THE CURSE OF NATURAL RESOURCES:
AN EMPIRICAL RESEARCH ON THE WORLD LEVEL

by

Xiangyu Xu

Approved:

John Mackenzie, Ph.D.
Professor in charge of thesis on behalf of the Advisory Committee

Approved:

Titus O. Awokuse, Ph.D.
Chair of the Department of Applied Economics and Statistics

Approved:

Mark Rieger, Ph.D.
Dean of the College of Agriculture and Natural Resources

Approved:

James G. Richards, Ph.D.
Vice Provost for Graduate and Professional Education
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ABSTRACT

Economists have traditionally viewed natural resources as essential for economic growth, and differing resource endowments as the foundation for trade to exploit comparative advantages. Until about 1980, the mainstream economics rarely questioned the assumed link between resource abundance and growth. Since that time, however, economists have identified, confirmed, and sought to explain a contradictory phenomenon: many empirical studies in the two decades have shown that economic growth rates tend to be lower in resource-abundant economies than in countries with scarce natural resources. This thesis seeks to explain why.

Auty (1993) was the first to call this phenomenon “the curse of natural resources”. My research uses cross-sectional data collected from 207 countries to analyze the nature of this “curse”. I begin with a pooled ordinary least squares (OLS) regression analysis, which is the most commonly used modeling method in previous studies of this topic. I then introduce, discuss and test some alternative regression techniques that improve upon the pooled OLS model. My findings do not support the contention that natural resource abundance per se has a negative effect on economic growth. Rather, my results indicate that corruption is the likely impediment to strong economic performance in resource-abundant economies.

Keywords: Natural Resources, Economic Development, Corruption Perceptions Index
Chapter 1

INTRODUCTION

Economists have long recognized that, along with human and physical capital, a society’s natural resources are essential factors of production; these are often referred to as natural capital. Logically, a rich natural resource endowment should augment economic growth for at least two reasons. First, it generates resource rents for the owners of these resources, and increases aggregate demand directly. Second, it complements (and thus increases the marginal productivities of) labor and capital, and thus increases the wages and interest they earn. This point of view, deriving from 18th and early 19th-century economists such as David Ricardo, has dominated traditional economic development theory.

In the past several decades, however, various economists have noted that resource-rich countries often have slower economic growth rates than their resource-poor counterparts, contrary to the conventional wisdom. This phenomenon has come to be known as the “curse of natural resources” (Sachs and Warner, 1995).

Various economists have sought to explain how a rich natural resource endowment could be a “curse” rather than a “blessing” for economic development. Some, such as Jeffrey Sachs, use conventional economic theory to explain the negative effect as an anomaly, e.g., the recessionary effects of distorted exchange rates following Holland’s discovery of oil. Others, such as James Robinson and Daron Acemoglu, focus more on the historical and institutional differences between resource-rich and resource-poor counties. Resource-rich economies may not
be reinvesting the rents they generate from natural resource exploitation into other productive assets. Resource booms might actually reduce efficiency by diverting human and capital resources from more productive and innovative sectors. “Boom and bust” consequences of resource exploitation are all too common, particularly with regard to economic development and land use in Latin America. That is what triggered my interest in this research.
Chapter 2

LITERATURE REVIEW

The curse of natural resources has been the focus of numerous studies and intensive debate, many of which are on the existence of the curse itself. Economists hold three main streams of opinions, namely, it does exist, it does not exist, and it exists under certain conditions. Sachs and Warner (1995) hold the opinion that the curse of natural resources exists. In their empirical studies, variables that are usually considered of importance to economic growth (trade policy and rate of investment) are kept constant. Then, they determine that economic growth has a negative correlation with resource abundance. Papyrakis and Gerlagh (2004) determine that resource abundance has positive direct effects and negative indirect effects on economic growth, and usually, the latter has a more significant effect than the former. Arezki and Ploeg (2007) assert that, even when the variables geography, openness, and institution are held constant, the export of natural resource will affect income per capita negatively and is more severe in those economies with less trade openness. Torvik (2002) uses a rent-seeking model and determines that abundant resource will induce more people into nonproductive rent-seeking activities, lowering the number of people participating in productive activities and slowing down economic growth.

Davis (1995) is on the other side of this debate. He considers 22 mineral resource-rich economies together as a whole, compares its economy with the other 57 non-mineral resource-rich countries, and denies the existence of the resource curse phenomenon. Manzano and Rigobon (2001) assume that the curse of natural resources
is caused by a deficient credit market and mortgage bubble rather than the natural resource abundance itself. Moreover, Lederman and Maloney (2008) conduct an empirical analysis on the 1980–2005 cross-country data using a new econometric method (3SLS) and reject the null hypothesis of the negative effect of resource abundance on economy.

