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A Threshold Analysis of the Relationship Between Governance and Growth

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Quality of governance has been found to be significant in economic growth. We investigate whether the quality of governance matters equally across all levels of economic development using a threshold technique. We find that the quality of governance is most significant for only a subset of relatively poor countries, while education is most significant for the poorest countries and region is most significant for the wealthiest.

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Introduction

There is a growing consensus among economists that differences in per capita income growth and per capita levels of income are due, in part, to differences in social infrastructure (See Hall and Jones (1999)). Differences in factor accumulation simply do not explain all of the observed cross-country variation in growth. A particular aspect of social infrastructure that has received much attention in the empirical literature on growth is the quality of governance. Earlier works by Bhagwati (1982) and Easterly (1993) among others has shown that poorly managed or corrupt government institutions adversely affect growth while well-managed institutions can contribute to growth (See Knack and Keefer 1995 and 1997b as well as Mauro 1995). More recently, Olson et al (2000) has shown that higher quality governance is associated with significantly higher growth.

The main thrust of the empirical research on the relationship between quality of governance and growth is that quality of governance matters for growth and countries can improve their growth prospects by establishing high-quality, well-managed and corruption-free government institutions. This policy implication has a logically intuitive and even moralistic appeal. And, as we argue in this paper, it is most likely a necessary first step towards improving growth. But we further argue in this paper that the effect of quality of governance on growth may have been overstated in previous research. In particular, we find that variations in the quality of governance across countries is statistically linked to variations in total factor productivity growth for only a subset of relatively poor countries around the world which suggests that improving the quality of governance results in improved growth for only a relatively poor subset of countries¹.

¹ This conclusion is similar in spirit to the conclusion reached by Ghosh and Wolf (1998). Using a different technique they find that there is “no single recipe for growth.”

We base our conclusions on our analysis of growth in 71 countries over a 34-year time period. Our methodology initially follows closely that of Olson et al (2000) although our sample of countries and time span are both larger than theirs. We estimate the aggregate production function for this subset of countries and then, using country-specific dummy variables, we measure country specific differences in total factor productivity (TFP) growth. We then explain the variations in TFP growth in a regression with a set of county-specific control variables, which include the International Country Risk Guide (ICRG) measures of the quality of governance.

We depart from the Olson et al methodology, however, by estimating a threshold regression (see Hansen (2000)) to determine whether the relationship between TFP growth and quality of governance holds for countries at all stages of development. Our threshold regression results indicate that there are indeed structural breaks in the relationship between quality of governance and TFP growth. Re-estimating our model using the sub-samples suggested by the threshold analysis (using both ordinary least squares and instrumental variables) we find that the quality of governance and TFP growth are significantly related for only a small subset of relatively poor countries.

The remainder of this paper is organized as follows. The following section provides a brief discussion of the relationship between the quality of governance and economic growth. We then discuss the data used in this study. Next we present the empirical methodology and results. We conclude with a brief summary of our findings and a discussion of the policy implications.

The Quality of Government Institutions and Long-Term Growth

Economic historians have argued that long-term economic growth is crucially dependent on governance. Countries can improve their growth prospects by inaugurating efficient, high quality

institutions. Institutions are the “rules of the game in a society” (North 1990, p 3). They guide human interaction and corporate conduct by giving overall structure to everyday life. Institutions can have a lasting effect. Baumol (1990) shows that variations in innovations over long spans of history are due mainly to variations in the institutions that provide incentives to innovate, and not to variations in the proportion of the population that has the ability or inclination to become an entrepreneur. He cites Medieval China as an example, where citizens gained status and wealth by becoming bureaucrats, not entrepreneurs. Despite early path breaking inventions such as the printing press, growth stagnated in China because the state expropriated the private gains from such innovations. As a result of these institutional decisions, China still lags behind much of the industrialized world.

Recent research has empirically demonstrated that governance matters. Knack and Keefer (1995) found that government institutions are crucial to growth and investment, particularly those institutions that protect property rights. They find this effect rival to the effect of education. In a later paper, Knack and Keefer (1997b) found that poor countries fall back rather than catch up mainly because of deficient institutions. They found that poor countries are unable to capitalize on current technological advances because of their deficient 'institutional environment.' Hall and Jones (1999) found that a composite measure of governance and institutions called social infrastructure, drives differences in labor productivity, a main determinant of growth. Acemoglu et al (2002) found that among European colonies many that were relatively rich in 1500 are now relatively poor. They conclude that this reversal in relative incomes reflects the effect of institutions on income today. Collier and Gunning (1999) suggest that slow growth in Africa over the past four decades is, in part, due to an incentive structure that encouraged government institutions and bureaucracy to grow at the expense of growth in the private sector. Easterly and

Levine (2003) found that tropics, germs and crops affect development directly through institutions. The impact of institutions is so strong that Acemoglu et al (2001) found that once they controlled for the effect of institutions, countries in Africa or those closer to the equator do not have lower incomes. Rodrik et al (2002) finds that the quality of institutions ‘trumps’ all contributions from other sources. More recently and using a different measure of institutions, Gwartney et al (2004) found the same result: that institutions matter. Work has even begun in dissecting the type of institutions that have the most impact. Acemoglu and Johnson (2005) find that property rights institutions have a major influence on long-run economic growth.

As shown by the above, institutions and governance are important. Proficient and established institutions permit society to function smoothly as citizens are able to invest their time on fruitful activities. Good institutions provide healthy environments for growth promoting activities such as investment and entrepreneurship. On the other hand, deficient institutions can have negative effects on growth. Inefficient institutions affect economic growth through rent-seeking (and also directly unproductive activities (DUP))². Rent-seeking involves situations where citizens spend their time on activities which benefit themselves privately, but do not contribute to the overall well-being of society. Rent-seekers try to obtain the highest possible income within or outside the rules of society and rent-seeking can take many forms including lobbying, corruption, protectionism, over-regulation and even advertising. Poor institutions allow and enable such unproductive activities which can slow economic growth as resources are diverted to less productive activities. For example, Jones (2002, Chapter 7) cites a study by de Soto (1989) who found that it took 289 person days to secure the required permits to open up a small factory in Peru. In addition, two bribes were required in order to obtain the required documents. This diversion of

²See Bhagwati (1982), Krueger (1974) and Rose-Ackerman (1978) among others.

resources away from productive activities has a profound effect on economic growth and can make significant differences over the long-term.

The main message from the above-referenced studies is that 'governance matters.' Whether by influencing investment, government size and structure or the entrepreneurial environment, institutions are important in economic growth. A priori, however, there is no reason to believe that institutional quality, particularly the quality of governance, is equally important at all stages of development. The effect may be non-linear meaning that at higher levels of per capita income, an increase in the quality of institutions may produce less growth than at lower levels of income. By estimating a threshold model, we are able to identify whether institutions (specifically, quality of governance) matter equally across all levels of development.

Measuring Quality of Governance

The historical examples cited above illustrate that there are many different dimensions to the quality of government institutions. Fortunately for empirical researchers, the International Country Risk Guide (ICRG) provides consistent cross-sectional time series of several measures of the quality of governance and government institutions. In the empirical work that follows we employ several of the ICRG measures³. In this section we briefly describe these measures.

³ As documented by Kaufmann, Kray and Zoido-Lobaton (1999) there are numerous measures of quality of governance and institutions covering various countries and time periods. In general, these measures tend to be highly correlated. Our motivation for using the ICRG data is threefold. First, our methodology extends the methodology used by Olson et al (2000). And because we wish to compare our results with theirs, we use the ICRG data as our measure of quality of governance. Our second motivation is that the ICRG data are widely used therefore serve as a benchmark for quality of governance measures in the growth literature (see Barro (1996, 1997) Clague et al (1995, 1996), Hall and Jones (1999), Knack and Keefer (1995, 1997a and 1997b), Knack (2002) and Olson et al (2000)). Finally, as pointed out by Kaufmann et al (1999) the ICRG measure of quality of governance is a high quality statistic which is subject to peer review to “ensure the coherence and comparability across countries.”

We employ a total of five separate measures of the quality of governance. We have annual data on each measure for the time period 1982 through 1997. The first measure is the ICRG index of corruption. This index takes values from zero (most corrupt) to six (least corrupt). Zaire and Bangladesh have average corruption indexes less than one indicating that bureaucrats are likely to take bribes and police officials are likely to require private payments for protection. At the other end of the spectrum, Canada, Sweden and Denmark all have average corruption indexes of six. The United States falls in the 80th percentile with an average corruption index of slightly greater than five.

The second measure of quality of governance is bureaucratic quality. The ICRG measures the professional quality of the bureaucracy in each country. Bureaucracies that are able to maintain the provision of government services during a change in government or regime receive a high rating. The index ranges from one (low quality) to six (high quality). Haiti and El Salvador are at the bottom of this list. The United States as well as Canada, Sweden and Denmark all have average bureaucratic quality indexes of six.

