedom based on the scores of the component variables *govtsize*, *ruleoflaw*, *soundmoney*, *freetrade*, and *regCLB*. This will analyze whether the set of regressors have different partial effects based on overall level of economic freedom. Holding $\boldsymbol{Z} = \tilde{\boldsymbol{Z}} = \varnothing$ and creating interaction terms between $EF$ and the Solow regressors yields *initialGDP*, $n$, and *maleschooling* all significant at the 10% level. The sign on $n$ is negative, suggesting that increased population growth actually hinders growth, not to mention that the magnitude of the coefficient is 8 times that of *initialGDP*, which indicates that population growth could be a stronger slowing force than conditional convergence. There are two interaction effects found to be significant at the 10% level. First, the interaction effect $EF * n$ is significantly positive, indicating that countries with more economic freedom are more able to deal with the negative effects of a growing population on economic growth. Second, the interaction effect $EF * per1$ is also significantly positive, meaning that economic freedom was more important to growth prior to the 1990s.

Regressing growth on the full set of regressors and regressors interacted with $EF$ yielded only three significant main effects–*soilquality*, *govtsize*, and *freetrade*. Government size was significantly negative, indicating that higher spending governments generate more growth, since *govtsize* scores are higher for those nations with smaller government expenditures relative to GDP. Interestingly, the coefficient on *freetrade* was also negative, indicating that encouraging more international trade may hamper one's economic growth. This model also predicted five significant interaction effects–$EF * distsea$, $EF * landsea$, $EF * soilquality$, $EF * freetrade$, and $EF * regCLB$. It suggests that countries with higher levels of economic freedom benefit more than less free states from geographic endowments, *distsea*, *landsea*, and *soilquality*, and also suggests that allowing more cost and time-effective international trade will not hurt more economically free states. On the other hand, it suggests that less economically free states benefit more from fewer regulations on credit, labor, and business. Dropping irrelevant variables leaves a model with $\tilde{\boldsymbol{X}} = \{n\}$, $\boldsymbol{Z} = \{partcomp, tropicland, soilquality, govtsize, freetrade, pctprot\}$, and $\tilde{\boldsymbol{Z}} = \{execopen, partcomp, soilquality, soundmoney, freetrade, pctprot\}$. This is a vastly different set of regressors from the model with *democracy*. It suggests that countries with high economic freedom benefit more from an open executive recruitment, high soil quality, freedom to trade internationally, and a highly protestant population than a country with less economic freedom. Conversely, high economic freedom countries pay a premium for competitive political groups,

Table 4.9: Significant Regressors and their Sign from the $EF$ Interaction Model, Excluding Irrelevant Regressors (10% significance level)

| Main Effects | | $*EF$ | |
|---|---|---|---|
| Regressor | Sign | Regressor | Sign |
| *initialGDP* | - | $n$ | + |
| $n$ | - | *execopen* | + |
| *maleschooling* | + | *partcomp* | - |
| *ishare* | + | *soilquality* | + |
| *per1* | + | *soundmoney* | - |
| *partcomp* | + | *freetrade* | + |
| *tropicland* | - | *pctprot* | + |
| *soilquality* | - | | |
| *govtsize* | - | | |
| *freetrade* | - | | |
| *pctprot* | - | | |

and setting a stable monetary system. This model had an adjusted R-squared of 0.7413 and a RMSE of 0.01344. While this is not as good of a fit as the model interacted with *democracy*, it highlighted several interactions that the previous model was not able to.

The final variable that an interaction model was run for was *initialGDP*, in hopes of finding differentiated effects based on wealth of a nation. After running an interaction model on the Solow variables with *initialGDP* as the interacting variable, the only main effect significant at a 10% level is *ishare*, which is significantly positive with a p-value of 0.023. There are two interaction effects significant at a 10% level–$initialGDP * maleschooling$ and $initialGDP * ishare$, indicating that richer countries benefit more from increased education, but poorer countries benefit more from increasing their investment share of GDP.

Regressing on the entire set of regressors and their interactions with *initialGDP* yields 9 significant regressors–*per*1, *partcomp*, *tropicland*, *soundmoney*, $initialGDP * per1$, $initialGDP * ishare$, $initialGDP * partcomp$, $initialGDP * tropicland$, and $initialGDP * soundmoney$. It suggests that competitive political groups are very beneficial to economic growth. It also predicts that a stable monetary system is beneficial to economic growth, contrary to what the previous model suggested. In terms of interaction effects, the model suggests that richer nations benefit more from increasing their investment share of GDP and can better withstand living in the geographic tropics. It also indicates that poorer nations benefit from allowing competitive political groups to exist and maintaining a stable monetary system more than rich nations do.

Table 4.10: Significant Regressors and their Sign from the *initialGDP* Interaction Model, Excluding Irrelevant Regressors (10% significance level)

| Main Effects | | **initialGDP* | |
|---|---|---|---|
| Regressor | Sign | Regressor | Sign |
| *initialGDP* | + | *ishare* | + |
| *maleschooling* | + | *per*1 | - |
| *ishare* | - | *execcomp* | + |
| *per*1 | + | *partcomp* | - |
| *execconst* | - | *tropicland* | + |
| *partcomp* | + | *govtsize* | - |
| *tropicland* | - | *ruleoflaw* | - |
| *soilquality* | - | *soundmoney* | - |
| *govtsize* | + | | |
| *ruleoflaw* | + | | |
| *soundmoney* | + | | |
| *regCLB* | + | | |
| *pctprot* | - | | |

Dropping the a priori irrelevant regressors leaves a model with $\tilde{\boldsymbol{X}} = \{per1, ishare\}$, $\boldsymbol{Z} = \{execconst, partcomp, tropicland, soilquality, govtsize, ruleoflaw, soundmoney, regCLB, pctprot\}$, and $\tilde{\boldsymbol{Z}} = \{execcomp, partcomp, tropicland, govtsize, ruleoflaw, soundmoney\}$. Unlike the model with the *EF* interactions, this model shows a significantly positive coefficient on *govtsize*, suggesting that higher government spending relative to GDP might actually be bad for economic growth. This model also suggests that richer countries benefit more than poorer countries when it comes to investment share of GDP and competitiveness of executive recruitment. However, it predicts that poorer nations receive a greater benefit from having competitive political groups and are not as

Table 4.11: Significant Regressors and their Sign from the Interaction Model using all 3 Interactions, Excluding Irrelevant Regressors (10% significance level)

| Main Effects | | *democracy | | *EF | | *initialGDP | |
|---|---|---|---|---|---|---|---|
| Regressor | Sign | Regressor | Sign | Regressor | Sign | Regressor | Sign |
| *initialGDP* | + | *initialGDP* | - | *n* | + | *initialGDP* | - |
| *maleschooling* | - | *n* | - | *execcomp* | - | *maleschooling* | + |
| *ishare* | - | *maleschooling* | + | *execopen* | + | *ishare* | + |
| *per1* | + | *ishare* | - | *partreg* | + | *per1* | - |
| *execreg* | + | *per1* | + | *soilquality* | + | *execreg* | - |
| *execconst* | - | *execreg* | - | *regCLB* | + | *execcomp* | + |
| *partreg* | - | *execcomp* | + | *ELF* | + | *execopen* | - |
| *partcomp* | + | *execopen* | + | *pctcath* | - | *execconst* | + |
| *distsea* | - | *execconst* | - | *pctmuslim* | - | *distsea* | + |
| *tropicland* | - | *distsea* | - | *pctprot* | - | *tropicland* | + |
| *pctmuslim* | - | *landsea* | - | | | *landsea* | + |
| | | *govtsize* | + | | | *soilquality* | - |
| | | *ruleoflaw* | + | | | *govtsize* | - |
| | | *soundmoney* | + | | | *ruleoflaw* | - |
| | | *freetrade* | + | | | *soundmoney* | - |
| | | *pctprot* | + | | | *freetrade* | - |
| | | | | | | *regCLB* | - |
| | | | | | | *ELF* | - |
| | | | | | | *pctcath* | + |
| | | | | | | *pctmuslim* | + |
| | | | | | | *pctprot* | + |

hampered by high spending governments. The model has an adjusted R-squared of 0.7827 and a RMSE equal to 0.01232, which is an improvement over the *EF* model. One concern with this model is that it does not predict conditional convergence, but that may be a result of the interactions with *initialGDP*. Nonetheless, this is a worthwhile concern.

Including all regressors and interactions with each of the three variables previously tested gives a new picture on the growth model. After eliminating the a priori irrelevant regressors, the model is left with $\tilde{\boldsymbol{X}}_d = \{per1,\ initialGDP,\ n,\ maleschooling,\ ishare\}$, $\tilde{\boldsymbol{X}}_e = \{n\}$, $\tilde{\boldsymbol{X}}_i = \{per1,\ initialGDP,\ maleschooling,\ ishare\}$, $\boldsymbol{Z} = \{execreg,\ execconst,\ partreg,\ partcomp,\ distsea,\ tropicland,\ pctmuslim\}$, $\tilde{\boldsymbol{Z}}_d = \{execreg,\ execcomp,\ execopen,\ execconst,\ distsea,\ landsea,\ govtsize,\ ruleoflaw,\ soundmoney,\ freetrade,\ pctprot\}$, $\tilde{\boldsymbol{Z}}_e = \{execcomp,\ execopen,\ partreg,\ ELF,\ soilquality,\ regCLB,\ pctcath,\ pctmuslim,\ pctprot\}$, and $\tilde{\boldsymbol{Z}}_i = \{execreg,\ execcomp,\ execopen,\ execconst,\ ELF,\ distsea,\ tropicland,\ landsea,\ soilquality, govtsize,\ ruleoflaw,\ soundmoney,\ freetrade,\ regCLB,\ pctcath,\ pctmuslim,\ pctprot\}$, where the members of $\tilde{\boldsymbol{Z}}_d$ are multiplied by *democracy*, the members of $\tilde{\boldsymbol{Z}}_e$ are multiplied by *EF*, and the members of $\tilde{\boldsymbol{Z}}_i$ are multiplied by *initialGDP*. The list of significant regressors and their signs can be seen in Table 4.11. What this model suggests more than anything else, is that the results of these regressions is extremely sensitive to the regressor selection. Adding additional regressors caused 14 additional interaction effects with *democracy* to become significant, while 5 previously significant interactions became insignificant.

A similar result occurred with the interactions with $EF$–6 new interactions became significant and 3 lost significance. In terms of interactions with $initialGDP$, only one effect lost significance, but 14 gained significance. While the adjusted R-squared rose to 0.8986 and the RMSE fell to 0.00841, this exercise has displayed the model uncertainty surrounding cross-country growth analysis.

One problem with the interaction models is that there are just too many possible interactions and combinations of variables to be sure that any one model is correct. Adding or subtracting one interaction creates such a difference in the results that it is hard to believe any of these results are robust. Furthermore, adding more and more terms can only be so effective when the number of observations is as small as the growth data allows for. With only so many countries offering reliable data for a relatively short period of history, there is a significant limit imposed in terms of degrees of freedom. Another problem is that there is no way to know which of these interactions statistically belong in the "true" model. To fix this, another model is required.

### 4.2.2 Threshold Regressions

While it is nice to see the continuous interactions of the previous model, the amount of model uncertainty makes it hard to declare any of the results valid. A threshold regression methodology can help identify nonlinearities in the data through both variable selection and threshold selection. This method will employ the method used by Hansen (2000) to pick the optimal splitting rules to build regression trees.

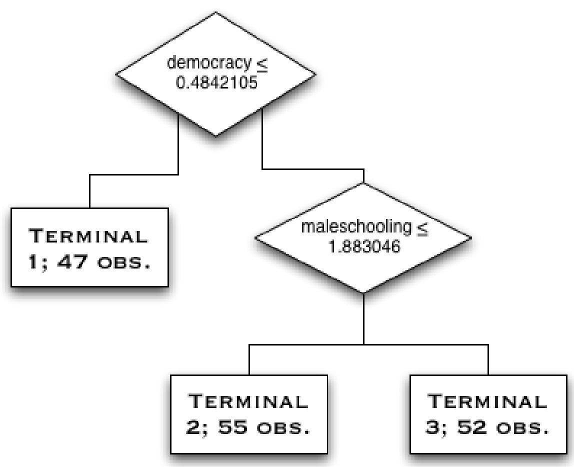


Figure 4.1: *democracy* Regression Tree

When run on the full set of regressors plus *democracy* and $EF$, three decision rules were discovered to have a bootstrap p-value of 0. The first of these that was tested a split at *democracy* $\leq 0.4842105$. After this split was made, both resulting datasets were tested for more splitting rules. The group for which *democracy* $\leq 0.4842105$ had no feasible splits that would leave enough observations into each group that a meaningful regression could be run. Therefore that group, containing 47 observations, became Terminal 1, the "low democracy" terminal. In the high democracy group, another test for

Table 4.12: Significant Regressors and their Sign in each Terminal from the *democracy* Regression Tree, (10% significance level)

| Terminal 1 | | Terminal 2 | | Terminal 3 | |
|---|---|---|---|---|---|
| Regressor | Sign | Regressor | Sign | Regressor | Sign |
| *ishare* | + | *per1* | + | *initialGDP* | - |
| | | *execconst* | - | *n* | + |
| | | *tropicland* | - | *ishare* | + |
| | | *regCLB* | + | *tropicland* | - |
| | | *pctprot* | - | *ruleoflaw* | + |
| (47 Obs.) | | (55 Obs.) | | (52 Obs.) | |

splitting rules identified a significant split at *maleschooling* $\leq 1.883046$. The 55 observations that satisfied that criterion, meaning the average male aged 25 or older during the given time period could expect to have about 6.5 years of education or less, did not have any other feasible splits, and therefore became Terminal 2, the "high democracy, low education" terminal. Those 52 observations with a higher average level of educational attainment also did not have any other feasible splitting rules. Thus that group became Terminal 3, the "high education" group. A diagram of this regression tree can be seen in Figure 4.1. The list of significant regressors and their sign can be seen in Table 4.12. When linear regressions containing the full range of regressors were run, all 3 groups exhibited conditional convergence, though it was only statistically significant in the high education group. Both the low democracy and the high education terminals showed a significantly positive coefficient on *ishare*. The high democracy, low education terminal showed a significantly negative coefficient on *execconst*, which may indicate that democratic nations with low levels on education must rely on a more educated leader to make smart decisions, and not constrain that leader's authority. The percentage of land in the geographic tropics was found to be significantly negative for the high democracy, low education and the high education groups, indicating that democracies have a tougher time succeeding in the tropics than nondemocracies. The rule of law was found to be statistically significant and positive for the high education group, which may suggest that a more educated society relies more heavily on well-enforced physical and intellectual property laws. The high democracy, low education terminal also found itself with a significantly positive coefficient on *regCLB* and a significantly negative coefficient on *pctprot*. While it is unclear why *pctprot* might have a negative coefficient in under-educated democratic nations, a less educated society would probably have a higher percentage of unskilled labor, so creating strict wage laws favoring unskilled workers may hurt industries who most likely already pay a high premium for less-common skilled labor.

Table 4.13: Significant Regressors and their Sign in each Terminal from the *execcomp* Regression Tree, (10% significance level)

| Terminal 1 | | Terminal 2 | | Terminal 3 | |
|---|---|---|---|---|---|
| Regressor | Sign | Regressor | Sign | Regressor | Sign |
| *ishare* | + | *initialGDP* | - | *initialGDP* | - |
| *per1* | + | *maleschooling* | + | *execconst* | - |
| | | *ishare* | + | *ruleoflaw* | + |
| | | *execopen* | + | | |
| | | *execconst* | - | | |
| | | *tropicland* | - | | |
| | | *soilquality* | + | | |
| | | *soundmoney* | - | | |
| (49 Obs.) | | (57 Obs.) | | (48 Obs.) | |

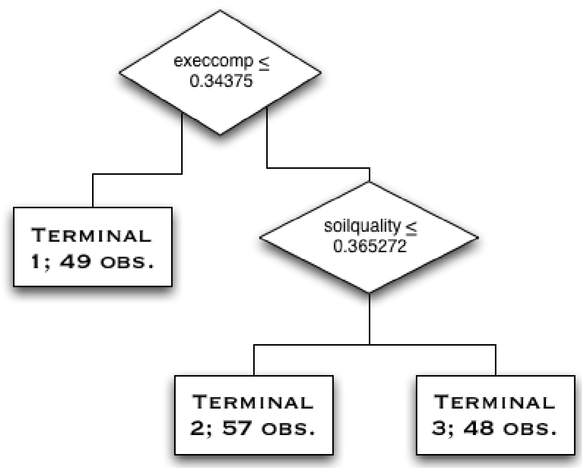


Figure 4.2: *execcomp* Regression Tree

The second regression tree made through this threshold regression method began with the decision rule at $execcomp \leq 0.34375$. The 49 observations that satisfied this rule did not have any other feasible splits, and thus became Terminal 1, the "low executive competition" group. The rest of the observations had another significant decision rule at $soilquality \leq 0.365272$. Those that satisfied this rule became Terminal 2, which resulted in 57 observations and was dubbed the "bad soil" group. The remaining 48 observations became Terminal 3, and was dubbed the "good soil" group. The diagram of this tree can be seen in Figure 4.2. The significant regressors and their sign can be seen in Table 4.13. Once again, all terminals observed conditional convergence, though it was only significant in Terminals 2 and 3. Schooling was found to be the most significant to the bad soil group, which makes sense, since those nations with bad soil would not be able to rely on agriculture as a source of jobs for an uneducated labor supply. The openness of executive recruitment was only found to be significant for the bad soil group, which may show that those nations without a significant agriculture sector constantly need new ideas from their leadership on how to effectively create economic growth, while those who do not allow new potential leaders to enter the spotlight grow more slowly. Terminals 2 and 3 both showed a significantly negative coefficient on *execconst*, which indicates that those nations with at least some semblance of competitive elections experience higher economic growth when they allow their elected leaders to make their own decisions. Another interesting result is that *soilquality* tests significantly positive for the bad soil group, which could mean that there is a level of soil suitable for agricultural activity that is optimal for economic growth and that it lies somewhere under 36.5%.

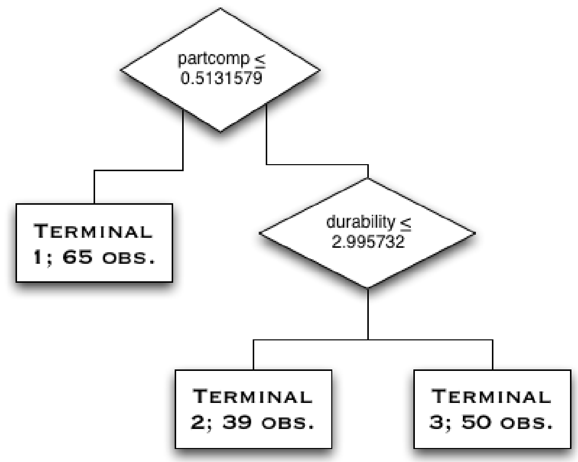


Figure 4.3: *partcomp* Regression Tree

The third regression tree began with a decision rule at $partcomp \leq 0.5131579$. There were 65 observations that satisfied this rule, but no other feasible decision rules existed for that data. Therefore, this group became Terminal 1, the "low political competition" group. A second splitting rule was found for the other observations at $durability \leq 2.995732$. The 39 observations that satisfied this rule became Terminal 2, the "new, competitive" group, while the remaining 50 observations that did not became Terminal 3, the "stable, competitive" group. The diagram of this tree can be seen in Figure 4.3. The significant regressors and their sign can be seen in Table 4.14. All three of these terminals observed significant conditional convergence. Education was found to be significant for both the low political competition group and the stable, competitive group. This could indicate that countries with low durability do not provide a stable enough environment for education to have a strong effect in the economy. However, this maybe be somewhat unlikely, given that a $durability = 3$ describes a regime that has been in power for about 20 years. However, when education is usually provided by the government, frequently changing regimes could drastically affect the quality of education. The new, competitive group was the only terminal for which *execcomp* was found to be significant. Its coefficient was positive, indicating that it is important for fairly new regimes to adopt a system of competitive elections in order to ensure heightened economic growth. Elections may help consumer confidence, stimulating economic activity in nations where there is uncertainty about the legitimacy of a new regime. The rule of law and the regulation of credit, labor and business were found to be significant for Terminal 1. This indicates that nations that outlaw seeking alternative policies or leadership should adopt strong property laws and an independent judiciary, while also limiting their restrictions on credit, labor and business. This probably plays into the hand of consumer and business confidence, since it would signal an unwillingness of the restrictive government to usurp property or profits for its own

Table 4.14: Significant Regressors and their Sign in each Terminal from the *partcomp* Regression Tree, (10% significance level)

| Terminal 1 | | Terminal 2 | | Terminal 3 | |
|---|---|---|---|---|---|
| Regressor | Sign | Regressor | Sign | Regressor | Sign |
| *initialGDP* | - | *initialGDP* | - | *initialGDP* | - |
| *maleschooling* | + | *execcomp* | + | *maleschooling* | + |
| *ishare* | + | *pctprot* | - | *freetrade* | + |
| *per1* | + | | | | |
| *ruleoflaw* | + | | | | |
| *regCLB* | + | | | | |
| *pctprot* | - | | | | |
| (65 Obs.) | | (39 Obs.) | | (50 Obs.) | |

gain. The coefficient on *freetrade* was found to be significantly positive for the stable,competitive group, which suggests that well-established regimes should encourage international trade to stimulate growth. Trade probably aids growth more in established regimes, because there is a lower risk of an established government commandeering a shipment of goods or stealing money from a deal, whereas trading with a country under a new regime would carry significant risk and uncertainty. Finally, *pctprot* was found to have a significantly negative impact on growth for Terminals 1 and 2. This might suggest that some ideals followed by Protestants are better suited for competitive, well-established regimes.

Comparing the results of the threshold methods with the interaction models, it is clear that some discrepancies exist. According to the interaction model described in Table 4.8, *execconst*, *partcomp*, *distsea*, *landsea*, *soundmoney*, *pctcath*, and *pctprot* are nonlinear in terms of *democracy*. However, the threshold regression from the *democracy* tree seen in Table 4.12 shows that *initialGDP*, *n*, *ishare*, *execconst*, *tropicland*, *ruleoflaw*, *regCLB*, and *pctprot* are nonlinear in terms of *democracy*, though it also incorporates nonlinearities in terms of education. The only true congruence exists on the nonlinearity of *execconst*, since the effect of *democracy* on the impact of *pctprot* is actually different in the two models. The similarity in terms of *execconst* helps to provide somewhat compelling evidence that imposing higher levels of constraints on executive power may less beneficial in democracies than in nondemocracies, although it does beg the question of who imposes and enforces constraints on the executive in a dictatorship. No other comparisons can be made between interaction and threshold methods, but it should be noted that the threshold method provides a mathematical method for determining splitting rules, which means there is a statistical significance behind the decision rules in the threshold models that is missing from the interaction models.

One problem with this regression tree methodology is that it requires that all nonlinearities be specified by step functions, since there is no means for a continuous interaction. Nonetheless, this may be the correct specification for these nonlinearities, since it seems fairly logical to assume that countries with elections fare differently than those without, and those that allow competition in the arena of ideas and policies will fare differently than those who shut out opposition. Perhaps this specification makes more sense than a perfectly continuous interaction. If one believes such a philosophy, then it is clear that the data suggests three possible regression trees. However, the three trees are found to be almost identical in goodness-of-fit as measured by a weighted adjusted R-squared, which means that the data does not suggest which tree is the most likely to best describe the world.

