Corruption and the Curse of Natural Resources

by

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B.A., Simon Fraser University, 2005

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Abstract

In 1995, Jeffrey Sachs and Andrew Warner found a negative relationship between natural resources and economic growth, and claimed that natural resource abundance is a curse. The work of Sachs and Warner has been widely cited, and many economists now accept the curse of natural resources as a proven phenomenon (e.g. Papyrakis and Gerlagh, 2004; Kronenberg, 2004). In this thesis, I provide a new framework for evaluating this claim. I begin by providing a summary of the related literature and discussion of possible explanations for the curse. This summary is followed by a critical assessment of the theory underlying previous research. Next, I develop a new model for evaluating the curse of natural resources. I find that natural resource abundance does not directly impact economic development. However, petroleum resources are associated with rent-seeking behaviour that can negatively influence economic development. Finally, I show that my results are robust to various sensitivity analyses. The results from my model provide a deeper understanding of how natural resource abundance affects economic outcomes.

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1 Introduction

What role do natural resources play in the process of economic development? Economists and other social scientists have been struggling to answer this question for several decades.

First, let's look at some examples from history. In the late nineteenth and early twentieth century, Britain and France gained economic prosperity by exploiting the natural resources of the colonies within their empires. Britain benefited from gold and diamond extraction in South Africa, while France benefited from harvesting rubber and mining bauxite in Guinea. During the nineteenth century, land was one of the most important natural resources, and land abundant countries such as Canada, the United States and Australia had some of the highest real wages in the world (Weil, 2005). Countries such as Britain, Germany and the United States relied heavily on coal and iron ores deposits during their industrialization phases (Sachs and Warner, 1995). In fact, some developed countries still rely heavily on natural resources to this day. For example, Canada's forestry sector provides about five percent of all jobs in Canada. These examples suggest that natural resources promote economic development.

History tells us that natural resource abundance is not a requirement for economic prosperity. Switzerland is one of the wealthiest countries in the world today, but its path to economic prosperity was more dependent on well-developed financial and manufacturing sectors than on natural resource extraction. More recently, the Asian countries of Hong Kong, Singapore, South Korea and Taiwan have become developed nations, although natural resources are relatively scarce in all of these countries.

Nor does natural resource abundance guarantee economic prosperity. South Africa and Venezuela possess an abundance of natural resources, but neither country enjoys a high standard of living; both countries are plagued by corruption, civil unrest and income inequality. Several million people in each of these countries live below the international poverty line. These examples suggest that natural resources may have a negative influence on economic development.

The historical evidence can be summarized with two basic claims: i) natural resources are not a necessary condition for economic development, and ii) natural resources are not a sufficient condition for economic development. So, are natural resources a curse or a blessing?

Other economists have already made attempts to answer this question. In 1995, Jeffrey Sachs and Andrew Warner found a negative relationship between natural resources and economic growth, and claimed that natural resource abundance is a curse. The work of Sachs and Warner has been widely cited, and many economists now accept that natural resources are an obstacle (curse) to economic development (e.g. Papyrakis and Gerlagh, 2004; Kronenberg, 2004). But not all economists agree. Despite widespread acceptance of the curse of natural resources, there is also a significant amount of contradictory evidence that suggests that natural resource abundance may not hinder economic outcomes (e.g. Sala-i-Martin and Subramanian, 2003). In this thesis, I provide a new framework for evaluating the curse of natural resources.

Chapter 2 begins with a review of previous literature related to the natural resource curse hypothesis, followed by a discussion of possible explanations for the existence of the curse. From here, Chapter 3 moves on to a theoretical discussion about how the resource curse should be specified. In Chapter 4, I lay out a new framework for evaluating the validity of the resource curse hypothesis. My empirical results are presented in Chapter 5, followed by a detailed discussion of the results in Chapter 6. The findings are subjected to various sensitivity analyses in Chapter 7. Finally, the last chapter provides concluding remarks and recommendations for future research.

2 Past Research

This section provides an overview of past research related to the curse of natural resources. First, I present some evidence for and against the curse. Next, I provide a detailed description of possible explanations for the existence of the curse.

2.1 Evidence For and Against the Curse

In the literature on the resource curse, it appears that the most commonly cited authors are Sachs and Warner. In their 1995 paper, Sachs and Warner found a negative relationship between the share of primary exports in GDP and economic growth between 1970 and 1989. Although the cross country regressions estimated by Sachs and Warner indicate a negative relationship between natural resources and economic growth, the mechanism through which the resource curse operates is unclear. Sachs and Warner claim that they have provided evidence of the negative effect of resource abundance on growth, but their measure of resource *abundance* (share of primary exports in GDP) is really more of a measure of resource *dependence* (the degree to which the economy depends on resources for its economic livelihood). Nonetheless, their work is often cited as proving a link between resource *abundance* and economic growth rates.

Sachs and Warner (1995) do show that their results are robust to alternative specifications of resource abundance, but each measure of resource abundance has its problems. Two of the alternative measures they test (share of mineral production in GDP and fraction of primary exports in total exports) are similar to their first measure in that they really capture resource *dependence*, not resource *abundance*. Similar results can be found in Sala-i-Martin (1997), and Sala-i-Martin, Doppelhofer and Miller (2003). The third alternative that Sachs and Warner explore, land area per person, can more accurately be described as a measure of resource *abundance*. However, all land is not created equal – desert in Sub-Saharan Africa contains far fewer natural resources than oil fields in Alberta. Even Sachs and Warner point out that land area per person is not a very precise measure of the production of the primary sector.

Additional support for the resource curse hypothesis can be found in the work of Robin Naidoo (2004). Naidoo measures extraction of forest resources by using the area of forest cover that a country has cleared during the period 1960-1999, and shows a negative association between the liquidation of forest resources and economic growth rates. Again, this measure may really reflect the degree to which a country *depends* on natural resources for its livelihood. Countries that cleared a large percentage of their total forest cover in a given period of time may have done so out of necessity (there were no other feasible options to earn income). Ideally, a country with forest resources should deplete a smaller percentage of its forest cover each year, in order to maintain a stock of natural resources for future generations. Naidoo's findings could be further improved by accounting for *relative* abundance of natural resources (i.e. resources per capita). Naidoo controls for the absolute size of a country (to distinguish large, resource poor countries from small, resource rich ones), but fails to control for the impact of population when measuring the abundance of resources a country possesses.

In a very interesting article, Sala-i-Martin and Subramanian (2003) challenge the widespread acceptance of Sachs and Warner's 1995 findings. They show that, by impairing institutional quality (measured by a composite index including property rights, rule of law, etc.), natural resources may impede economic growth. However, Sala-i-Martin and Subramanian find that, after controlling for their effect on institutions, natural resources are *not* significantly related to economic growth. They also show that the effect of natural resources depends on the particular resource being considered. They find that fuel and mineral resources negatively impact institutions (and hence economic growth), but that the relationships between economic growth and other types of resources are generally insignificant. This is a very important finding, because it suggests that the curse of "natural resources" may really be a curse of *particular* natural resources.

Papyrakis and Gerlagh (2004) agree that natural resource abundance slows economic growth, but they find that, when other variables such as corruption, investment, openness, terms of trade and schooling are taken into account, natural resource abundance has a positive impact on growth. Focusing on these additional explanatory variables may hold the key to unlocking the natural resource curse mystery. However, although Papyrakis and Gerlagh make claims about the connection between natural resource abundance and economic growth, their measure of resource abundance (share of mineral production in GDP) is problematic. Not only does this variable really measure resource intensity (not abundance), but, as shown by Sala-i-Martin and Subramanian (2003), abundance of mineral and fuel resources may not yield the same economic outcome as abundance of other natural resources.

Manzano and Rigobon (2001) build on Sachs and Warner's model by re-estimating the effect of natural resources on economic growth using panel data and alternative measures of the non-resource side of the economy. Interestingly, in every specification used by these authors, the negative impact of the resource curse appears in their cross-sectional data, but is insignificant when they estimate using a fixed effects panel model.