The third measure of quality of governance is the rule of law. This measure captures the stability of laws and the degree of compliance among citizens as well as the degree of enforcement of laws by government officials and the court system. The index ranges from one (low quality) to six (high quality). Haiti and Zaire are at the bottom of this list. The United States as well as Canada, Sweden and Denmark all have average rule of law indexes of six.

The fourth and fifth measures of quality of governance are the risk of expropriation and the risk of repudiation. Expropriation refers to the nationalization of domestic industries. Repudiation means that the government of a country reneges on contracts with foreign investors. Both indexes

range from a low of zero to a high of ten. Sudan and Zaire are at the bottom of both measures of quality of governance. Norway and Switzerland are at the top of both measures.

In our empirical work that follows we also use a summary measure of all five indexes which we call the “average quality of governance.” We construct this measure by re-scaling all of the indexes to range from one to ten. We then average the five measures to obtain an overall measure of quality of governance for each country. Zaire, Haiti and Sudan are at the bottom of the overall list. Switzerland, the Netherlands and Iceland are at the top. Our basic hypothesis is that total factor productivity growth is positively related to each of the 5 measures of quality of governance as well as the overall average quality of governance.

Methodology

Our empirical methodology initially follows Olson et al (2000). They note that it is inappropriate to estimate the effect of quality of governance on growth in a panel regression because quality of governance varies little over time. Thus, while it is likely that quality of governance affects the average growth of countries over our sample it is unlikely (because of the lack of time series variation in the quality of governance measure) that quality of governance affects year-to-year growth within specific countries. We computed the standard deviation of each quality of governance measure for each country over the period 1982 through 1994. The average of those standard deviations is reported in the first column of the table below. These numbers reveal that there is very little time-variation in quality of governance within each country. For comparison we also computed the standard deviation of each quality of governance measure across all 77 countries in our sample. The averages of those standard deviations over time are shown in

the second column of the table below. These standard deviations clearly show that there is (in most cases) at least twice as much cross-sectional variation as there is time series variation.

Cross-Sectional vs. Time-Series Variation in Quality of Governance Measures

	Average Time-Series Standard Deviation	Standard Deviation of Time Series Average
Corruption	0.28	1.49
Rule of Law	0.51	1.61
Bureaucratic Quality	0.22	1.64
Expropriation Risk	0.96	2.11
Repudiation Risk	1.10	1.87
Average of All	0.63	2.08

The low degree of time-series variation in the quality of governance measures suggests that the best way to capture the effect of quality of governance on growth is to estimate a fixed effects growth regression and then explain variation in the fixed effects across countries using the (time series) average of the quality of governance measures. This is the approach followed by Olson et al and it is the one recommended by Hsiao (1986).

We begin by estimating a production function for the countries listed in Table 1. We regress the growth rate of real GDP on the growth rate of capital, the growth rate of labor and a set of country-specific dummy variables. The country specific dummy variables capture the cross-country differences in the growth rate of total factor productivity. We explain differences in total

factor productivity growth in a second-stage regression that includes a measure of the quality of governance as well as several control variables.

Our initial sample is comprised of 77 countries and 34 years (1961-1994) for a total sample of 2618 cross-sectional/time series observations. The data used to estimate the production function were from Abdelhak Senhadji (1999) and include data on real GDP from the World Bank, capital stock from Nehru and Dhareshwar (1993) and labor force from the International Labor Organization. We estimated the production function in growth rate form using the entire sample. We constrained the production function to conform to constant returns to scale (the coefficients on labor and capital growth sum to 1). Our results (suppressing the 77 country-specific dummy estimates) are as follows⁴:

$$(1) \quad \% \Delta Y = .595 * \% \Delta K + .405 * \% \Delta L$$

(0.03) (0.03)

These coefficient estimates seem reasonable and statistically significant (standard errors are reported in parentheses below the estimates). They are in the range found by Senhadji (1999) using seven different econometric estimation methods. The summary statistics for the fixed effects are presented in Table 2. The adjusted R² for this equation was 0.18 and the standard error was 4.56.

The basic hypothesis tested by Olson et al is that the fixed effect (which measures average TFP growth) is positively related to the quality of governance. Figure 1 shows a scatter plot of the

⁴ We also estimated the production function without imposing the constant returns to scale constraint. The unconstrained coefficient on capital growth is .586 and the unconstrained coefficient on labor growth is .31. Both coefficients are highly significant and we fail to reject the null hypothesis that they sum to 1. The adjusted R-squared was 0.18%. In addition, the results from our second stage regression were nearly identical when we used the fixed effects estimated from the unconstrained production function.

fixed effects and overall measure of quality of governance. The regression line shown on the plot is:

$$(2) \text{ Fixed Effect} = -1.45 + .22 * (\text{average quality of governance})$$

(.87) (.05)

with an adjusted R-squared of .23 and a regression standard error of 0.88. Standard errors are in parentheses below the parameter estimates. The estimated slope coefficient is close to that found by Olson et al (they found .272) in their regression, which included a number of control variables.

Although the scatter plot and regression line shown in Figure 1 are suggestive of a relationship between governance and TFP growth it is important to control for factors that may be correlated with both of these variables in order to determine whether governance exerts an independent influence on TFP growth or whether it is simply picking up the influence of factors such as region of the country that might also explain variation in TFP growth.

We estimated the following regression to measure the influence of quality of governance on growth in our sample of countries:

$$(3) \text{ Fixed Effect} = c_0 + c_1G + c_2\text{Africa} + c_3\text{South America} + c_4\text{Central America} + c_5\text{Asia} + c_6\text{GDP60} + c_7\text{Enroll} + c_8\text{quality of governance}$$

The variable G is the average percent of government consumption in GDP for each country over the sample period 1961 through 1994⁵ from the Penn World Tables 6.0⁶. The variables Africa, South America and Central America are simply dummy variables representing regions of

⁵ Data for Cyprus is 1960-1996, Sudan 1996 only, Sierra Leone 1961-1996 and Tunisia 1961-1997.

⁶ Government consumption as a percent of GDP from the Penn World Tables is measured using international rather than local prices. As pointed out by Knowles (2001), using international rather than local prices may artificially inflate government consumption as a percent of GDP for low-income countries.

the world. We include GDP60 which is real GDP per capita in 1960 (chain weighted 1996 prices)⁷ from the Penn World Tables 6.0 and Enroll from Barro and Lee (1993) which is secondary school enrollment rate in 1960 to control for possible convergence effects.⁸

Data for all of these control variables were not available for our complete sample of 77 countries so we had to drop six countries from the sample (Ethiopia, Ivory Coast, Morocco, Mali, Myanmar, Nicaragua). An additional control variable that we did not include is the average black market premium on the foreign exchange rate. Including the black market premium in our regression (as in Olson et al) reduces the sample to 53 countries that we determined was too small for the threshold regression analysis.

Our benchmark results using the full sample are presented in Table 3. Each column reports the results of a separate regression where the only difference among the regression specifications is the measure of quality of governance. The top row of Table 3 lists the particular measure of quality of governance employed in each regression. For example, the column labeled “corruption” reports the results of equation (3) for the case where quality of governance is measured by the ICRG corruption index.

Our coefficient estimates for the quality of governance variables are quite reasonable. They are similar in magnitude (and identical in sign) to those presented by Olson et al. With the exception of “rule of law” quality of governance, as measured by the ICRG, is positively (and significantly) related to movements in country-specific TFP growth. The coefficient on “rule of law” enters with a negative sign but is only marginally significant. Furthermore as we show below, “rule of law” is positive and statistically significant for the sub-sample containing the poorest

⁷ GDP data is first available in 1960. For Haiti the GDP data begins in 1967, the Sudan in 1996, Sierra Leone in 1961 and Tunisia in 1961.

⁸ Data for China and Egypt are from 1975.

countries. Thus, the negative and insignificant sign found in the full sample is a symptom of the fact that the coefficient on “rule of law” differs across levels of per capita GDP.

Unlike Olson et al, we did not find government’s share of GDP to be significant. We did find initial GDP per capita to be significant but our estimates are roughly one half to one third the size of Olson et al’s estimates. The differences in results are likely due to the fact that our sample differs from theirs (we have larger number of cross-section and time-series observations).

Threshold Effects

Our main focus in this paper is to investigate whether the results presented in Table 3 are representative of the relationship between quality of governance and country-specific TFP growth for *all* countries in our sample. In particular, we want to know whether quality of governance affects country-specific TFP growth for countries at all levels of development⁹. To investigate this question, we estimated a threshold regression as described by Hansen (2000)¹⁰.