### 4.2.3 BART

Bayesian Additive Regression Trees (BART) can be used to account for multiple regression trees in the same model. BART incorporates all regressors and all possible interaction effects into its partial dependence estimates. These estimates are then plotted for different values of each individual regressor against the dependent variable, *growth*, generating a function that indicates the partial dependence of *growth* on the regressor. Taking the 90% confidence bounds into consideration, the partial dependence plots can describe robust effects of the regressors on economic growth and uncover any nonlinearities hiding in the data. While only some of the plots will be shown here, every plot can be seen in the Full Regression Results Appendix. Starting with the Solow variables, it is clear that *maleschooling* has a slight, positive effect on economic growth, indicating that human capital has a positive impact on growth. It does not exhibit any nonlinearities. The plot for initial real GDP per capita has a fairly steep and negative slope, highlighting conditional convergence, and shows evidence that it may exhibit diminishing losses as *initialGDP* rises, though it is not significantly nonlinear according to the 90% confidence bounds. The slope for *ishare* is positive to a point, and then seems to level off, indicating that there is an optimal point of $\frac{I}{Y}$, after which increasing the investment share will not necessarily enhance economic growth. However, the nonlinearity cannot be confirmed at a 10%

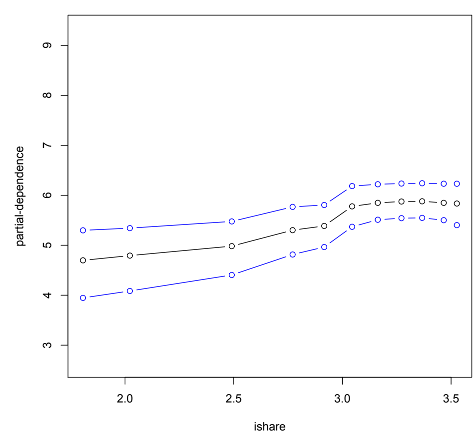


Figure 4.4: Partial Dependence of *ishare* ($x$-axis) from the BART model; *growth* on the $y$-axis

level. The plot of the partial dependence of *ishare* can be seen in Figure 4.4. The slope on $n$ is almost flat, indicating that population growth, depreciation and the growth of TFP average each other out for the most part, having almost no impact on economic growth. To no surprise, the slope of $per1$ is positive, indicating that growth was higher in period 1 than period 2 ($per1 = 0$).

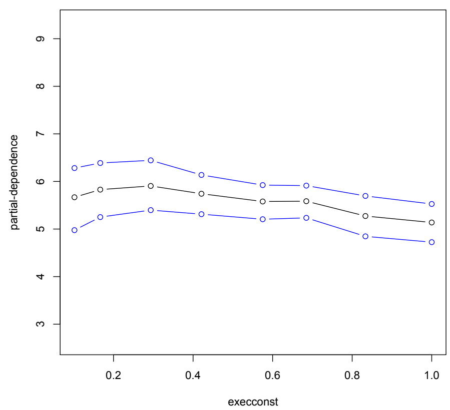


Figure 4.5: Partial Dependence of *execconst* ($x$-axis) from the BART model; *growth* on the $y$-axis

Moving onto the political institution variables, *durability* seems to have a slight negative effect until around the point where the regime is about 8 years old (*durability* $\approx$ 2.1), after which it has a slightly positive impact on growth. This would support the theory that a regime requires a few years to "settle in" before economic growth can follow. Once again, however, this nonlinearity cannot be confirmed at a 10% level. The slope on the regulation of executive recruitment appears to be slightly positive to around 0.55 and then slightly negative after, suggesting that a system where the executive is handpicked by the political elite is best suited for economic growth. This effect is not significant according to the 90% confidence bounds. The slope of *execcomp* is very slightly positive, albeit not significantly so, offering evidence that competitive elections are beneficial to economic growth. The slope of *execopen* appears to be very slightly negative until *execopen* $\approx$ 0.52, after which it is slightly positive thereafter. This effect is also not significant at the 10% level. The plot of *execconst* comes very close to expressing significant nonlinearities. It suggests a slightly positive impact on *growth* from very small values of *execconst* to about 0.2, then a stagnant to slightly negative impact to about 0.7, after which there is a strong negative impact thereafter (Figure 4.5). This suggests that nations that impose some restrictions on the power of their executive, but do not completely restrain that power have an economic advantage. The slope of *partreg* is insignificant and shows that the regulations placed on political participation have little impact on economic growth. The slope on *partcomp* appears to be negative, which would mean that, in general, allowing competing ideas to enter the political arena has a negative impact on growth.

In terms of economic policies, *govtsize* is found to have a negligible effect on economic growth. The rule of law is found to be significantly positive, and shows some evidence of a nonlinearity, since the slope is positive from 0 to around 6, slightly negative to 8, and then slightly positive to 9 and presumably on (Figure 4.6). This could indicate that there is a threshold around a score of 6 after which additional legal and judicial structure stops becoming beneficial to economic growth, although the nonlinearity is within the 90% confidence bounds, suggesting it may just be a coincidence. The slope of *soundmoney* is positive until a score of 6, and then becomes slightly negative thereafter, which may also indicate that there is a certain level after which a nation must pay a premium to maintain a sound monetary system. This nonlinearity is also not confirmed by the 90% confidence bounds. The plot of *freetrade* shows that encouraging international trade is beneficial to growth. The plot itself has a flat slope from 0 to 5, then is significantly positive to a little over 6, and then becomes fairly flat thereafter. Although this is within the 90% bounds, it could indicate that only adopting a few trade-friendly policies does not significantly alter economic growth, but there is a certain threshold that, if reached, will greatly heighten growth, though adopting more trade-friendly policies will not further heighten growth thereafter. Finally, *regCLB* is found to be generally positive to growth, without much evidence of nonlinearities.

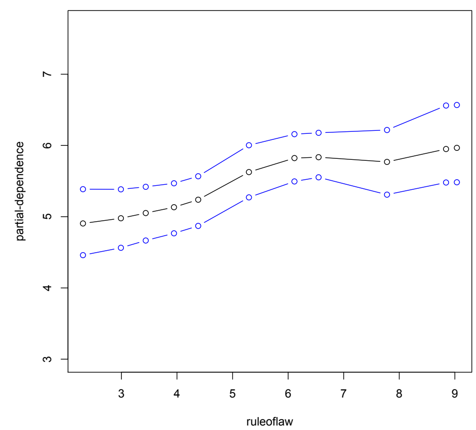


Figure 4.6: Partial Dependence of *ruleoflaw* ($x$-axis) from the BART model; *growth* on the $y$-axis

To start the geographic variables, *distsea* had an interesting plot that suggested that the mean distance to the coast or river has a negative impact on growth to about 148km (*distsea* $\approx$ 5), and then has a positive impact on growth to about 854km (*distsea* $\approx$ 6.75), and then a negative impact again afterwards (Figure 4.7). This could indicate that nations too close to water rely too heavily on it to grow at an optimal level, and those too far away cannot access its resources, such as lush river valleys, important trade routes, and natural resources such as water and fish. Although the nonlinearity is within the 90% bounds, the only linear function that can be drawn is positive in slope, which might not make sense, since it would suggest a nation grows faster the farther away from a navigable waterway it is.

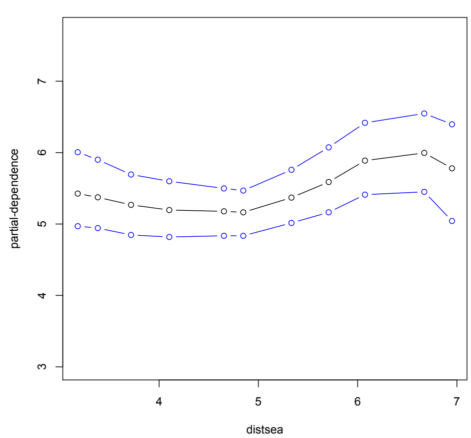


Figure 4.7: Partial Dependence of *distsea* ($x$-axis) from the BART model; *growth* on the $y$-axis

(This nonlinearity may also impact the model averaging results discussed later in this section.) The slope on *tropicland*, on the other hand is fairly linear, and significantly negative, indicating that living in the tropics is detrimental to economic growth. The slope of *landsea* is also fairly linear, but positive, indicating that nations having more land within 100km of ice-free waterways are better suited for economic growth. This is another reason why a positive relationship between *distsea* and *growth* would not make a whole lot of sense. The plot of *soilquality* begins flat to slightly increasing until about 0.2, and then declines slowly until about 0.275, then there is a sharp decline until around 0.32, after which it remains flat to somewhat decreasing, as seen in Figure 4.8. This could indicate that the aforementioned theory of an optimal level of soil suitable for agriculture under 36.5% could exist around 20%. The only line that can be drawn between the 95% confidence bounds is a distinctly negative curve, indicating that, overall, an increased amount of quality soil is a curse in disguise, perhaps because it subjects a nation to over-producing agricultural goods instead of developing more industrial endeavors.

The ethnic division variable, *ELF*, shows a plot that starts decreasing from 0 to 0.2, then stays stagnant until around 0.4, before rising to 0.6, where it begins to decrease thereafter (Figure 4.9). This plot suggests that having a completely homogeneous society is not terrible for economic growth, but having one strongly dominant ethnicity (around 80%), will hinder economic growth comparatively. However, increasing the mix of ethnicities to where there are 2 dominant and almost equally represented ethnicities in the population (between $ELF = 0.4$ and $ELF = 0.6$) seems to be the most beneficial distribution of ethnicities, after which increasing heterogeneity has a negative impact on growth. This plot is very surprising, since the near equal ethnicity mix has not historically suggested it is optimal for peaceful stability, and it is hard to imagine a war-torn society that can maintain high levels of economic growth. (The Tutsis and Hutus in Rwanda, the Serbs and Croats in the former Yugoslavia, and the Sunni and Shi'a in Iraq all come to mind.) The only line that can be drawn within the confidence bounds would indicate that increased heterogeneity improves growth, which is a somewhat curious relationship to ponder, but it could be the result of a lack of highly heterogeneous societies in the data.

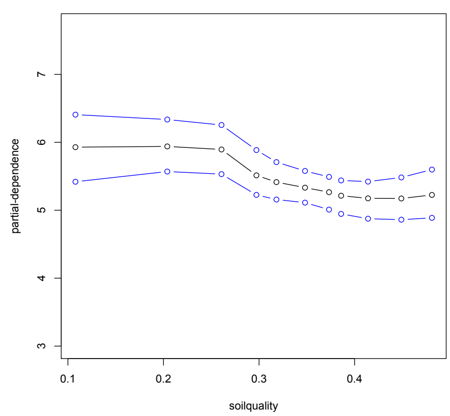


Figure 4.8: Partial Dependence of *soilquality* ($x$-axis) from the BART model; *growth* on the $y$-axis

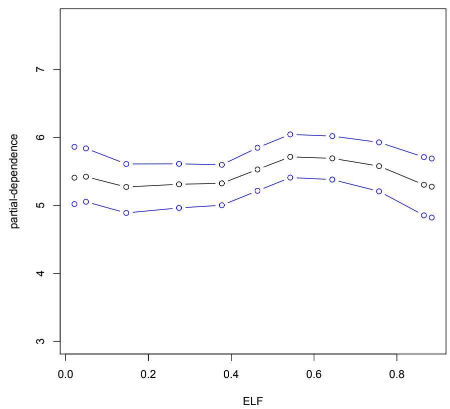


Figure 4.9: Partial Dependence of *ELF* ($x$-axis) from the BART model; *growth* on the $y$-axis

Finally, for the cultural variables, the slope of *pctcath* started negative from 0 to about 0.175, then remained mostly close to horizontal thereafter, indicating little impact on growth. The slope of *pctmuslim* was relatively flat until about 0.9, then was positive to 1.0, again indicating little impact on economic growth. Finally, the plot of *pctprot* is significantly decreasing throughout, indicating higher percentages of protestants leads to slower economic growth. There is little evidence of nonlinearities in *pctprot*, though it does appear the slope is most negative between about 0.175 and 0.25.

Despite the fact that no nonlinearities could be confirmed at the 10% level, there was still fairly convincing evidence of nonlinearities in the partial dependence plots created by the BART process. One reason that these nonlinearities could not be confirmed at a reasonable significance level is because of the high number of degrees of freedom that BART requires to produce small confidence bounds. Perhaps with more years of data and/or more countries with reliable data for many years, the confidence bounds on the partial dependence plots could be trimmed down. This would help to provide more evidence of nonlinearities. Some of the plots, featured in the Full Regression Results Appendix, appear that they would predict significant nonlinearities with just a small shrinking of the confidence bounds.

### 4.2.4 Summary of Nonlinear Analyses

Although the rest of this paper will operate under the assumption that nonlinearities do not exist in the growth data based on the findings in BART, it is important to note that these results do not necessarily invalidate the findings of the threshold regressions. While BART may provide a more robust analysis of nonlinearities, it does not create a specific regression tree by which one can make a comparison of partial effects conditional on the value of other variables. BART produces results by which one can identify individual parameter heterogeneity, while threshold regressions identify parameter heterogeneity conditional on the level of other factors. These are two very different phenomena, and thus should be considered as separate pieces of the cross-country growth regression puzzle.

## 4.3 Accounting for Model Uncertainty

To account for the model uncertainty present in the growth data, the remaining analysis of this paper will use model averaging techniques to incorporate many different possible models into one cohesive model. There will be four different models tested–two non-Bayesian methods of model averaging, and two Bayesian methods of model averaging.

### 4.3.1 Non-Bayesian Model Averaging–LSMA

Non-Bayesian methods of model averaging attempt to create a framework with an abstract method of optimization, so as not to allow prior beliefs about the data to influence the results of the model averaging exercise. Least Squares Model Averaging (LSMA) creates a framework where the Mallows Criterion is minimized in order to generate an optimal weight vector from which robust coefficients can be predicted. Minimizing the Mallows Criterion, which is an unbiased estimator of the squared error, gives a method of finding robust results without having to make inferences about prior distributions.

LSMA was run on the 25 regressors in this analysis. The results show conditional convergence at about 1.285% per year. The coefficient on $n$ is roughly equal to 0, indicating again that population growth, depreciation, and TFP growth tend to cancel out. Education is shown to have a positive impact on growth, as is the investment share of GDP, which are both expected given previous findings. The $per1$ dummy variable is found to have a positive coefficient, indicating that growth was naturally higher in the earlier period.

Regime durability is found to have a positive effect on economic growth, as is $execcomp$ and $execopen$. This would indicate that open, competitive elections and stable regimes are benficial to economic growth. The coefficients on $execreg$ and $execconst$ are negative, however, which suggests that countries grow best when they are not confined to a specific executive recruitment process (being able to choose who you want, when you want), and that they grow best when they allow their executives to lead without too many constraints. The coefficients on $partreg$ and $partcomp$ are both negative, suggesting that a lack of political competition may lead to greater growth.

The size of government was found to have almost no effect on economic growth. The other four economic policies, $ruleoflaw$, $soundmoney$, $freetrade$, and $regCLB$ were all positive, though the coefficient on $soundmoney$ was extremely small. This suggests that increasing the rule of law, placing fewer regulations on credit, labor and business, and adopting policies which encourage international trade are all ways of stimulating economic growth.

The coefficient on *distsea* was positive, but fairly close to 0. The coefficients on the other three geographic variables all had a greater magnitude, indicating they have a stronger impact on growth. The coefficient on *tropicland* indicated that countries mostly within the geographic tropics innately have more trouble generating economic growth. The coefficient on *landsea* suggests that countries with more land within 100km of sea-navigable waterway naturally have a higher rate of economic growth. Finally, the coefficient on *soilquality* reiterates the notion that having a high percentage of quality soil is a curse, making it difficult to generate economic expansion.

The ethnic dvision variable indicates that nations with a higher ethnolinguistic fractionalization rate should expect a lower base growth rate. The cultural results indicate that all three of the tested ideology groups, Catholics, Muslims, and Protestants, are, on average, detrimental to growth compared to the omitted group. The coefficient of *pctprot* was the most negative, indicating that something in the Protestant ideology may negatively affect economic growth.

One problem with the validity of the LSMA technique is that it does not allow for the statistical exclusion of irrelevant variables. While standard regression techniques deliver a t-statistic and p-value that give an idea of a regressor's importance, LSMA only returns a coefficient and claims it is robust based on the minimization of the Mallows Criterion. The Mallows Criterion is minimized through a process that incorporates each independent variable put into the analysis. While an irrelevant variable should be omitted based on receiving an extremely low corresponding weight from the weight vector, it is still hard to discern which effects are "important" or "not important." It is also hard to compare the results of LSMA with other regression techniques, since there is no use of standard errors or t-statistics like a standard model would call for.

### 4.3.2 Bayesian Model Averaging

Bayesian techniques follow in the work of $18^{th}$ century mathematician Thomas Bayes. Bayes' rule implies that

$$P(\theta \mid X) = \frac{P(X \mid \theta) * P(\theta)}{P(X)} \tag{4.5}$$

where $P(\theta \mid X)$ is defined as the posterior distribution, $P(\theta)$ is the prior distribution, reflecting prior beliefs about $\theta$, $P(X \mid \theta)$ is said to be the likelihood, and $P(X)$ is the marginal, where $\theta$ is the parameter in question and $X$ is the observed variable.

**BMA** The first Bayesian technique employed is the form of Bayesian model averaging (BMA) developed for the R programming language by Raftery (1995). First, BMA was run on the variables with a strict model filter, which means that any model with a more successful submodel was omitted from the BMA results. This ensures that only the most successful models are tested, but may disregard some of the importance of variables that appear in many probable models. When run on the growth data, the strict filter kept only 6 successful models. The posterior probabilities suggest how important each regressor is based on the probability of the parameter associated with the regressor is not equal to 0. Looking at the list of posterior probabilities suggests that the $per1$ dummy, $initialGDP$, $ishare$, $ruleoflaw$, and *pctprot* should be included in all of the models, since the probability that their parameters are not equal to 0 is 100%. Similarly, the probabilities of *tropicland* and $regCLB$ are both over 50%, indicating that they are probably important regressors to have in a growth model. Finally, the probability of *maleschooling* having a parameter equal to 0 was about 30%, and the probability that the coefficient of *soilquality* is equal to 0 was 15%. This indicates that education and soil quality may be valuable in the growth regression.

The coefficient posterior expected values of the independent variables grant a coefficient estimate based on the Bayesian process. These predictions estimate a conditional convergence of 1.47% per year, not far off from previous estimates. They also predict the signs of the rest of the high probability regressors, where $per1$, *maleschooling*, $ishare$, $ruleoflaw$, and $regCLB$ are positive, and *tropicland*, *soilquality*, and *pctprot* are negative. The best 5 models had a cumulative posterior probabliity of 0.9257 and had 6 or 7 regressors a piece, always containing those regressors with a probability of 100%, and then some linear combination of the other regressors that had probabilities above 0%. The single most successful model, with a posterior probability of 0.441, contained $per1$, $initialGDP$, $ishare$, *tropicland*, $ruleoflaw$, $regCLB$, and *pctprot*.

Table 4.15: Regressors with a Posterior Probability Greater Than 50% in the two BMA Frameworks

| Non-Strict | | Strict Framework | |
|---|---|---|---|
| Regressor | P!=0 | Regressor | P!=0 |
| *initialGDP* | 100 | *initialGDP* | 100 |
| *maleschooling* | 53.6 | *ishare* | 100 |
| *ishare* | 100 | *per1* | 100 |
| *per1* | 100 | *tropicland* | 52.5 |
| *tropicland* | 72.2 | *ruleoflaw* | 100 |
| *ruleoflaw* | 100 | *regCLB* | 54.5 |
| *regCLB* | 77.5 | *pctprot* | 100 |
| *pctprot* | 100 | | |

The second version of BMA did not use a strict model filter, so those models with more successful submodels were included, so as not to lose any successful models, regardless of their submodels. This time, BMA kept 50 models as opposed to 6 before. The resulting posterior probabilities indicated several changes. Those regressors with a probability of 100% in the first model maintained a probability of 100%. The probability of *maleschooling* rose to 53.6%, *tropicland* rose to 72.2%, $regCLB$ rose to 77.5%, and *soilquality* rose to 34.2%. Many other regressors gained probabilities above 0%, but only two others found a probability above 10%–*execopen* at 13.1% and *landsea* at 17.5%. The list of regressors with a posterior probability greater than 50% from each framwork is listed in Table 4.15. For full results, including the regressors included in each of the top 5 models for both frameworks, please see the Model Averaging section of the Full Regression Results Appendix located at the end of this paper.

The coefficient expected values confirmed all of the expected signs from the previous test, and predicted a positive coefficient on *execopen*, and a positive coefficient on *landsea*. The best 5 models had a cumulative posterior probability of 0.2989, and the best model, with a posterior probability of 0.093 was the same exact model that was the most successful model of the strict filtered BMA test. The other 4 best models tended to include a couple more variables than the strict filtered test, underlining the fact that the less strict framework allowed more effects to enter the data pool.

**BACE** The second form of Bayesian averaging is the Bayesian Averaging of Classical Estimates (BACE) approach introduced by Sala-I-Martin, et al. (2004). One nice thing about BACE is that it delivers coefficients and standard errors both unconditioned and conditioned on inclusion in the model. For those regressors that have a high posterior probability, the two estimates are extremely similar. For those with a slightly lower posterior probability, the coefficients may change significantly. For example, *pctmuslim*, which has a posterior probability of 0.064, has a coefficient over 15 times greater in magnitude when conditioned on inclusion than the unconditioned coefficient. This section will focus on the unconditional coefficient and standard error, since it will incorporate the chance that the variable does not belong in the true model, thus limiting the significance of the regressor. Those regressors with a posterior probability greater than 0.5 are listed in Table 4.16, and full results, including the coefficients conditional on inclusion, are available in the Full Regression Results Appendix.

The variables with a posterior probability greater than 0.30 included *maleschooling*, *tropicland*, *regCLB*, *pctprot*, *per*1, *ruleoflaw*, *initialGDP*, and *ishare*. Out of those variables, only *per*1, *initialGDP*, *ishare*, *ruleoflaw*, and *pctprot* were found to be statistically significant in the unconditioned models. The coefficients on *initialGDP* and *pctprot* were negative, and the rest were positive, all as expected.

Table 4.16: Regressors with a Posterior Probability Greater Than 0.5 and their Coefficient Sign in a BACE Framework

| Regressor | Post. Prob. | Sign |
|---|---|---|
| *initialGDP* | 0.9999 | - |
| *ishare* | 0.9999 | + |
| *per*1 | 0.9920 | + |
| *ruleoflaw* | 0.9973 | + |
| *pctprot* | 0.9968 | - |

Allowing for the conditional coefficients and standard deviations results in 8 additional significant regressors at the 10% level, including 3 negative effects, *tropicland*, *soilquality*, and *pctcath*, and 5 positive effects, *maleschooling*, *execopen*, *landsea*, $freetrade$, and $regCLB$. However, these significances must be taken with a grain of salt, since the posterior probabilities indicate they likely may not belong in the true model.

**WALS** The final Bayesian technique is the most recent trend, Magnus, et al.'s (2010) Weighted Average Least Squares (WALS). This method uses an orthogonalization process that allows for a much less cumbersome computation stage. WALS also allowed for the requirement that the Solow variables be kept in every model. This was held as a requirement in adherence to the past growth literature.