2.2 Possible Explanations for the Curse

Several possible explanations for the curse of natural resources can be found in the literature. Gylfason (2001) provides a good outline of four of the most common explanations:

i. The Dutch disease and crowding out of foreign capital
ii. Rent seeking and crowding out of social capital
iii. Crowding out of education and human capital
iv. Crowding out of saving, investment and physical capital

I discuss each of these transmission mechanisms in turn. After reviewing these four common explanations, I provide two additional explanations that exist in the literature. These two additional explanations emphasize the following ideas:

v. The relationship between natural resources and armed conflict
vi. The problems associated with the volatility of commodity prices.

2.2.1 The Dutch disease

Historically, the Dutch disease phenomenon explained a situation in which a rise in the value of natural resource exports caused an appreciation of a country's real exchange rate, making it more difficult for that country to compete internationally. A rise in the value of natural resource exports could be caused by export commodity price increases, or by an increase in the total volume of resource exports (which could be caused by the discovery of new resource reserves). The resulting appreciation of a country's real exchange rate has typically led to a decline in the secondary (or manufacturing) sector of the economy (Barbier, 2003). Many economists expect increased emphasis on primary sector production and reduced attention to the manufacturing sector to have a negative impact on economic growth (e.g. Kronenberg, 2004; Papyrakis and Gerlagh, 2004; Gylfason, 2001). More recently, the Dutch disease explanation has placed less emphasis on exchange rate movements, and instead focuses on economic distortions that encourage growth of the primary sector at the expense of more advanced economic sectors (e.g. manufacturing) (Barbier, 2003).

Under the traditional view of the Dutch disease, the volatility of commodity prices leads to volatile exchange rates. This harms the domestic economy further by creating uncertainty that is harmful to exports, trade and foreign investment (Gylfason, 2001).

2.2.2 Rent seeking

Barbier (2003) argues that "any depreciation of natural resources must be offset by investment in other productive assets" (p. 263). Barbier's research suggests that in many developing countries, economic rents generated from natural resources are not channelled into productive investments. Instead, resource rents are often dissipated through corruption, bureaucratic inefficiency and policies aimed at special interest groups.

If natural resources rents are not captured by special interest groups through rent seeking, then these rents could be used to invest in long term economic growth, leading to a higher standard of living. The empirical framework developed in this thesis will explore how rent seeking and natural resource rents are related.

2.2.3 Reduced investment in education and human capital

Gylfason (2001) argues that countries with abundant natural resources may have reduced incentives to invest in human capital. Temporary riches from the sale of resources may cause countries to underestimate the need to accumulate human capital in order to foster long-term growth. Gylfason uses a simple regression equation with one independent variable to show that public spending on education is negatively related to abundance of natural resources.

2.2.4 Reduced savings and investment in physical capital

Like human capital, physical capital may also be crowded out by an abundance of natural resources. Gylfason (2001, 2002) discusses how abundance of natural resources reduces incentives to save and invest, thereby limiting physical capital formation and economic growth potential. Gylfason's argument is that, as owners of capital earn a higher share of output, their demand for capital falls, lowering real interest rates and reducing investment in the economy.

2.2.5 Resource rents and armed conflict

There is an interesting and expansive literature that examines the relationship between resource rents and the outbreak of civil war. Collier and Hoeffler (2004) argue that extortion of natural resources provides an opportunity to finance rebellion. Lujala, Gleditsch and Gilmore (2005) provide examples of case studies in which rebel groups have used resource rents to finance warfare and personal incomes. They argue that natural resources may be related to civil conflict through three mechanisms: first, resource rents provide income for corrupt governments while simultaneously making it more desirable to hold political power; second, these rents increase the motivation to overthrow the government; and, third, an abundance of natural resources creates opportunities for looting and extortion that provide insurgents with the financial means to undertake such rebellions.

Using a logit regression to predict the outbreak of civil war, Collier and Hoeffler find that the share of primary commodity exports in GDP is a significant predictor of conflict. Disaggregating commodity exports into various subgroups leads to the finding that only oil exports are a significant predictor of conflict. Fearon (2005) also presents evidence to back up this claim. Lujala, Gleditsch and Gilmore (2005) find a positive relationship between diamond production and the incidence of civil war, but argue that this relationship only holds for secondary diamonds (which are lootable). Production of primary diamonds (non-lootable) is negatively related to the incidence of civil war. Clearly, the characteristics of resources and their associated rents must be taken into account when considering the resource curse.

2.2.6 Commodity prices

Sachs and Warner (2001) claim that the curse of natural resources exists, even after controlling for commodity prices. Despite their claim, the role of commodity prices in understanding the curse should not be overlooked.

In fact, some researchers believe that the natural resource curse is a result of the volatility of commodity prices. For example, Manzano and Rigobon (2001) argue that high commodity prices in the 1970s encouraged resource-abundant developing countries to borrow heavily. When commodity prices dropped in the 1980s, these countries were left with a large debt burden and a lower stream of resource rents to service this debt. Manzano and Rigobon describe this as a debt-overhang problem. They argue that the resource curse disappears once this debt-overhang problem is taken into account

Angus Deaton (1999) also discusses the difficulties associated with the volatility of commodity prices. Deaton argues that commodity price booms are handled so poorly that they form part of the “curse” of natural resources. This argument is supported by the work of Gelb (1988) and Auty (1993). Interestingly, Deaton shows that commodity prices, although highly volatile, show a distinct lack of upward trend. If real commodity prices do not grow over time, then any country dependent on export-led growth through the sale of these commodities will have difficulty achieving long run growth.

Collier and Goderis (2007) provide empirical evidence to suggest that commodity prices form an important component of the resource curse. They use a panel cointegration method to show that commodity booms have positive short-term effects on output, but adverse effects in the long run. However, they find that these adverse effects are confined to non-agricultural commodities.

If the natural resource curse hypothesis is supported by empirical evidence, understanding commodity prices is important for achieving economic growth. See Gylfason (2002) for a discussion of how mismanagement of natural resources can curb economic growth. Understanding commodity prices is crucial for effective management of natural resources, and thus is critical to ensuring a positive relationship between natural resources and economic growth.

3 Defining the "Curse of Natural Resources"

Before creating a model to evaluate the claim that natural resources are a curse, I spent a great deal of time considering what is and should be meant by any statement suggesting that natural resources are a curse or a blessing. This section provides a theoretical discussion of how the resource curse hypothesis should be evaluated.

3.1 Specifying the Appropriate Research Question

First of all, if we want to claim that natural resources are a curse or a blessing, we should think carefully about how such statements might be interpreted. What do people think of when we say that natural resources are a curse? The phrase "the curse of natural resources" implies some negative relationship between natural resources and well-being. But how is this relationship defined? There are several possible relationships between resources and well-being that might be described as "the curse of natural resources".

- Natural resource *dependence* might necessitate a low level of well being (which could be defined in various ways).
- Natural resource *dependence* might inhibit economic growth (i.e. the growth rate of GDP, or the growth rate of GDP per capita).
- *Abundance* of natural resources might lead to low levels of well being.
- *Abundance* of natural resources might inhibit economic growth.

Each of these relationships might operate through any one of the transmission mechanisms described in sections 2.2.1-2.2.6. While the impact of natural resources on economic growth rates might prove interesting, a country with a slow economic growth rate but a relatively high standard of living should not be considered "cursed". Therefore, the most relevant research question should relate to levels of well being, not economic growth rates.

Even more importantly, using economic growth to address the resource curse hypothesis may cause researchers to find a spurious correlation between economic growth and natural resources. For example, suppose abundance of natural resources is good for economic development. As countries experience rising income levels, they tend to find that their economic growth rates decline. Developed countries typically grow at relatively low, stable rates. Furthermore, they may find slow, stable growth desirable and attempt to prevent their economies from growing too quickly (primarily to mitigate inflationary pressures). If natural resource abundance is good for economic development, most resource abundant countries will be developed nations, currently experiencing relatively slow but stable economic growth rates. In contrast, resource poor countries will tend to be less developed nations, and may experience more volatile economic growth rates. Hence, regressing economic growth rates on abundance of natural resources may lead to spurious correlation between these two variables.