We begin by ordering our data by the level of GDP per capita in 1960. This ordering is shown in Table 1. The poorest country in 1960 was Tanzania with per capita GDP of \$452. The richest country in 1960 was Switzerland with per capita income of \$15,214. Figure 2 shows the distribution of per capita GDP in 1960 with selected countries listed on the horizontal axis. The median per capita income is \$2523 which is for Columbia (which is just to the left of Guyana in Figure 2). Half the countries in our sample had per capita income of one sixth or less of the richest

⁹ An alternative technique for assessing whether quality of governance matters for all stages of development would be to include an interaction term (quality of governance multiplied times per capita income). The advantage of the threshold technique, however, is that it allows us to determine the optimal break point in the relationship between governance and TFP growth.

¹⁰ The threshold technique has been used by previous authors to study aspects of economic growth other than the quality of governance. Earlier studies which used the threshold technique are: Kahn

county (Switzerland). In Hansen's (2000) terminology, our threshold variable is per capita GDP in 1960. Our hypothesis is that the effect of quality of governance on TFP growth varies by the level of per capita GDP in 1960.

To identify whether there is a threshold we estimated pairs of regressions for each possible break point in our ordered sample. We began by estimating equation (3) over two sub-samples: observations 1-10 and observations 11-71. We computed the combined regression SSE from this pair of regressions and we then added one observation to the first sample and deleted one observation from the second sample. Thus, our second pair of regressions was for sub-samples 1-11 and 12-71. We again computed and saved the combined regression SSE from this pair of regressions and proceeded to add another observation to the first sample and delete another observation from the second sample. We continued this process until we had stepped through the entire sample, each time moving an observation from the second sub-sample to the first sub-sample. The end result is a sequence of regression SSE's, one for each possible breakpoint in the sample. The breakpoint for which the combined SSE reaches a minimum is best fitting combined pair of regressions and by allowing the coefficient values to differ over the two sub-samples we potentially improve the fit of the regression relative to the benchmark regression which constrains the coefficient values to be the same across the entire sample.

Table 4 reports the minimum values of the combined SSEs for the sub-sample regressions along with the SSEs for the benchmark regression for each measure of quality of governance. The minimum values for corruption, rule of law and average quality of governance all occurred when the sample was split at income per capita of \$2176 (Sudan). The minimum values for the

and Senhadji (2000), Ghosh and Wolf (1998), Liu and Stengos (1999), Durlauf and Johnson (1995) and Hansen (2000).

bureaucratic quality, repudiation risk and expropriation risk all occurred when the sample was split at income per capita of \$1606 (Ghana)

Figures 3 through 8 show the sequence of estimated SSEs for 6 measures of quality of governance. The SSEs from models estimated with the average quality of governance, corruption and rule of law (Figures 3, 4 and 5) all reach a global minimum at \$2176 (Sudan, which is next to Tunisia). But notice that there is another dip (local minimum) at \$1606 (Ghana, which is next to Sri Lanka). The SSEs from the models estimated with bureaucratic quality, repudiation risk and expropriation risk (Figures 6, 7 and 8) follow a similar pattern but here the global minimum is at \$1606 (Ghana) and the local minimum is at \$2176 (Sudan).

Figures 3 through 8 also show the 95% critical value proposed by Hansen (2000, p. 584). SSE values above the 95% critical value are significantly different from the identified minimum SSE at the 5% level (or less). For example, in Figure 3 the minimum SSE is 31.45 at Sudan (next to Tunisia in the Figure) and the critical value passes through Columbia. Any breakpoint to the right of Columbia (the 28th poorest country in the sample) produces an SSE that is significantly greater than the SSE obtained by breaking the sample at Sudan. For each of the measures of quality of governance, the critical value crosses the sequence of SSEs at roughly the same location (from the 27th poorest, Singapore to the 32nd poorest, Jamaica). In addition, for all measures except repudiation risk and expropriation risk, there is a second point of crossing which occurs at around the 21th poorest country (Cameroon).

In the results presented below we chose break the sample at the Sudan for two reasons. First, the estimates are often unstable at the beginning and end of the sample splits because the samples are quite small. Second, when we split the sample at Ghana, the major difference between the poor and rich countries was in terms of the enrollment variable. The enrollment variable was

highly significant for the countries at or below \$1606 per capita GDP in 1960 and insignificant for countries above \$1606.

Having chosen a point at which to split the sample, our next task was to determine whether the threshold effect was statistically significant. We conduct this test using the likelihood ratio statistic:

$$(4) L = (SSE_b - SSE_{th})/\sigma_{th}^2$$

Where SSE_b is the sum of squared errors for the benchmark model reported in Table 3, SSE_{th} is the sum of squared errors for the threshold model and σ_{th}^2 is the estimated variance of the threshold model. The threshold model is the model estimated at the sample split identified by the minimum SSE procedure described above. Hansen (1996) shows that this test statistic has a non-standard distribution that may be approximated by constructing a bootstrap distribution using a large number of simulated series.

To estimate the bootstrap simulation we assume the independent variables as well as the threshold are given. We then sample (with replacement) from the estimated regression residuals in order to generate 1000 simulated series (sample size 71) of dependent variables. The likelihood ratio statistic is calculated for each of the 1000 simulated series and the percentage of times the simulated likelihood statistic exceeds the actual is the p-value for the null hypothesis of no threshold effect.

The results for the test of one versus no threshold are presented in the first two columns of Table 5. The results strongly indicate a sample split at \$1606 (Ghana) and four of the six measures of governance also suggest a sample split at \$2176 (Sudan). Because there are two potential breaks in the sample, we also tested for the existence of two thresholds. We followed Hansen's (1999) procedure for finding two thresholds in a sample. We estimated the sums of squared errors

for each sample split using the first 29 observations and found the minimum SSE occurred at \$1607 (Egypt, observation 17, just next to Ghana). We then estimated the sums of squared errors for each sample split using observations 18 through 71 and found the minimum SSE occurred at \$2176, the Sudan.

To test the alternative hypothesis that there are two thresholds against the null hypothesis of one threshold we repeated the bootstrap procedure described above. This time, however, our sample of estimated residuals came from the model estimated with two breakpoints (at Egypt and Sudan). We then randomly drew from the sample of residuals to construct 1000 new data series using the coefficients estimated from the model with one breakpoint¹¹. Using these constructed data series we constructed the following likelihood ratio test statistic:

$$(5) L = (SSE_1 - SSE_2)/\sigma_2^2$$

Where SSE_1 is the sum of squared errors for the model with one breakpoint and SSE_2 and σ_2^2 are the sum of squared errors and estimated variance from the model with two breakpoints. The p-value for the null hypothesis of one threshold is the number of times the bootstrap simulated likelihood ratio statistic exceeds the actual likelihood ratio statistic.

The last column of Table 5 shows the result from this test. The null hypothesis of one threshold is clearly rejected in favor of the alternative hypothesis of two thresholds for all measures of the quality of governance.

The threshold tests indicate that there are two thresholds in the data—one at observation 17 (Egypt) and the other at observation 29 (Sudan). Thus, the appropriate samples to use in estimating our model are: 1-17, 18-29 and 30-71. Clearly, the middle sample is quite small so

¹¹ We chose the model with the breakpoint at observation 17 (Egypt) because the previous bootstrap test indicated that this was a significant breakpoint for all of the measures of quality of governance.

instead of estimating our model over all three sub-samples, we instead estimated it over the first sub-sample (observations 1-17) and the last sub-sample (observations 18-71) and two overlapping samples which include the middle sample: observations 1-29 and observations 18-71.

Tables 6 through 9 present the results from estimating our model over these sub-samples. The dependent variable in each regression is the fixed effect that we estimated from equation (1). Each regression employs a different measure of the quality of governance. These measures are listed across the top row of each table. For example, the results presented in Table 6, column 1 were obtained by regressing the fixed effect on corruption, the regional dummy variables, GDP per capita in 1960, secondary school enrollment, government's share of GDP and an intercept. The second column shows the same regression but with "rule of law" replacing corruption as the measure of quality of governance.

Although there are a large number of coefficients to digest, three distinct patterns emerge from these estimates. First, the enrollment variable appears significant in the first sample (Table 6, observations 1-17) but not third sample (Table 7, observations 30-71).

The second pattern is that the coefficients on the measures of quality of governance are statistically significant only when the middle sub-sample is included in the first sub-sample (Table 8, observations 1-29).¹² When the middle sub-sample is included in with the last sub-sample (Table 9, observations 18-71), quality of governance is no longer significant.

The third pattern that is important to point out is that almost all of the explanatory power in the third sample (Table 7, observations 30-71) comes from the regional dummy variables. The coefficients on enrollment and the various measures of quality of governance are all insignificant

¹² We did estimate our model over the middle sub-sample with 12 observations and the adjusted R-square is negative for all measures of quality of governance. Nonetheless, the coefficients on

in this sample. Thus, it appears that secondary school enrollment matters for growth in countries at or below initial per capita income of \$1607. Quality of governance matters for growth in countries with initial per capita income of between \$1638 and \$2176 and finally, region matters for growth in countries with initial per capita income of \$2246 and above.