The third group of economists holds the opinion of the conditional existence of resource curse. Many economists argue that different choices of variables, transformation of data, and research methods lead to contradictory conclusions. Ding and Field (2005) use natural resource per capita as the main independent variable in the single-equation linear regression model and determine the positive effect that natural resource has on economic growth. By contrast, using the percentage share of the total capital of natural resources as the main independent variable, the regression result shows that natural resource has a negative effect on economic growth. Meanwhile, conflicting results are obtained when different types of natural resources are used in the regression. Sala-i-Maitin and Subramanian (2003) study the case of Nigeria and conclude that only mineral and oil resources result in the resource curse phenomenon, whereas other resources do not. Moreover, the quality of the institution matters significantly. Wen and King (2004) argue that countries with highly efficient institutions can develop well even with scarce resource endowment. By contrast, resource-rich countries with deficient institutions cannot develop well. Robinson, Torvik, and Verdie (2006) also raise similar assertions.

There are various theories purporting to explain the alleged negative correlation between natural resource abundance and economic growth.
The first theory is that the exportation of natural resources as primary products will worsen the terms of trade (TOT) of the exporting country. In essence, a comparative advantage in raw materials likely implies a comparative disadvantage in manufacturing. Given a competitive primary product market, the benefits from cost reduction can be shared by consumers eventually. However, benefits in the manufacturing industry will be shared by shareholders and workers rather than consumers because of the market advantage of manufacturing industry. The role of the manufacturing sector is more prominent than is suggested solely by its output or number of workers. It is a cornerstone of innovation in most major economies: manufacturing firms deeply involve in domestic corporate research and development (R&D), and the resulting innovations and productivity growth improve our standard of living. In economics, these characteristics decide there is a seller’s market for it. Thus, in the long term, countries that produce and export primary products have to increase its export to balance the import of the manufacturing industry, which undermine social welfare. However, this opinion is controversial. First, although the TOT worsens, the relationship between this fact and economic development is uncertain. Moreover, the scarcity of natural resource makes it different from ordinary primary products, as well as its price trend. Price fluctuation in the resource market is usually severe. However, whether price fluctuation is good or bad for economic development has not yet been determined by economists.

Recent contributions emphasize that the type of natural resource also matters. Murshed (2004) distinguishes “point-resource” economies, e.g., oil and mining, from “diffuse-resource” economies, which apply to those economies whose economic industry is highly diversified. Point resources (oil, ores, and crop plantations) are
considered to have more detrimental effects than diffuse resources. Compared with a diffuse-resource economy, a point-resource economy exhibits more centralized production modes and larger economies of scale, which makes it easier to generate nonproductive activities, such as rent seeking. Empirical studies suggest that the resource curse phenomenon is more severe in the point-resource economies of Latin America, Africa, and the Middle East compared with the diffuse-resource economies of East Asia. When considering the relationship between natural resource abundance and economic development, this theory places more weight on the type of resource than the level of abundance. If the economy of a country simply relies on the export of several types of natural resources, then labor, capital, and technology will aggregate in the single-resource sector and other industries, such as agriculture and manufacturing, will suffer loss. Thus, the foundation of economy is weakened.

A well-known explanation of the curse of natural resources is the Dutch disease effect. A decrease in Dutch manufacturing occurred because of the worsening of competitiveness associated with the export of natural gas found in Slochteren between the 1950s and 1960s. The windfall generated from the export of natural resources led to an increase in the real exchange rate, a decrease in the trade sector, and some deindustrialization (Corden and Neary, 1982).

Crowding-out effect theory is extensively recognized and supported by many economists. The basic theory postulates that an abundance of raw resources crowds out the activities that drive economic development. For example, education may suffer from crowding out if the dominant resource extraction sector does not require skilled labor, so human capital is underdeveloped. Asea and Lahiri (1999) tested a cross-sector endogenous growth model and to show how resource abundance crowds
out education by increasing the relative wages of unskilled labor. Papyrakis and Gerlagh (2007) used US state-level data on investment, education, trade openness, research and development, and corruption to estimate that the crowding out of education is the most significant factor contributing to 25% of the total negative effect that comes along with natural resource abundance. They also use an iterative model to determine the unexpected benefit from the sale of resource that increases future income, thus crowding out investment. The decrease in production outweighs the increase in income, thus resulting in the resource curse (Papyrakis and Gerlagh, 2006).

Another important crowding-out factor is innovation. Sachs and Warner (2001) assert that, if wages in the resource sector are high enough to encourage the innovator–entrepreneur to work there, then resource abundance will crowd out innovation.

There are various institutional explanations for the curse of natural resources as well. The most common institutional explanation is that resource abundance breeds corruption, favors rent seeking behavior over innovation and investment, and weakens the institutions on which economic growth depends. Acemoglu and Robinson (2012) have studied numerous cases of different nations particularly and proposed a global viewpoint of the mechanism based on the effect of political institutions on economic development. Their explanation for the economic failure of some nations is that their extractive economic institutions do not create the incentives needed for people to save, invest, and innovate. Extractive political institutions support these economic institutions by cementing the power of those who benefit from the extraction, which keeps poor countries poor and prevents them from attaining economic development.