When run on the growth regressors, WALS reveals that all of the Solow regressors are significant at a 5% level except for $n$–the usual findings. It predicts a conditional convergence of 1.356% per year, and predicts positive coefficients for $per1$, *maleschooling*, and $ishare$. It finds that 3 political institutions have significantly positive partial effects on growth at the 10% level, including *durability*, *execcomp*, and *execopen*. It also finds that 4 political institutions have significantly negative partial effects on growth, including *execreg*, *execconst*, *partreg*, and *partcomp*. These are in line with previously identified results, and all but *durability* are significant at a 1% level. WALS also predicts that 3 economic policy variables have significantly positive partial effects on growth at the 1% level, including $ruleoflaw$, $freetrade$, and $regCLB$. In terms of geographic endowments, WALS finds that all 4 variables are statistically significant at a 5% level. Both *distsea* and *landsea* are found to have positive coefficients, while *tropicland* and *soilquality* both have negative partial effects on growth. These are in line with this paper's previous findings, as well. WALS also suggests that $ELF$ has a significantly negative impact on *growth* at the 1% level. Finally, WALS discovers 2 significant effects of cultural variables. It suggests that *pctcath*, and *pctprot* both have significantly negative impacts on economic growth at the 1% level.

### 4.3.3 Comparing Model Averaging Techniques

Each of these techniques has advantages and disadvantages, but comparing across all 4 can give a more robust idea about what really causes growth. Each model predicted conditional convergence in the range of 1.28% to 1.57% per year. They also all found postive partial effects of *maleschooling* and *ishare* on *growth*, suggesting the importance of human capital and investment to economic expansion. In general, $n$ was found to be insignificant and its coefficient slightly fluctuated around

Table 4.17: Comparison of Model Averaging Techniques in Several Key Areas

| | LSMA | BMA | BMA-Strict | BACE | WALS |
|---|---|---|---|---|---|
| Conditional Convergence | 1.285% | 1.569% | 1.472% | 1.441% | 1.356% |
| Effect of Human Capital | 0.7758 | 0.4515 | 0.2911 | 0.3126 | 0.7207 |
| Effect of I/Y | 1.281 | 1.629 | 1.745 | 1.700 | 1.211 |
| Effect of *tropicland* | -0.726 | -0.721 | -0.519 | -0.400 | -0.930 |
| Effect of *ruleoflaw* | 0.248 | 0.476 | 0.538 | 0.545 | 0.300 |
| Effect of *regCLB* | 0.245 | 0.303 | 0.227 | 0.167 | 0.313 |
| Note: Human Capital measured by average male educational attainment | | | | | |

0. Comparisons between the 5 models in several key areas can be seen in Table 4.17.

The political variables were not generally found to be significant, but a case could be made for the positive partial effect of *durability*, *execopen*, and *execcomp*, while negative effects could be argued for *execreg*, *execconst*, *partreg*, and *partcomp*. One economic policy variable that consistently tested significant for a positive impact on economic growth was *ruleoflaw*. Similarly, the coefficients of *regCLB* and *freetrade* were generally found to be significantly positive. While not found to be significant for the most part, *soundmoney* was found to have a positive partial effect on growth, while *govtsize* had a negative but insignificant impact on growth.

Geography was found to have an important role in determining economic expansion. The variables *tropicland* and *soilquality* consistently tested for significant negative partial effects on growth, while *landsea* was generally found to be significantly positive. The sign of *distsea* differed between model averaging techniques, which is odd, but may indicate that the nonlinearity suggested earlier was accounted for differently in the different model averaging techniques.

Finally, in terms of ethnic division and cultural regressors, only *pctprot* was consistently found to have a significant impact on growth. Its coefficient was always negative, but the other religious groups were also usually negative (albeit insignificant), which points to the dominance of the omitted ideology group. The coefficient on *ELF* was not generally found to be significant, but when it was, it was always negative, indicating that a higher ethnolinguistic fractionalization rate has an adverse effect on economic growth.

# 5 Case Studies - Evidence

## 5.1 Where's the Growth? - Taiwan's Economic Mystery

Chinese Taipei, commonly referred to as Taiwan, was considered one of the "Asian Tigers," four Southeast Asian nations that experienced rapid economic growth between 1960 and 1990, along with Hong Kong, Singapore, and South Korea. In period 1, Taiwan observed an average growth rate of 12.845%. Unfortunately, as is evidenced in the data, Taiwan was unable to sustain its enormous growth rate, and its average growth rate fell to 6.189% in the second period, less than half of the earlier figure. Why did Taiwan's growth rate decline so sharply? There have been many theories as to the cause of this phenomenon, but the results presented in this paper describe a story that helps to explain what happened to Taiwan's incredible growth of the mid to late 1900s.

First, note that Taiwan did not necessarily make bad policy decisions. The average years of schooling for a male aged 25 or older rose from about 7 years to close to 9 years, and the investment share of GDP rose from about 20.88% to about 22.42%. These changes were probably too miniscule to really generate a large increase in the average growth rate. Taiwan also made strides to increase economic freedom, earning increases in scores given for $soundmoney$, $freetrade$, and $regCLB$, although there was a decline in score for $ruleoflaw$ (7.885 to 6.532). Overall, the $EF$ index rose by about 0.7, indicating that Taiwan was indeed pursuing economic freedom in the second time period. According to the WALS estimates, the overall increase in economic freedom would have predicted just a 0.05% increase in average growth rate.

However, despite these beneficial policies, Taiwan's growth rate was cut in half. One of the biggest causes of this phenomenon was conditional convergence. In 1970, Taiwan's real GDP per capita was roughly US$822. After 19 years of experiencing an average 12.845% growth rate, that number had swelled to about US$9,153, over 10 times what the previous generous had experienced. According to the WALS estimates, this increase in *initialGDP* would account for a 3.267% decline in the growth rate, roughly about half of the decline Taiwan experienced. This shows that conditional convergence was likely the single biggest influence slowing Taiwan's growth. The natural shift from period 1 to period 2 yields an expected loss of 2.092% from the average growth rate, which means only a 1.297% decrease remains unaccounted for.

This remaining change can best be explained by Taiwan's democratization during the late $20^{th}$ century. In the second period, Taiwan underwent a political reformation, introducing greater democratic rights, more political freedom, and even free elections. The resulting change of the political system lowered Taiwan's *durability* by roughly 1.3, but raised its average score of *execcomp* by 0.73, which WALS predicts will have a joint effect of raising the growth rate by about 0.8%. However, democratization also raised the average scores of *execreg*, *execconst*, *partreg*, and *partcomp*, the joint effect of which would lower the growth rate by about 1.765%. Taking the 0.05% increase from economic freedom, and the 0.8% increase from *execcomp* and adding it to the unexplained loss yields a total of 2.147% yet to be explained. Subtracting the 1.765% attributed to democratization yields a mere 0.382% loss that is not explained by the WALS estimates.

Looking at Taiwan through the lens of the nonlinear framework, specifically the *democracy* tree, Taiwan's growth mystery can also be fairly well explained. In the first period, Taiwan was a member of the low democracy terminal. In the second period, Taiwan moved to the high democracy, high education terminal. In the first period, the only significant regressor for the first terminal was *ishare*, which yields an expceted growth rate of about 3.6%. In the second period, Taiwan's increased *initialGDP* has a strongly negative impact on growth that it did not have in the first period, which, when added to the constant, yields about a -7% growth rate for the period. The newly significant parameter of *tropicland* would further slow Taiwan's growth to about an expected -8.2%. However, after moving to the third terminal, the parameters of $n$ and *ruleoflaw* become significantly positive, and the parameter of *ishare* increases in value by 150%. These results counter the negative effects of *initialGDP* and *tropicland*, yielding a total expected growth rate of close to 0. Admittedly, the *democracy* tree can not accurately project the levels of growth in Taiwan in either period. However, it does predict a significant decline in economic growth between the first and second periods, suggesting that democratization may not have directly hurt the growth rate, but actually moved Taiwan into a different framework where their high level of income would become a hindrance to growth. The other two regression trees also predict a sharp decline in economic growth between the two periods, though both predict growth rates in the second period of more than a 14% *decline* in the second period. This nonlinear story helps to supplement the linear model in an effort to explain Taiwan's decline in growth rate between the two periods.

The case of Taiwan gives an example of how the forces of conditional convergence and democratization affect economic growth. It is worth noting that despite seeing half of its previous growth fade away, Taiwan was still able to produce 1.552 times the world average in the second period, a tribute to the hard work and adaptability of the Taiwanese economy and society.

## 5.2 Africa's Growth Puzzle - Why is Zambia more successful than the DRC?

The Democratic Republic of the Congo (DRC), located in central, sub-Saharan Africa, experienced a 2.333% *contraction* from 1989-2007. The reason for this contraction is almost certainly a combination of factors, but some common explanations are political instability and a bad luck of the draw in terms of geography. However, the DRC's southern neighbor, Zambia, has almost the same geographic features as the DRC and was also politically unstable, but Zambia was somehow able to generate a 4.8% average growth rate while the DRC suffered from the lowest average growth rate of any country in the analysis.

Zambia and the DRC are extremely similar in terms of geography. While the DRC has a *soilquality* of 38.44%, Zambia has only 20.64%. Both nations are completely contained in the geographic tropics, neither has over 1% of its land within 100km of a sea-navigable waterway, and the average distance to such a waterway or coastline is well above the global average for each (about 992km for Zambia and 1115km for the DRC, while the global average is about 140km).

On top of these similarities are many political parallels between the two African nations. Both nations were ruled by military dictatorships in period 1, Zambia by Kaunda's regime, and the DRC (then Zaire) by Mobutu's regime. Both were full of corruption, human rights violations, and severely limited political rights, as evidenced by the political variables of the analysis. Both saw relative democratization movements in the second period, though both are still transitional democracies, as the *democracy* score for the DRC was 0.48 in the second period, and the *democracy* score for Zambia was slightly higher at 0.64. Both nations also have similar economies. Both rely on international trade of natural resources. The DRC is a leading exporter of cobalt and coltan, while Zambia is a leading exporter of copper. While one may argue that the world price of copper rose significantly over the given period while the price of cobalt did not, coltan is needed to produce electrical capacitors used in many electronic devices, meaning it was in extremely high demand during the global dotcom boom. So why was the growth pattern so different in these two neighbors? Examining the evidence provided in the data can help shed some light on this growth puzzle.

First, looking at the *execcomp* regression tree from the threshold results, we can see that the DRC remains in Terminal 1 for both periods, while Zambia is placed in Terminal 1 for period 1, and Terminal 3 (the high *execcomp*, high *soilquality* group) for period 2. The results of the threshold regression suggest that the DRC should have observed a 3% decline in growth between the two periods, while in reality they experienced a 5% decline. The results also expect an increase of 3.5% in Zambia's growth rate between the two periods, which is almost exactly what was observed. The reason for these predictions is that in Terminal 1, only the $per1$ dummy and $ishare$ matter for growth, whereas Terminal 3 depends on $initialGDP$, $execconst$, and $ruleoflaw$, while also adding a significantly positive constant. This tree accurately depicts why Zambia was able to increase their growth, while the DRC suffered a decline in growth.

The African growth puzzle can also be analyzed with the model averaging methods. Starting with the Solow variables and using the WALS coefficient estimates, Zambia actually began period 2 with a higher initial real GDP per capita than that of the DRC (US$967.84 and US$630.07, respectively). This difference alone would have predicted the DRC to grow an average of 0.58% *faster* than Zambia. Clearly the answer to Taiwan's growth problems are not the same as that of the DRC. There are also some differences in *maleschooling* and *ishare* that directly help Zambia generate more growth. The combined effects of these variables account for a difference of approximately 1.5%.

To find the true cause of the difference, one must look at the economic policy variables. Zambia adopted more advantageous policies in each of the 5 variables. Most notably, the difference in $ruleoflaw$ (5.512 for Zambia and just 1.935 for the DRC), accounts for a full percentage point of growth. The failure of the DRC to adopt policies enforcing property laws and independent judiciaries constricted business dealings and made the DRC an extremely unattractive investment opportunity. On the other hand, Zambia made an effort to increase their rule of the law, which most likely was one of the main reasons other nations were willing to invest in Zambia's copper mining industry over the DRC's cobalt or coltan mining industries. This could be a major factor in determining the difference in growth between the two nations. Furthermore, Zambia's fewer regulations on credit, labor, and business accounted for an estimated 0.75% difference in the growth rate. This probably allowed the copper mining industries to become more lucrative for Zambia in comparison to the cobalt and coltan mining industries in the DRC. Altogether, the economic policy variables predict a difference of 2.3% in the average growth rate. This leaves roughly half of the difference to be explained by factors outside of the scope of this paper.

One factor to consider is the difference in $freetrade$. While the WALS estimate predicts only a difference of 0.345% in growth rate as a direct result of the difference in $freetrade$, the coefficient estimate from WALS is an average taken across all nations in the analysis. Since Zambia and the DRC rely so heavily on foreign buyers of their minerals, it is likely that the coefficient of $freetrade$ underestimates the importance of that measure for these two nations. An interesting future analysis could test for nonlinearities in the economic freedom measures based on relative size of different economic sectors. For example, $freetrade$ may be much more important to nations relying heavily on exports, such as Zambia and the DRC, while nations serving as financial centers, such as Singapore or Switzerland, may rely much more heavily on *soundmoney* and $regCLB$. However, in these examples, bilateral causality is likely, since a country with a surplus of a certain good or service is likely to encourage international trade more than a country with no surplus goods or services.

## 5.3 The Chilean Miracle

The South American nation of Chile began the 1970s embroiled in political tension and economic hardships. Salvador Allende, the newly elected socialist President of Chile, had worked quickly to nationalize the nation's firms, fairly distribute land claims, and set wages and prices. After the military coup d'état in 1973, General Augusto Pinochet, one of South America's most famous, not to mention feared, leaders, began his reformation of Chilean politics and the Chilean economy. Pinochet returned nationalized firms to private owners and allowed the market to dictate wages and prices. These changes are all reflected in the data. The $EF$ index for Chile in 1970 sat at 4.31. By 1975, after 3 years of Allende's policies and before the reforms of Pinochet had fully taken effect, that number had fallen to just 3.93. The two biggest problem were the $ruleoflaw$, which averaged a score of just 2.92 between 1970 and 1975, and the value of *soundmoney*, which fell from 5.98 in 1970 to 0.1 in 1975 as a result of the hyperinflation caused by Allende's failed socialist reforms.

Because of the beneficial reforms of the Pinochet dictatorship, the growth rate of Chile in period 1 averaged out to 5.61%. Note that this economic growth did not guarantee a better well-being for Chileans. Pinochet's regime, despite featuring the famed "Chicago Boys" and proving capable of steering the nation out of economic disaster, was one of the most ruthless in South American history and thrust the nation into a military dictatorship that would last almost 20 years. As a result, Chile's *democracy* score fell to 0.28 for period 1, and economic inequality was among the worst in the world despite the high growth figure. In 1990, Pinochet voluntarily stepped down from power after Chile voted to hold elections in 1989 via referendum.

This transition to democracy did not change the economic policies that Pinochet had began. In fact, the democratic state continued to pursue Pinochet's policies, albeit somewhat more democratically, and the $EF$ index for Chile rose from an average 4.995 in period 1 to 7.587 in period 2. The result was enhanced economic expansion from South America's greatest success story. From 1989-2007, Chile observed an average per year growth rate of 7.41% despite a rise in $initialGDP$, despite the natural progression from period 1 to period two, and despite the democratization that swept the nation in the early 1990s. By the WALS estimates, the economic policy reforms accounted for an increase of 1.53% to the average growth rate in period 2.

Due to the drastic changes in political institutions, Chile is placed into a different terminal in period 2 from its placement in period 2 in all three regression trees found by the threshold regressions. Both the *execcomp* tree and the *partcomp* tree predict that Chile should have observed a stark decline in growth between the two periods. Only the *democracy* tree even came close to predicting that Chile's growth in period 2 would match its growth in period 1, and even that tree predicted a slight decline. The fact that none of the trees can adequately explain Chile's growth story is most likely due to the nation's peculiar history of having a dictator with his goals set on economic freedom.

The example of Chile shows that political institutions are not the most important determinants of economic growth, and in some cases, may have no impact on growth patterns at all. In the case of Chile, Pinochet's dictatorship pursued economic growth, and the democracy that came to Chile in the 1990s continued Pincohet's policies, resulting in even greater economic growth. The example of Chile may also provide evidence of economic conditions and political preferences. It is curious that an economic downturn sparked political unrest, which led to Pinochet's dictatorship, but then once growth ensued, the people of Chile voted for democracy and greater political rights. This is a topic best suited for a separate research project.

## 5.4 Ireland–The Celtic Tiger

Ireland, on the other hand, had no such political turmoil from 1970-2007. The days of mass emigration in the past, Ireland set out to achieve sustainable growth and fix its recurrent problems of stagnation once and for all. The case of Ireland is particularly interesting to richer democracies, since Ireland, a democracy in both periods of this analysis, was able to generate an average growth rate of 7.139% in period 2, despite having a real GDP per capita of roughly US$11,992.82 in 1989. In fact, the WALS coefficient estimate of *initialGDP* would suggest that Ireland's starting point in period 2 should have decreased the growth rate by 2.135% from its average growth rate in period 1, not to mention that natural progression from period 1 to period 2 should have decreased the growth rate by about 2.092%.

However, Ireland's growth rate actually fell by less than 1%. Education increased slightly, but the investment share of GDP fell, basically canceling each other out, with a net change of +0.007%. The increase in *durability* suggests an increase of 0.03%. The cultural make up of Ireland hardly changed at all, as the country had an ethnolinguistic fractionalization rate of less than 5% in both periods. So what saved Ireland's growth from declining in the second period? The answer again lies in the economic policy variables. The WALS estimates predict that the changes to Ireland's economic policies could account for a 0.396% increase in the average growth rate. The value for *govtsize* rose, indicating that Ireland's government began to spend less as a percentage of GDP and limited its role in the economy. Despite the average coefficient estimate being negative, this was probably a significantly positive change for Ireland, as its economic crisis of the 1980s was caused by huge government debt resulting from almost a third of the workforce being public employees (Dorgan, 2006). Furthermore, a leap in scores for *soundmoney* (from 6.23 to 9.317) and $freetrade$ (from 7.585 to 8.56) probably had a bigger impact on Ireland than they would the average nation of the world, since Ireland has become somewhat of a financial center since its economic expansion of the 1990s and 2000s.

Viewed through the lens of the *execcomp* regression tree, the threshold results suggest that Ireland had an expected growth of 8.35% in the first period, and 6.25% in the second period. While the first period prediction is spot on, the second period's prediction is about a percentage point too low. Since Ireland is placed into Terminal 3, the high *execcomp*, high *soilquality* group, for both period 1 and period 2, The same set of parameters apply to both time periods. Therefore, the increased $initialGDP$ accounts for the entire loss in growth, while small increase of $ruleoflaw$ slightly helps to defray the cost of a higher level of real GDP per capita. This model is actually quite effective at explaining why Ireland was able to preserve its growth. It did not make any major changes, so the only difference came from the fact that income rose.

The case of Ireland gives another reason why further research must be done on the impact of different economic policies in different types of countries. While the model averaging models provide strong evidence suggesting that it was indeed the economic policy changes that drove Ireland's economic expansion, the threshold results suggest that Ireland's stability in terms of institutions and policy allowed the nation to maintain a high level of growth.

# 6 Conclusions

The empirical literature on cross-country growth in the past 20 years has resulted in one common conclusion– the existence of vast uncertainty in cross-country growth models. This paper has worked dilligently to address both model and parameter uncertainty. The results of this analysis help to provide a clearer picture of cross-country growth in the world.

In terms of nonlinearities, the threshold regressions revealed three significant regression trees identified by an asymptotic sample-splitting procedure. one of these trees, the *democracy* tree, directly supports the hypothesis of this paper. Only *ishare* was found to be significant for non-democracies, which might make sense, since nondemocratic leaders have no reason to rely on free markets to dictate their economic progress, but can, instead, use threat of military force to change economic behavior. The fact that the parameter on $per1$ is so strongly positive in the high democracy, low education terminal reflects how much more important education has become to growth in the past 20 years. It also makes complete sense that the regulations on the labor market would have a much stronger impact on democracies with low levels of education due to the lower levels of high-skilled workers. Finally, the parameter on $ruleoflaw$ reflects the importance of the rule of law in highly educated societies, most likely because the highly educated work force is well-versed in their legal rights and demand a high level of judicial competence to ensure those rights are protected. The threshold regression framework helps to reject the null hypothesis that democracies and nondemocracies have the same marginal benefits from adopting various political institutions and economic policies, revealing statistically significant nonlinearities between the two groups.

Following the robust findings of BART that no individual parameter heterogeneity could be confirmed at a 10% level, a linear framework was used for the model uncertainty portion of the analysis. Using model averaging techniques, several key impacts were found to be consistent across different probable models. This analysis has shown with a strong degree of confidence that conditional convergence is an active force in economic growth. Human capital in the form of education was also found to have a positive effect on economic growth. The investment share of GDP was found to have a positive effect on growth. There is most likely a level at which investment has a marginal cost greater than its marginal benefit, but no evidence of such a limit was found in the data, suggesting that no country has yet reached that level. Political institutions were generally found to not have a significant impact on growth, although LSMA, BMA, and WALS all suggested that *execopen* may have a significantly positive impact on growth. Stronger arguments can be made for several economic policy regressors, specifically $ruleoflaw$ and $regCLB$. A greater rule of law, such as creating and maintaining an independent judiciary and efficiently enforcing property laws, can help generate economic expansion. Fewer regulations on credit, labor, and business can also help stimulate growth. That being said, the recent economic recession can be seen as a warning of what completely unbridled credit markets can do. While fewer regulations may stimulate growth, a few regulations may help to *protect* that growth. In addition to these policies, *tropicland*, *soilquality*, and *pctprot* were found to have significant negative effects on growth, while *landsea* was found to have a significantly positive effect on growth. It is important to note that the negative partial effect of *pctprot* is most likely a construct of the data, indicating the success of the Eastern ideologies contained in the omitted group.

These findings help to reject the null hypothesis that economic policies have no impact on the growth of real GDP per capita. However, they can not reject the null hypothesis that political institutions have no impact on economic growth. This does not mean that democracy has no intrinsic value to a nation, as it still helps to improve a population's well-being by offering basic human rights, such as freedom, equality, and opportunity. In terms of policy relevance, this suggests that international organizations should consider giving aid to third-world countries conditional on the development of economic freedom, not conditional on the development of democracy. While democracy provides many important human rights, the case studies, especially the case of Chile, provide evidence that democratization follows economic growth, not necessarily vice-versa. If this is the true state of the world, then encouraging economic freedom will lead not only to economic growth, but also democratization and the protection of human rights.

In the future, it would be extremely beneficial to see the individual effects of the components of each of the economic policy variables. For example, it would be interesting to see the individual effect of having a minimum wage instead of only being able to view it as an entire group of regulations on credit, labor, and business. This would require a more complete data set than is currently readily available. It would also be interesting to see how much of the partial effect of $ruleoflaw$ is due solely to the enforcement of property laws. There is also a need for further analysis of the impact of economic policies on countries with different dominant sectors, as evidenced in the case studies presented in this paper. It would be enlightening to see if nonlinearities exist based on the relative size of different sectors of a nation's economy. The methods used in this paper allow cross-country growth models to offer more policy-relevant analysis than otherwise possible. While economists may never find the "true" growth model, advances in econometric modeling are sure to continue eliminating model uncertainty and extending the predictive power of growth models.