Not surprisingly, the same patterns are present in these coefficient estimates. Quality of governance matters for the poorer countries (countries 1-29) but does not matter for countries with 1960 per capita income greater than \$2176 (the Sudan).¹³

To help visualize the patterns in the coefficients on quality of governance and secondary school enrollment we plotted the coefficients in Figures 9 and 10. Figure 9 shows the coefficients on quality of governance for the sample split 1-29 and 30-71. The lines on the graph represent coefficient estimates for each of the measures of quality of governance. The coefficient estimates fall dramatically over the two sub-samples. In addition, all of the measures of quality of governance are significant in the first sample but insignificantly different from zero in the second sub-sample.

Figure 10 shows the coefficients on secondary school enrollment over the sample split 1-17 and 18-71. In the first sub-sample the coefficients range from 0.05 to 0.06 and are all statistically significant. In the second sub-sample these coefficient estimates to .001 to .003 and are all insignificantly different from zero.

bureaucratic quality and expropriation risk are significant at the 5% level while the overall average measures as well as corruption and repudiation risk are significant at the 10% level.

¹³ An alternative interpretation of our results is that the poor countries in our sample are “outliers.” By including these outliers in our full sample (Table 3) we are mistakenly led to the conclusion that quality of governance matters for growth in TFP. By removing these outliers from our sample (Tables 7 and 9) we find that quality of governance does not matter for TFP growth. Thus, the fact that the sample size for the regressions using the countries for which quality of governance matters (Tables 8) is small does not matter. We are mainly interested in the larger sample results showing that quality of governance does not matter for the vast majority of countries in our sample.

Reverse Causation

Recent work on the relationship between growth and institutional quality has addressed the issue of reverse causation. Our above analysis assumes that institutional quality is exogenous with respect to growth (and total factor productivity). But it is certainly possible that institutions are not entirely exogenous and that to some extent, high growth leads countries to adopt high-quality institutions. Hall and Jones (1999), Acemoglu et al (2001), Rodrik, et al (2002), Dollar and Kraay (2003) have employed a variety of instrumental variables in an effort to capture the exogenous component of the quality of governance. Those instruments include the fraction of a country's population that speaks a European language (Eurofrac), the fraction of the population that speaks English (Engfrac), distance from the equator (Latitude) the (log) predicted trade share of an economy (LogFrank) from Frankel and Romer (1996) and log of the initial mortality rate of the colonizers (LogMort) from Acemoglu et al (2001).

To address the possibility of reverse causation in our results we re-estimated equation 3 using instrumental variables. Table 10 presents the estimates of the quality of governance on TFP growth using two sets of instruments. The top portion of table 10 presents results for all of the instruments listed above except for the log of initial mortality (LogMort). We excluded the log of initial mortality from the instrument list because it is available for only 40 of the 71 countries in our sample. The bottom portion of table 10 presents results using all 5 instruments listed above (Eurofrac, Engfrac, Latitude, LogFrank and LogMort).

We estimated equation 3 over the sample partitions identified by the endogenous breakpoint tests in the previous section. These sample partitions are listed in the first column of Table 10. Beneath each sample partition we list the number of observations included in the regression. For

the estimates reported in the top portion of the table there is only one country (Switzerland) for which the instruments were not available. For the estimates reported in the bottom portion of the table there were 27 countries for which the initial mortality was not available. No estimates are reported for the sub-sample 1-17 for the estimates excluding initial mortality (reported in the top portion of Table 10) and for the sub-samples 1-17 and 30-71 for the estimates including initial mortality (reported in the bottom half of Table 10) because there were too few degrees of freedom to estimate the instrumental variables regressions for those sub-samples.

The results reported in Table 10 are broadly consistent with our OLS estimates reported in Tables 3 through 9. Quality of governance measures are significantly related to TFP growth only in the sample partition which includes the poorest 29 countries in our sample. Rule of law is only marginally significant in the instrumental variable regression which excludes log of initial mortality (sample partition 1-29) and it is insignificant in the regression which excludes log of initial mortality (again, sample partition 1-29). Bureaucratic quality is highly significant in the instrumental variable regression which excludes log of initial mortality (sample partition 1-29) and is insignificant in the regression which includes log of initial mortality (again, sample partition 1-29). For the poorest 29 countries in the sample, the overall average quality of governance measure is significant (at the 1% level excluding log of initial mortality and the 5% level including the log of initial mortality). Moreover, the instrumental variables estimates of the effect of average quality of governance for the poorest 29 countries is 50% higher than the OLS estimates.

Conclusion and Policy Implications

We presented estimates of the determinants of cross-country TFP growth. As shown by previous authors (namely, Olson et al) measures of the quality of governance matter for explaining

differences in TFP growth across all of the countries in our sample. The question we address in this paper is whether that relationship holds across countries of different per capita income levels. To answer this question we estimate a threshold model. We find two thresholds in the data. Differences in TFP growth in very poor countries are explained by differences in secondary school enrollment rates. Differences in TFP growth in the next poorest set of countries depends on quality of governance as measured along various dimensions. This result holds for both the OLS and instrumental variables estimation. Finally, differences in TFP growth for the top 60% of our sample (arranged by initial per capita GDP) are accounted for by region of the world. Secondary school enrollment and quality of governance fail to explain differences in TFP growth among the top 60% of the countries in our sample.

These results are important in two respects. First, the size of the coefficients on quality of governance in our sub-samples of poor countries is roughly twice as large as the coefficients found by Olson et al using their entire sample (more than twice as large for the instrumental variables regression). This means that quality of governance matters a lot for these very poor countries in terms of TFP growth. This makes the institutional decisions all the more important for this group of countries¹⁴. Second, and more importantly, however, is the finding that quality of governance does not appear to matter for TFP growth for countries with initial per capita incomes greater than \$2176. The sample of countries with initial per capita incomes greater than \$2176 still includes a large number of very poor countries. In particular, 70% of the countries in the sample have initial per capita income of less than half the richest country (Switzerland). These results indicate that improvements in quality of governance still may not improve the growth prospects of a large

¹⁴ See Beck et al (2001) who compile a new database to determine which institutions are most conducive to development and reform and under what conditions these institutions emerge.

number of very poor countries and that perhaps there are diminishing marginal returns to good governance.

Although our results suggest that quality of governance does not matter for the vast majority of countries in our sample, it is important to point out that this result is based solely on the ICRG measures of quality of governance. These measures have been used by several authors (Hall and Jones (1999), Olson, et. al) and so have become a standard measure of quality of governance. A question for future research is whether other measures of quality of governance produce similar results.

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Table 1: GDP per capita in 1960

Reverse Rank Order Lowest GDP per capita to Highest GDP per capita, 1960	Country	GDP per Capita 1960 in 1996 \$s
1	Tanzania	\$452
2	Malawi	\$556
3	Uganda	\$570
4	China, People's Rep.	\$686
5	Pakistan	\$883
6	Kenya	\$905
7	India	\$913
8	Zaire	\$934
9	Haiti	\$987
10	Sierra Leone	\$1,073
11	Bangladesh	\$1,084
12	Thailand	\$1,159
13	Taiwan	\$1,466
14	Madagascar	\$1,490
15	Sri Lanka	\$1,523
16	Ghana	\$1,606
17	Egypt	\$1,607
18	Dominican Republic	\$1,638
19	Honduras	\$1,702
20	Zambia	\$1,725
21	Cameroon	\$1,731
22	Senegal	\$1,975
23	Zimbabwe	\$2,037
24	Mozambique	\$2,072
25	Philippines	\$2,090
26	Malaysia	\$2,134
27	Ecuador	\$2,157
28	Paraguay	\$2,166
29	Sudan	\$2,176
30	Tunisia	\$2,246
31	Iran	\$2,320
32	Panama	\$2,420
33	Bolivia	\$2,426
34	Brazil	\$2,440
35	Singapore	\$2,514
36	Colombia	\$2,523
37	Guyana	\$2,530
38	Guatemala	\$2,565
39	Jordan	\$2,672
40	Jamaica	\$2,701

Table 1 Continued...