Acemoglu and Robinson discuss a number of countries across Africa, South America, Asia, and the Middle East as case studies. The common element leading to
failure is the dominance of elites who design and exploit extractive political and economic institutions to enrich themselves and perpetuate their power at the expense of the majority of the people in the society. Acemoglu and Robinson (2012) assert a strong synergy between economic and political institutions. Extractive institutions concentrate power in the hands of a few elites and place few constraints on it. They structure the economic institutions to extract resources from the rest of the society. Extractive institutions concentrate the wealth generated by abundant resources in the hands of an elite minority, rather than promoting broad-based economic growth.

There are actually two parallel types of rent-seeking: namely, rent-seeking by entrepreneurs and rent-seeking by politicians. Abundant resources may attract entrepreneurs into nonproductive rent-seeking activities from real production sectors, which may impair economic growth (Torvik, 2002). Nonproductive rent-seeking activities can also concentrate political power, driving politicians to take advantage of resources for personal purposes, such as winning the election. Thus, allocations of resource endowments may become distorted by a synergy of political and economic rent-seeking (Robinson, Torvik, and Verdie, 2006).

Research on the relationship between natural resources and corruption is far from adequate. Leite and Weidmann (1999) conclude that capital-intensive natural resources can be a major inducement for corruption to emerge. Isham, Pritchett, and Busby (2005) state that natural resources and corruption are more closely tied together in those countries that are rich in point resources, such as oil, gas, and minerals. Bhattacharyya and Hodler (2008) set up an incomplete information dynamic game model to show how resource abundance can accelerate corruption, particularly where democratic institutions are weak.
When the rents from resources become high enough, but the government faces obstacles in allocating or difficulties in operating such resources, competitive rent-seeking may even lead to civil war. Shleifer, Murphy, and Vishny (1991) have discussed the importance of rent to the allocation of human capital. They assume that, if talents in the society are concentrated on nonproductive activities, then economic development will suffer.

Several economists have studied the relationship between resource abundance and civil war. A comprehensive study of civil war was carried out by a team from the World Bank in the early 21st century. The study framework, which comes to be called the Collier–Hoeffler Model, examines 78 five-year increments when civil war occurred from 1960 to 1999, as well as 1,167 five-year increments of "no civil war" for comparison, and subjects the dataset to regression analysis to see the effect of various factors. The model reveals that the propensity to civil war depends on three variables, namely, income per capita, economic growth rate, and economic structure, of which the proxy variable is the level of reliance on the export of primary products. The relationship between primary product export and civil war is nonlinear. When the ratio of primary product export to gross domestic product reaches as high as 30%, the risk of civil war reaches its maximum. A common explanation for a positive relationship between resource abundance and risk of civil war is that the resource provides war funding. This explanation is not yet supported by empirical studies, however.
Chapter 3

RAW DATA AND PRELIMINARY TESTS

In this thesis I use cross-sectional data covering up to 207 countries to test the relationship between natural resource endowments and economic growth. Data on forestry reserves, agricultural land and many other control variables on economic performance were collected from Nation Master’s consolidated database; the source of these data is the World Resources Institute. I extracted mineral reserves data from MineralsUK, the British Geological Survey's Centre for Sustainable Mineral Development. I collected GDP growth data, as a proxy of economic development, as well as fossil energy reserves data, from the CIA World Fact Book.

In addition, I used recent Corruption Perceptions Index data compiled by Transparency International, an international non-governmental organization, as a proxy for institution quality. This index is a distillation of many data sources; a detailed introduction and description of these is included in Appendix A.

At the start of this study, I looked at the relationship between the economic growth and natural resources reserves by plotting the real GDP growth over 10 years (or 5 years) against the total fossil fuel energy reserves equivalent in quadrillions, of each country. The results are shown in Figure 1 and Figure 2.
Figure 1. Plotted 10-Year Economic Growth (2004-2013) vs. Natural Resource Reserve
The two charts above indicate that energy reserves affect economic development positively, and do not support the hypothesis of a resource “curse” effect. In the following two chapters I develop a set of multivariate regression models to test
both resource endowments and institutional quality as drivers of economic development.
Chapter 4

METHODOLOGY AND DATA

My empirical analysis begins with two simple pooled Ordinary Least Squares (OLS) regressions. The dependent variables are GDP growth rates over five- and ten-year periods. The right-hand-side variables include endowments of various categories of natural resources, grouped into fossil fuel energy, mineral wealth, agricultural land and forestry. I include Transparency International’s Corruption Perceptions Index as a gauge of institutional and political quality.

The regression model is specified as:

\[ \text{Log(Economic Growth)} = \beta_0 + \beta_1 \times \text{Log(Corruption)} + \beta_2 \times \text{Log(Fossil Fuel Energy Reserve)} + \beta_3 \times \text{Log(Agricultural Land)} + \beta_4 \times \text{Log(Forestry)} + \beta_5 \times \text{Log(Mineral Wealth Index)} + \mu \]

Basically, the model is built in the form of Cobb-Douglas production function. The beauty of it lies in that the estimated coefficients represent the elasticity of the dependent variable against each RHS variables. This is very useful information as it reveals the practical significance each independent variable has; namely we will be able to infer through the coefficient that how the economic growth is going to change if the endowment of a RHS variable is changed.
I use real GDP growth to represent overall economic growth. Rather than short-term growth, long-term growth is supposed to be better explained by natural resource endowments. Thus, throughout the whole modeling process, I test separate regressions for 5-year and 10-year growth respectively.