While natural resource dependence might prevent countries from achieving a high standard of living, dependence on agricultural products can be easily accounted for by structural change theories of economic development. These theories suggest that economic development occurs as economies transition away from subsistence agriculture and move toward an industrially diverse manufacturing and service sector (Todaro and Smith, 2002). For example, in the dual sector Lewis model, the marginal productivity of labour in the industrial sector is higher than in the primary sector, and the transition of surplus labour from the primary sector to the industrial sector leads to gains in total productivity (Lewis, 1954). According to structural change theories of economic development, it is the transition towards manufacturing and services that improve a country's total productivity. If countries do not make this structural transformation, and remain dependent on agriculture, it is unlikely that they will have the means to achieve higher productivity levels and the potential for increased standards of living.

The relatively simple "value-added" concept can also explain how resource dependence might inhibit economic development. Activities in the secondary and tertiary sectors of the economy tend to add more value to a given product/service than activities in the primary sector of the economy. For example, the process of converting raw material into an automobile adds more value than the process of extracting those raw materials.

Because the secondary and tertiary sectors of the economy create more value-added, economies with large secondary and tertiary sectors are able to support a higher standard of living. Economies with large primary sectors (high dependence on natural resources as a source of income) are not able to support this same standard of living. As Murphy, Shleifer and Vishny (1989) point out, virtually every country that has experienced rapid gains in productivity in the past two centuries has done so by industrializing. The decreased importance of the primary sector has allowed these countries to enjoy higher living standards. In this case, the "natural resource curse" seems to be an almost certainty, and researching this relationship would not provide particularly novel insights.

This only leaves the question of the relationship between resource abundance and levels of well being. The question then becomes, how should "well being" be specified? Modern development economists (e.g. Amartya Sen) argue that development is a multi-faceted goal – it can only be achieved through a holistic approach to increase material, physical and psychological well-being.[1] Some of the common indicators economists use to measure these objectives include per capita GDP, the Gini coefficient (a measure of income inequality), infant mortality rates, life expectancy, literacy rates, and primary enrolment rates. To address the resource curse hypothesis properly, the dependent variable should be specified in a way that captures this multi-dimensional approach toward economic development.

3.2 Measuring Resource Abundance

To explore the relationship between natural resource abundance and economic development, we must first determine how to measure natural resource abundance. Gylfason (2002) suggests three different measures of natural resource abundance:

i. The share of primary exports in total exports or share in GDP,
ii. The share of primary production in employment of the labour force, and
iii. The share of natural capital in national wealth.

[1] Alkire (2002) provides several examples of the possible dimensions of human development.

At first glance, these measures of natural resource abundance might seem reasonable. However, upon further reflection, it should become clear that each of these proposed measures fails to capture the true construct of resource abundance. To determine whether or not a country has an abundance of natural resources, we should think in absolute terms. For example, we could consider the absolute size of a country's inventory of natural resources or the inventory of natural resources per capita. To measure a country's natural resource abundance, we should not consider the size of its primary industry relative to non-primary industries. Measures such as resource production as a share of total goods and services production, employment in the natural resource industry compared to other industries, or the value of natural resources compared to the value of all of other assets can more accurately be described as measuring the *relative* degree of resource *dependence*.

Using any of the measures proposed by Gylfason would imply that resource abundance is measured in relative terms, not in terms of absolute quantities (or quantities relative to the size of the population). All of Gylfason's suggestions imply that natural resources are only abundant if they make up a large share of exports, employment or wealth. However, it is possible for a country to have abundant natural resources (in terms of available resources per capita), but not have resources make up a large share of exports, employment or wealth. As a country develops other sectors of its economy, the share of natural resources in exports, employment and wealth should fall. For example, Canada has an abundance of natural resources (measured by the absolute size of its natural capital stock or by its level of natural capital per capita), but Canada also has advanced secondary and tertiary sectors of its economy. A country with a smaller absolute level of natural capital (e.g. Kenya) may have a higher share of primary product exports in GDP than Canada. In this case, using the share of primary product exports in GDP to measure natural resource abundance may lead to the misleading conclusion that natural resources are more abundant in Kenya than they are in Canada. This example highlights the difference between measuring natural resource abundance in relative terms (relative to the size of other sectors of the economy) and absolute terms (available natural resources per capita).

Of the measures proposed by Gylfason, measure (i) appears most commonly in the literature on natural resources and economic growth. In their influential paper, Sachs and Warner (1995) measure natural resource abundance using the ratio of primary product exports to GDP, and claim to find a negative relationship between natural resources and economic growth. However, using this measure of resource abundance to model economic growth rates causes endogeneity problems. The following example illustrates how using this measure of resource abundance may lead to erroneous results.

Suppose that the secondary and tertiary sectors of economies grow faster than the primary sector. In these economies, the share of primary exports in GDP will decline over time, even if the primary sector contributes positively to economic growth. In this type of economy, economic growth is correlated with a declining share of primary exports in GDP. Regressing economic growth on the share of primary exports in GDP, ceteris paribus, would lead to the conclusion that the primary sector is negatively related to economic growth. However, as long as the primary sector is growing, the primary sector is actually contributing positively to economic growth. This is where the distinction between natural resource abundance and natural resource dependence becomes very clear. An abundance of natural resources may lead to positive economic growth, but if this comes at the expense of the secondary and tertiary sectors of the economy, this natural resource dependence may decrease economic growth.

Other economists and political scientists (e.g. Lujala et al., 2005; de Soysa, 2002) have also pointed out various problems associated with measuring resource abundance by the share of primary commodity exports to GDP. To overcome these problems, de Soysa (2002) measures resource abundance in terms of available natural resources per capita. In my measurement of resource abundance, I use a similar technique. I estimate available resource rents using per capita measures of resource exports and resource production. The transformation of resource exports and production into per capita terms is crucial in determining the extent to which resource rents have the potential to increase average living standards in a given country. If resource exports and/or production were measured in aggregate terms, then large countries with massive populations would appear resource rich, when, in fact, the potential for resource rents to impact overall standards of living could be quite small. Similarly, small countries with modest populations would appear resource poor, even if the available natural resources per capita were substantial. Transforming aggregate natural resource exports and production into per capita terms creates a measure of resource abundance that more accurately reflects the potential for resource rents to impact average overall standards of living.

3.3 Defining and Measuring Natural Resources

What is a "natural resource"? I define natural resources in the following way:

i. A natural resource must be "natural". In other words, a natural resource is an entity that exists in nature.
ii. To be considered a "resource", a natural resource must have some value. The value of this resource should be measured by people's willingness to pay for this resource.

Based on these criteria, there are six basic types of natural resources: air, water, land, minerals, plants, and animals.

Some natural resources are non-rivalrous or non-excludable (or both), and their values are difficult to measure.[2] However, many natural resources are both rivalrous and excludable (private goods), and their values can be approximated by their prices in the global market economy. For practical purposes, in my study of the curse of natural resources, I confine the analysis to those natural resources that are openly traded in the global market economy. This limits the analysis to four basic resources: agricultural

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[2] A good is non-rivalrous if one person's consumption of that good does not diminish another person's ability to consume that good (e.g. a scenic view). A good is non-excludable if it is not possible to limit a person from consuming that good (e.g. the air we breathe).

resources (e.g. coffee, tea, beef), forestry resources (e.g. lumber), fuel resources (e.g. coal, natural gas, crude oil), and ores and mineral resources (e.g. gold, tungsten, diamonds).

Some researchers (e.g. Sachs and Warner, 1995, 2001) have treated these groups of natural resources as relatively homogenous, and have made blanket statements regarding the general relationships between natural resources and economic outcomes. However, there is evidence to suggest that natural resources cannot be treated as one homogenous group (e.g. Sala-i-Martin and Subramanian, 2003; Collier and Hoeffler; 2004, 2005). As Collier and Hoeffler (2005) put it, "rents–the surplus over costs and normal profit–differ between commodities" (p.628). The validity of the natural resource curse claim clearly depends on how natural resources are grouped and defined.

4 A New Framework

This chapter builds a new theoretical framework for evaluating the claim that natural resources are a curse. First, the underlying assumptions of the new framework are briefly described, and then they are discussed individually in more detail.

4.1 Underlying Assumptions

Here is a summary of the five main underlying assumptions in my framework for evaluating the resource curse hypothesis:

1. Natural resources cannot be treated as a homogeneous group. Different natural resources have different physical and economic properties. These physical and economic properties influence the characteristics of the resource rents associated with natural resources.