Reverse Rank Order Lowest GDP per capita to Highest GDP per capita, 1960	Country	GDP per Capita 1960 in 1996 \$s
43	Nicaragua	\$3,171
44	Peru	\$3,202
45	Portugal	\$3,215
46	El Salvador	\$3,438
47	Costa Rica	\$3,651
48	Greece	\$3,765
49	Chile	\$3,966
50	Trinidad and Tobago	\$4,140
51	Ireland	\$4,820
52	Israel	\$5,610
53	Venezuela	\$5,769
54	Uruguay	\$6,058
55	Italy	\$6,918
56	Austria	\$7,438
57	Finland	\$7,492
58	Argentina	\$7,493
59	France	\$8,037
60	Belgium	\$8,223
61	Iceland	\$8,246
62	Norway	\$8,317
63	Netherlands	\$9,127
64	United Kingdom	\$9,601
65	Sweden	\$9,974
66	Denmark	\$10,245
67	Canada	\$10,399
68	Australia	\$10,484
69	New Zealand	\$11,152
70	USA	\$12,821
71	Switzerland	\$15,214

Table 2: Estimated Fixed Effects Summary Statistics

Minimum	-2.46 (Sudan)
Maximum	2.18 (Cyprus)
Median	0.064 (Denmark)
Mean	-0.10

Table 3
Full-Sample Regressions

	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
Quality of Governance	0.20** (0.13)	-0.25 [†] (0.13)	0.31** (0.12)	0.29** (0.10)	0.44** (0.10)	0.31** (0.10)
Africa	-1.13** (0.40)	-0.96* (0.47)	-1.00** (0.38)	-0.60 (0.44)	-0.38 (0.42)	-0.63 (0.44)
Asia	-0.81 [†] (0.44)	-0.70 (0.46)	-0.77* (0.38)	-0.54 (0.39)	-0.35 (0.37)	-0.48 (0.42)
Central America	-1.07* (0.42)	-0.93* (0.37)	-0.76* (0.35)	-0.60 (0.37)	-0.30 (0.36)	-0.52 (0.10)
South America	-0.29 (0.32)	-0.16 (0.37)	-0.08 (0.28)	-0.08 (.32)	0.18 (0.31)	0.14 (0.35)
GDP per Capita '60	-.14* (0.06)	-.14* (0.06)	-.16** (0.06)	-0.14** (0.05)	-.16** (0.05)	-.18** (.06)
Enroll	.01 (.008)	0.01 (0.008)	0.008 (0.007)	0.008 (0.008)	0.007 (0.007)	.009 (.007)
Govt's Share of GDP	-.006 (.02)	-.004 (.02)	0.005 (0.02)	0.002 (0.02)	-0.004 (0.02)	-.001 (.02)
Intercept	0.26 (.66)	-.07 (0.70)	-0.21 (.56)	-1.35 [†] (0.71)	-2.53** (0.78)	-1.14 (0.75)
Adj R ²	0.23	0.24	0.27	0.27	0.37	0.30

Notes: heteroscedastic-consistent standard errors are in parentheses below the parameter estimates, † denotes significant at the .10 level, * denotes significant at the .05 level and ** denotes significant at the .01 level.

Table 4: Sums of Squared Errors

Quality of Governance Measure	Benchmark Model	Minimum	1960 per capita GDP at Minimum SSE
Corruption	46.86	31.45	\$2176 (Sudan)
Rule of Law	46.17	30.32	\$2176 (Sudan)
Bureaucratic Quality	44.16	30.56	\$1606 (Ghana)
Repudiation Risk	42.92	30.93	\$1606 (Ghana)
Expropriation Risk	38.40	29.99	\$1606 (Ghana)
Average Quality Of Governance	42.47	29.79	\$2176 (Sudan)

Table 5: P-Values For Threshold Tests

Quality of Governance Measure	P-Value For Split At \$1606 (Ghana)	P-Value For Split At \$2176 (Sudan)	P-Value For Splits At <i>Both</i> \$1606 and \$2106
Corruption	0.006	0.000	0.001
Rule of Law	0.008	0.007	0.002
Bureaucratic Quality	0.001	0.04	0.007
Repudiation Risk	0.007	0.12	0.001
Expropriation Risk	0.04	0.15	0.007
Average Quality Of Governance	0.008	0.025	0.000

Table 6
Sample 1-17 Regressions

	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
Quality of Governance	0.22 (0.17)	0.51* (0.20)	0.49 [†] (0.24)	0.30 [†] (0.15)	0.29 [†] (0.15)	0.36* (0.16)
Africa	-0.43 (0.52)	0.31 (0.60)	-0.31 (0.47)	0.13 (0.70)	-0.009 (0.67)	0.12 (0.65)
Asia	0.23 (0.31)	0.91 [†] (0.46)	-0.01 (0.21)	0.47 (0.33)	-0.33 (0.22)	0.55 (0.32)
Central America	-1.90** (0.45)	-0.93* (0.60)	-1.43* (0.52)	-1.21 [†] (0.65)	-1.37* (0.60)	-0.98 (0.67)
South America	-----	-----	-----	-----	-----	-----
GDP per Capita '60	-1.20 [†] (0.60)	-1.13* (0.50)	-1.79* (0.70)	-.143 [†] (0.70)	-1.20 [†] (0.60)	-.14* (.06)
Enroll	0.05** (0.013)	0.048* (0.013)	0.06** (0.009)	0.05** (0.009)	0.05** (0.007)	0.05** (.007)
Govt's Share of GDP	-0.05 (0.03)	0.03 (.03)	-0.06 (0.04)	-0.06 (0.03)	-0.04 (0.03)	-0.05 (.03)
Intercept	1.22 (0.88)	-0.58 (1.04)	1.29 (0.83)	0.10 (0.64)	-0.36 (0.61)	-0.25 (0.75)
Adj R ²	0.38	0.38	0.53	0.47	0.42	0.51

Notes: heteroscedastic-consistent standard errors are in parentheses below the parameter estimates, † denotes significant at the .10 level, * denotes significant at the .05 level and ** denotes significant at the .01 level. The South American regional dummy was omitted because there are no South American countries in this sample.

Table 7
Sample 30-71 Regressions

	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
Quality of Governance	-0.25 (0.15)	-.06 (0.10)	0.009 (0.11)	0.16 (0.11)	0.10 (0.14)	-.03 (1.00)
Africa	-2.19** (0.43)	-1.82** (0.34)	-1.65** (0.33)	-1.35** (0.31)	-1.44** (0.36)	-1.76** (0.38)
Asia	-3.57** (0.47)	-3.29** (0.43)	-3.18** (0.44)	-2.74** (0.54)	-2.86** (0.64)	-3.27** (0.50)
Central America	-1.98** (0.48)	-1.72** (0.37)	-1.59** (0.35)	-1.25** (0.32)	-1.36** (0.31)	-1.69 (0.41)
South America	-1.05** (0.35)	-0.76* (0.30)	-0.63* (0.29)	-0.33 (.31)	-0.45 (0.33)	-0.72 (0.34)
GDP per Capita '60	-.04 (0.06)	-.07 (0.05)	-.09 (0.06)	-0.11 [†] (0.06)	-.10 [†] (0.06)	-.08 (.06)
Enroll	-.001 (.006)	0.0006 (0.005)	0.0005 (0.006)	0.0003 (0.006)	0.0003 (0.006)	.0006 (.005)
Govt's Share of GDP	.03 [†] (.16)	0.02 (.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.03)	.02 (.02)
Intercept	1.55* (.70)	.98 (0.57)	0.72 (.54)	-0.39 (0.71)	-0.64 (0.90)	0.93 (0.68)
Adj R ²	0.58	0.54	0.54	0.56	0.55	0.54

Notes: heteroscedastic-consistent standard errors are in parentheses below the parameter estimates, † denotes significant at the .10 level, * denotes significant at the .05 level and ** denotes significant at the .01 level.

Table 8
Sample 1-29 Regressions

	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
Quality of Governance	0.49* (0.18)	0.68** (0.21)	0.52* (0.20)	0.37* (0.15)	0.53** (0.14)	0.50** (0.15)
Africa	-.16 (0.47)	0.70 (0.63)	-0.40 (0.65)	0.30 (0.71)	0.48 (0.66)	0.43 (0.67)
Asia	0.38 (0.30)	1.04 [†] (0.53)	-0.04 (0.57)	0.44 (0.47)	0.52 (0.46)	0.67 (0.52)
Central America	0.03 (0.62)	0.53 (0.62)	-0.15 (0.77)	0.44 (0.81)	0.60 (0.70)	0.60 (0.71)
South America	0.48 (0.71)	0.56 (0.67)	0.08 (0.74)	-0.73 (.55)	-0.05 (0.60)	0.45 (0.68)
GDP per Capita '60	-.41 (0.39)	-.38 (0.34)	-.42 (0.33)	-0.29 (0.36)	-.34 (0.35)	-.45 (.33)
Enroll	0.028 [†] (0.015)	0.028 [†] (0.015)	0.027 (0.018)	0.02 (0.02)	0.02 (0.02)	.02 (.02)
Govt's Share of GDP	.006 (.03)	-.02 (.02)	0.02 (0.03)	0.02 (0.03)	0.008 (0.02)	.02 (.03)
Intercept	-1.37 [†] (0.80)	-2.85** (1.00)	-1.41 (.93)	-2.67* (1.11)	-3.94** (1.11)	-3.09* (1.16)
Adj R ²	0.14	0.23	0.15	0.09	0.24	0.26

Notes: heteroscedastic-consistent standard errors are in parentheses below the parameter estimates, † denotes significant at the .10 level, * denotes significant at the .05 level and ** denotes significant at the .01 level.