The Corruption Perceptions Index is a calculated score in the range of 0-100, where higher score indicates better institutional performance and function, and a more transparent political and economic environment. In other words, this index of “corruption” is actually the reverse of common understanding of its name.

My fossil fuel energy reserve variable is the summation of total oil, gas and coal reserves converted to BTU equivalents (in quadrillions). Agricultural land and forestry are gauged as land areas. I generated the Mineral Wealth Index by multiplying the amount of each major mineral resource reserve (diamonds, gold, silver, iron, copper, zinc, lead, nickel, manganese) by its current market value in US dollars, and then summing across reserves. This is a very crude but serviceable measure of mineral wealth. Actually a more ideal way to calculate the index is to use the unit rent of each mineral resource reserve in its country instead of using the market price, as there is a cost to exploit and utilize the reserve. Unfortunately that information and data is barely available, I choose to use the market value in this research.

In using Pooled OLS model as a starting point, there are several assumptions regarding the data that are necessary for valid hypothesis testing. Since the raw data have skewed distributions and are likely to generate heteroscedasticity, I transformed them into log form for regression analysis. The residuals are implicitly multiplicative rather than additive, but they are approximately normal. I also divided all natural resource related control variables by the population of their countries, namely we run
all the regressions on a per capita basis. This solves the heteroscedasticity problem quite well. The residuals from the transformed data are shown in Figure 3 and Figure 4.

Figure 3. Plotted Residuals vs. Natural Resource Related Variables (10-Year Regression)
Figure 4. Plotted Residuals vs. Natural Resource Related Variables (5-Year Regression)
These plot charts do not reveal any patterns of heteroscedasticity. I also performed Glejser and White tests to make sure the data is free from the problem of heteroscedasticity.

Another concern is to be sure that the data does not suffer multicollinearity. The correlation between variables is shown in Table 1 and Table 2. Table 1 has 71 observations for 10-year analysis and Table 2 has 63 for 5-year analysis.

Table 1. Correlation Table (10-Year Regression)

<table>
<thead>
<tr>
<th></th>
<th>Corruption Perceptions Index</th>
<th>Fossil Fuel Energy</th>
<th>Agricultural Land</th>
<th>Forestry</th>
<th>Mineral Wealth Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corruption Perceptions Index</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.1230632</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.0337168</td>
<td>0.3017708</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forestry</td>
<td>0.1000214</td>
<td>0.1960500</td>
<td>0.3852300</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.0376162</td>
<td>0.2316308</td>
<td>0.5235272</td>
<td>0.6747476</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 2. Correlation Table (5-Year Regression)

<table>
<thead>
<tr>
<th></th>
<th>Corruption Perceptions Index</th>
<th>Fossil Fuel Energy</th>
<th>Agricultural Land</th>
<th>Forestry</th>
<th>Mineral Wealth Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corruption Perceptions Index</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.1469335</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>0.0277548</td>
<td>0.3265640</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forestry</td>
<td>0.2031251</td>
<td>0.2675009</td>
<td>0.3690575</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.1604500</td>
<td>0.2681214</td>
<td>0.5246195</td>
<td>0.6623640</td>
<td>1</td>
</tr>
</tbody>
</table>

These tables indicate some multicollinearity between forest and mineral resource endowments while the other variables are free from the problem.

I begin with OLS regressions as a baseline for comparing results from several other regression methods. The first alternative method is a standardized coefficient regression procedure in which the independent variables are standardized to $N(0,1)$. The standardized regression coefficients refer to how many standard deviations a dependent variable will change, per standard deviation increase in the RHS variable. This is to find out the level of impact that each control variable has on the dependent variable.
The next method to be tested is robust regression. My data include certain outlier countries that exert excessive leverage in the OLS regression. Some countries have extremely large reserves of certain resources, and/or very high GDP. I could delete these countries from my analysis, but this will lead to a loss of information. In this case, robust regression reduces the effect of these outliers in the model. Moreover, the residual plot charts reveal that although the distribution is roughly normal, it probably suffers the fat-tailed problem. In other words, it exhibits large kurtosis, which makes the hypothesis testing in the OLS regression problematic. Robust regression is more appropriate for using to deal with this problem as it down-weights the observations with residuals in the tail part of the distribution.