2. The resource rents associated with some types of natural resources lead to rent seeking and corruption. The physical and economic properties of a particular natural resource determine the potential size of resource rents and the extent to which resource rents lead to rent seeking and corruption.

3. Rent seeking and corruption inhibit economic development by limiting economic growth and worsening income inequality, depressing overall standards of living.

4. Well developed institutions can mitigate the effects of rent-seeking and corruptive behaviours on economic development. However, the relationship between rent seeking and corruption and institutional quality is bi-directional. While well developed institutions may reduce corruption, corruption may also reduce the quality of institutions.

5. Economic development can be measured using a composite index of various economic and social indicators.

4.1.1 Assumption one: Natural resources are not homogeneous

Natural resources cannot be treated as a homogeneous group. Different natural resources have different physical and economic properties. These physical and economic properties influence the characteristics of the resource rents associated with natural resources.

For example, under sustainable harvesting practices, agricultural and forest resources provide owners with a flow of resource rents over time. Mineral and fuel resources are non-renewable and the associated resource rents can be captured as quickly as the resources can be extracted.

Secondly, differences in ownership of resources affect the associated resource rents. For example, the resource rents from agricultural products are typically dissipated across a large number of farmers within a country. In contrast, the resource rents from mining or fossil fuel extraction may be concentrated in the hands of a few select groups (typically governments and/or large corporations).

The physical properties of resources also affect their resource rents. For example, agricultural and forestry products may be perishable goods, implying that, once harvested, these goods are not a good store of value. Moreover, the resource rents associated with these goods may be depressed due to risks such as fire and weather. Precious metals and gemstones do not perish, and provide an excellent store of value. Once extracted, diamonds can be physically transported relatively easily, but transportation and storage of oil and natural gas requires expensive infrastructure.

Finally, the inputs of labour and capital required to extract different resources vary widely. For example, agricultural production generally requires large inputs of either labour or capital. The cost of these inputs increases the cost of investing in these resources, and decreases the potential resource rents. Other natural resources (such as precious metals) may cost less to extract and offer a greater net resource rent per dollar of labour or capital investment. Even within a particular group of natural resources (e.g.

fuel resources), the costs of resource extraction may vary significantly. For example, extraction of oil from tar sands usually requires more labour and capital inputs than extraction of oil from wells.

4.1.2 Assumption two: Resource rents can lead to corruption

The resource rents associated with some types of natural resources lead to rent seeking and corruption. The physical and economic properties of a particular natural resource determine the extent to which its resource rents lead to rent seeking and corruption.

Resource rents can (but do not necessarily) lead to rent seeking and corruption. Using data from the 1980s, Ades and Di Tella (1999) confirm this claim. They build an econometric model to explain corruption, and find that the proportion of total exports accounted for by fuels, minerals and metals is positively related to corruption. My framework for the resource curse will investigate how some types of resources (e.g. petroleum) may lead to corruption, while some may not (e.g. forests). I use measures of resource exports and production per capita as proxies for the size of resources rents from different types of resources.

4.1.3 Assumption three: Corruption inhibits economic development

Rent seeking and corruption inhibit economic development by limiting economic growth and worsening income inequality, depressing overall standards of living.

Economists suggest that rent-seeking and corruptive behaviours have both income and re-distributive effects. The cost of rent-seeking behaviour reduces the net wealth an economy gains from resource rents. Corruption re-distributes wealth to those who have control over natural resources and their rents. In addition, when governments focus on rent-seeking behaviours, capital may be diverted from other productive investments, such as health care and education.

Somewhat surprisingly, some political scientists (e.g. Leff, 1964; Huntington, 1968) have actually argued that corruption might be beneficial for economic development. As outlined in Mauro (1995), corruption might positively impact economic growth through two mechanisms. First, in corrupt regimes, bureaucratic delays and inefficiencies may be reduced through incentives (bribes) for timely processing. Second, individuals working for corrupt governments may have an incentive to work harder, as the hard work may be rewarded with the payout of a sizeable bribe. Although, in theory, corruption might be beneficial for economic development, empirical evidence suggests otherwise (e.g. Azfar, Young and Swamy, 2001). According to Azfar et al., it is now generally acknowledged that corruption has a negative impact on economic development. Ades and Di Tella's (1999) simple regression model for corruption helped form the basis of the model in this thesis.

4.1.4 Assumption four: Institutions can mitigate the effects of corruption

Well developed institutions can mitigate the effects of rent-seeking and corruptive behaviours on economic development. However, the relationship between rent seeking and corruption and institutional quality is bi-directional. While well developed institutions may reduce corruption, corruption may also reduce the quality of institutions. If social institutions such as civil law and property rights exist, then rent seeking and corruption may not occur to the same degree. In my framework for evaluating the resource curse, I include a measure of regulatory quality to capture these institutional effects.

4.1.5 Assumption five: Economic development can be measured

Economic development can be measured using a composite index of various economic and social indicators.

Economic development could be measured in several different ways. One of the most popular development indexes is the United Nations' *Human Development Index,* which equally weights income levels, health and education. However, the *Human Development Index* does not directly incorporate a measure of income distribution.

I originally wanted to measure economic development using a simple index that accounts for both income levels and income inequality. Montenegro (2004) has proposed a simple index that equally weights per capita GDP and the Gini coefficient. He uses a simple function to normalize per capita GDP and the Gini coefficient in the same way that the *Human Development Index* normalizes its input variables. However, reliable estimates of income inequality are only available for selected countries in certain time periods. As a result, I chose to use the Human Development Index to measure average standards of living across countries. Although the Human Development Index does not directly incorporate a measure of income distribution, income inequality might be indirectly accounted for in the education and health components of the index.

4.2 The Econometric Specification

To overcome problems associated with endogeneity, the framework was modeled using a system of equations. The basic model was represented by the following equations:

Eq.1. $HDI_{it} = \alpha_{it} + \beta_1 \times \text{Inverse of Investment per capita}_{it} + \beta_2 \times \text{Openness}_{it} + \beta_3 \times \text{Number languages}_i + \beta_4 \times \text{Latitude}_i + \beta_5 \times \text{Control of corruption}_{it} + \varepsilon_{it}$

Eq. 2. $\text{Control of corruption}_{it} = \delta_{it} + \beta_6 \times \text{GDP per capita}_{it} + \beta_7 \times \text{Fuel exports per capita}_{it} + \beta_8 \times \text{Ores and minerals exports per capita}_{it} + \beta_9 \times \text{Forestry production per capita}_{it} + \beta_{10} \times \text{Regulatory quality}_{it} + \beta_{11} \times \text{Largest ethnic group}_i + \beta_{12} \times \text{Civil war dummy}_i + \mu_{it}$

The following sections discuss each equation in more detail. Appendix A provides detailed information about the definitions and sources of each variable

.

4.2.1 The Human Development Index equation

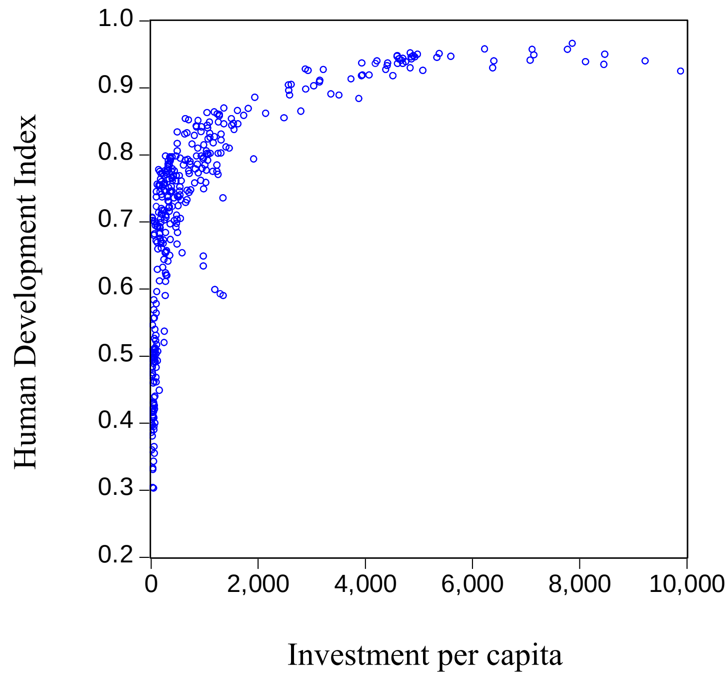
The Human Development Index (HDI) is a weighted index comprised of income (measured by purchasing power parity GDP per capita), health (measured by life expectancy at birth), and education (measured by the adult literacy rate and combined gross school enrolment rate). Sachs and Warner (2001) include investment and degree of openness in their cross-country growth rates of income, and I expect that these would also influence cross-country differences in levels of income and well being, so I have included these indicators in my model.