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# A Data Appendix

Table A.1: Summary of Variables in the Analysis

| VARIABLE | DESCRIPTION | SOURCE |
|---|---|---|
| *country* | Country name | Heston, Summers and Aten (2009) |
| *growth* | Per year growth rate of real GDP per capita averaged across the given time period. | Heston, Summers and Aten (2009) |
| *initialGDP* | Natural log of GDP in first year of period (1970 for period 1, 1989 for period 2). | Heston, Summers and Aten (2009) |
| $n$ | Solow variable equal to the natural log of the sum of the population growth rate, growth of TFP ($g$), and depreciation ($\delta$), averaged across the given period. (As a standard, $g + \delta = 0.05$, as suggested by Mankiw, et. al (1992). | Heston, Summers and Aten (2009) |
| *maleschooling* | Average years of schooling attained by a 25 year old or over male, averaged across the given period. | Barro and Lee (2000) |
| *ishare* | Natural log of investment share of real GDP per capita, averaged across the given period. | Heston, Summers and Aten (2009) |
| *per*1 | Dummy variable indicating the observation is from the years 1970-1988 | |
| *democracy* | Polity score reflecting the sum of the AUTOC score and DEMOC score. Scales from 0 to 1, with 1 being the most democratic, averaged across the given period. | Marshall and Jaggers (2008) |
| *durability* | Regime Durability: The number of years since the most recent regime change or the end of transition period defined by the lack of stable political institutions. | Marshall and Jaggers (2008) |
| *execreg* | Regulation of Chief Executive Recruitment: Measures the effective regulation level of executive recruitment from 0 to 1, with 1 being well-regulated and 0 being totally unregulated. | Marshall and Jaggers (2008) |
| *execcomp* | Competitiveness of Executive Recruitment: Competitiveness refers to the extent that prevailing modes of advancement give subordinates equal opportunities to become superordinates | Marshall and Jaggers (2008) |
| *execopen* | Openness of Executive Recruitment: Recruitment of the chief executive is "open" to the extent that all the politically active population has an opportunity, in principle, to attain the position through a regularized process. | Marshall and Jaggers (2008) |
| *execconst* | Executive Constraints (Decision Rules): The extent of institutionalized constraints on the decision- making powers of chief executives, whether individuals or collectivities. | Marshall and Jaggers (2008) |
| *partreg* | Regulation of Participation: Participation is regulated to the extent that there are binding rules on when, whether, and how political preferences are expressed. | Marshall and Jaggers (2008) |
| *partcomp* | The Competitiveness of Participation: The competitiveness of participation refers to the extent to which alternative preferences for policy and leadership can be pursued in the political arena. | Marshall and Jaggers (2008) |
| *govtsize* | Index measuring Size of Government: Expenditures, Taxes, and Enterprise | Gwartney, et. al (2009) |
| *ruleoflaw* | Index measuring Legal Structure and Security of Property Rights | Gwartney, et. al (2009) |

Table A.1: (continued)

| VARIABLE | DESCRIPTION | SOURCE |
|---|---|---|
| *soundmoney* | Index measuring Access to Sound Money | Gwartney, et. al (2009) |
| *freetrade* | Index measuring Freedom to Trade Internationally | Gwartney, et. al (2009) |
| *regCLB* | Index measuring Regulation of Credit, Labor, and Business | Gwartney, et. al (2009) |
| *EF* | Summary Index of Economic Freedom | Gwartney, et. al (2009) |
| *distsea* | Natural log of the mean distance to coast or river (km) | Gallup, et. al (2001) |
| *tropicland* | Percent of land in geographical tropics | Gallup, et. al (2001) |
| *landsea* | Percent of land within 100km of ice-free coast or sea-navigable river | Gallup, et. al (2001) |
| *soilquality* | Percent of soil deemed at least moderately suitable for agricultural activity | Matthews (1983) |
| *ELF* | Chance that any two randomly chosen citizens will be of a different ethnolinguistic background from each other, measured in 1961 for per1 and 1985 for per2. | Roeder (2001) |
| *pctcath* | Percentage of population that is Catholic, measured in 1980 | Barrett (1980) |
| *pctmuslim* | Percentage of the population that is Muslim, measured in 1980 | Barrett (1980) |
| *pctprot* | Percentage of the population that is Protestant, measured in 1980 | Barrett (1980) |

Table A.2: Summary Statistics

| Variable | Obs | Mean | Std. Dev | Min | Max |
|---:|---:|---:|---:|---:|---:|
| *growth* | 154 | 5.444955 | 2.642057 | -2.332646 | 13.45323 |
| *per*1 | 154 | 0.4415584 | 0.498193 | 0 | 1 |
| *initialGDP* | 154 | 7.771446 | 1.154307 | 5.163243 | 10.02178 |
| *n* | 154 | 0.1949737 | 0.1610947 | -0.007837 | 0.7347676 |
| *maleschooling* | 154 | 1.610939 | 0.5774169 | -0.6621332 | 2.501251 |
| *ishare* | 154 | 2.901792 | 0.5721208 | 0.9227847 | 3.894627 |
| *democracy* | 154 | 0.6733918 | 0.3185211 | 0.0236842 | 1 |
| *durability* | 154 | 2.736122 | 1.09206 | 0.0512933 | 5.241747 |
| *execreg* | 154 | 0.7691324 | 0.2483029 | 0 | 1 |
| *execcomp* | 154 | 0.6168948 | 0.4042031 | 0 | 1 |
| *execopen* | 154 | 0.8892351 | 0.246439 | 0 | 1 |
| *execconst* | 154 | 0.647164 | 0.33166 | 0 | 1 |
| *partreg* | 154 | 0.6493732 | 0.2811895 | 0 | 1 |
| *partcomp* | 154 | 0.5965216 | 0.3383344 | 0 | 1 |
| *distsea* | 154 | 4.941101 | 1.207644 | 2.40148 | 7.29075 |
| *tropicland* | 154 | 0.4907626 | 0.4752939 | 0 | 1 |
| *landsea* | 154 | 0.4951573 | 0.3671175 | 0 | 1 |
| *soilquality* | 154 | 0.335016 | 0.105587 | 0.052292 | 0.618373 |
| *govtsize* | 154 | 5.75159 | 1.442782 | 2.205 | 8.93 |
| *ruleoflaw* | 154 | 5.468928 | 2.163171 | 1.74 | 9.8075 |
| *soundmoney* | 154 | 7.117899 | 1.766517 | 1.413333 | 9.746 |
| *freetrade* | 154 | 6.171295 | 1.407455 | 2.61 | 8.79 |
| *regCLB* | 154 | 5.58214 | 1.147706 | 1.864 | 7.971 |
| *EF* | 154 | 6.010017 | 1.11418 | 3.1 | 8.266 |
| *ELF* | 154 | 0.4574805 | 0.2829054 | 0.003 | 0.984 |
| *pctcath* | 154 | 0.4004805 | 0.3858901 | 0 | 0.969 |
| *pctmuslim* | 154 | 0.1665 | 0.3174145 | 0 | 0.994 |
| *pctprot* | 154 | 0.1462922 | 0.228548 | 0 | 0.978 |

Table A.3: Pairwise Correlations; * indicates significance at 5% level

| | *growth* | *per1* | *initialGDP* | *n* | *maleschooling* | *ishare* | *democracy* | *durabilily* | *execreg* | *execcomp* | *execopen* | *execconst* | *partreg* | *partcomp* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *growth* | 1 | | | | | | | | | | | | | |
| *per1* | 0.6222* | 1 | | | | | | | | | | | | |
| *initialGDP* | -0.2057* | -0.4887* | 1 | | | | | | | | | | | |
| *n* | -0.4353* | -0.7026* | 0.2215* | 1 | | | | | | | | | | |
| *maleschooling* | 0.1825* | -0.1261 | 0.7339* | -0.0051 | 1 | | | | | | | | | |
| *ishare* | 0.4133* | 0.0944 | 0.5121* | -0.1438 | 0.6267* | 1 | | | | | | | | |
| *democracy* | -0.0434 | -0.2668* | 0.6717* | 0.1824* | 0.5409* | 0.4870* | 1 | | | | | | | |
| *durability* | 0.1219 | -0.0542 | 0.5442* | -0.0563 | 0.4902* | 0.3266* | 0.4541* | 1 | | | | | | |
| *execreg* | 0.0532 | -0.1977* | 0.6662* | 0.0581 | 0.5739* | 0.5430* | 0.8011* | 0.5260* | 1 | | | | | |
| *execcomp* | 0.0162 | -0.1941* | 0.6226* | 0.1085 | 0.5159* | 0.4878* | 0.9602* | 0.4598* | 0.8594* | 1 | | | | |
| *execopen* | 0.1855* | -0.0671 | 0.3328* | 0.0789 | 0.4030* | 0.3987* | 0.4602* | 0.3161* | 0.4971* | 0.4871* | 1 | | | |
| *execconst* | 0.0096 | -0.2432* | 0.6947* | 0.1416 | 0.5921* | 0.5073* | 0.9650* | 0.5313* | 0.8223* | 0.9271* | 0.5161* | 1 | | |
| *partreg* | 0.2008* | 0.2588* | 0.4035* | -0.2650* | 0.4180* | 0.2975* | 0.1992* | 0.5219* | 0.2649* | 0.2010* | 0.0758 | 0.2455* | 1 | |
| *partcomp* | -0.0185 | -0.2321* | 0.7374* | 0.1374 | 0.5992* | 0.5075* | 0.9268* | 0.4968* | 0.7832* | 0.8559* | 0.4357* | 0.8806* | 0.3938* | 1 |
| *ELF* | -0.2027* | -0.0079 | -0.4516* | 0.09 | -0.4834* | -0.5279* | -0.3173* | -0.2337* | -0.3196* | -0.2943* | -0.2921* | -0.3405* | -0.3565* | -0.4038* |
| *distsea* | -0.2224* | -0.0453 | -0.3578* | 0.1515 | -0.4148* | -0.4558* | -0.3564* | -0.1839* | -0.4221* | -0.3737* | -0.3244* | -0.3649* | -0.2267* | -0.3895* |
| *tropicland* | -0.2928* | -0.0477 | -0.5542* | 0.1432 | -0.5886* | -0.4820* | -0.2974* | -0.4262* | -0.4305* | -0.2824* | -0.1586* | -0.3839* | -0.5355* | -0.3828* |
| *landsea* | 0.2531* | 0.0514 | 0.3715* | -0.1274 | 0.4376* | 0.4520* | 0.3791* | 0.2417* | 0.4098* | 0.3932* | 0.3281* | 0.3841* | 0.2680* | 0.4129* |
| *soilquality* | -0.1118 | 0.0323 | -0.2148* | -0.0699 | -0.1329 | -0.1755* | -0.1102 | -0.2600* | -0.0465 | -0.0561 | 0.0671 | -0.119 | -0.2374* | -0.1662* |
| *govtsize* | -0.3013* | -0.3891* | -0.0101 | 0.2644* | -0.1646* | -0.1614* | 0.0411 | -0.2555* | -0.0277 | 0.0244 | -0.0328 | -0.0063 | -0.3858* | -0.021 |
| *ruleoflaw* | 0.2944* | 0.0026 | 0.6574* | -0.0785 | 0.6749* | 0.5275* | 0.5520* | 0.6825* | 0.5206* | 0.5047* | 0.3870* | 0.6054* | 0.6094* | 0.6530* |
| *soundmoney* | -0.0087 | -0.3794* | 0.6085* | 0.1618* | 0.4648* | 0.3969* | 0.4593* | 0.5146* | 0.4765* | 0.4024* | 0.2338* | 0.4870* | 0.3224* | 0.5382* |
| *freetrade* | 0.0364 | -0.4039* | 0.6642* | 0.2505* | 0.5719* | 0.4785* | 0.6127* | 0.4865* | 0.5651* | 0.5449* | 0.3145* | 0.6235* | 0.2890* | 0.6564* |
| *regCLB* | 0.1245 | -0.1890* | 0.6068* | 0.0648 | 0.5677* | 0.4159* | 0.6030* | 0.4774* | 0.5502* | 0.5624* | 0.3162* | 0.6166* | 0.2751* | 0.6064* |
| *EF* | 0.0678 | -0.3685* | 0.7331* | 0.1714* | 0.6185* | 0.4836* | 0.6454* | 0.5753* | 0.6088* | 0.5842* | 0.3582* | 0.6683* | 0.3647* | 0.7023* |
| *pctcath* | -0.1027 | 0.0189 | 0.129 | -0.0764 | 0.083 | 0.09 | 0.1655* | -0.0873 | 0.1004 | 0.1871* | 0.0725 | 0.1089 | -0.0592 | 0.1385 |
| *pctmuslim* | 0.0084 | -0.0452 | -0.2611* | 0.062 | -0.3744* | -0.2564* | -0.4230* | -0.2038* | -0.2279* | -0.4173* | -0.2578* | -0.3966* | -0.1622* | -0.3587* |
| *pctprot* | -0.1157 | 0.0329 | 0.2437* | -0.0534 | 0.2366* | 0.1021 | 0.2403* | 0.3568* | 0.141 | 0.2052* | 0.1041 | 0.2576* | 0.3198* | 0.2475* |

## Pairwise Correlations, continued

| | *ELF* | *distsea* | *tropicland* | *landsea* | *soilquality* | *govtsize* | *ruleoflaw* | *soundmoney* | *freetrade* | *regCLB* | *EF* | *pctcath* | *pctmuslim* | *pctprot* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *growth* | | | | | | | | | | | | | | |
| *per1* | | | | | | | | | | | | | | |
| *initialGDP* | | | | | | | | | | | | | | |
| *n* | | | | | | | | | | | | | | |
| *maleschooling* | | | | | | | | | | | | | | |
| *ishare* | | | | | | | | | | | | | | |
| *democracy* | | | | | | | | | | | | | | |
| *durability* | | | | | | | | | | | | | | |
| *execreg* | | | | | | | | | | | | | | |
| *execcomp* | | | | | | | | | | | | | | |
| *execopen* | | | | | | | | | | | | | | |
| *execconst* | | | | | | | | | | | | | | |
| *partreg* | | | | | | | | | | | | | | |
| *partcomp* | | | | | | | | | | | | | | |
| *ELF* | 1 | | | | | | | | | | | | | |
| *distsea* | 0.4685* | 1 | | | | | | | | | | | | |
| *tropicland* | 0.5736* | 0.1965* | 1 | | | | | | | | | | | |
| *landsea* | -0.4909* | -0.9531* | -0.2209* | 1 | | | | | | | | | | |
| *soilquality* | 0.0939 | -0.0364 | 0.2009* | -0.024 | 1 | | | | | | | | | |
| *govtsize* | 0.2322* | -0.0663 | 0.3888* | 0.0124 | 0.1867* | 1 | | | | | | | | |
| *ruleoflaw* | -0.3880* | -0.2662* | -0.6426* | 0.3264* | -0.3367* | -0.3386* | 1 | | | | | | | |
| *soundmoney* | -0.2756* | -0.2903* | -0.3361* | 0.3075* | -0.2850* | 0.0757 | 0.5253* | 1 | | | | | | |
| *freetrade* | -0.2474* | -0.3127* | -0.3593* | 0.3379* | -0.2858* | 0.0187 | 0.6356* | 0.7038* | 1 | | | | | |
| *regCLB* | -0.1845* | -0.3006* | -0.3579* | 0.3006* | -0.2577* | 0.038 | 0.6602* | 0.4940* | 0.6629* | 1 | | | | |
| *EF* | -0.2597* | -0.3437* | -0.4164* | 0.3595* | -0.2884* | 0.1760* | 0.7520* | 0.8243* | 0.8732* | 0.8066* | 1 | | | |
| *pctcath* | -0.0698 | -0.1561 | 0.1895* | 0.1537 | 0.2954* | 0.2227* | -0.1311 | 0.0389 | 0.0391 | -0.0006 | 0.0115 | 1 | | |
| *pctmuslim* | 0.1155 | 0.1939* | -0.1045 | -0.2139* | -0.0767 | -0.0054 | -0.2561* | -0.1302 | -0.2310* | -0.2625* | -0.2383* | -0.4843* | 1 | |
| *pctprot* | -0.0763 | 0.0827 | -0.136 | -0.0712 | -0.3501* | -0.3022* | 0.3941* | 0.1345 | 0.2190* | 0.3348* | 0.2425* | -0.2805* | -0.2862* | 1 |

Table A.4: Countries Included in the Analysis

| PERIOD 1: 1970-1988 | PERIOD 2: 1989-2007 |
|---|---|
| Argentina, Australia, Austria, Belgium, Botswana, Brazil, Cameroon, Canada, Central African Republic, Chile, Colombia, Democratic Republic of the Congo, Costa Rica, Cyprus, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, France, Ghana, Greece, Guatemala, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Malawi, Malaysia, Mali, Mexico, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Taiwan, Thailand, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Zambia, Zimbabwe | Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Benin, Bolivia, Botswana, Brazil, Cameroon, Canada, Central African Republic, Chile, China, Colombia, Democratic Republic of the Congo, Republic of the Congo, Costa Rica, Cyprus, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Kuwait, Malawi, Malaysia, Mali, Mexico, Mozambique, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Taiwan, Thailand, Togo, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Zambia, Zimbabwe |
| (68 observations) | (86 observations) |

Table A.5: Data Used for Taiwan Case Study

| VARIABLE | 1970-1988 | 1989-2007 |
|---|---|---|
| *country* | Taiwan | Taiwan |
| *growth* | 12.84548 | 6.188684 |
| *per*1 | 1 | 0 |
| *initialGDP* | 6.712875 | 9.121838 |
| *n* | 0.0815072 | 0.4472557 |
| *maleschooling* | 1.934235 | 2.170938 |
| *ishare* | 3.038869 | 3.109835 |
| *democracy* | 0.1684211 | 0.8578947 |
| *durability* | 3.258096 | 1.915373 |
| *execreg* | 0.5 | 0.8157895 |
| *execcomp* | 0 | 0.7368421 |
| *execopen* | 1 | 1 |
| *execconst* | 0.2894737 | 0.7456141 |
| *partreg* | 0.6973684 | 0.8815789 |
| *partcomp* | 0.0789474 | 0.9605263 |
| *ELF* | 0.274 | 0.274 |
| *distsea* | 3.300164 | 3.300164 |
| *tropicland* | 0.4370258 | 0.4370258 |
| *landsea* | 0.9986233 | 0.9986233 |
| *soilquality* | 0.193572 | 0.193572 |
| *govtsize* | 4.9575 | 6.763 |
| *ruleoflaw* | 7.885 | 6.532 |
| *soundmoney* | 8.54 | 9.644 |
| *freetrade* | 7.0375 | 7.953 |
| *regCLB* | 5.5775 | 6.328 |
| *EF* | 6.7675 | 7.442 |
| *pctcath* | 0.015 | 0.015 |
| *pctmuslim* | 0.005 | 0.005 |
| *pctprot* | 0.03 | 0.03 |

Table A.6: Data Used for DRC and Zambia Case Study

| Variable | 1970-1988 | | 1989-2007 | |
|---|---|---|---|---|
| *country* | DRC | Zambia | DRC | Zambia |
| *growth* | 3.549309 | 1.370313 | -2.332646 | 4.80044 |
| *per*1 | 1 | 1 | 0 | 0 |
| *initialGDP* | 5.912676 | 6.839238 | 6.445838 | 6.875068 |
| *n* | 0.0774324 | 0.07425 | 0.481933 | 0.5379832 |
| *maleschooling* | 0.7380011 | 1.361681 | 1.320622 | 1.719637 |
| *ishare* | 1.567529 | 2.958605 | 1.759306 | 2.77183 |
| *democracy* | 0.05 | 0.0973684 | 0.4815789 | 0.6368421 |
| *durability* | 2.564949 | 2.059507 | 1.34602 | 1.386294 |
| *execreg* | 0.5 | 0.5 | 0.5 | 0.6315789 |
| *execcomp* | 0 | 0.0526316 | 0.2 | 0.4473684 |
| *execopen* | 1 | 1 | 1 | 1 |
| *execconst* | 0 | 0.0175439 | 0.2666667 | 0.5964912 |
| *partreg* | 0.75 | 0.7236842 | 0.65 | 0.3026316 |
| *partcomp* | 0 | 0.0526316 | 0.4 | 0.4473684 |
| *ELF* | 0.902 | 0.818 | 0.902 | 0.807 |
| *distsea* | 7.016959 | 6.89992 | 7.016959 | 6.89992 |
| *tropicland* | 1 | 1 | 1 | 1 |
| *landsea* | 0.0092272 | 0 | 0.0092272 | 0 |
| *soilquality* | 0.384369 | 0.372247 | 0.384369 | 0.372247 |
| *govtsize* | 4.75 | 2.8375 | 6.877 | 6.598 |
| *ruleoflaw* | 2.415 | 5.515 | 1.935 | 5.512 |
| *soundmoney* | 3.7425 | 4.9675 | 3.584 | 6.312 |
| *freetrade* | 3.5525 | 4.926667 | 5.161 | 6.877 |
| *regCLB* | 3.2025 | 4.776667 | 3.618 | 5.94 |
| *EF* | 3.6925 | 4.513333 | 4.235 | 6.247 |
| *pctcath* | 0.484 | 0.262 | 0.484 | 0.262 |
| *pctmuslim* | 0.014 | 0.003 | 0.014 | 0.003 |
| *pctprot* | 0.29 | 0.319 | 0.29 | 0.319 |

Table A.7: Data Used for Chile Case Study

| VARIABLE | 1970-1988 | 1989-2007 |
|---|---|---|
| *country* | Chile | Chile |
| *growth* | 5.610296 | 7.409046 |
| $per1$ | 1 | 0 |
| $initialGDP$ | 7.525906 | 8.64443 |
| $n$ | 0.0648781 | 0.2648367 |
| *maleschooling* | 1.776265 | 1.97592 |
| *ishare* | 2.834767 | 3.190127 |
| *democracy* | 0.281579 | 0.9263158 |
| *durability* | 2.085999 | 2.197225 |
| *execreg* | 0.368421 | 0.7105263 |
| *execcomp* | 0.1578947 | 0.7105263 |
| *execopen* | 0.1578947 | 1 |
| *execconst* | 0.1140351 | 1 |
| *partreg* | 0.6578947 | 0.3289474 |
| *partcomp* | 0.1842105 | 0.7763158 |
| $ELF$ | 0.501 | 0.515 |
| *distsea* | 4.721183 | 4.721183 |
| *tropicland* | 0.1858728 | 0.1858728 |
| *landsea* | 0.5821023 | 0.5821023 |
| *soilquality* | 0.303885 | 0.303885 |
| *govtsize* | 4.75 | 7.163 |
| $ruleoflaw$ | 4.6275 | 6.518 |
| *soundmoney* | 3.8625 | 9.088 |
| $freetrade$ | 5.61 | 8.06 |
| $regCLB$ | 6.48 | 7.117 |
| $EF$ | 4.995 | 7.587 |
| *pctcath* | 0.821 | 0.821 |
| *pctmuslim* | 0 | 0 |
| *pctprot* | 0.019 | 0.019 |

Table A.8: Data Used for Ireland Case Study

| Variable | 1970-1988 | 1989-2007 |
|---|---|---|
| *country* | Ireland | Ireland |
| *growth* | 8.096142 | 7.139042 |
| $per1$ | 1 | 0 |
| $initialGDP$ | 7.818072 | 9.392063 |
| $n$ | 0.0802281 | 0.4297777 |
| *maleschooling* | 1.964767 | 2.144761 |
| *ishare* | 3.488591 | 3.387419 |
| *democracy* | 1 | 1 |
| *durability* | 4.060443 | 4.343805 |
| *execreg* | 1 | 1 |
| *execcomp* | 1 | 1 |
| *execopen* | 1 | 1 |
| *execconst* | 1 | 1 |
| *partreg* | 1 | 1 |
| *partcomp* | 1 | 1 |
| $ELF$ | 0.045 | 0.029 |
| *distsea* | 3.775933 | 3.775933 |
| *tropicland* | 0 | 0 |
| *landsea* | 0.9112768 | 0.9112768 |
| *soilquality* | 0.374787 | 0.374787 |
| *govtsize* | 4.3625 | 6.019 |
| $ruleoflaw$ | 8.4075 | 8.658 |
| *soundmoney* | 6.23 | 9.317 |
| $freetrade$ | 7.585 | 8.56 |
| $regCLB$ | 7.1425 | 7.041 |
| $EF$ | 6.7025 | 7.914 |
| *pctcath* | 0.953 | 0.953 |
| *pctmuslim* | 0 | 0 |
| *pctprot* | 0.011 | 0.011 |