Robust regression can be used on any data with large outliers or high-leverage data points, where these data points are not in error, and there is no other reason to exclude them from the analysis. The basic idea of robust regression is to weight the observations by some alternative to least squared deviations. I use two OLS modifications (bi-square and Huber weighting) at the end of Chapter 5, and present two programming-based methods, a minimized absolute deviation model and an orthogonal regression model, in Chapter 6.
Chapter 5

RESULTS AND INTERPRETATIONS

The results from the OLS model, as well as from the Standardized Coefficient Regression model, are consolidated and summarized in Table 3-6 shown as below:

Table 3. Summarized Results of Pooled OLS Model for 10-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>T Value (P Value)</th>
<th>Standardized Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8.66935</td>
<td>13.08*** (&lt;0.0001)</td>
<td>0</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.02574</td>
<td>4.64*** (&lt;0.0001)</td>
<td>0.43197</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.25352</td>
<td>4.94*** (&lt;0.0001)</td>
<td>0.48119</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.04589</td>
<td>-0.52 (0.6058)</td>
<td>-0.05739</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.00431</td>
<td>0.05 (0.9566)</td>
<td>0.00683</td>
</tr>
</tbody>
</table>
Number of Observations: 71

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Table 4. ANOVA Table of Pooled OLS Model for 10-Year Growth

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>35.45896</td>
<td>7.09179</td>
<td>10.88***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>65</td>
<td>42.38634</td>
<td>0.65210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>70</td>
<td>77.84530</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Observations: 71

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 5. Summarized Results of Pooled OLS Model for 5-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>T Value (P Value)</th>
<th>Standardized Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.07905</td>
<td>12.82*** (&lt;0.0001)</td>
<td>0</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.01611</td>
<td>3.33*** (0.0015)</td>
<td>0.34730</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.16634</td>
<td>3.74*** (0.0004)</td>
<td>0.40852</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.00094</td>
<td>-0.01 (0.9896)</td>
<td>-0.00161</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.02150</td>
<td>0.33 (0.7412)</td>
<td>0.04547</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.03648</td>
<td>0.91 (0.3676)</td>
<td>0.13417</td>
</tr>
</tbody>
</table>

Number of Observations: 63

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 6. ANOVA Table of Pooled OLS Model for 5-Year Growth

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>16.87508</td>
<td>3.37502</td>
<td>8.16***</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>57</td>
<td>23.56261</td>
<td>0.41338</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>62</td>
<td>40.43769</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Observations: 63
* Significant at 10%; ** Significant at 5%; *** Significant at 1%

The regression results show that, first of all, these models are strongly significant overall. The agricultural land, forestry and mineral wealth indices are not shown to have significant impact on economic growth rates. However, the estimated coefficients on the other two RHS variables, Corruption Perceptions Index and fossil fuel energy, are significant at 99% confidence level. The parameter estimates indicate that both of these two factors will have positive effect on the economic development, meaning that the theory of natural resource curse is rejected by our OLS model.

The standardized OLS model yields similar results, with the Corruption Perceptions Index and fossil fuel energy reserves shown to be major drivers of economic growth.
economic development (10-Year Regression: 0.43 vs. 0.48; 5-Year Regression: 0.35 vs. 0.41).

These results show how countries with rich resource reserves can have poor economic performance because of institutional failures. In fact, institutional failures appear to be the true “curse” frustrating development, regardless of natural resource wealth. For instance, in the 10-year regression, the estimated coefficient for Corruption Perceptions Index is 0.026, meaning that, for a moderately corrupted country with a score of 60, if it improves by 6 points (a 10% improvement), it’s economic growth can improve by 15.6%; if it go worse by 6 points, its development rate will drop by 15.6%. This change is indeed dramatic. Then, does resource wealth invite corruption? The low correlation between the Corruption Perceptions Index and resource endowments (in Tables 1 and 2) does not suggest this.

I tested two different robust regressions based on Tukey bi-square and Huber weighting. In bi-square weighting, all cases with a non-zero residual get down-weighted at least a little; while in Huber weighting, observations with small residuals get a weight of 1 and the larger the residual, the smaller the weight.

The results of these robust regressions are summarized in Tables 7 – 10.
Table 7. Summarized Results of Robust Regression (Bisquare Weighting) for 10-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>Chi-Square (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.9786</td>
<td>240.16*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0210</td>
<td>23.74*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.2218</td>
<td>31.02*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.1029</td>
<td>2.24 (0.1342)</td>
</tr>
<tr>
<td>Forestry</td>
<td>-0.0222</td>
<td>0.13 (0.7167)</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.0731</td>
<td>3.91** (0.0480)</td>
</tr>
</tbody>
</table>

Number of Observations: 71

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 8. Summarized Results of Robust Regression (Bisquare Weighting) for 5-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>Chi-Square (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.7578</td>
<td>144.92*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0134</td>
<td>7.47*** (0.0063)</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.1516</td>
<td>11.23*** (0.0008)</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.0384</td>
<td>0.28 (0.5981)</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0052</td>
<td>0.01 (0.9373)</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.0766</td>
<td>3.52* (0.0606)</td>
</tr>
</tbody>
</table>

Number of Observations: 63

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 9. Summarized Results of Robust Regression (Huber Weighting) for 10-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>Chi-Square (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8.1189</td>
<td>239.07*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0221</td>
<td>25.38*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.2267</td>
<td>31.14*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.0879</td>
<td>1.57 (0.2100)</td>
</tr>
<tr>
<td>Forestry</td>
<td>-0.0204</td>
<td>0.11 (0.7444)</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.0549</td>
<td>2.12 (0.1455)</td>
</tr>
</tbody>
</table>