Although I agree that investment and degree of openness should be included in the model, I have measured these variables differently than Sachs and Warner. First, I noticed that, in preliminary exploratory specifications, the statistical significance of the investment variable changed dramatically with small changes in the econometric specification. Thinking about this, I realized that, while the HDI ranges from 0 to 1, investment per capita has a very broad range of values. This led me to speculate that the relationship between the HDI and investment per capita might be non-linear. If the relationship is non-linear, then at high levels of investment per capita, countries should experience decreasing returns from investment.

The relationship between the HDI and the constant dollar value of investment per capita is plotted in Figure 1. The data represents 102 different countries, and the observations include all available time periods, namely, 1998, 2000, 2002 and 2004. As shown in the figure, plotting HDI against investment per capita confirmed my expectation that the relationship between these variables is non-linear.

I chose to use the inverse of investment, rather than the log of investment, because the derivative of $1/x$ is $1/x^2$, while the derivative of $\log(x)$ is $1/x$. Therefore, using the inverse of investment allows the marginal effect of investment on the HDI to decrease at a faster rate than would occur if I used the log of investment.

Figure 1. The Human Development Index vs. Investment per capita



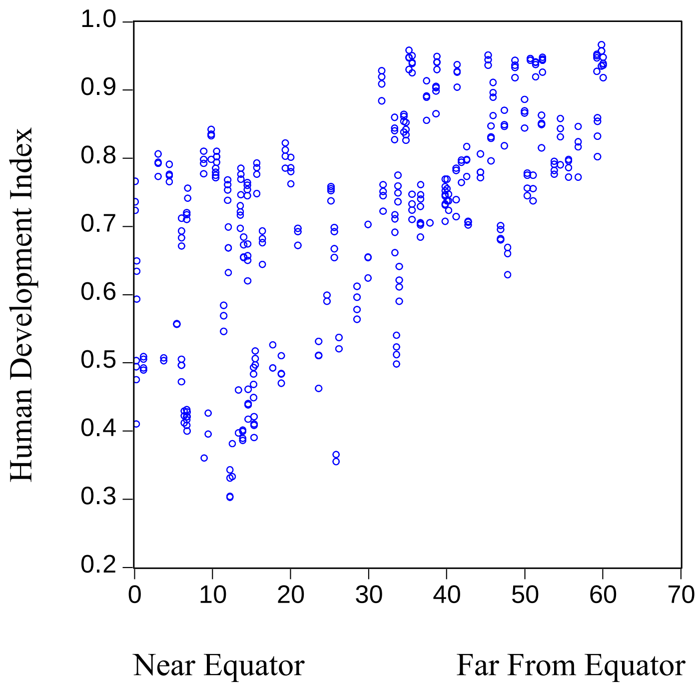
The number of languages in a country could negatively impact both the income and education components of the HDI. If the number of languages spoken in a country is large, it will be more difficult to conduct business (higher transaction costs), and the income indicator may be adversely affected. In addition, a greater diversity in languages spoken will make it more difficult for governments to deliver educational services, and the education indicators may also be affected.

Latitude is included in the HDI equation to capture other unobservable cross-
differences (e.g. geography and climate) that may affect the overall standard of
As Theil and Chen (1995) and Theil and Galvez (1995) show, differences in
explain up to 70% of the variation in cross-country levels of income.
Bulte (2007) use latitude as an instrument for institutional quality in their
the resource curse. This previous research shows that, in addition to capturing the
of geography and climate, latitude may also be a strong indicator of other
otherwise unobservable differences across countries. In my dataset, the

between latitude and overall standards of living is quite clear. The correlation the HDI and latitude is 0.61 in my dataset. The relationship between latitude and is shown in

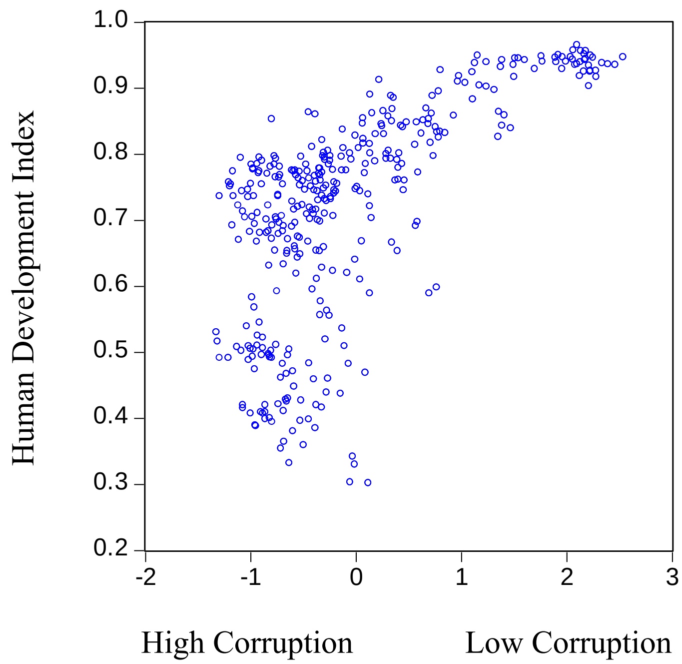
Figure 2. As in Figure 1, the data represent 366 observations on 102 countries between 1998 and 2004. As shown in the figure, countries farther away from the equator (whether it is north or south) tend to have higher overall standards of living, while countries near the equator tend to have lower overall standards of living.

Figure 2. The Human Development Index vs. Latitude



Finally, control of corruption is included in the HDI equation because, according to the new framework I have developed, it is through rent seeking and corruption that natural resources may lower overall levels of well being (see previous chapter for a more detailed discussion). The relationship between the control of corruption variable and the HDI is shown in Figure 3. Again, the data represent 366 observations on 102 different countries over the period 1998-2004. Looking at all of the observations together, it appears that the data supports the hypothesis that higher levels of corruption are associated with lower levels of well being. This general finding holds if we consider a simple linear or non-linear relationship between the HDI and control of corruption, assuming constant parameters for each observation. It may be worthwhile for other researchers to explore the possibility of non-constant parameters across observations. For example, this might be done by considering the observations for developed and developing countries separately.

Figure 3. The Human Development Index vs. Control of corruption



4.2.2 The control of corruption equation

Control of corruption is modelled as a function of the available resource rents per capita. Exports and production of resources per capita are used as proxies for the availability of resource rents. Potential rents from fuel resources and ores and mineral resources are measured in the dollar value of exports per capita. Potential rents from forestry resources are measured by the total volume of forestry production per capita. In order to interpret the resulting coefficients on resource rents appropriately, per capita GDP is included in the regression. If per capita GDP were not included in the regression, then values of the resource variables would be a simple indicator of a country's level of income, which we know to be highly correlated with control of corruption.

The control of corruption equation also includes indicators of regulatory quality, ethnic diversity, and a dummy for recent civil war. Regulatory quality measures the quality of institutions, which may play an important role in mitigating the effect of resource rents on corruption activities. If the resource curse does exist, countries with well-developed institutions should be able to overcome it.

The largest ethnic group variable measures the size of a country's largest ethnic group, as a share of that country's total population. In general, in countries where the largest ethnic group constitutes a smaller proportion of the population, there are more likely to be sizeable secondary and other ethnic groups. In my dataset, the correlation between the share of the population accounted for by the largest ethnic group and the share accounted for by the second largest ethnic group is -0.61.

Countries with a smaller share of the population accounted for by the largest ethnic group are more likely to have secondary or tertiary ethnic groups of considerable size, which may lead to ethnic tensions. Ethnic tensions may be associated with a greater risk of internal conflict, and hence increased rent-seeking behaviour. Internal conflict can lead to rent seeking and corruption as different groups try to achieve political and economic power. Furthermore, in the presence of civil wars, looting of natural resources may be more prevalent, increasing opportunities for bribery and corruption.