Table 9
Sample 18-71 Regressions

	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
Quality of Governance	0.03 (0.16)	0.09 (0.12)	0.18 (0.13)	0.19 (0.12)	0.31* (0.13)	0.16 (0.11)
Africa	-1.55** (0.48)	-1.44** (0.49)	-1.32** (0.46)	-1.06* (0.45)	-0.86 [†] (0.45)	-1.16* (0.49)
Asia	-2.22** (0.56)	-2.15** (0.54)	-2.00** (0.55)	-1.87** (0.52)	-1.55** (0.50)	-1.90** (0.55)
Central America	-1.37** (0.48)	-1.29** (0.38)	-1.05* (0.40)	-0.95* (0.41)	-0.68 [†] (0.38)	-0.98* (0.44)
South America	-0.70 [†] (0.38)	-0.60 [†] (0.34)	-0.42 (0.33)	-0.40 (0.37)	-0.17 (0.35)	-0.34 (0.38)
GDP per Capita '60	-.10 [†] (0.06)	-.11 [†] (0.06)	-.12* (0.06)	-0.12* (0.05)	-.13* (0.06)	-.13* (.06)
Enroll	0.003 (0.06)	0.002 (0.006)	0.001 (0.006)	0.001 (0.006)	0.001 (0.006)	.002 (.006)
Govt's Share of GDP	0.01 (0.02)	0.01 (0.02)	0.02 (0.02)	0.02 (0.02)	0.01 (0.02)	0.01 (.02)
Intercept	0.75 (0.71)	0.54 (0.63)	0.19 (0.64)	-0.64 (0.89)	-1.53 (0.94)	-0.22 (0.79)
Adj R ²	0.34	0.34	0.36	0.37	0.41	0.36

Notes: heteroscedastic-consistent standard errors are in parentheses below the parameter estimates, † denotes significant at the .10 level, * denotes significant at the .05 level and ** denotes significant at the .01 level.

Table 10
Instrumental Variable Estimates of the Impact of Quality of Governance on TFP Growth

All Instruments Sample	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
1-71 (70)	0.04 (0.31)	0.59 (0.56)	0.42 (0.55)	-0.08 (0.31)	0.27 (0.38)	0.43 (0.56)
30-71 (41)	-0.18 (0.38)	-0.75 (0.86)	0.27 (0.42)	0.06 (0.30)	0.11 (0.35)	0.06 (0.61)
1-29 (29)	0.52 (0.38)	0.61 (0.44)	1.60** (0.42)	1.88* (0.72)	0.99* (0.39)	0.74** (0.25)
18-71 (53)	0.08 (0.36)	0.40 (0.72)	-0.37 (0.96)	-.23 (0.33)	-.22 (0.56)	-.40 (1.01)
All Instruments Excluding LogMort Sample	Corruption	Rule of Law	Bureaucratic Quality	Repudiation Risk	Expropriation Risk	Average Quality of Governance
1-71 (44)	0.34 (0.27)	0.58 (0.43)	0.89 [†] (0.45)	0.15 (0.21)	0.71* (0.30)	0.97 (0.64)
1-29 (22)	0.62 (0.53)	0.71 [†] (0.36)	1.10 (0.75)	0.73* (0.35)	0.80* (0.35)	0.72* (0.31)
18-71 (30)	0.11 (0.30)	-0.30 (0.54)	0.25 (0.28)	0.08 (0.26)	0.43 (0.44)	0.41 (0.59)

Notes: heteroscedastic-consistent standard errors are in parentheses below the parameter estimates, † denotes significant at the .10 level, * denotes significant at the .05 level and ** denotes significant at the .01 level. Reported in parentheses below each sample partition is the number of actual observations employed in the regression. The complete list of instruments is as follows: the fraction of a country's population that speaks a European language (Eurofrac), the fraction of the population that speaks English (Engfrac), distance from the equator (Latitude) the (log) predicted trade share of an economy (LogFrank) from Frankel and Romer (1996) and (log) of the initial mortality rate of the colonizers (LogMort) from Acemoglu et al (2001).