Number of Observations: 71

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 10. Summarized Results of Robust Regression (Huber Weighting) for 5-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>Chi-Square (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.8710</td>
<td>166.09*** (&lt;0.0001)</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0147</td>
<td>9.85*** (0.0017)</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.1546</td>
<td>12.96*** (0.0003)</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.0285</td>
<td>0.17 (0.6807)</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0134</td>
<td>0.05 (0.8309)</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.0606</td>
<td>2.44 (0.1180)</td>
</tr>
</tbody>
</table>

Number of Observations: 63

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

The regression results in the tables above roughly agree with the results from the OLS model: the most significant variables are still Corruption Perceptions Index and fossil fuel energy reserve, and the signs of parameters are positive as well. One big difference is that, compared to OLS Regression, Robust Regression gives the
mineral wealth index higher significance: around 95% confidence level for the 10-Year growth regression and 90% for the 5-Year growth.
Chapter 6

DISCUSSION

The pooled OLS regression is the most common method used in previous studies of this topic. However, further discussions of its feasibility and optimization is needed given the properties of the data.

I discussed two weight-based robust regression models in the previous chapter. These two regressions, based on different weights assigned to each observation, have not changed the basic OLS regression method. In this chapter I test two other regression methods: a Least Absolute Deviations Regression (LAD) method, and an Orthogonal Regression method.

The LAD model minimizes the sum of absolute errors (SAE) in the RHS variables, i.e., the sum of the absolute values of the vertical "residuals" between points generated by the function and corresponding points in the data. LAD gives equal emphasis to all observations, in contrast to OLS which, by squaring the residuals, gives more weight to large residuals, that is, outliers in which predicted values are far from actual observations. This may be helpful in studies where outliers do not need to be given greater weight than other observations. It is also more appropriate to deal with the problem of fat-tailed distribution that often occurs to OLS regression.

Another drawback of the OLS model is its assumption that the “error” lies solely in the dependent variable Y, but not in the RHS variables. This is not necessarily true of most research data, including my data. If the RHS variables are truly “fixed in repeated samples,” then it is sensible to attribute all the error terms to
Y, and use an estimator that minimizes the squared vertical distances. But when the X and Y variables are subject to the same measurement errors, other methods than OLS may provide a better fit for this research. In this thesis, I use an Orthogonal Regression method, which minimizes the sum of the squared perpendicular deviations of the data points from the regression line.

The regression results for both 10-year and 5-year analysis using LAD are given in Table 11 – 14.

Table 11. Summarized Results of LAD Model for 10-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>T Value (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.6391</td>
<td>7.2439***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0241</td>
<td>3.0188***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.2309</td>
<td>3.5197***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.1313</td>
<td>-1.2660</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;0.100</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0124</td>
<td>0.1500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;0.100</td>
</tr>
</tbody>
</table>
Mineral Wealth Index  

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>47.4883</td>
<td>9.4977</td>
<td>20.3363***</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Error</td>
<td>65</td>
<td>30.3570</td>
<td>0.4670</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>70</td>
<td>77.8453</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Observations: 71  

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 13. Summarized Results of LAD Model for 5-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>T Value (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.5927</td>
<td>8.1633***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0118</td>
<td>2.0028**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.1379</td>
<td>2.6666***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.0822</td>
<td>2.3803**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.025</td>
</tr>
</tbody>
</table>

Number of Observations: 63

* Significant at 10%; ** Significant at 5%; *** Significant at 1%
Table 14. ANOVA Table of LAD Model for 5-Year Growth

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>24.7133</td>
<td>4.9427</td>
<td>17.9168***</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Error</td>
<td>57</td>
<td>15.7244</td>
<td>0.2759</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>62</td>
<td>40.4377</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of Observations: 63

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Table 15 – 18 below give summarized results from Orthogonal Regression.

Table 15. Summarized Results of Orthogonal Regression for 10-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>T Value (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8.1174</td>
<td>7.6975***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Corruption Index 0.0227 3.1874*** <0.005
Fossil Fuel Energy 0.2770 4.3988*** <0.001
Agricultural Land -0.2248 -2.3523** <0.025
Forestry 0.0269 0.3564 >0.100
Mineral Wealth Index 0.1080 2.5562*** <0.01

Number of Observations: 71
* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Table 16. ANOVA Table of Orthogonal Regression for 10-Year Growth

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>50.7006</td>
<td>10.1401</td>
<td>24.2813***</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Error</td>
<td>65</td>
<td>27.1447</td>
<td>0.4176</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Number of Observations: 71

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Table 17. Summarized Results of Orthogonal Regression for 5-Year Growth

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimates</th>
<th>T Value (P Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>6.7625</td>
<td>8.3736***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Corruption Index</td>
<td>0.0099</td>
<td>1.6803**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.050</td>
</tr>
<tr>
<td>Fossil Fuel Energy</td>
<td>0.1803</td>
<td>3.4865***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>-0.1387</td>
<td>-1.8678**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.050</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0066</td>
<td>0.1099</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;0.100</td>
</tr>
<tr>
<td>Mineral Wealth Index</td>
<td>0.1291</td>
<td>3.7383***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Both the LAD and Orthogonal Regression models yield higher-significance parameters than the OLS models presented earlier. The Orthogonal Regression models indicate that both corruption and agricultural resources impede growth, while
both energy and mineral endowments promote growth. These results appear to contradict Murshed’s “point” vs. “diffuse” hypothesis.