5 Empirical Results

5.1 About the Data

The dataset for this analysis was compiled from various sources, although many of the indicators come directly or indirectly from the World Bank. Appendix A provides a detailed description of the variables included in the analysis, including sources and notes about how certain variables were derived.

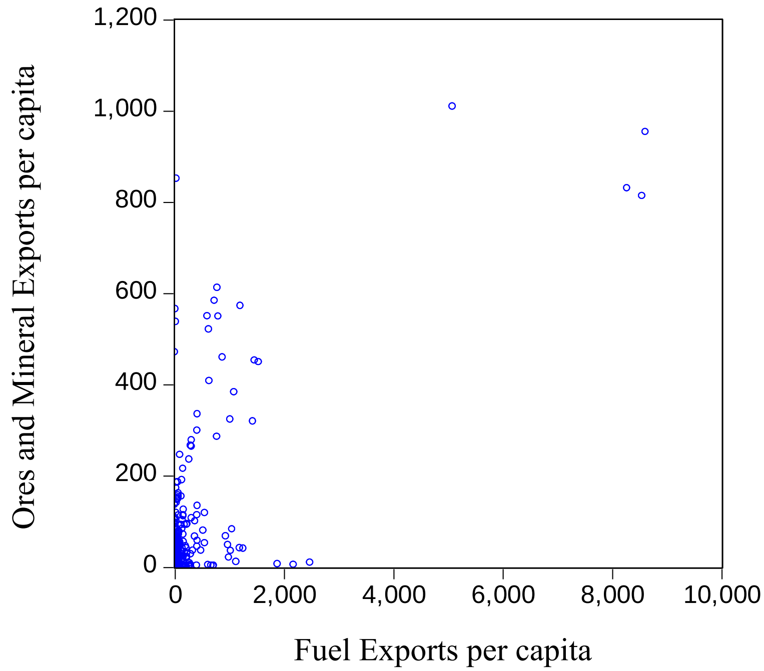
In total, there are 366 observations in the dataset. These cover 102 different countries at four points in time (1998, 2000, 2002 and 2004). The countries included in the analysis appear to be somewhat random, and cover a wide range of different country types. For example, the sample includes several developed countries (e.g. United Kingdom, Canada, United States) and several less developed or developing countries (e.g. Cameroon, Sri Lanka, India). A list of all included countries and the number of data points for each is provided in Appendix B.

Table 1. Descriptive statistics of variables included in the model

Variable	Mean	Median	Minimum	Maximum	Std. Dev.
Human Development Index	0.718	0.753	0.302	0.965	0.163
Investment per capita	$1,205	$402	$16	$9,901	$1,835
Trade (% of GDP)	78.5	70.5	17.2	228.9	38.7
Number of Languages	6.7	3.0	1.0	46.0	7.6
Latitude	29.138	31.950	0.217	60.167	17.357
Control of Corruption	-0.030	-0.323	-1.324	2.535	0.945
GDP per capita (2000 US$)	$5,527	$1,809	$126	$39,353	$8,687
Fuel Exports per capita	$229	$24	$0	$8,611	$856
Ores/Minerals Exports per capita	$69	$17	$0	$1,010	$145
Forestry Production per capita	1.021	0.574	0.000	10.483	1.663
Regulatory Quality	0.152	0.047	-2.569	1.990	0.821
Largest Ethnic Group	0.669	0.691	0.120	0.998	0.234
Civil War Dummy	0.221	0.000	0.000	1.000	0.416
Total Observations: 366					

Descriptive statistics for each of the variables included in the analysis are provided in Table 1. Note that all of the variables that are measured in monetary terms (investment, fuel exports, and ores/minerals exports) are measured in constant 2000 US$. Forestry production is measured in cubic meters of roundwood.

Figure 4: Ores and mineral exports per capita vs. Fuel exports per capita



The dollar value of fuel exports per capita is plotted against the dollar value of ores and mineral exports per capita in Figure 4. There are four clear points in the figure that are strong outliers, with very high levels of natural resource exports (both fuel and ores and mineral) per capita. Each of these four observations represents Norway. Because Norway also has a high Human Development Index, these observations represent evidence against the existence of the resource curse. Including this country in the dataset might cause a positive relationship between natural resource exports and standards of living, and bias the results in favour of rejecting the resource curse claim. However, I ran the regression analyses omitting this outlier, and the impact on the results was very small. Given that the results are not sensitive to inclusion of this outlier, and that there is no reason to doubt the quality of data for this country, I have chosen to keep the observations for Norway in the analysis.

5.2 Estimation Using the New Framework

For reference, the specification from section 4.2 is presented again below:

Eq.1. $HDI_{it} = \alpha_{it} + \beta_1 \times$Inverse of Investment per capita$_{it}$ + $\beta_2\times$Openness$_{it}$ + $\beta_3\times$Number languages$_i$ + $\beta_4\times$Latitude$_i$ + $\beta_5\times$Control of corruption$_{it}$ + ε_{it}

Eq. 2. Control of corruption$_{it}$ = δ_{it} + $\beta_6\times$GDP per capita$_{it}$ + $\beta_7\times$Fuel exports per capita$_{it}$+ $\beta_8\times$Ores and minerals exports per capita$_{it}$ + $\beta_9\times$Forestry production per capita$_{it}$ + $\beta_{10}\times$Regulatory quality$_{it}$ + $\beta_{11}\times$Largest ethnic group$_i$ + $\beta_{12}\times$Civil war dummy$_i$ + μ_{it}

Notice that neither equation contains dummy variables representing period effects. Hypothesis testing revealed that period effects are clearly insignificant in the corruption equation. It is less obvious whether or not period effects belong in the HDI equation. For this reason, I have estimated the results both with and without period effects in this equation. The results are shown in Table 2. A Wald test that each period dummy simultaneously equals zero yielded a p-value of 0.04, suggesting that the null hypothesis can be rejected at the 95% confidence level, but not at the 99% level. I have chosen to adopt the specification with these period effects as my core model, but have presented the results of both specifications. It should be noted, however, that the inclusion of period effects has little effect on the overall findings from the model.

Table 2. Empirical results with and without period effects in HDI equation

Systems Estimation
Method: Generalized Method of Moments (N=366)
Heteroskedasticity-Consistent Standard Errors

Dependent Variable: Human Development Index

	Core Model		*No HDI Period Effects*	
	Coefficient	St. Error	Coefficient	St. Error
Constant	0.7284	0.0148***	0.7406	0.0135***
Inverse of Investment per capita	-9.2497	1.0850***	-9.3574	1.1115***
Openness	1.47E-04	9.77E-05*	1.58E-04	9.86E-05*
Number of Languages	-0.0045	7.44E-04***	-0.0045	7.49E-04***
Latitude	0.0017	2.23E-04***	0.0017	2.27E-04***
Control of Corruption	0.0528	0.0040***	0.0523	0.0041***
Year 2000 Dummy	0.0083	0.0104		
Year 2002 Dummy	0.0137	0.0108		
Year 2004 Dummy	0.0291	0.0100***		
Adjusted R-squared	0.798		0.795	

Dependent Variable: Control of Corruption

	Core Model		*No HDI Period Effects*	
	Coefficient	St. Error	Coefficient	St. Error
Constant	-0.5673	0.0582***	-0.5673	0.0582***
GDP per capita	5.93E-05	5.64E-06***	5.93E-05	5.64E-06***
Fuel Exports per capita	-1.51E-04	2.49E-05***	-1.51E-04	2.49E-05***
Ores/Mineral Exports per capita	0.0010	1.55E-04***	0.0010	1.55E-04***
Forestry Production per capita	0.0411	0.0105***	0.0411	0.0105***
Regulatory Quality	0.4363	0.0468***	0.4363	0.0468***
Largest Ethnic Group	0.1296	0.0904*	0.1296	0.0904*
Civil War Dummy	-0.0910	0.0424**	-0.0910	0.0424**
Adjusted R-squared	0.860		0.860	

***, **, * indicate significance at the 1, 5, and 10% level.

The system of equations was estimated using the systems generalized method of moments (GMM) estimator. A full information systems estimator was chosen because a full information estimator estimates all equations in a system simultaneously, incorporating knowledge of all restrictions when estimating each parameter (Kennedy, 2003).