# B Full Regression Results

## B.1 Linear Models

Table B.1: Linear Regression (OLS) Results for Individual Categories; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| Regressor | Models | | | | |
|---|---|---|---|---|---|
| *initialGDP* | -0.9795*** | -1.1856*** | -1.6160*** | -1.4855*** | -0.6934** |
| | (0.3136) | (0.4067) | (0.3338) | (0.2977) | (0.2850) |
| $n$ | 0.2932 | 0.2429 | 0.0430 | 0.2281 | 0.1446 |
| | (1.0504) | (1.0045) | (1.0404) | (1.0174) | (1.0098) |
| *maleschooling* | 1.3348*** | 1.1550** | 0.8807** | 1.0186** | 1.3361*** |
| | (0.4999) | (0.4975) | (0.4388) | (0.4447) | (0.4862) |
| *ishare* | 1.9038*** | 1.9064*** | 1.7383*** | 1.6750*** | 1.6714*** |
| | (0.3987) | (0.4354) | (0.3554) | (0.3804) | (0.3721) |
| *per1* | 2.2461*** | 2.0265*** | 1.7558*** | 1.5378*** | 2.6183*** |
| | (0.5156) | (0.5916) | (0.5738) | (0.5245) | (0.4568) |
| *durability* | | 0.3384* | | | |
| | | (0.1827) | | | |
| *execreg* | | 0.3901 | | | |
| | | (1.4357) | | | |
| *execcomp* | | -0.6193 | | | |
| | | (1.2604) | | | |
| *execopen* | | 0.8214 | | | |
| | | (0.9041) | | | |
| *execconst* | | 0.4193 | | | |
| | | (1.5767) | | | |
| *partreg* | | 0.0781 | | | |
| | | (0.8411) | | | |
| *partcomp* | | -0.0842 | | | |
| | | (1.3210) | | | |
| *govtsize* | | | 0.0194 | | |
| | | | (0.1330) | | |
| *ruleoflaw* | | | 0.3873*** | | |
| | | | (0.1236) | | |
| *soundmoney* | | | 0.1031 | | |
| | | | (0.1063) | | |
| *freetrade* | | | 0.0933 | | |
| | | | (0.1457) | | |
| *regCLB* | | | 0.1676 | | |
| | | | (0.2160) | | |
| *distsea* | | | | 0.3298 | |
| | | | | (0.3580) | |
| *tropicland* | | | | -1.5490*** | |
| | | | | (0.3700) | |
| *landsea* | | | | 2.1551* | |
| | | | | (1.1356) | |
| *soilquality* | | | | -2.4446* | |
| | | | | (1.3371) | |
| *ELF* | | | | | -0.3227 |
| | | | | | (0.5336) |
| *pctcath* | | | | | -1.3212*** |
| | | | | | (0.4869) |

Table B.1: (continued)

| Regressor | Models | | | | |
|---|---|---|---|---|---|
| *pctmuslim* | | | | | 0.0056 |
| | | | | | (0.6246) |
| *pctprot* | | | | | -2.5469*** |
| | | | | | (0.7742) |
| Constant | 4.3336** | 4.4775* | 6.2825*** | 8.6468*** | 3.6951* |
| | (1.8807) | (2.4579) | (2.2363) | (3.0914) | (2.0087) |
| Observations | 154 | 154 | 154 | 154 | 154 |
| Adj R-Squared | 0.553 | 0.554 | 0.616 | 0.610 | 0.597 |
| SER | 1.767 | 1.765 | 1.637 | 1.649 | 1.677 |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | | |

Table B.2: Linear Regression (OLS) Results with Combined Models; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| Regressor | Models | | | |
|---|---|---|---|---|
| *initialGDP* | -1.3217*** | -1.6029*** | -1.4068*** | -1.7820*** |
| | (0.3740) | (0.3713) | (0.3821) | (0.2960) |
| $n$ | 0.3686 | 0.3477 | -0.0889 | -0.0015 |
| | (0.9778) | (0.9466) | (0.9144) | (0.9708) |
| *maleschooling* | 0.7675* | 0.5439 | 0.6832 | 0.7746** |
| | (0.4482) | (0.4304) | (0.4142) | (0.3863) |
| *ishare* | 1.5450*** | 1.3204*** | 1.1755*** | 1.4568*** |
| | (0.3948) | (0.3752) | (0.3677) | (0.3278) |
| *per1* | 2.2070*** | 1.9258*** | 2.0711*** | 1.3839*** |
| | (0.6274) | (0.5890) | (0.5826) | (0.4896) |
| *durability* | -0.0548 | 0.0730 | 0.1065 | |
| | (0.1880) | (0.1974) | (0.1845) | |
| *execreg* | 0.9963 | -0.1573 | -0.6446 | |
| | (1.4647) | (1.5332) | (1.4263) | |
| *execcomp* | 0.3174 | 1.0320 | 1.3014 | |
| | (1.3013) | (1.1731) | (1.1316) | |
| *execopen* | 0.5840 | 0.9626 | 1.0046 | |
| | (0.8389) | (0.8164) | (0.7698) | |
| *execconst* | -0.6440 | -1.5193 | -1.0358 | |
| | (1.5112) | (1.3224) | (1.3192) | |
| *partreg* | -0.6369 | -1.1917 | -0.7158 | |
| | (0.8960) | (0.8844) | (0.8369) | |
| *partcomp* | -1.5114 | -0.7692 | -1.1139 | |
| | (1.3126) | (1.3550) | (1.2751) | |
| *govtsize* | 0.0299 | 0.0954 | -0.0053 | |
| | (0.1370) | (0.1203) | (0.1245) | |
| *ruleoflaw* | 0.4689*** | 0.3189** | 0.3308** | 0.4084*** |
| | (0.1412) | (0.1568) | (0.1459) | (0.1137) |
| *soundmoney* | 0.1349 | 0.1019 | 0.0712 | |
| | (0.1130) | (0.1100) | (0.1040) | |
| *freetrade* | 0.1699 | 0.1810 | 0.2028 | |
| | (0.1410) | (0.1439) | (0.1411) | |
| *regCLB* | 0.1376 | 0.2047 | 0.3261* | 0.3715** |
| | (0.1971) | (0.1782) | (0.1775) | (0.1653) |

Table B.2: (continued)

| Regressor | Models | | | |
|---|---|---|---|---|
| *distsea* | | 0.2070 | 0.1196 | |
| | | (0.3542) | (0.3682) | |
| *tropicland* | | -1.6317*** | -0.9683 | -0.9965*** |
| | | (0.4771) | (0.5867) | (0.3696) |
| *landsea* | | 1.6495 | 0.8490 | 0.6831* |
| | | (1.1300) | (1.1834) | (0.3863) |
| *soilquality* | | -1.2441 | -2.3350* | -2.5883** |
| | | (1.4704) | (1.4056) | (1.2089) |
| *ELF* | | | -0.3192 | |
| | | | (0.6474) | |
| *pctcath* | | | -0.4728 | |
| | | | (0.4387) | |
| *pctmuslim* | | | -0.0353 | |
| | | | (0.6145) | |
| *pctprot* | | | -3.0728*** | -2.8502*** |
| | | | (0.8137) | (0.6231) |
| Constant | 3.8375 | 7.0217** | 6.9559* | 10.3346*** |
| | (2.3702) | (3.3836) | (3.9352) | (2.1047) |
| Observations | 154 | 154 | 154 | 154 |
| Adj R-Squared | 0.614 | 0.653 | 0.688 | 0.697 |
| SER | 1.641 | 1.556 | 1.476 | 1.454 |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | |

## B.2 Interaction Models

Table B.3: OLS Results for Interaction Model with *democracy*; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| | Base | | Full | | Relevant | |
|---|---|---|---|---|---|---|
| Regressor | Main | **democracy* | Main | **democracy* | Main | **democracy* |
| *per1* | 1.2632 | 1.2393 | 2.8984* | -2.2739 | 1.8883*** | |
| | (1.2201) | (1.3825) | (1.4834) | (1.9207) | (0.5041) | |
| *initialGDP* | -1.0005** | -0.0152 | -1.6404** | -0.2014 | -1.3717*** | |
| | (0.5026) | (0.5569) | (0.7625) | (1.0805) | (0.3298) | |
| *n* | -5.3070 | 7.3812 | 0.7939 | -0.0384 | 1.2835 | |
| | (4.5795) | (5.1812) | (4.2281) | (5.0111) | (0.8750) | |
| *maleschooling* | 1.0247 | 0.5782 | 0.4531 | 0.8339 | 0.5042 | |
| | (0.8508) | (1.2286) | (1.0297) | (1.4217) | (0.3711) | |
| *ishare* | 2.3686*** | -0.8907 | 0.9915 | 0.8225 | 1.4414*** | |
| | (0.8590) | (1.3991) | (0.6897) | (1.2368) | (0.3318) | |
| *durability* | | | 0.1474 | -0.0554 | | |
| | | | (0.6183) | (0.7955) | | |
| *execreg* | | | -2.4092 | -5.3465 | -3.7945*** | |
| | | | (2.4649) | (4.9471) | (1.2042) | |
| *execcomp* | | | 6.6862 | 1.8260 | 6.3548*** | |
| | | | (4.3121) | (6.4859) | (1.3295) | |
| *execopen* | | | -0.4743 | 3.4958 | | |
| | | | (1.0664) | (3.1978) | | |

Table B.3: (continued)

| | Base | | Full | | Relevant | |
|---|---|---|---|---|---|---|
| Regressor | Main | *democracy | Main | *democracy | Main | *democracy |
| *execconst* | | | 7.0495 | -6.2668 | 5.2098*** | -3.8039* |
| | | | (4.9298) | (6.3037) | (1.9137) | (1.9427) |
| *partreg* | | | -1.9267 | 0.1888 | -2.1306** | |
| | | | (4.1350) | (4.1253) | (0.9345) | |
| *partcomp* | | | 1.3731 | 7.0029 | | 6.4346*** |
| | | | (3.2568) | (5.4021) | | (2.1156) |
| *distsea* | | | 1.4555* | -1.6560 | 1.6636*** | -1.7349*** |
| | | | (0.8757) | (1.0374) | (0.5099) | (0.5114) |
| *tropicland* | | | -2.9547* | 1.8502 | -1.0682** | |
| | | | (1.6580) | (1.9716) | (0.4299) | |
| *landsea* | | | 5.4931 | -6.0150 | 7.0341*** | -7.3306*** |
| | | | (3.5627) | (4.3437) | (1.7913) | (1.8759) |
| *soilquality* | | | -4.9701 | 4.7654 | | |
| | | | (5.0285) | (5.4240) | | |
| *govtsize* | | | 0.4143 | -0.6328 | | |
| | | | (0.3525) | (0.4195) | | |
| *ruleoflaw* | | | 0.2851 | -0.0221 | 0.3299*** | |
| | | | (0.3654) | (0.4816) | (0.1255) | |
| *soundmoney* | | | 0.3553 | -0.5674 | 0.3857** | -0.5776** |
| | | | (0.2541) | (0.3420) | (0.1616) | (0.2303) |
| *freetrade* | | | 0.0884 | -0.1056 | | |
| | | | (0.4171) | (0.5444) | | |
| *regCLB* | | | 0.5079 | -0.2019 | 0.4828*** | |
| | | | (0.3657) | (0.5615) | (0.1465) | |
| *ELF* | | | 1.0498 | -0.1002 | | |
| | | | (1.6894) | (2.1148) | | |
| *pctcath* | | | -2.1149 | 2.4460 | -3.5587*** | 3.8813*** |
| | | | (1.8792) | (2.1568) | (1.0185) | (1.1206) |
| *pctmuslim* | | | -1.1625 | -0.0630 | -1.2517** | |
| | | | (1.7783) | (2.3829) | (0.5204) | |
| *pctprot* | | | -6.4941** | 5.1657 | -8.6644*** | 7.2315*** |
| | | | (3.0082) | (3.3912) | (2.3431) | (2.6242) |
| Constant | 5.0370** | | 1.8214 | | -0.4100 | |
| | (2.2903) | | (4.7793) | | (3.8870) | |
| Observations | 154 | | 154 | | 154 | |
| Adj R-Squared | 0.547 | | 0.740 | | 0.761 | |
| SER | 1.779 | | 1.348 | | 1.291 | |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

Table B.4: OLS Results for Interaction Model with $EF$; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| | Base | | Full | | Relevant | |
|---|---|---|---|---|---|---|
| Regressor | Main | $*EF$ | Main | $*EF$ | Main | $*EF$ |
| $per1$ | -0.9493 | 0.5342* | 4.6755 | -0.6010 | 1.6405*** | |
| | (1.9187) | (0.2751) | (4.1345) | (0.6499) | (0.5170) | |
| $initialGDP$ | -2.0981*** | 0.1372 | -0.3841 | -0.2109 | -1.5036*** | |
| | (0.7523) | (0.1235) | (1.9870) | (0.3390) | (0.3314) | |
| $n$ | -16.4802* | 2.5934** | -6.5788 | 0.9614 | -12.3840** | 1.9081** |
| | (8.7819) | (1.2925) | (8.2425) | (1.1751) | (5.5486) | (0.8252) |
| $maleschooling$ | 3.4098* | -0.4175 | -0.2313 | 0.1767 | 0.8816** | |
| | (2.0095) | (0.3678) | (2.5813) | (0.4361) | (0.4101) | |
| $ishare$ | 2.0918 | -0.0971 | 0.1907 | 0.1644 | 1.1462*** | |
| | (1.5871) | (0.2819) | (2.6161) | (0.4616) | (0.3227) | |
| $durability$ | | | 1.3855 | -0.2037 | | |
| | | | (9.3250) | (1.5855) | | |
| $execcomp$ | | | 0.9271 | -0.0074 | | |
| | | | (7.5573) | (1.3109) | | |
| $execopen$ | | | -3.6807 | 0.8973 | | 0.2603** |
| | | | (5.3894) | (0.9545) | | (0.1238) |
| $execconst$ | | | -1.2531 | -0.1217 | | |
| | | | (10.4140) | (1.7404) | | |
| $partreg$ | | | -2.3481 | 0.5233 | | |
| | | | (5.0536) | (0.7896) | | |
| $partcomp$ | | | 14.2668 | -2.4636 | 11.8840*** | -2.1467*** |
| | | | (8.7056) | (1.5259) | (3.9360) | (0.6427) |
| $distsea$ | | | -2.0242 | 0.4106* | | |
| | | | (1.6461) | (0.2420) | | |
| $tropicland$ | | | -2.7097 | 0.2647 | -1.0256** | |
| | | | (3.4013) | (0.5411) | (0.4334) | |
| $landsea$ | | | -7.1950 | 1.4117* | | |
| | | | (5.0580) | (0.7768) | | |
| $soilquality$ | | | -21.7450* | 2.9827* | -20.7018*** | 2.7917*** |
| | | | (11.3097) | (1.6843) | (6.6581) | (0.9742) |
| $govtsize$ | | | -1.6194* | 0.1714 | -0.3973*** | |
| | | | (0.8910) | (0.1221) | (0.1274) | |
| $ruleoflaw$ | | | -1.4042 | 0.2176 | | |
| | | | (0.9591) | (0.1423) | | |
| $soundmoney$ | | | -0.0543 | -0.1042 | | -0.0501** |
| | | | (0.8264) | (0.1134) | | (0.0215) |
| $freetrade$ | | | -2.9958* | 0.3990* | -1.9761*** | 0.2895*** |
| | | | (1.6824) | (0.2313) | (0.6876) | (0.1031) |
| $regCLB$ | | | 1.4609 | -0.3517* | | |
| | | | (1.1991) | (0.1834) | | |
| $ELF$ | | | -2.5906 | 0.4570 | | |
| | | | (4.7051) | (0.7603) | | |
| $pctcath$ | | | 2.7886 | -0.4475 | | |
| | | | (4.1294) | (0.6241) | | |
| $pctmuslim$ | | | 0.3370 | -0.1161 | | |
| | | | (4.5664) | (0.7372) | | |
| $pctprot$ | | | -7.9664 | 0.9414 | -8.4515** | 0.9335* |
| | | | (5.0017) | (0.7372) | (3.5127) | (0.5241) |

Table B.4: (continued)

| | Base | | Full | | Relevant | |
|---|---|---|---|---|---|---|
| Regressor | Main | $*EF$ | Main | $*EF$ | Main | $*EF$ |
| Constant | 8.7869*** | | 27.7611* | | 19.3801*** | |
| | (2.1336) | | (14.5472) | | (3.2097) | |
| Observations | 154 | | 154 | | 154 | |
| Adj R-Squared | 0.612 | | 0.722 | | 0.741 | |
| SER | 1.647 | | 1.392 | | 1.344 | |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

Table B.5: OLS Results for Interaction Model with *initialGDP*; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| | Base | | Full | | Relevant | |
|---|---|---|---|---|---|---|
| Regressor | Main | $*initialGDP$ | Main | $*initialGDP$ | Main | $*initialGDP$ |
| $per1$ | 6.6938 | -0.6117 | 16.9018*** | -2.0326*** | 20.3334*** | -2.4300*** |
| | (5.5667) | (0.7005) | (5.5035) | (0.7025) | (3.3507) | (0.4231) |
| $initialGDP$ | 1.3972 | -0.1094 | -2.7773 | 0.1469 | 1.4264* | |
| | (4.1264) | (0.2817) | (6.1120) | (0.3668) | (0.7914) | |
| $n$ | -8.3455 | 1.0804 | -7.7968 | 1.0890 | 1.0150 | |
| | (8.6193) | (0.9852) | (6.6043) | (0.7604) | (0.8310) | |
| $maleschooling$ | -2.8696 | 0.6006* | -2.2515 | 0.4126 | 1.0318*** | |
| | (2.5313) | (0.3412) | (2.5108) | (0.3335) | (0.3099) | |
| $ishare$ | 6.0712** | -0.5878* | -5.2133 | 0.8221* | -3.9168* | 0.6402** |
| | (2.6334) | (0.3491) | (3.2334) | (0.4254) | (2.2384) | (0.2936) |
| $durability$ | | | -0.3646 | 0.0480 | | |
| | | | (1.2672) | (0.1627) | | |
| $execreg$ | | | -0.5377 | -0.0291 | | |
| | | | (9.3099) | (1.2543) | | |
| $execcomp$ | | | -6.5109 | 1.1917 | | 0.2759** |
| | | | (8.0003) | (1.0769) | | (0.1196) |
| $execopen$ | | | 1.6650 | -0.1288 | | |
| | | | (5.7693) | (0.8341) | | |
| $execconst$ | | | -1.5769 | -0.0952 | -2.2125* | |
| | | | (11.6845) | (1.5378) | (1.1602) | |
| $partreg$ | | | 0.4570 | 0.1133 | | |
| | | | (5.7706) | (0.7152) | | |
| $partcomp$ | | | 21.8055* | -2.9456* | 11.4307** | -1.5284** |
| | | | (12.0611) | (1.6704) | (5.7212) | (0.7473) |
| $distsea$ | | | -0.5364 | 0.0762 | | |
| | | | (2.6146) | (0.2954) | | |
| $tropicland$ | | | -8.6399** | 0.9232** | -7.0239*** | 0.7354** |
| | | | (3.7673) | (0.4574) | (2.2538) | (0.2815) |
| $landsea$ | | | -0.5398 | 0.1054 | | |
| | | | (8.1012) | (0.9338) | | |
| $soilquality$ | | | -3.2583 | 0.2201 | -2.5682** | |
| | | | (11.2929) | (1.3289) | (1.0843) | |
| $govtsize$ | | | 1.0297 | -0.1342 | 1.0651* | -0.1316* |
| | | | (0.8622) | (0.1062) | (0.6261) | (0.0716) |
| $ruleoflaw$ | | | 1.8679 | -0.1859 | 1.9979*** | -0.1859** |
| | | | (1.1666) | (0.1512) | (0.6436) | (0.0841) |

Table B.5: (continued)

| | Base | | Full | | Relevant | |
|---|---|---|---|---|---|---|
| Regressor | Main | *initialGDP | Main | *initialGDP | Main | *initialGDP |
| *soundmoney* | | | 2.3030** | -0.2773** | 2.2438*** | -0.2686*** |
| | | | (0.9763) | (0.1284) | (0.7778) | (0.1015) |
| *freetrade* | | | 0.2194 | -0.0136 | | |
| | | | (1.5035) | (0.2023) | | |
| *regCLB* | | | 0.9966 | -0.0899 | 0.3044** | |
| | | | (1.4416) | (0.1948) | (0.1323) | |
| *ELF* | | | -5.2222 | 0.6823 | | |
| | | | (5.2710) | (0.6652) | | |
| *pctcath* | | | -1.5563 | 0.1789 | | |
| | | | (4.5310) | (0.5544) | | |
| *pctmuslim* | | | -6.0517 | 0.7372 | | |
| | | | (5.2348) | (0.7037) | | |
| *pctprot* | | | -7.3017 | 0.7261 | -1.2006** | |
| | | | (5.0168) | (0.5727) | (0.5324) | |
| Constant | -7.0945 | | 8.0022 | | -14.9182** | |
| | (16.2724) | | (30.1983) | | (5.7785) | |
| Observations | 154 | | 154 | | 154 | |
| Adj R-Squared | 0.578 | | 0.761 | | 0.783 | |
| SER | 1.717 | | 1.292 | | 1.232 | |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | | | |

Table B.6: OLS Results for Interaction Model with all 3 interactions; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| Regressor | Main | *democracy | *EF | *initialGDP |
|---|---|---|---|---|
| *per1* | 21.9277*** | 9.1142*** | | -3.7114*** |
| | (3.3635) | (1.5249) | | (0.5009) |
| *initialGDP* | 9.6438*** | -4.6213*** | | -0.6345*** |
| | (3.4376) | (1.3473) | | (0.2163) |
| *n* | -7.1755 | -14.6738*** | 3.0115*** | |
| | (5.2324) | (4.4920) | (1.0268) | |
| *maleschooling* | -6.6627*** | 1.9705* | | 0.7371** |
| | (2.0029) | (1.1444) | | (0.3248) |
| *ishare* | -5.0102*** | -3.3818*** | | 1.1378*** |
| | (1.7613) | (0.8828) | | (0.2839) |
| *durability* | | | | |
| | | | | |
| *execreg* | 17.7626*** | -12.0600*** | | -1.8081* |
| | (6.6546) | (3.3343) | | (0.9780) |
| *execcomp* | | 15.4046*** | -6.2727*** | 4.5508*** |
| | | (4.3557) | (0.9743) | (0.6833) |
| *execopen* | | 4.9861** | 3.1048*** | -2.6444*** |
| | | (2.3140) | (0.4752) | (0.3943) |
| *execconst* | -25.5910*** | -14.6042*** | | 4.9117*** |
| | (9.0236) | (4.8807) | | (1.5157) |
| *partreg* | -8.0333*** | | 1.2337*** | |
| | (2.9394) | | (0.4471) | |
| *partcomp* | 5.2382*** | | | |
| | (1.1328) | | | |