Figure 1: Average Quality of Governance and TFP Growth

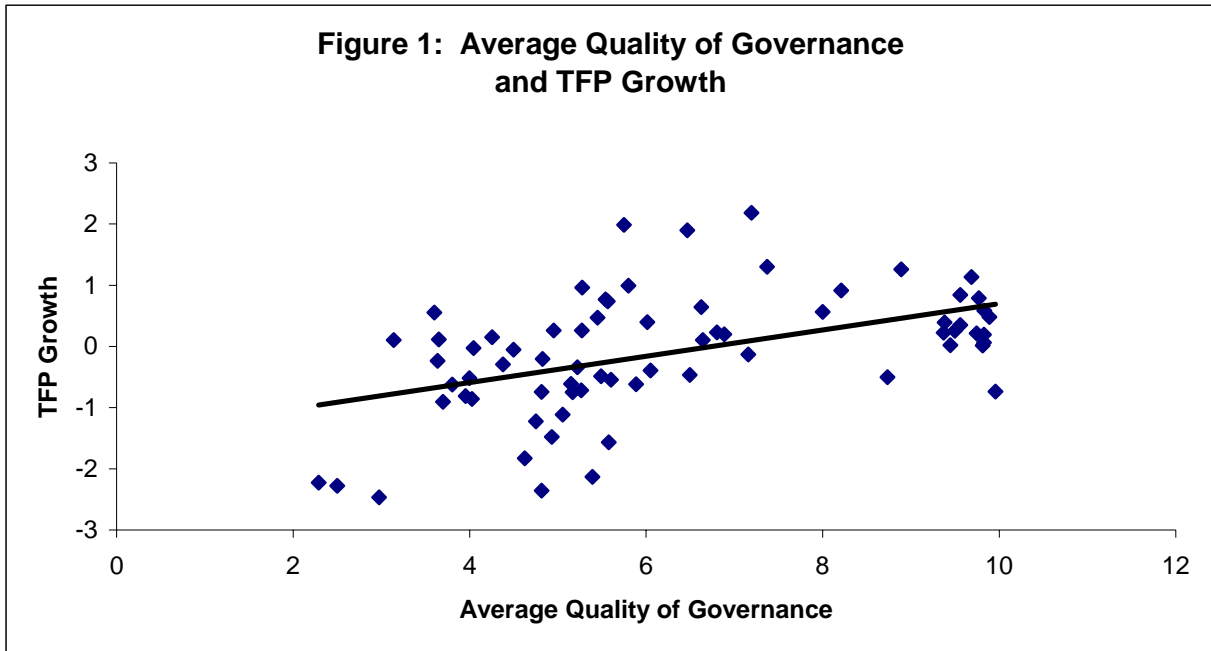
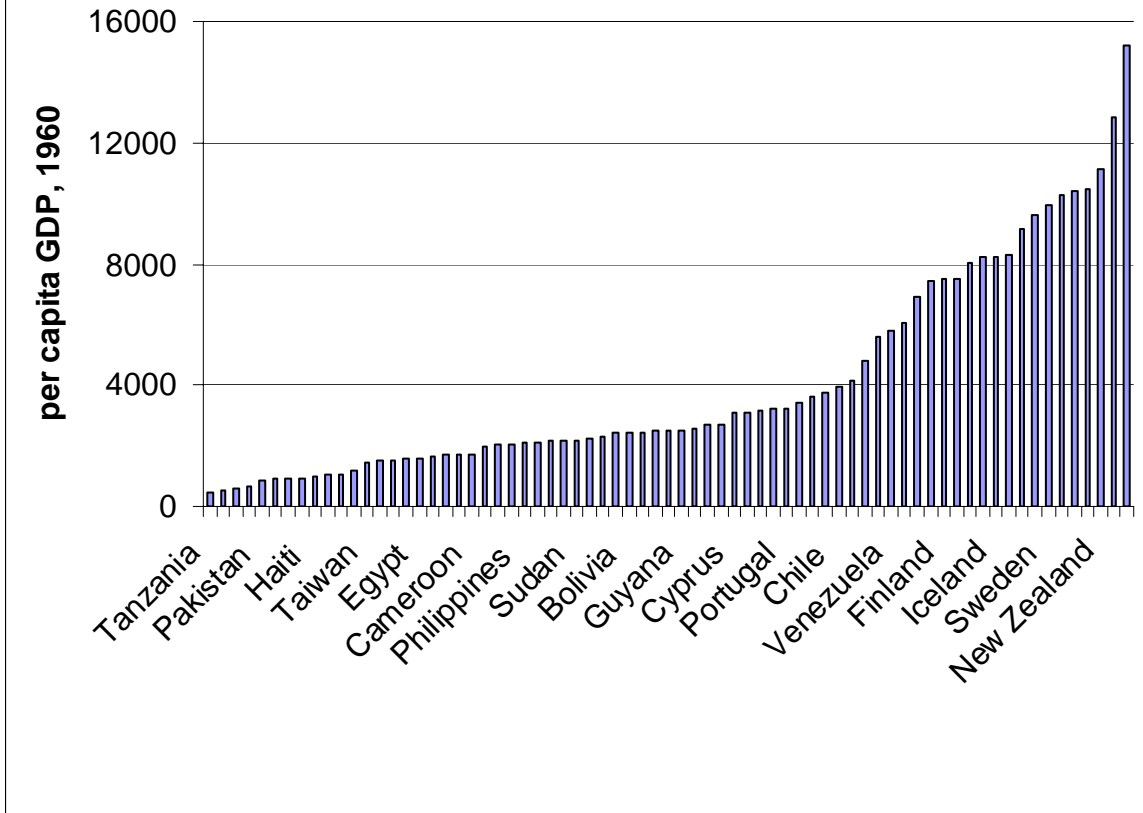
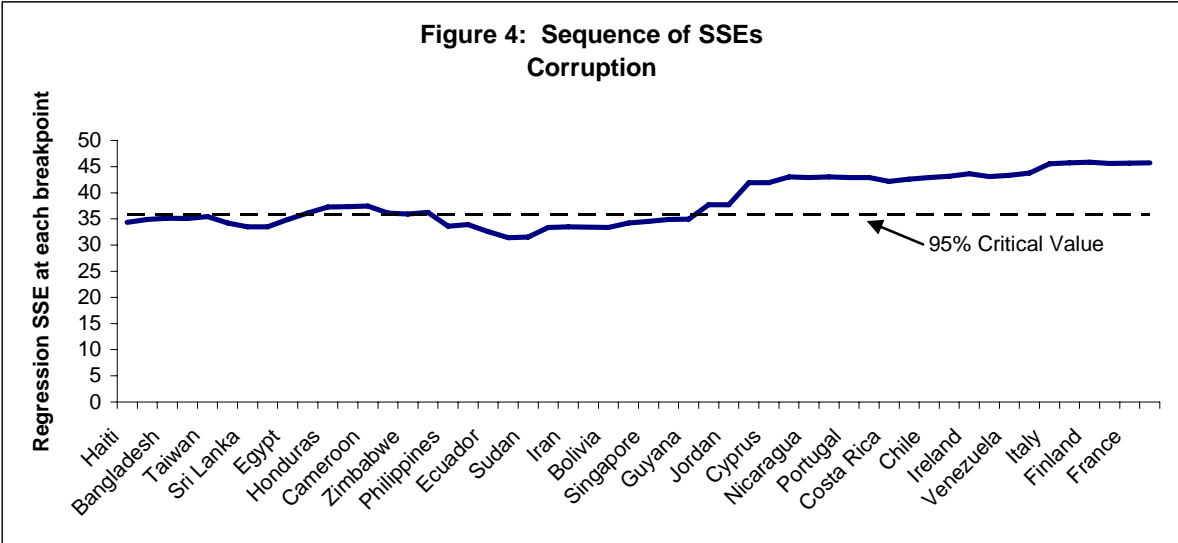
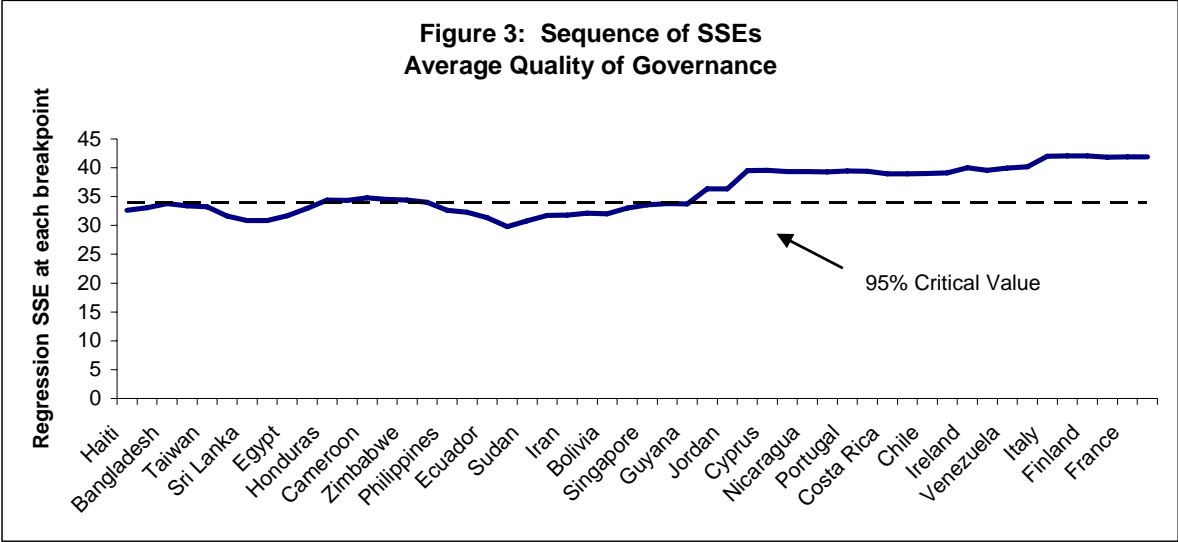
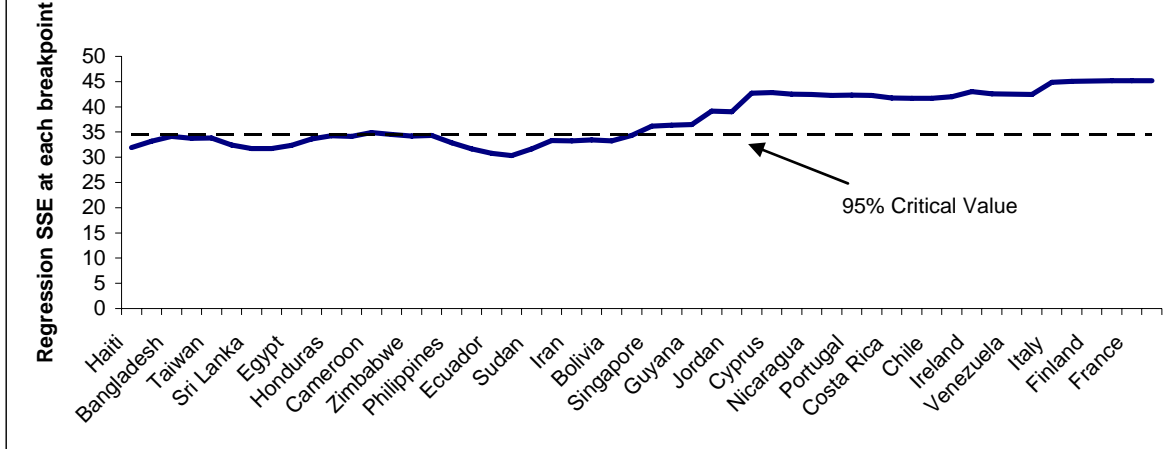