The GMM estimator is an instrumental variables estimator. The GMM estimator uses the information that the instruments are uncorrelated with the error term (moment conditions) to form parameter estimates. Because the GMM estimator cannot usually satisfy all of the moment conditions simultaneously, the competing objectives to satisfy each condition are minimized using a quadratic objective function (Stock and Watson, 2007).

By employing an instrumental variables technique, I hoped to overcome endogeneity problems and the likelihood of a circular relationship between the HDI and control of corruption (i.e., as HDI increases, control of corruption increases, further increasing the HDI). Another reason that I chose the GMM estimator is because my software package could produce heteroskedastic-consistent robust estimates of standard errors under this estimation technique.

In the system of equations I have defined, I expect some of the variables to be endogenous. The control of corruption variable in the HDI equation is clearly endogenous, as control of corruption is the dependent variable in the second equation in the system. The GDP per capita variable in the control of corruption equation may also be endogenous, as GDP per capita may be correlated with the HDI.[3] This relationship between the left hand variable of one equation and the right hand variable of the other equation gives reason to suspect endogeneity. I have assumed all other variables in my system to be exogenous.

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[3] GDP per capita enters indirectly into the calculation of the Human Development Index. In the HDI calculation, GDP per capita is measured in purchasing power terms, and then transformed into an index that ranges between zero and one. Although development economists might argue that the HDI is not strongly correlated with GDP per capita, the correlation may still be strong enough to suspect endogeneity.

To estimate the system by GMM, I created a separate list of instruments for each equation. In the HDI equation, I used all exogenous variables and a lagged value of control of corruption as instruments, with control of corruption lagged two years. A two year lag was chosen based on data availability. However, this lag period also fits nicely with the dataset, which are at two year intervals. In the control of corruption equation, I included all exogenous variables and a measure of the volume of trade as instruments. Trade volume per capita, measured by the total dollar value of imports plus the total dollar value of exports per capita, is highly correlated with GDP per capita (r=0.82). I do not expect trade volume per capita to be associated with the error term in this equation, and thus believe this is a suitable instrument for GDP per capita. Because I have chosen to include the same number of instruments as regressors in each equation, I did not need to specify a weighting matrix for the GMM estimator.

To investigate how the results would differ under a single equation systems estimator, I ran an exploratory systems regression using the OLS systems estimator. As Kennedy (2003) points out, the OLS systems estimator is relatively robust and often produces results similar to other systems estimators. As shown in Table 3, the estimates I obtained from the single equation OLS estimator are quite similar to the results I obtained using the GMM estimator (Table 2). Furthermore, the standard errors produced by the OLS estimator lead to similar conclusions about the significance of the model's coefficient estimates.

Table 3. Empirical results using OLS estimator

Systems Estimation
Method: Ordinary Least Squares (N=366)
Non-robust Standard Errors

Dependent Variable: Human Development Index

	Core Model	
	Coefficient	St. Error
Constant	0.7283	0.0152***
Inverse of Investment per capita	-9.2563	0.5586***
Openness	1.47E-04	1.02E-04*
Number of Languages	-0.0045	5.90E-04***
Latitude	0.0017	2.71E-04***
Control of Corruption	0.0526	0.0048***
Year 2000 Dummy	0.0085	0.0108
Year 2002 Dummy	0.0138	0.0107*
Year 2004 Dummy	0.0292	0.0109***
Adjusted R-squared	0.800	

Dependent Variable: Control of Corruption

	Core Model	
	Coefficient	St. Error
Constant	-0.5723	5.83E-02***
GDP per capita	4.57E-05	3.33E-06***
Fuel Exports per capita	-1.21E-04	2.96E-05***
Ores/Mineral Exports per capita	0.0012	2.00E-04***
Forestry Production per capita	0.0441	0.0125***
Regulatory Quality	0.5004	0.0328***
Largest Ethnic Group	0.2092	0.0825***
Civil War Dummy	-0.1080	0.0454***
Adjusted R-squared	0.866	

***, **, * indicate significance at the 1, 5, and 10% level.

5.3 Estimation Using the Traditional Framework

The model I have used is quite different from traditional models of the resource curse. As a validity check, I use my data to estimate the resource curse in a method similar to that of Sachs and Warner (1995).

In this estimation, the dependent variable is the growth rate of real GDP per capita between 1998 and 2004. I have included all countries from my original dataset that had observations available in each of the four time periods. As in Sachs' and Warner's (1995) model, I have included estimates of initial income, investment, openness and rule of law. Investment, openness and rule of law were measured in the same manner as in my core model. The share of natural resource exports in GDP was derived from the shares of agricultural, fuel, and ores and mineral exports in total merchandise exports. With the exception of initial income, each variable was measured by its average value over the period 1998-2004.

Sachs and Warner also measure openness and investment as averages over the time period. They measure openness by the fraction of years during the period that the country met certain "openness" criteria, and they measure investment by the average investment to GDP ratio over the time period. One noticeable difference between my estimation and that of Sachs and Warner is the measure of resource abundance. Sachs and Warner measure natural resource abundance as the share of primary exports in GDP at the start of the time period, while I have chosen to average the share of natural resources in GDP over each time period. However, whereas Sachs and Warner were considering a relatively long time horizon, I am considering a period of only seven years (1998-2004). I have chosen to average the share of natural resource exports in GDP to minimize the possibility of getting erratic data for a particular country (e.g. due to an exogenous shock such as weather). In Sachs and Warner's model, it made more sense to measure resource exports at the beginning of the time period, as the time period under investigation was much longer.

In their estimation, Sachs and Warner include observations on 62 countries, but they do not provide a list of which countries have been included. Sachs and Warner (1997) do discuss a number of African countries that are missing from their analysis. With the exception of Mauritius and Togo, the same set of countries is missing from my analysis as well. However, Sachs and Warner show that their model can reasonably predict growth for these missing observations. My dataset includes 88 countries that are listed in Appendix C. The countries represent a wide range of economies, from developed nations (e.g. France, United States) to undeveloped nations (e.g. Kenya, Pakistan), and from resource-rich nations (e.g. Finland, Mexico) to resource-poor nations (e.g. Lebanon, Japan).

The results of this estimation are presented in Table 4. The results confirm my prior expectations. Consistent with economic theory, the signs on initial income and the inverse of investment are negative, and the signs on openness and rule of law are positive. All of these results are statistically significant. Note that I am not able to reproduce Sachs' and Warner's finding regarding the curse of natural resources – the coefficient on natural resource dependence is insignificant. For comparison, the results from Sachs and Warner (1995) are provided in Table 5.

Table 4. Estimation using a traditional model of the resource curse

Dependent Variable: Growth Rate of Real GDP Per Capita, 1998-2004
Method: Ordinary Least Squares (N=88)
Heteroskedasticity-Consistent Standard Errors

	Coefficient	St. Error	
Constant	110.8184	23.1145	***
Log GDP per capita, 1998	-12.1729	2.7607	***
Inverse of Investment per capita	-1383.0821	381.6824	***
Openness	0.0901	0.0268	***
Rule of Law	9.3676	3.2279	***
Share of Natural Resource Exports in GDP	0.0505	0.2310	
Adjusted R-squared	0.208		

***, **, * indicate significance at the 1, 5, and 10% level.

Table 5. Results from Sachs & Warner (1995)

Dependent Variable: Growth Rate of Real GDP Per Capita Per Annum

	Coefficient	St. Error	
Constant	12.472	1.978	***
Log GDP per capita, 1970	-1.921	0.308	***
Average investment to GDP ratio, 1970-89	9.085	3.391	***
Openness	2.167	0.564	***
Quality of Bureaucracy	0.370	0.117	***
Share of Natural Resource Exports in GDP	-7.806	2.653	***
Adjusted R-squared	0.597		
Number of Observations	62		

***, **, * indicate significance at the 1, 5, and 10% level.

By using my data to re-estimate a more traditional economic model of the resource curse, I have shown that my measures of investment, openness, and rule of law yield results that are consistent with economic theory. The results are consistent for the traditional model of the resource curse (Sachs and Warner, 1995, 2001) and for my model. However, changes in the underlying model specification and framework do affect comparisons between the two models. It is imperative that the resource curse hypothesis is carefully specified before drawing any definitive conclusions about the relationship between natural resource abundance and economic outcomes.