Table B.6: (continued)

| Regressor | Main | $*democracy$ | $*EF$ | $*initialGDP$ |
|---|---|---|---|---|
| *distsea* | -1.1190* | -2.4299*** | | 0.3772*** |
| | (0.6408) | (0.8165) | | (0.1173) |
| *tropicland* | -13.9371*** | | | 1.4910*** |
| | (2.5883) | | | (0.3231) |
| *landsea* | | -14.4153*** | | 1.5083*** |
| | | (2.9405) | | (0.3035) |
| *soilquality* | | | 3.3747*** | -2.5578*** |
| | | | (1.0637) | (0.8446) |
| *govtsize* | | 2.2708*** | | -0.2690*** |
| | | (0.4849) | | (0.0433) |
| *ruleoflaw* | | 1.0749*** | | -0.0987*** |
| | | (0.3442) | | (0.0286) |
| *soundmoney* | | 1.8907*** | | -0.2382*** |
| | | (0.3638) | | (0.0352) |
| *freetrade* | | 2.7872*** | | -0.3350*** |
| | | (0.5543) | | (0.0440) |
| *regCLB* | | | 0.3288** | -0.2862** |
| | | | (0.1312) | (0.1191) |
| *ELF* | | | 1.5250*** | -1.1031*** |
| | | | (0.4853) | (0.3820) |
| *pctcath* | | | -1.3787*** | 1.1256*** |
| | | | (0.3383) | (0.2765) |
| *pctmuslim* | -6.3602* | | -0.8373* | 1.3182*** |
| | (3.2235) | | (0.4533) | (0.4589) |
| *pctprot* | | 6.5964** | -2.9580*** | 1.5767** |
| | | (2.8659) | (0.8104) | (0.7074) |
| Constant | -7.1241 | | | |
| | (15.0256) | | | |
| Observations | 154 | | | |
| Adj R-Squared | 0.899 | | | |
| SER | 0.841 | | | |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | |

## B.3 Threshold Models

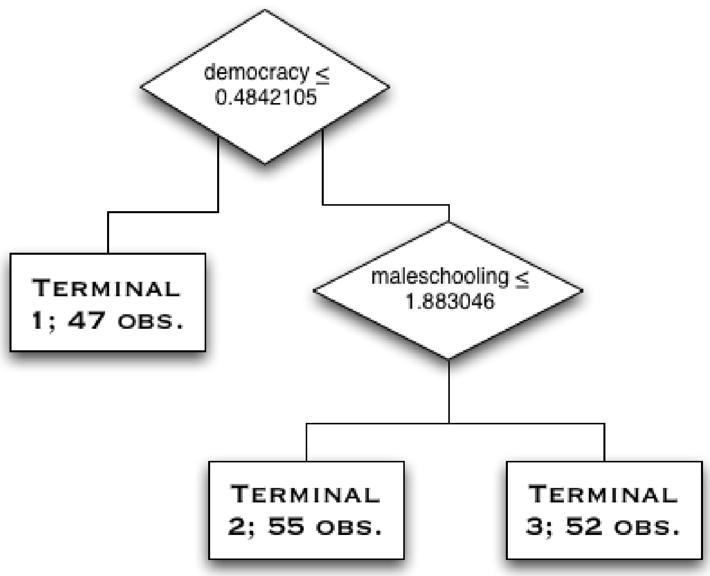



Figure B.1: *democracy* Regression Tree

Table B.7: Threshold Regression Results for *democracy* Tree; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| Regressor | Terminal 1 | Terminal 2 | Terminal 3 |
|---|---|---|---|
| *per*1 | 2.2105 | 3.0631*** | -2.1093 |
| | (2.9778) | (0.6479) | (1.8713) |
| *initialGDP* | -1.9042 | -0.4897 | -4.3734*** |
| | (1.9194) | (0.5129) | (1.2785) |
| *n* | 2.6906 | -1.9861 | 2.2624* |
| | (3.8227) | (1.5782) | (1.1374) |
| *maleschooling* | 0.0657 | -0.0001 | 0.3527 |
| | (1.7022) | (0.7734) | (1.5053) |
| *ishare* | 1.1984* | 0.9045 | 2.5590** |
| | (0.6736) | (0.6882) | (1.0228) |
| *durability* | -0.1859 | 0.3293 | 0.4621 |
| | (0.7258) | (0.3015) | (0.4755) |
| *execreg* | 1.0470 | -0.6904 | 21.3571 |
| | (3.2906) | (2.5560) | (18.0668) |
| *execcomp* | 3.2224 | 0.5802 | -26.3259 |
| | (4.1975) | (2.1362) | (15.7664) |
| *execopen* | 0.4850 | 1.4987 | 1.9727 |
| | (1.1399) | (1.3945) | (6.5618) |
| *execconst* | 1.4775 | -4.4303** | -2.2882 |
| | (6.3592) | (1.7135) | (2.6533) |
| *partreg* | 3.1010 | -1.6529 | -1.1779 |
| | (6.0105) | (1.2467) | (1.9544) |
| *partcomp* | -2.0169 | 2.5164 | 7.8011 |
| | (4.7078) | (1.6341) | (5.1915) |

Table B.7: (continued)

| Regressor | Terminal 1 | Terminal 2 | Terminal 3 |
|---|---|---|---|
| *distsea* | 0.1079 | 0.7262 | 0.2010 |
| | (2.3021) | (0.6592) | (0.3563) |
| *tropicland* | -1.6403 | -1.3946* | -2.8586** |
| | (3.0146) | (0.7434) | (1.0726) |
| *landsea* | 0.4881 | 2.5156 | -0.6366 |
| | (6.8696) | (1.8440) | (1.4174) |
| *soilquality* | -7.2140 | 3.5369 | 2.4217 |
| | (6.8719) | (4.1698) | (1.4596) |
| *govtsize* | 0.0845 | -0.1465 | -0.1307 |
| | (0.3608) | (0.2119) | (0.1937) |
| *ruleoflaw* | 0.5243 | 0.1941 | 0.4048* |
| | (0.3594) | (0.2492) | (0.2210) |
| *soundmoney* | 0.3299 | -0.2735 | 0.1939 |
| | (0.4533) | (0.1841) | (0.2167) |
| *freetrade* | 0.0348 | 0.4336 | 0.0236 |
| | (0.4038) | (0.2661) | (0.4865) |
| *regCLB* | 0.4498 | 0.6460** | -0.2501 |
| | (0.3676) | (0.3023) | (0.3811) |
| *ELF* | -1.0933 | 1.5163 | 0.5421 |
| | (2.0588) | (1.1891) | (1.4069) |
| *pctcath* | -1.0599 | -1.0304 | 0.0596 |
| | (3.8368) | (0.6773) | (0.7908) |
| *pctmuslim* | -1.1233 | -1.2296 | 4.5159 |
| | (2.2549) | (0.9963) | (3.5384) |
| *pctprot* | -4.6018 | -4.0491*** | 0.5629 |
| | (5.6867) | (1.4270) | (1.0852) |
| Constant | 8.6123 | -3.0503 | 29.0442** |
| | (31.1077) | (6.7257) | (11.1985) |
| Observations | 47 | 55 | 52 |
| Adj. R-Squared | 0.624 | 0.802 | 0.796 |
| SER | 2.063 | 1.145 | 0.840 |
| *** p<0.01, ** p<0.05, * p<0.1 | | | |

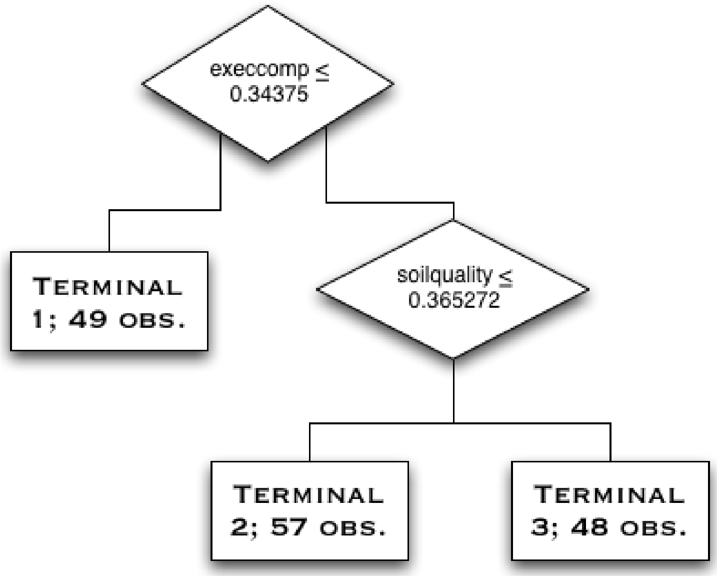



Figure B.2: *execcomp* Regression Tree

Table B.8: Threshold Regression Results for *execcomp* Tree; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

| Regressor | Terminal 1 | Terminal 2 | Terminal 3 |
|---|---|---|---|
| *per*1 | 3.1229* | -0.4707 | 0.8720 |
| | (1.6453) | (1.4812) | (1.0788) |
| *initialGDP* | -1.5726 | -2.6136** | -1.4244** |
| | (1.0018) | (0.9944) | (0.5207) |
| *n* | 1.8646 | 1.0707 | -2.9167 |
| | (3.8922) | (1.3573) | (2.0169) |
| *maleschooling* | 0.9605 | 2.6827** | 1.2013 |
| | (1.1243) | (1.0219) | (0.8785) |
| *ishare* | 1.0012* | 1.6178** | 0.1264 |
| | (0.5759) | (0.6430) | (0.6705) |
| *durability* | 0.0097 | -0.5228 | 0.1015 |
| | (0.5998) | (0.5103) | (0.2961) |
| *execreg* | -2.8557 | -3.6537 | 5.1723 |
| | (3.0067) | (2.4964) | (5.4487) |
| *execcomp* | -3.9627 | 2.5045 | -0.2406 |
| | (6.3609) | (2.5199) | (3.2813) |
| *execopen* | 1.0634 | 9.4062*** | 1.2343 |
| | (1.0525) | (3.2623) | (2.2183) |
| *execconst* | 4.8119 | -6.6982** | -3.4952** |
| | (5.5202) | (3.1066) | (1.3725) |
| *partreg* | -0.0759 | 2.0491 | 0.5632 |
| | (6.0259) | (1.3653) | (0.8525) |
| *partcomp* | -3.1543 | 2.3279 | 1.6948 |
| | (4.3049) | (1.4680) | (2.1391) |
| *distsea* | -0.5366 | 0.2583 | -0.7725 |
| | (1.9553) | (0.4356) | (0.9763) |

Table B.8: (continued)

| Regressor | Terminal 1 | Terminal 2 | Terminal 3 |
|---|---|---|---|
| *tropicland* | -3.7037 | -2.7107*** | -0.1276 |
| | (2.9409) | (0.7909) | (1.1095) |
| *landsea* | -1.3280 | -1.4468 | -3.2365 |
| | (6.3221) | (1.5988) | (3.1858) |
| *soilquality* | -8.9581 | 5.7403** | -8.0178 |
| | (6.3040) | (2.8098) | (5.3802) |
| *govtsize* | 0.3323 | -0.1390 | 0.1719 |
| | (0.4013) | (0.2141) | (0.1312) |
| *ruleoflaw* | 0.0176 | 0.1746 | 0.5483* |
| | (0.4883) | (0.2490) | (0.2708) |
| *soundmoney* | 0.2717 | -0.5674** | -0.0625 |
| | (0.3730) | (0.2602) | (0.1224) |
| *freetrade* | 0.2907 | 0.6851 | -0.0680 |
| | (0.4200) | (0.4948) | (0.2839) |
| *regCLB* | 0.4072 | 0.4586 | -0.3824 |
| | (0.4104) | (0.3702) | (0.2932) |
| *ELF* | 1.9656 | 0.4340 | -0.6593 |
| | (2.7884) | (1.2082) | (1.3408) |
| *pctcath* | -2.0932 | -0.2223 | 0.2312 |
| | (2.7617) | (0.6372) | (0.7268) |
| *pctmuslim* | -1.6734 | -0.6753 | -0.2350 |
| | (2.0106) | (1.2133) | (1.1963) |
| *pctprot* | -2.5828 | -1.4143 | -2.8215 |
| | (3.5367) | (0.9890) | (1.8423) |
| Constant | 12.8902 | 9.2796 | 18.3732* |
| | (21.8509) | (7.8872) | (9.0281) |
| Observations | 49 | 57 | 48 |
| Adj. R-Squared | 0.706 | 0.773 | 0.746 |
| SER | 1.844 | 1.177 | 0.943 |
| *** p<0.01, ** p<0.05, * p<0.1 | | | |

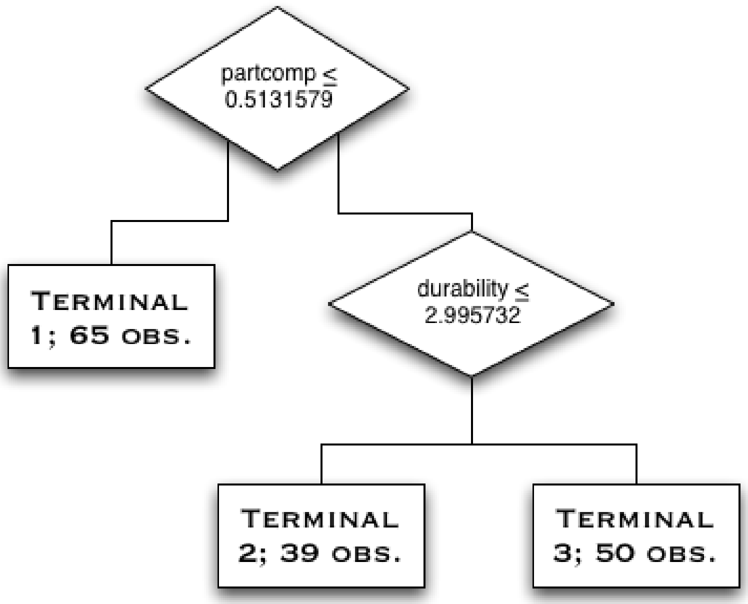



Figure B.3: *partcomp* Regression Tree

Table B.9: Threshold Regression Results for *partcomp* Tree; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita; Robust standard errors in parantheses

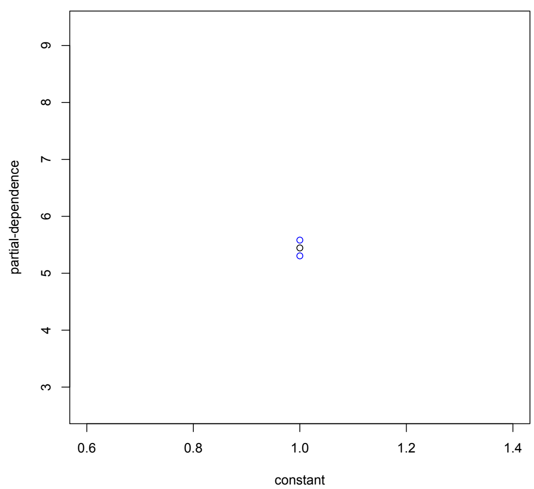
| Regressor | Terminal 1 | Terminal 2 | Terminal 3 |
|---|---|---|---|
| *per*1 | 2.5679** | 0.7569 | 0.0696 |
| | (1.1714) | (2.2480) | (1.5870) |
| *initialGDP* | -1.5947* | -2.1517* | -2.6505** |
| | (0.8631) | (1.0004) | (1.1127) |
| *n* | 0.1888 | -5.0241 | 1.5886 |
| | (2.0930) | (4.6658) | (0.9845) |
| *maleschooling* | 1.2911* | 2.1299 | 3.7114*** |
| | (0.6810) | (1.3359) | (1.2532) |
| *ishare* | 1.2903** | 0.4094 | -0.0394 |
| | (0.4850) | (1.8671) | (1.2664) |
| *durability* | 0.0225 | 0.0458 | -0.4555 |
| | (0.3678) | (0.8562) | (0.5182) |
| *execreg* | 0.1969 | -5.8947 | -0.8591 |
| | (1.5572) | (4.1841) | (1.8491) |
| *execcomp* | -0.3028 | 6.3995* | 0.0000 |
| | (1.5296) | (3.4865) | (0.0000) |
| *execopen* | 0.1655 | 4.5518 | 0.0000 |
| | (0.9411) | (2.7195) | (0.0000) |
| *execconst* | 0.5806 | -5.6136 | -2.1409 |
| | (2.5739) | (4.4832) | (4.1643) |
| *partreg* | 0.5356 | -1.9427 | 0.2835 |
| | (1.9676) | (2.5819) | (1.1227) |
| *partcomp* | -1.4626 | 2.6074 | 3.3367 |
| | (2.0582) | (4.1370) | (4.6154) |

Table B.9: (continued)

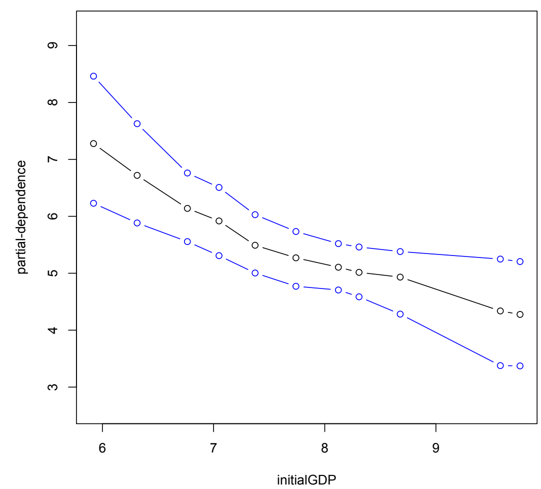
| REGRESSOR | TERMINAL 1 | TERMINAL 2 | TERMINAL 3 |
|---|---|---|---|
| *distsea* | 0.7296 | 0.1498 | 0.3854 |
| | (1.1094) | (1.7772) | (0.3045) |
| *tropicland* | -0.6493 | -2.0002 | -0.5627 |
| | (1.0232) | (1.2181) | (1.0008) |
| *landsea* | 2.0079 | -0.1814 | 0.1619 |
| | (3.2066) | (5.5443) | (1.0544) |
| *soilquality* | -5.2077 | -3.6167 | 1.7123 |
| | (3.2731) | (5.0075) | (1.3819) |
| *govtsize* | 0.2354 | -0.2305 | 0.1892 |
| | (0.2044) | (0.5714) | (0.1611) |
| *ruleoflaw* | 0.6272** | 0.3603 | 0.0698 |
| | (0.2422) | (0.9576) | (0.2366) |
| *soundmoney* | 0.1905 | -0.1005 | -0.1681 |
| | (0.1864) | (0.3234) | (0.1710) |
| *freetrade* | -0.0597 | 0.7041 | 0.4000* |
| | (0.1842) | (0.7746) | (0.2188) |
| *regCLB* | 0.4778* | 0.2585 | -0.2187 |
| | (0.2493) | (0.8233) | (0.3513) |
| *ELF* | -0.3019 | 1.6463 | -1.4477 |
| | (1.0308) | (3.3708) | (0.8605) |
| *pctcath* | -0.4634 | -1.2284 | 0.7966 |
| | (1.5905) | (1.2500) | (0.6517) |
| *pctmuslim* | 0.5034 | -1.9301 | -0.2602 |
| | (1.3085) | (1.5639) | (7.2727) |
| *pctprot* | -4.4229** | -7.4123* | 0.0405 |
| | (2.1295) | (3.8986) | (0.8525) |
| Constant | 0.6438 | 14.2052 | 18.8896** |
| | (11.1442) | (13.0414) | (8.2208) |
| Observations | 65 | 39 | 50 |
| Adj. R-Squared | 0.737 | 0.680 | 0.812 |
| SER | 1.631 | 1.435 | 0.800 |
| *** p<0.01, ** p<0.05, * p<0.1 | | | |

## B.4 BART Plots

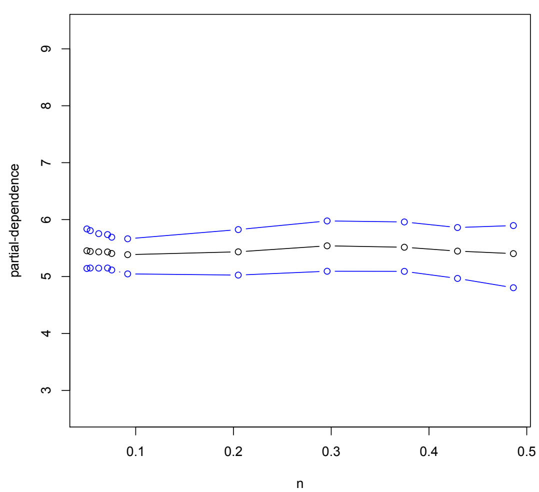
Table B.10: BART partial dependence plots; *growth* on the $y$-axis, independent variable on $x$-axis



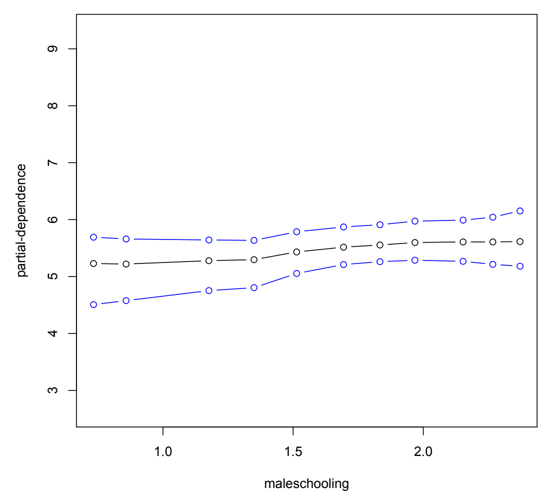

Constant




*initialGDP*

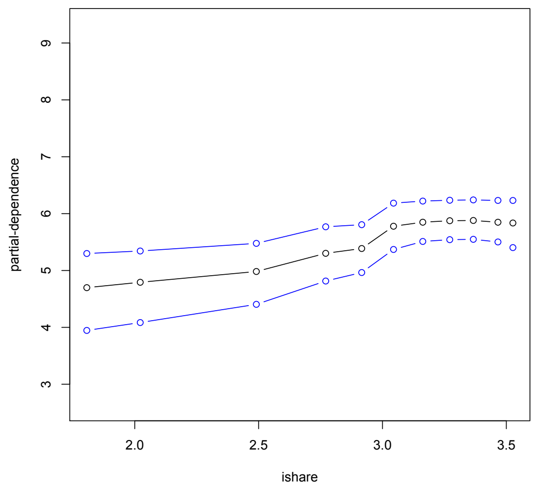



$n$

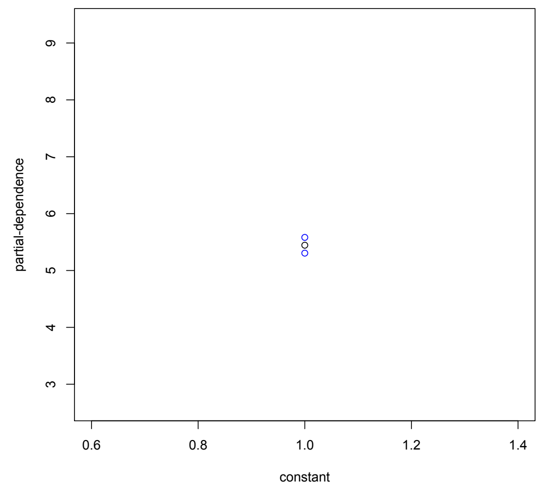



*maleschooling*

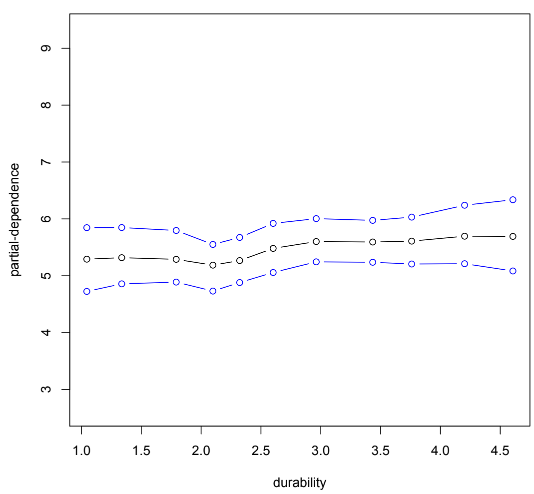
Table B.10: (continued)