Figure 2: Distribution of Income, 1960

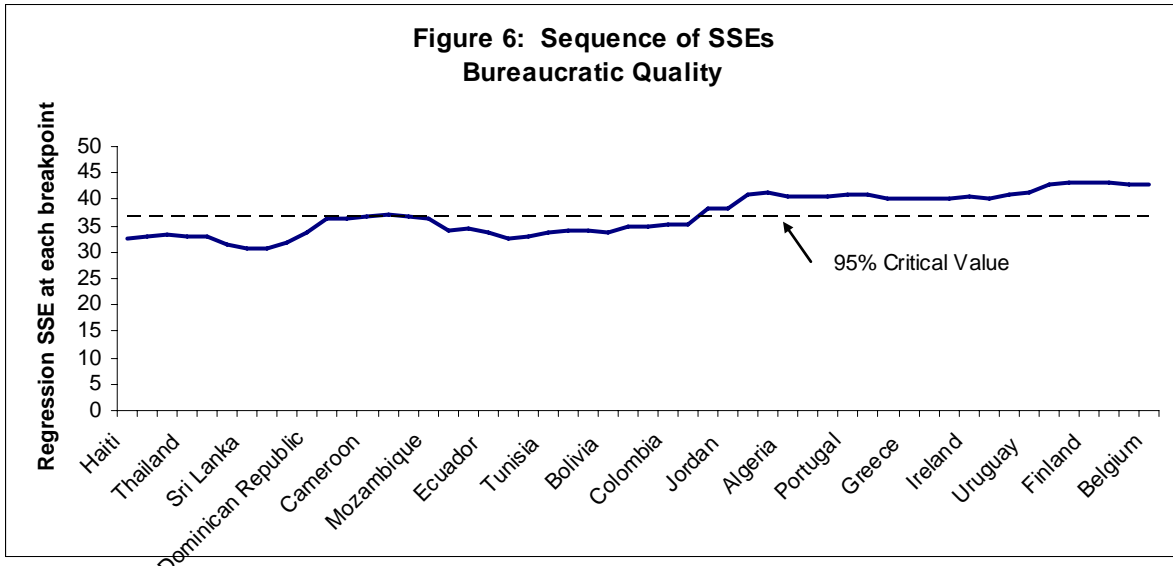




**Figure 5: Sequence of SSEs
Rule of Law**



**Figure 6: Sequence of SSEs
Bureaucratic Quality**



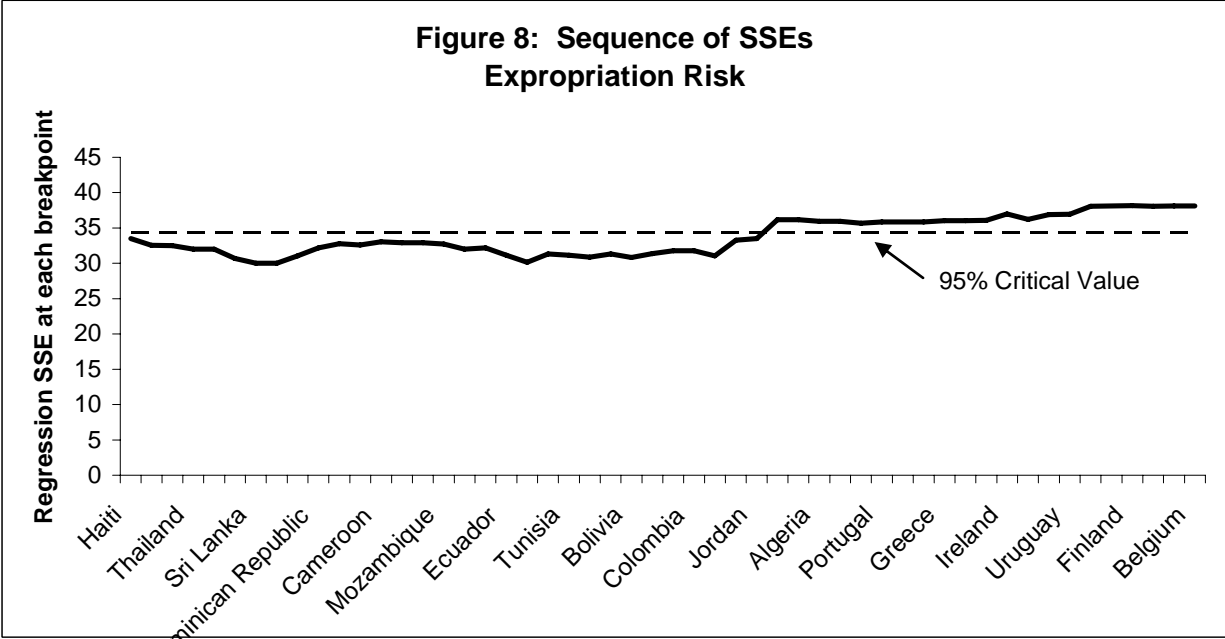
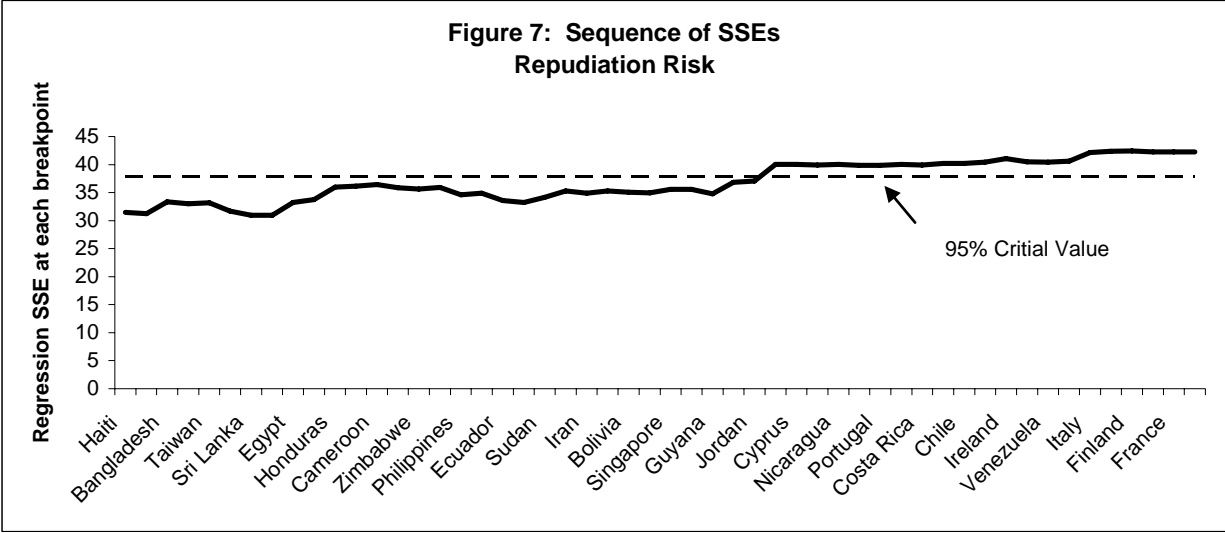


Figure 9: Coefficients on Quality of Governance Measures

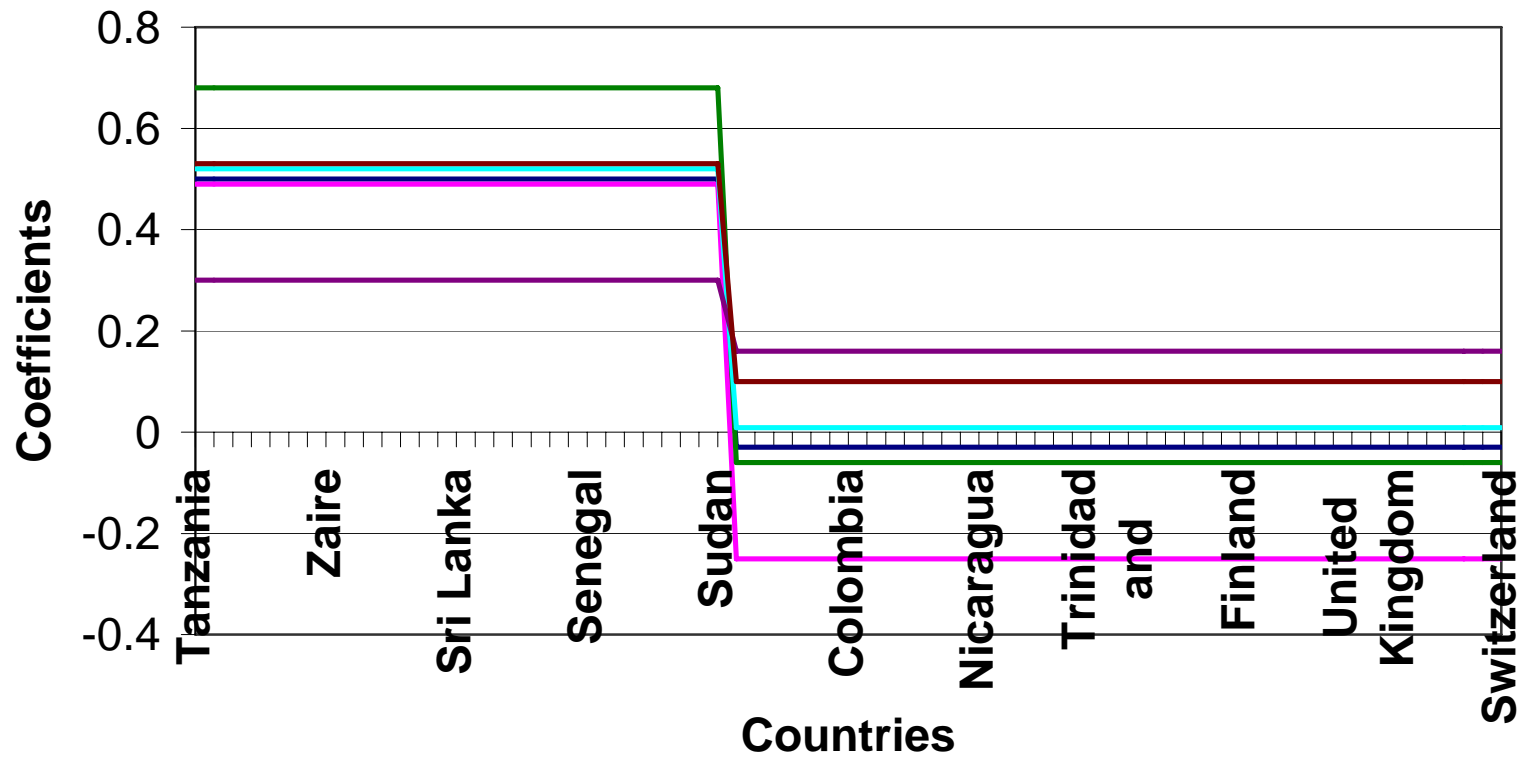


Figure 10: Coefficients on Enrollment