Obviously the data used in this thesis are problematic. Although I started with 207 countries, at least some data are missing for most of these. The resource endowment data are estimated with varying degrees of accuracy, and are updated irregularly. Data on specific natural resource sub-categories (such as specific mineral reserves) are unavailable for many countries. The more sub-categories to include, the more observations to lose. My final 10- and 5-year growth models were estimated with data on only 70 and 63 countries respectively.
Chapter 7

CONCLUSION

This thesis has investigated the statistical relationship between countries’ natural resource endowments, institutional efficiencies and economic growth rates. I used various regression methods to reject the standard “curse of natural resources” hypothesis, and showed that institutional failures are a true impediment to growth.

Starting from a conventional OLS regression model, I tested a variety of alternative estimation methods: standardized regression, two re-weighted robust regression methods, a Least Absolute Deviations model, and an orthogonal model. I conclude that the LAD and orthogonal regression methods are preferable when modeling with data such as the variables used here.

The results from all of these models are broadly consistent. Fossil fuel energy resources are shown to be significant drivers of economic growth, so at least on a global scale, the theory of “the curse of natural resources” is rejected.

My thesis also proves the importance of efficient economic and political institutions (represented by the Corruption Perceptions Index) in supporting growth. This is consistent with Amecoglu and Robinson.

There are numerous avenues for future research on this topic. I would like to see more research on possible linkages between resource wealth and corruption. I did not find any direct “curse” of natural resources, but there may be an indirect “curse” if resource wealth breeds corruption.
REFERENCES


Bhattacharyya, S. and R. Hodler. 2008. “Natural Resources, Democracy and Corruption” Department of Economics, the University of Melbourne, Research Paper NO. 1047,


Appendix A

DATA SOURCE – CORRUPTION PERCEPTIONS INDEX

This data is obtained at Transparency International (http://www.transparency.org/), according to the description on their website, we summarize the data sources and descriptions below:

13 data sources were used to construct the Corruption Perceptions Index 2013:

1. **African Development Bank Governance Ratings 2012**

   The AfDB’s 2012 Governance Ratings are part of the Country Policy and Institutional Assessment (CPIA), which assesses the quality of a country’s institutional framework in terms of how conducive it is to fostering the effective use of development assistance.

   All African Countries (54) are covered.

   Countries are scored in terms of their performance during the year of the rating vis-à-vis the criteria, which are included in the CPIA Manual for Drafters and updated every year. The CPIA is a three-phase process involving i) the rating of countries by country teams; iii) the review of all ratings by sector experts; and iii) the endorsement of final ratings at open discussions between country teams and reviewers.

2. **Bertelsmann Foundation Sustainable Governance Indicators 2014**

   The Sustainable Governance Indicators (SGI) examine governance and policymaking in all OECD and EU member states in order to evaluate each country's
need for, and ability to carry out, reform. The indicators are calculated using quantitative data from international organizations and then supplemented by qualitative assessments from recognized country experts.

All 41 OECD and EU countries were scored.

The quantitative data are compiled centrally by the SGI project team from official, publicly accessible statistics (primarily from OECD sources). The qualitative data are captured and examined by a worldwide network of around 100 respected researchers.

3. Bertelsmann Foundation Transformation Index 2014

The Transformation Index provides the framework for an exchange of good practice among agents of reform. Within this framework, the BTI publishes two rankings, the Status Index and the Management Index, both of which are based on in-depth assessments of 129 countries. The scores are based on detailed country reports which assess 52 questions divided into 17 criteria.

129 countries and territories are scored.

Country scores pass through an intra-regional review stage followed by an inter-regional review and ratings aggregation.

4. Economist Intelligence Unit Country Risk Ratings

Country Risk Ratings are designed to provide in-depth and timely analysis of the risks of financial exposure in more than 140 countries. The economic and political reports produced by EIU analysts are subjected to a rigorous review process before publication.
139 countries/territories were scored in 2013 and data for 2012 was used for 4 countries, Barbados, Dominica, Guinea and Swaziland and from 2011 for Benin.

5. Freedom House Nations in Transit 2013

The Nations in Transit (NIT) reports measure democratisation in 29 nations and administrative areas throughout Central Europe and the Newly Independent States (NIS). The reports focus on democratic progress and setbacks. Each report focuses on the following thematic areas: national democratic governance; electoral process; civil society; independent media; local democratic governance; judicial framework and independence; and corruption.