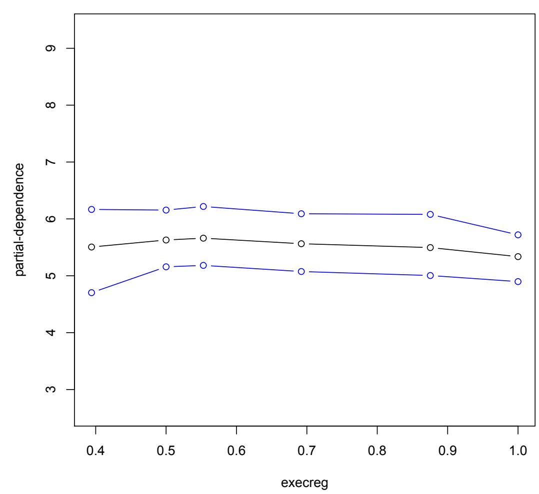

*ishare*




*per1*




*durability*




*execreg*

Table B.10: (continued)

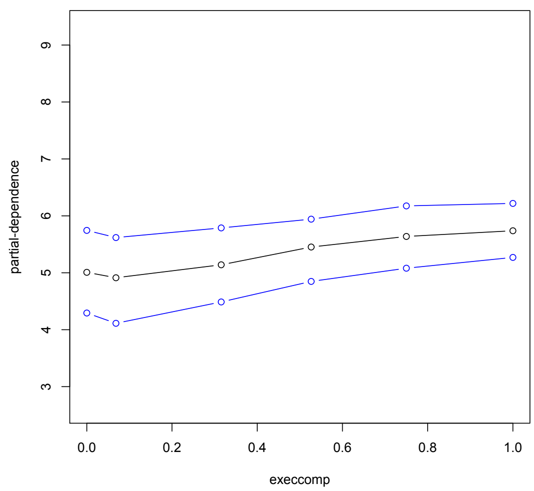
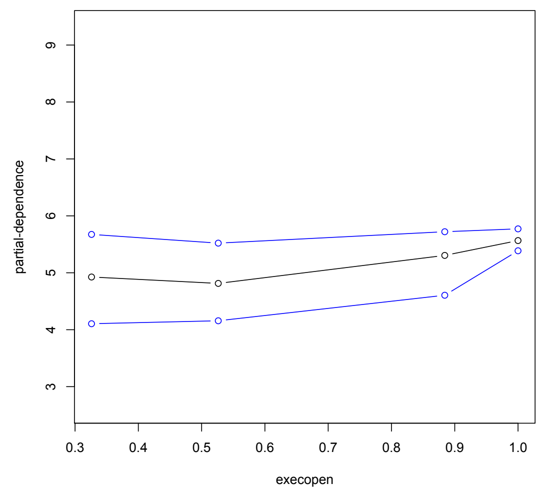
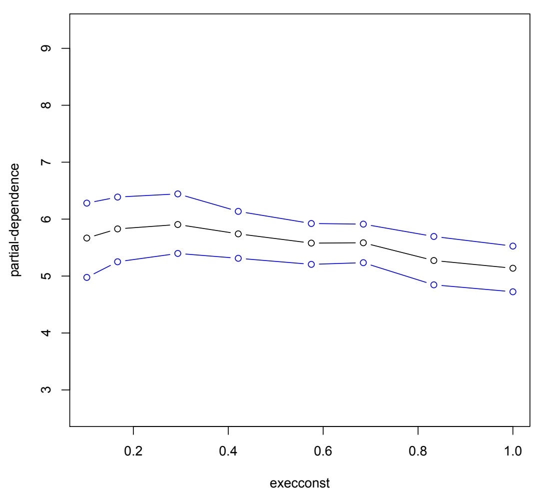
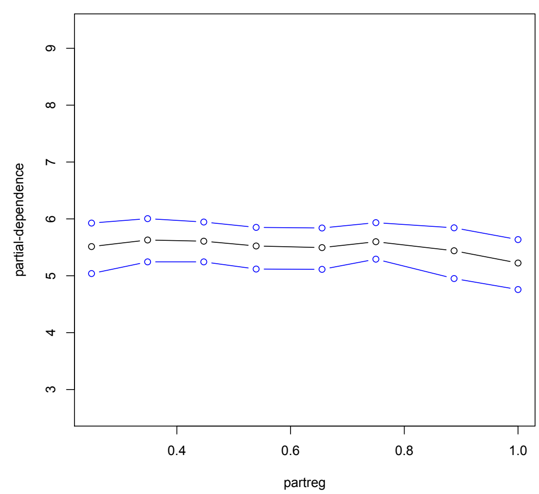
| | |
|---|---|
|  *execcomp* |  *execopen* |
|  *execconst* |  *partreg* |

Table B.10: (continued)

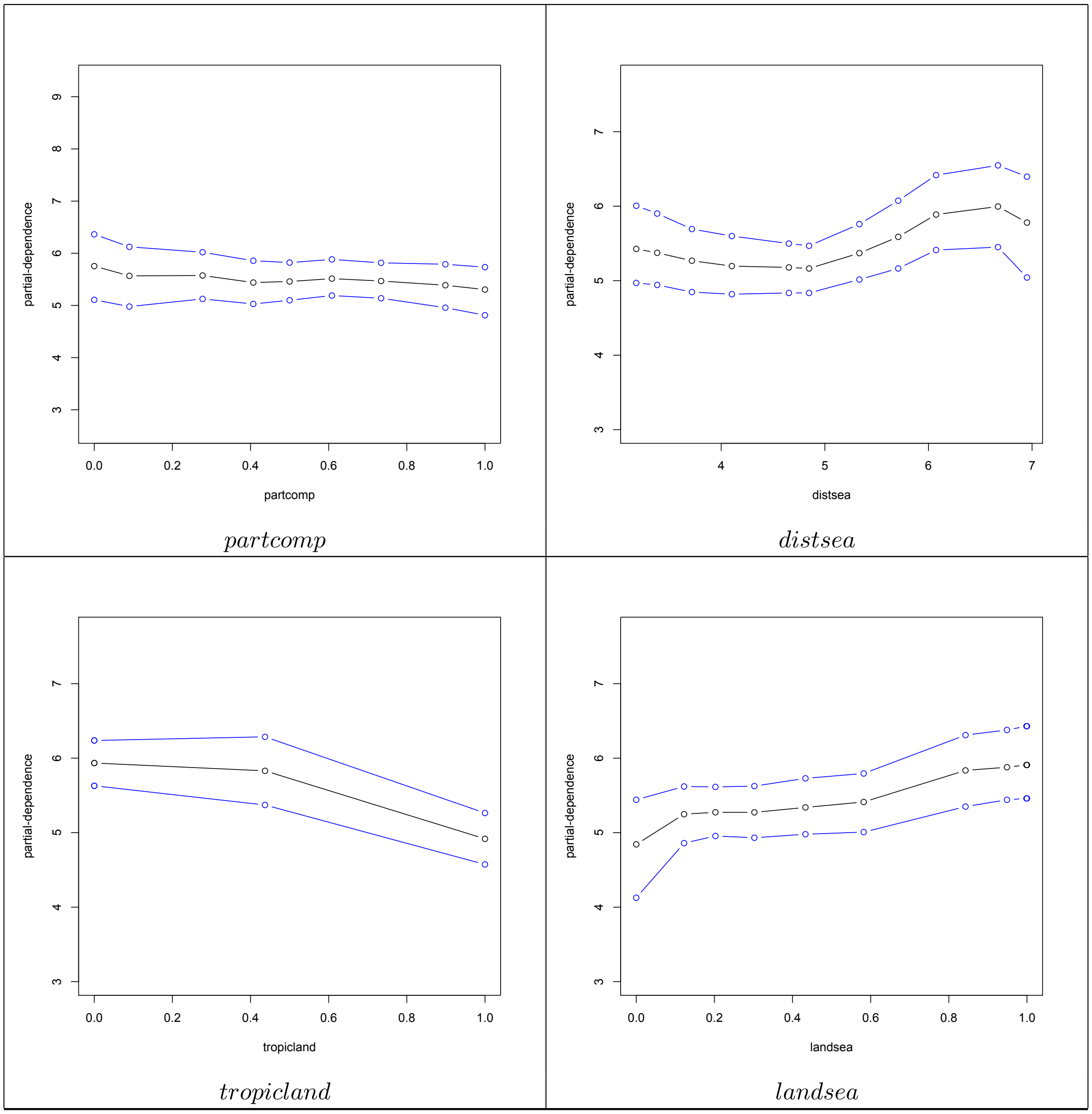
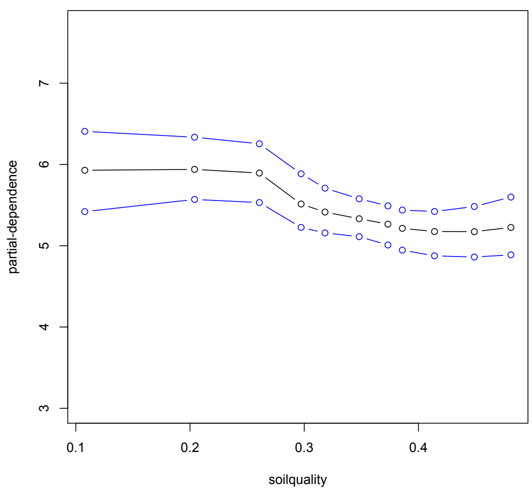
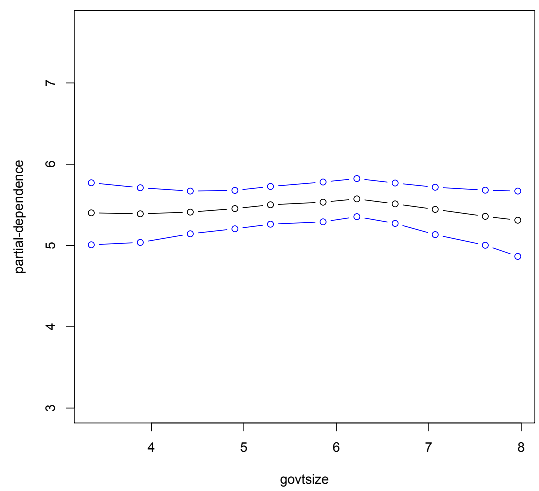


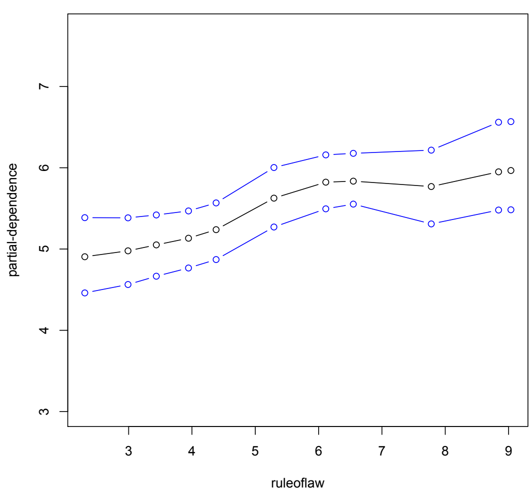
Table B.10: (continued)



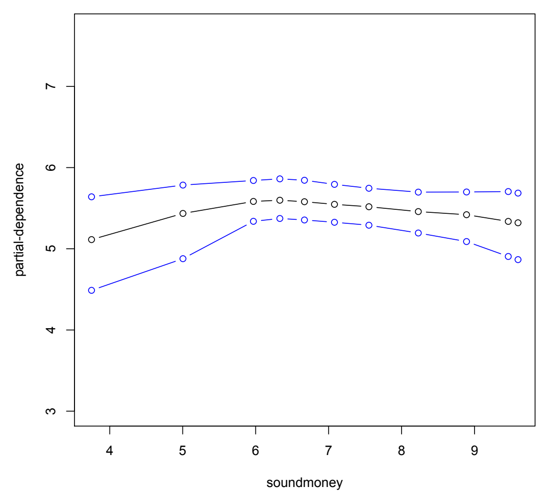

*soilquality*




*govtsize*




*ruleoflaw*




*soundmoney*

Table B.10: (continued)

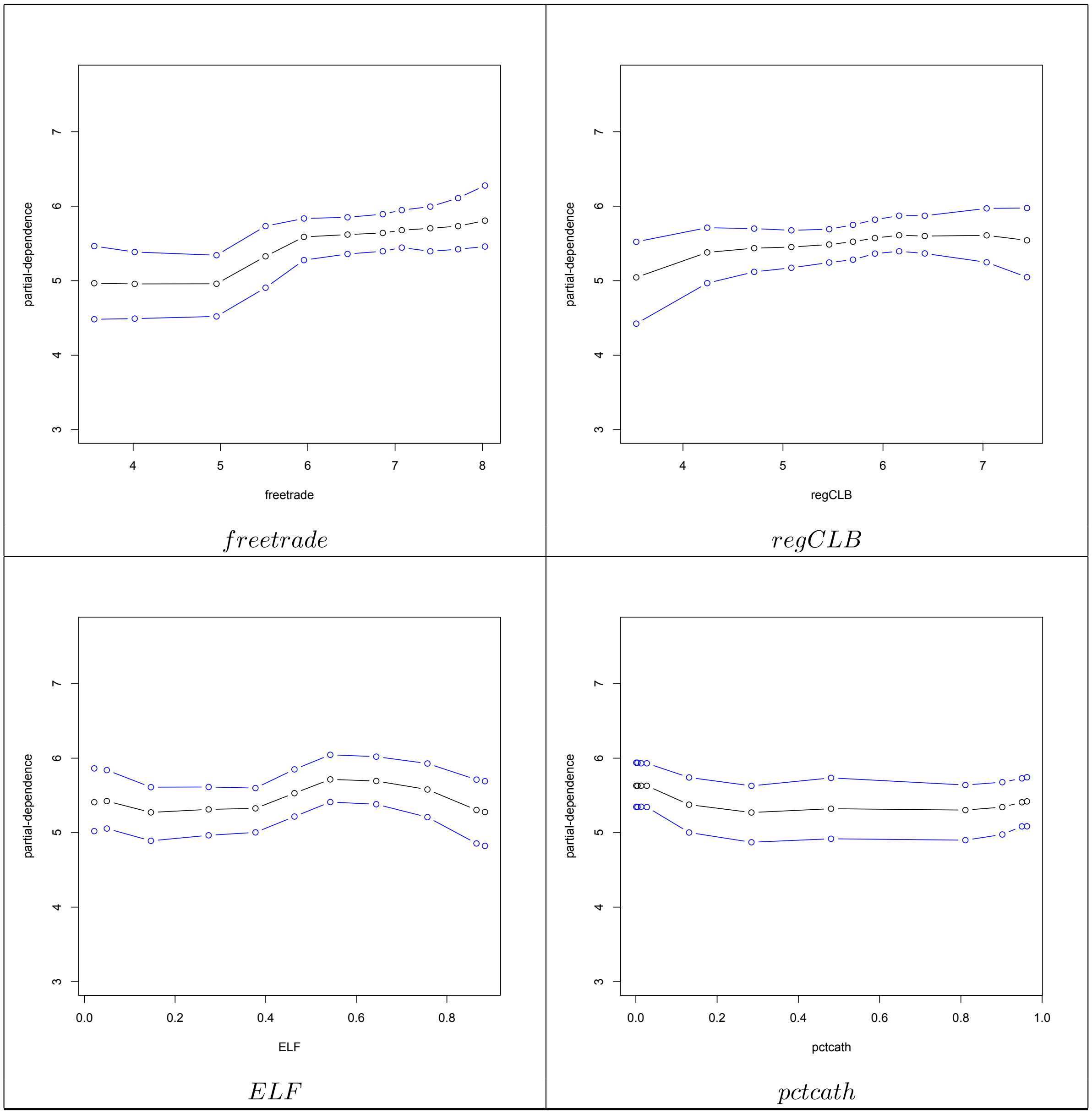
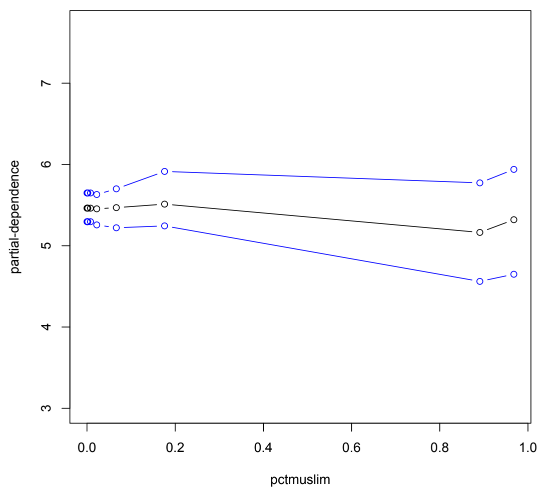
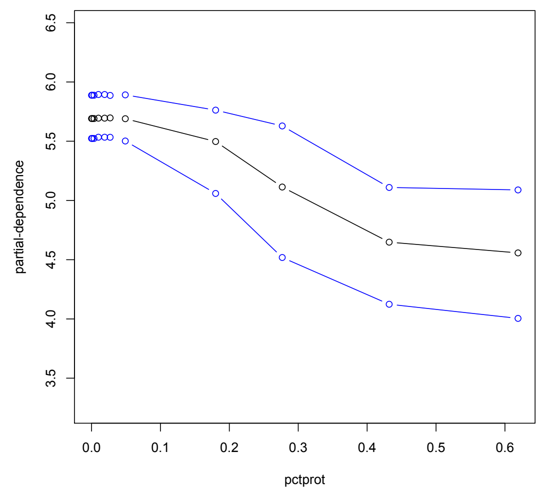


Table B.10: (continued)




*pctmuslim*




*pctprot*

## B.5 Model Averaging Models

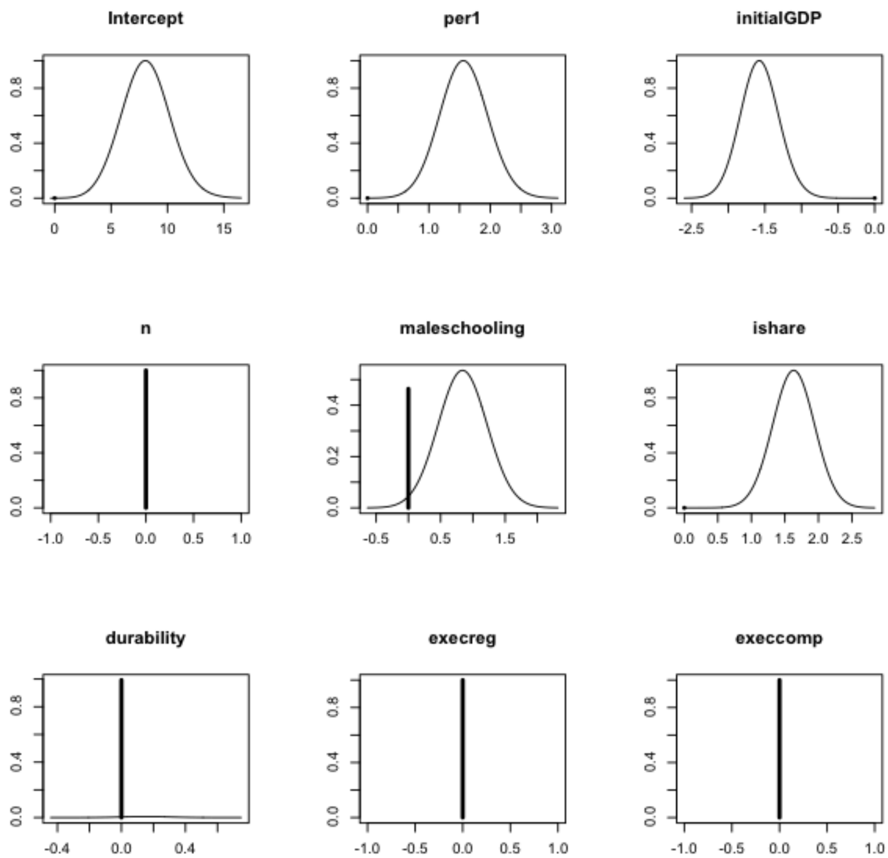
Table B.11: Least Squares Model Averaging (LSMA) Results; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita

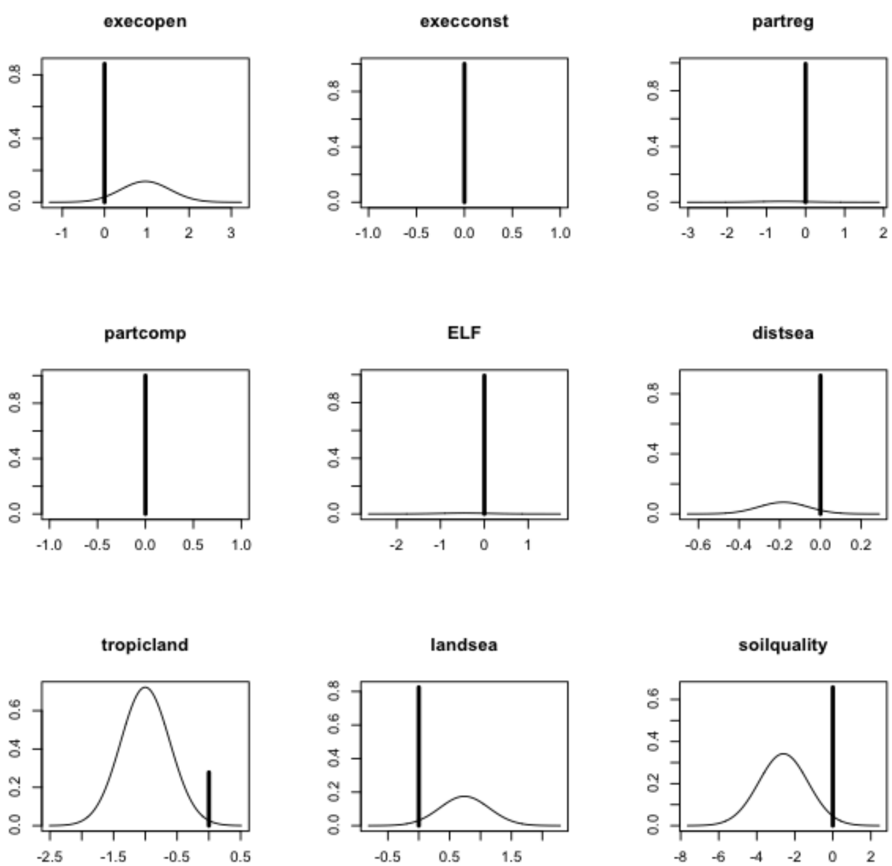
| Regressor | Coeff. |
|---|---|
| Constant | 6.391096 |
| $per1$ | 2.1166899 |
| $initialGDP$ | -1.2851562 |
| $n$ | 0.000978634 |
| $maleschooling$ | 0.77580311 |
| $ishare$ | 1.2809817 |
| $durability$ | 0.12704655 |
| $execreg$ | -0.48361101 |
| $execcomp$ | 0.97641018 |
| $execopen$ | 0.75367132 |
| $execconst$ | -0.777119 |
| $partreg$ | -0.53702902 |
| $partcomp$ | -0.83571959 |
| $distsea$ | 0.089761524 |
| $tropicland$ | -0.72648772 |
| $landsea$ | 0.63700484 |
| $soilquality$ | -1.7518629 |
| $govtsize$ | -0.003967096 |
| $ruleoflaw$ | 0.24817336 |
| $soundmoney$ | 0.053428416 |
| $freetrade$ | 0.15215929 |
| $regCLB$ | 0.24465368 |
| $ELF$ | -0.23951683 |
| $pctcath$ | -0.35471644 |
| $pctmuslim$ | -0.026518785 |
| $pctprot$ | -2.3054122 |

Table B.12: Bayesian Model Averaging (BMA) Results and Best 5 Models in the Non-Strict Framework; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita

| Regressor | p!=0 | Coeff. | Std. Err. | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|---|---|---|
| Constant | 100 | 8.092154 | 2.17095 | 7.4245 | 8.3879 | 8.5559 | 9.4432 | 8.5209 |
| *per*1 | 100 | 1.571368 | 0.3938 | 1.5571 | 1.4734 | 1.3868 | 1.5239 | 1.6301 |
| *initialGDP* | 100 | -1.568579 | 0.2651 | -1.527 | -1.7032 | -1.6457 | -1.6984 | -1.5124 |
| *n* | 0 | 0 | 0 | . | . | . | . | . |
| *maleschooling* | 53.6 | 0.451467 | 0.50382 | . | 0.7333 | . | 0.8613 | 1.0472 |
| *ishare* | 100 | 1.629021 | 0.31128 | 1.7706 | 1.6047 | 1.653 | 1.5412 | 1.5854 |
| *durability* | 0.7 | 0.001046 | 0.01785 | . | . | . | . | . |
| *execreg* | 0 | 0 | 0 | . | . | . | . | . |
| *execcomp* | 0 | 0 | 0 | . | . | . | . | . |
| *execopen* | 13.1 | 0.12685 | 0.38892 | . | . | . | . | . |
| *execconst* | 0 | 0 | 0 | . | . | . | . | . |
| *partreg* | 0.6 | -0.003496 | 0.06645 | . | . | . | . | . |
| *partcomp* | 0 | 0 | 0 | . | . | . | . | . |
| *distsea* | 7.8 | -0.014249 | 0.05951 | . | . | . | . | . |
| *tropicland* | 72.2 | -0.720767 | 0.55536 | -1.0172 | -0.9241 | -1.1428 | -0.8751 | . |
| *landsea* | 17.5 | 0.129094 | 0.32637 | . | . | 0.7748 | . | . |
| *soilquality* | 34.2 | -0.890192 | 1.44824 | . | . | . | -2.5676 | -2.8495 |
| *govtsize* | 0 | 0 | 0 | . | . | . | . | . |
| *ruleoflaw* | 100 | 0.476229 | 0.12205 | 0.4685 | 0.4462 | 0.4605 | 0.4131 | 0.5654 |
| *soundmoney* | 0 | 0 | 0 | . | . | . | . | . |
| *freetrade* | 6.3 | 0.013319 | 0.06393 | . | . | . | . | . |
| *regCLB* | 77.5 | 0.302861 | 0.2119 | 0.4311 | 0.3989 | 0.4104 | 0.3861 | . |
| *ELF* | 0.6 | -0.00258 | 0.0544 | . | . | . | . | . |
| *pctcath* | 8 | -0.052734 | 0.20986 | . | . | . | . | . |
| *pctmuslim* | 3.1 | 0.025135 | 0.15902 | . | . | . | . | . |
| *pctprot* | 100 | -2.866874 | 0.6544 | -2.783 | -2.7925 | -2.4769 | -3.1186 | -3.195 |
| nVar | | | | 7 | 8 | 8 | 9 | 7 |
| $R^2$ | | | | 0.696 | 0.705 | 0.704 | 0.713 | 0.692 |
| Post. Prob. | | | | 0.093 | 0.067 | 0.057 | 0.049 | 0.032 |

Figure B.4: BMA Estimate Plots for the Non-Strict Framework

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-1 0 1 2 3
execconst
0.0 0.4 0.8
-1.0 -0.5 0.0 0.5 1.0
partreg
0.0 0.4 0.8
-3 -2 -1 0 1 2
partcomp
0.0 0.4 0.8
-1.0 -0.5 0.0 0.5 1.0
ELF
0.0 0.4 0.8
-2 -1 0 1
distsea
0.0 0.4 0.8
-0.6 -0.4 -0.2 0.0 0.2
tropicland
0.0 0.2 0.4 0.6
-2.5 -1.5 -0.5 0.5
landsea
0.0 0.2 0.4 0.6 0.8
-0.5 0.5 1.5
soilquality
0.0 0.2 0.4 0.6
-8 -6 -4 -2 0 2

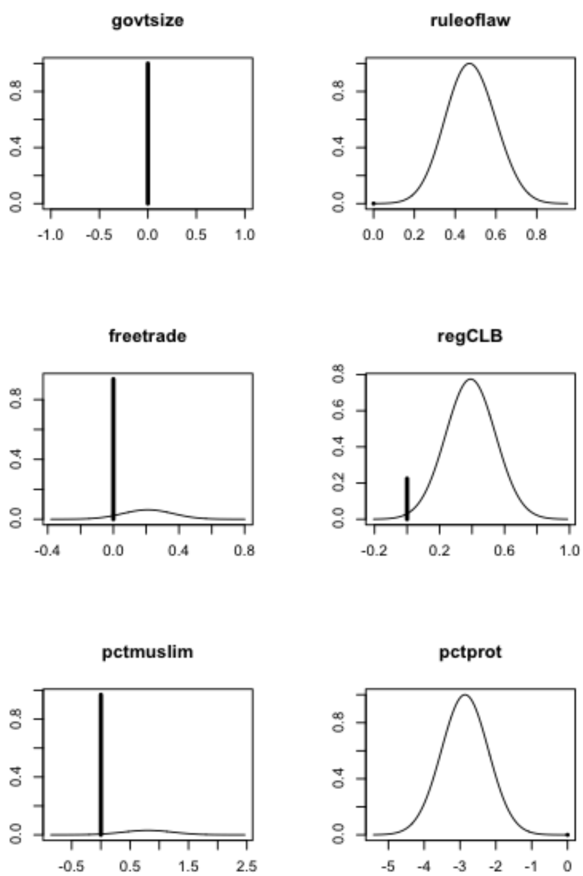
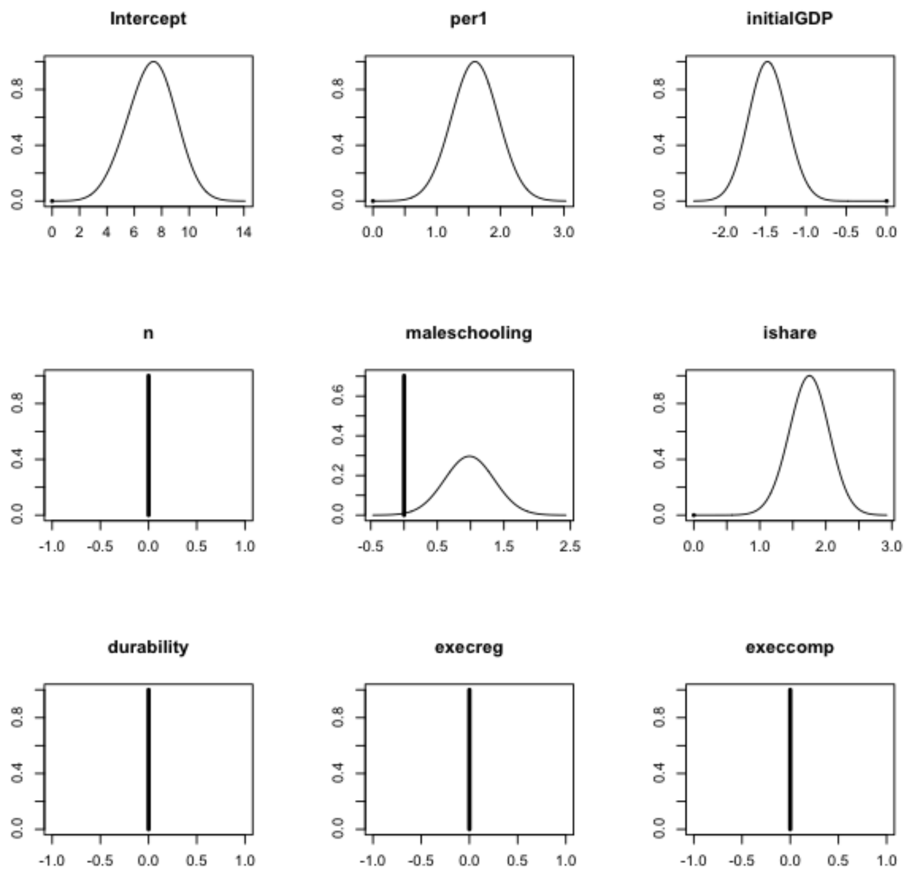
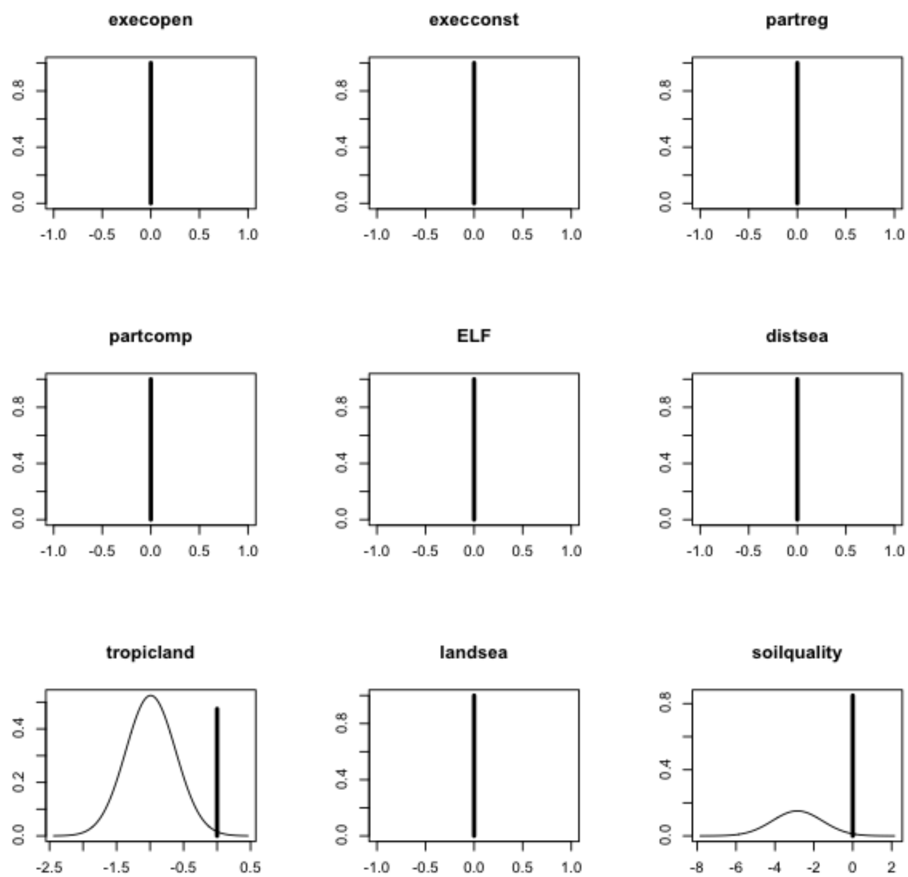

govtsize
ruleoflaw
soundmoney
freetrade
regCLB
pctcath
pctmuslim
pctprot

Table B.13: Bayesian Model Averaging (BMA) Results and Best 5 Models in the Strict Framework; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita

| Regressor | p!=0 | Coeff. | Std. Err. | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|---|---|---|
| Constant | 100 | 7.2463 | 1.7559 | 7.4245 | 8.5209 | 7.2586 | 5.0093 | 7.987 |
| *per*1 | 100 | 1.6025 | 0.3665 | 1.5571 | 1.6301 | 1.583 | 1.7956 | 1.4954 |
| *initialGDP* | 100 | -1.4716 | 0.2365 | -1.527 | -1.5124 | -1.5074 | -1.3272 | -1.4122 |
| *n* | 0 | 0 | 0 | . | . | . | . | . |
| *maleschooling* | 29.7 | 0.2911 | 0.4921 | . | 1.0472 | 0.9139 | . | . |
| *ishare* | 100 | 1.7452 | 0.3023 | 1.7706 | 1.5854 | 1.658 | 1.8181 | 1.8456 |
| *durability* | 0 | 0 | 0 | . | . | . | . | . |
| *execreg* | 0 | 0 | 0 | . | . | . | . | . |
| *execcomp* | 0 | 0 | 0 | . | . | . | . | . |
| *execopen* | 0 | 0 | 0 | . | . | . | . | . |
| *execconst* | 0 | 0 | 0 | . | . | . | . | . |
| *partreg* | 0 | 0 | 0 | . | . | . | . | . |
| *partcomp* | 0 | 0 | 0 | . | . | . | . | . |
| *distsea* | 0 | 0 | 0 | . | . | . | . | . |
| *tropicland* | 52.5 | -0.5193 | 0.5626 | -1.0172 | . | . | . | -0.8373 |
| *landsea* | 0 | 0 | 0 | . | . | . | . | . |
| *soilquality* | 15.1 | -0.4304 | 1.1358 | . | -2.8495 | . | . | . |
| *govtsize* | 0 | 0 | 0 | . | . | . | . | . |
| *ruleoflaw* | 100 | 0.5382 | 0.1183 | 0.4685 | 0.5654 | 0.6097 | 0.5709 | 0.5867 |
| *soundmoney* | 0 | 0 | 0 | . | . | . | . | . |
| *freetrade* | 0 | 0 | 0 | . | . | . | . | . |
| *regCLB* | 54.5 | 0.2274 | 0.2369 | 0.4311 | . | . | 0.3588 | . |
| *ELF* | 0 | 0 | 0 | . | . | . | . | . |
| *pctcath* | 0 | 0 | 0 | . | . | . | . | . |
| *pctmuslim* | 0 | 0 | 0 | . | . | . | . | . |
| *pctprot* | 100 | -2.8686 | 0.6208 | -2.783 | -3.195 | -2.8408 | -3.031 | -2.6046 |
| nVar | | | | 7 | 7 | 6 | 6 | 6 |
| $R^2$ | | | | 0.696 | 0.692 | 0.681 | 0.680 | 0.679 |
| Post. Prob. | | | | 0.441 | 0.151 | 0.146 | 0.104 | 0.084 |

Figure B.5: BMA Estimate Plots for the Strict Framework




execopen
execconst
partreg
partcomp
ELF
distsea
tropicland
landsea
soilquality
0.0
0.4
0.8
-1.0
-0.5
0.0
0.5
1.0
0.2
-2.5
-1.5
-0.5
0.5
-8
-6
-4
-2
0
2

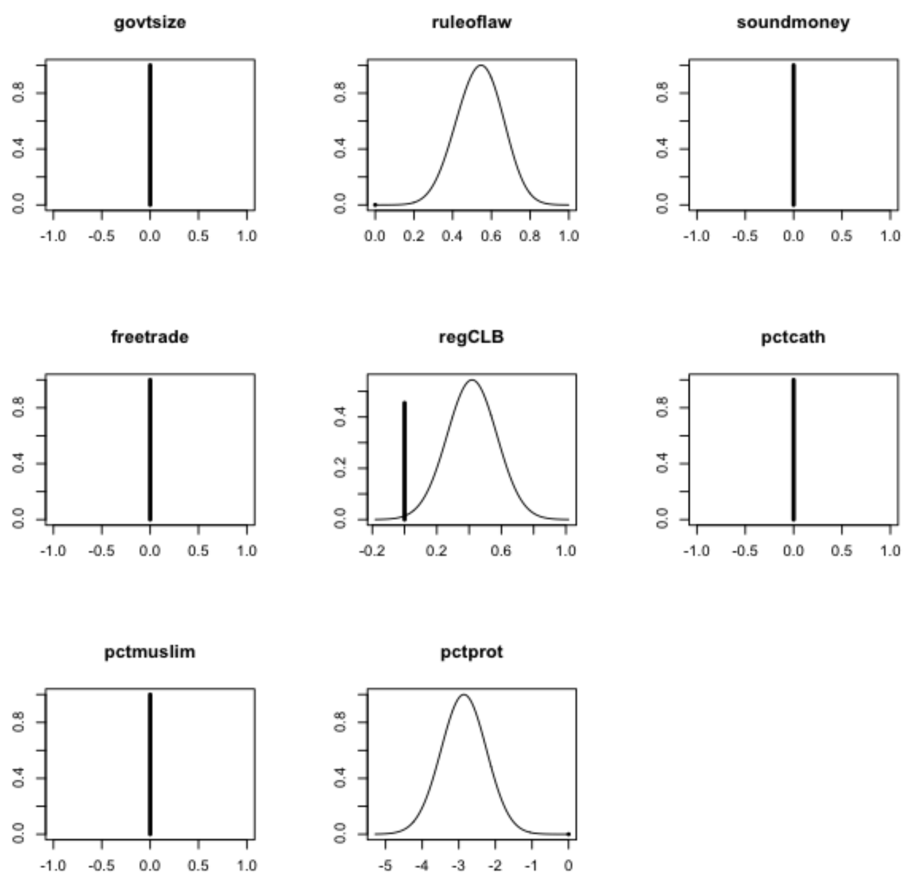

govtsize
ruleoflaw
soundmoney
freetrade
regCLB
pctcath
pctmuslim
pctprot

Table B.14: Bayesian Averaging of Classical Estimates (BACE) Results; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita

| | | Unconditional | | | Conditional on Inclusion | | |
|---|---|---|---|---|---|---|---|
| Regressor | Post. Prob. | Coeff. | Std. Err. | T-stat | Coeff. | Std. Err. | T-stat |
| *per*1 | 0.9919729 | 1.650537 | 0.4435821 | 3.720928 | 1.663893 | 0.4196833 | 3.964641 |
| *initialGDP* | 0.9999042 | -1.441108 | 0.2829709 | -5.092779 | -1.441246 | 0.2826328 | -5.09936 |
| *n* | 0.0341079 | -3.78E-03 | 0.2282086 | -0.0165486 | -0.1107235 | 1.230876 | -0.0899551 |
| *maleschooling* | 0.350946 | 0.3126339 | 0.4810966 | 0.649836 | 0.8908319 | 0.3800488 | 2.343993 |
| *ishare* | 0.9999365 | 1.70013 | 0.3201474 | 5.310458 | 1.700238 | 0.3198706 | 5.315392 |
| *durability* | 0.0516935 | 7.30E-03 | 0.0482684 | 0.1512551 | 0.1412332 | 0.1617235 | 0.8733008 |
| *execreg* | 0.0354234 | 0.0116833 | 0.1718946 | 0.0679676 | 0.329818 | 0.8539354 | 0.3862329 |
| *execcomp* | 0.0344897 | 5.51E-03 | 0.1134242 | 0.0485597 | 0.1596954 | 0.5902442 | 0.2705581 |
| *execopen* | 0.0869559 | 0.070979 | 0.2923655 | 0.2427748 | 0.816264 | 0.6120865 | 1.333576 |
| *execconst* | 0.0350217 | -2.85E-05 | 0.135815 | -0.0002097 | -8.13E-04 | 0.7257363 | -0.0011206 |
| *partreg* | 0.051603 | -0.0348834 | 0.2151358 | -0.1621459 | -0.6759953 | 0.6808264 | -0.9929041 |
| *partcomp* | 0.0703724 | -0.0614224 | 0.2943061 | -0.2087024 | -0.8728198 | 0.7229258 | -1.207344 |
| *distsea* | 0.1033089 | -0.0173284 | 0.0737348 | -0.2350103 | -0.1677342 | 0.1655254 | -1.013345 |
| *tropicland* | 0.412956 | -0.4001796 | 0.5417535 | -0.7386748 | -0.9690613 | 0.3993002 | -2.426899 |
| *landsea* | 0.1259698 | 0.0915622 | 0.2966847 | 0.3086179 | 0.7268584 | 0.4868088 | 1.493109 |
| *soilquality* | 0.1604142 | -0.4037693 | 1.067756 | -0.3781475 | -2.517042 | 1.337179 | -1.882352 |
| *govtsize* | 0.0329268 | -1.05E-03 | 0.0223122 | -0.0468524 | -0.0317485 | 0.118931 | -0.2669491 |
| *ruleoflaw* | 0.9973301 | 0.5454834 | 0.1267977 | 4.301998 | 0.5469437 | 0.1237821 | 4.418601 |
| *soundmoney* | 0.0532057 | 5.21E-03 | 0.0316393 | 0.1647383 | 0.0979634 | 0.0986329 | 0.9932118 |
| *freetrade* | 0.1083762 | 0.0256985 | 0.0897481 | 0.2863404 | 0.2371231 | 0.1555254 | 1.524658 |
| *regCLB* | 0.4321059 | 0.1672476 | 0.2183463 | 0.765974 | 0.3870523 | 0.1589216 | 2.435493 |
| *ELF* | 0.0591848 | -0.0373961 | 0.2129365 | -0.175621 | -0.6318533 | 0.6248986 | -1.011129 |
| *pctcath* | 0.111927 | -0.0719044 | 0.2429788 | -0.2959286 | -0.6424223 | 0.4012003 | -1.601251 |
| *pctmuslim* | 0.0641552 | 0.0351501 | 0.189779 | 0.1852161 | 0.5478918 | 0.529587 | 1.034564 |
| *pctprot* | 0.9968246 | -2.82887 | 0.6786407 | -4.168436 | -2.837882 | 0.6606416 | -4.295644 |

Table B.15: Weighted-Average Least Squares (WALS) Results; Dependent Variable: Average Yearly Growth Rate of Real GDP Per Capita

| Regressor | Coeff. | Std. Err. | T-stat |
|---|---|---|---|
| Constant | 6.6892562 | 1.6639826 | 4.0200277 |
| $per1$ | 2.0920473 | 0.47989176 | 4.3594149 |
| $initialGDP$ | -1.3563495 | 0.24992876 | -5.4269446 |
| $n$ | -0.10079609 | 1.0729268 | -0.093944981 |
| $maleschooling$ | 0.72067565 | 0.36112612 | 1.9956342 |
| $ishare$ | 1.2107603 | 0.30211707 | 4.0075865 |
| $durability$ | 0.10583298 | 0.071837589 | 1.4732256 |
| $execreg$ | -0.63820432 | 0.067986667 | -9.3871981 |
| $execcomp$ | 1.2834417 | 0.093119245 | 13.782776 |
| $execopen$ | 0.99854304 | 0.067361091 | 14.823736 |
| $execconst$ | -1.0165301 | 0.077155604 | -13.175065 |
| $partreg$ | -0.68662035 | 0.081514599 | -8.4232807 |
| $partcomp$ | -1.1036921 | 0.088728848 | -12.438932 |
| $distsea$ | 0.12921238 | 0.064517418 | 2.0027519 |
| $tropicland$ | -0.9304162 | 0.089990612 | -10.339036 |
| $landsea$ | 0.81656728 | 0.076734941 | 10.641401 |
| $soilquality$ | -2.3048035 | 0.061037437 | -37.76049 |
| $govtsize$ | -0.014620183 | 0.076631167 | -0.19078639 |
| $ruleoflaw$ | 0.30020547 | 0.076260157 | 3.9365965 |
| $soundmoney$ | 0.058442294 | 0.069585139 | 0.83986746 |
| $freetrade$ | 0.20093424 | 0.063649092 | 3.1569067 |
| $regCLB$ | 0.3127454 | 0.053859776 | 5.80666 |
| $ELF$ | -0.29591544 | 0.070255321 | -4.2120004 |
| $pctcath$ | -0.45286547 | 0.099626356 | -4.5456392 |
| $pctmuslim$ | -0.065234715 | 0.08118363 | -0.80354519 |
| $pctprot$ | -3.0361875 | 0.075569099 | -40.177633 |