29 countries/territories were ranked in 2013.

Country scores are reviewed at the regional level and then centrally by the Freedom House academic advisory board.

6. Global Insight Country Risk Ratings

The Global Insight country risk rating system has been in operation since 1999 and provides a six-factor analysis of the risk environment in 204 countries/territories. The six factors are political, economic, legal, tax operational and security risk. The ratings assess the broad range of corruption, from petty bribe-paying to higher-level political corruption and the scores assigned to each country are based on a qualitative assessment of corruption in each country/territory.

203 countries/territories worldwide are scored.

Scores provided by country analysts are reviewed and benchmarked by IHS Global Insight's risk specialists at both the regional and global level.
7. IMD World Competitiveness Yearbook 2013

The World Competitiveness Yearbook (WCY) measures the competitiveness of nations and, in doing so, both ranks and examines how a nation’s socio-political and economic climate affects corporate competitiveness. The IMD World Competitiveness Centre works in collaboration with 54 partner institutes around the world to assure the validity and relevance of data.

60 countries/territories around the world were scored in 2013.

8. Political and Economic Risk Consultancy Asian Intelligence 2013

The Political and Economic Risk Consultancy or PERC is a consulting firm specialising in strategic business information and analysis for companies doing business in the countries of East and Southeast Asia. As part of its services, PERC produces a range of risk reports on Asian countries, paying special attention to critical socio-political variables like corruption, intellectual property rights and risks, labour quality, and other systemic strengths and weakness of individual Asian countries/territories.

PERC publishes fortnightly newsletters, which are available to subscribers, on a number of issues. The data for the CPI was gathered from the corruption newsletter, which gathers and interprets data from an executive opinion survey of local and expatriate businesspeople.

The survey was conducted via face-to-face, telephone and online interviews. Business people were asked about both the country in which they currently work and their country of origin. 100 business executives were surveyed in each country.
15 Asian countries/territories plus the United States were surveyed in 2013. The same questions and survey methodology were employed in each country surveyed.


ICRG staffs collect political information and convert it to risk points on the basis of a consistent pattern of evaluation. Political risk assessments and other political information form the basis of ICRG risk ratings. It is therefore possible for the user to check through the information and data so as to assess the ratings against their own assessments, or against some other risk ratings system.

The ICRG provides ratings for 140 countries on a monthly basis.

To ensure consistency both between countries/territories and over time, points are assigned by ICRG editors on the basis of a series of pre-set questions for each risk component.


Transparency International commissioned the tailor-made Bribe Payers Survey. This is a survey of business executives in 30 countries/territories around the world which probes perceptions of bribery and corruption both in their country of operation and by companies from other countries that they do business with.

30 countries were surveyed in 2011.

The same question was asked of respondents in all countries, about bribery and corruption both at home and in the context of international business dealings.

The CPIA rates all IDA-eligible countries against a set of 16 criteria grouped in four clusters: (a) economic management; (b) structural policies; (c) policies for social inclusion and equity; and (d) public sector management and institutions. The criteria are focused on balancing the capture of those factors critical to fostering growth and poverty reduction against avoiding undue burden on the assessment process.

80 countries were scored in the CPIA 2012.

12. World Economic Forum Executive Opinion Survey (EOS) 2013

The Executive Opinion Survey (EOS) is the World Economic Forum's annual survey of business executives. The survey has evolved over time to capture new data points essential to the Global Competitiveness Index (GCI) and other Forum indexes.

The Forum's Global Competitiveness and Benchmarking Network works closely with a network of over 160 Partner Institutes that administer the survey in their respective countries/territories. They are selected because of their capacity to reach out to leading business executives as well as their understanding of the national business environment and their commitment to the Forum's research on competitiveness. The Partner Institutes are, for the most part, well-respected economics departments of national universities, independent research institutes or business organizations.

In 2013 the survey captured the views of business executives in 148 economies. Data for Tajikistan was taken from the 2012 survey.

13. World Justice Project Rule of Law Index 2013
The WJP Rule of Law Index is an assessment tool designed by The World Justice Project to offer a detailed and comprehensive picture of the extent to which countries/territories adhere to the rule of law in practice. The Index provides detailed information and original data regarding a variety of dimensions of the rule of law, which enables stakeholders to assess a nation’s adherence to the rule of law in practice, identify a nation’s strengths and weaknesses in comparison to similarly situated countries, and track changes over time.

The Index’s rankings and scores are the product of a rigorous data collection and aggregation process. Data comes from a global poll of the general public and detailed questionnaires administered to local experts. To date, over 2,000 experts and 66,000 other individuals from around the world have participated in this project.

97 countries were scored in the 2012-2013 Rule of Law index.

The index is deliberately intended to be applied in countries with vastly differing social, cultural, economic, and political systems.
Appendix B

DATASET FOR 10-YEAR REGRESSION

Table B1. Dataset for 10-Year Regression

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### Appendix C

**DATASET FOR 5-YEAR REGRESSION**

Table C1. Dataset for 5-Year Regression

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