6 Discussion

6.1 Signs and Significance

In Table 2 (and all of the tables presented in this thesis), the reported significance levels are based on one-sided hypothesis testing. This is because I had prior expectations about the signs of all of the coefficients, with the exception of fuel exports and ores and minerals exports per capita. In the case of both fuel and ores and minerals exports, the p-values I obtained were so low that there would be no difference if I reported one-sided or two-sided significance levels.

As expected, the sign on the inverse of investment per capita in the HDI equation was negative, suggesting that higher levels of investment are associated with higher levels of the HDI. This result was statistically significant at the 99% confidence level. The coefficient on the openness variable also had the expected sign (positive), suggesting that countries that are more open have higher standards of living. The inclusion of the investment and openness variables was motivated in part by the research of Sachs and Warner (1995, 2001), and my results parallel their findings. However, the coefficient on the openness variable was only significant at the 90% confidence level, suggesting that this variable may be less important in my model of human development than in Sachs and Warner's model of economic growth. As I will show in Chapter 7, the sign and significance of the openness variables appears to be somewhat sensitive to changes in the econometric specification and methodology.

The sign on the number of languages coefficient was negative, confirming my expectation that an increased number of languages in a country would be associated with decreased levels of income and education. As I suggested in section 4.2.1, ceteris paribus, an increase in the number of languages in a given country should make it more difficult to conduct economic transactions and deliver educational services, thereby decreasing income, literacy rates and educational enrolment. Together these three indicators form two-thirds of the Human Development Index.

The coefficient on latitude was positive and significant, implying that countries farther away from the equator tend to have higher standards of living. This result supports the findings of Theil and Chen (1995) and Theil and Galvez (1995).

Control of corruption was positively associated with the HDI, suggesting that countries with more corruption tend to have lower levels of well being. This finding confirms the first part of the transmission mechanism through which I expect the resource curse (if it exists) to operate.

In the control of corruption equation, the coefficients on each of the resource rent variables were significant, although the signs varied. The coefficients on ores and mineral exports and forestry production per capita were positive, while the coefficient on fuel exports was negative. These findings are discussed further in sections 6.2 and 6.3.

Regulatory quality was positively associated with control over corruption, and the result was significant. This finding shows that, even if resources are a curse, improved institutional quality can help overcome this obstacle. Countries with better institutions tend to have more control over corruption and rent-seeking behaviours.

And finally, the ethnicity and civil war variables also had the expected signs. Countries with a larger share of their population accounted for by the largest ethnic group (less ethnic diversity) experienced less corruption, and countries that experienced civil war experienced more corruption. These findings confirm my hypothesis that increased ethnic diversity and civil war provide opportunities for rent seeking and corruption, as different groups try to gain political power.

6.2 Magnitudes

Using a technique suggested by Bulte, Damania, and Deacon (2005), I computed beta coefficients for each of the variables of interest. The beta coefficients were derived by multiplying each coefficient estimate from the core model (Table 2) by each variable's standard deviation (Table 1), and then dividing by the standard deviation of the associated dependent variable.[4] The resulting beta coefficients are presented in Table 6.

Table 6. Relative magnitude of variables from the core model (beta coefficients)

Dependent Variable: Human Development Index

	Beta coefficient
Inverse of Investment per capita	-0.46
Openness	0.03
Number of Languages	-0.21
Latitude	0.18
Control of Corruption	0.31

Dependent Variable: Control of Corruption

	Beta coefficient
GDP per capita	0.55
Fuel Exports per capita	-0.14
Ores/Mineral Exports per capita	0.15
Forestry Production per capita	0.07
Regulatory Quality	0.38
Largest Ethnic Group	0.03
Civil War Dummy	-0.04

The reported beta coefficients measure the magnitude of each variable in terms of standard deviations. For example, a one standard deviation increase in numbers of languages variable is associated with a 0.21 standard deviations decrease in the HDI. This method of reporting coefficients makes it easier to compare the relative magnitudes

[4] The standard deviation of the inverse of investment per capita is not provided in Table 1. This standard deviation was computed separately (value= 0.008164).

of the coefficients on each explanatory variable. Looking at the table, it appears that investment and control of corruption are the two most important indicators of the Human Development index. The openness variable appears to be less important in determining a country's standard of living.

In the control of corruption equation, per capita GDP and regulatory quality appear to be the most important indicators of the dependent variable. Although the coefficients on resource exports per capita are smaller, they all appear more important than the ethnicity and civil war variables.

The beta coefficient on fuel exports per capita is -0.14, and the beta coefficient on ores and mineral exports per capita is 0.15. Bulte, Damania and Deacon (2005) estimated the impact of point resources (resources concentrated in a narrow geographic region, including oil, minerals, and plantations) on two measures of institutional quality: rule of law and government effectiveness. In the rule of law equation, they obtained a beta coefficient of -0.21 on point resources, and in the government effectiveness equation, they obtained a beta coefficient of -0.27 on point resources. When compared to the results of this previous research, the magnitudes of the beta coefficients I have obtained on fuel exports and ores and minerals exports seem reasonable.

6.3 Are Natural Resources a Curse?

The results suggest that in determining whether or not natural resources are a curse or a blessing, individual types of natural resources must be considered separately. If all types of resources were aggregated into one measure, the positive and negative impacts of different resource types would offset each other, resulting in insignificant results or possibly misleading conclusions.

My results suggest that fuel resources can be considered a "curse". Rents from fuel resources are associated with increased levels of corruption, which is associated with lower standards of living. The negative impact of oil exports has also been shown by

Fearon (2005), who demonstrates that oil exports are positively associated with increased risk of internal conflict. In my analysis, institutional quality can offset the impact of the fuel resource curse. As shown in Table 6, the magnitude of the regulatory quality variable is much greater than the magnitude of the fuel exports per capita variable. This suggests that improvements in institutional quality can more than offset the curse of fuel resources. This might explain why some countries, such as Norway, have both high levels of fuel exports per capita and high standards of living.

Ores and minerals, and to a lesser extent, forests, appear to be a blessing rather than a curse. As I will show in the following Chapter, the sign on the ores and mineral exports variable may be influenced by the panel data techniques I have employed.

7 Sensitivity Analysis

7.1 Choice of Panel Estimation Technique

The framework used in this paper relied on a systems estimator to estimate simultaneously the parameters of the HDI and control of corruption equations. Unfortunately, this increased sophistication comes at a cost. Programming techniques that estimate systems estimators do not offer the full range of other econometric specification options. For example, software packages are not equipped to deal simultaneously with systems estimation and panel estimation techniques.

To address these limitations, I temporarily set aside the issue of systems estimation. I used ordinary least squares to estimate each of the model equations separately, using a pooled estimator, fixed effects estimator, and random effects estimator. To estimate the fixed effects equations, I had to drop the time-invariant variables that appear in each equation. The results of these analyses are provided in Table 7. Examining the table yields some interesting insights. First, the results of the pooled estimates using the independent equations method are quite similar to the results I obtained using a systems estimator (Table 2). Although systems estimation techniques do not dramatically affect the overall results, the systems model is more appropriate because it explicitly allows for the endogeneity of some of the regressors.

Table 7 also reveals that many of the qualitative conclusions from the model are the same whether a pooled, fixed effects or random effects estimator is employed. One notable exception is the effect of ores and mineral resources on control of corruption. In the pooled and random effects models, these variables have a significant positive relationship with control of corruption, but there is no significant relationship in the fixed effects model.

Table 7. Estimation of the system using separate equations

Dependent Variable: Human Development Index

	Pooled estimator			*Fixed effects*			*Random effects*		
	Coefficient	St. Error		Coefficient	St. Error		Coefficient	St. Error	
Constant	0.7284	0.0152	***	0.6928	0.0077	***	0.6577	0.0194	***
Inverse of Investment per capita	-9.2768	0.5699	***	-0.1582	0.4676		-1.8979	0.4250	***
Openness	1.47E-04	0.0001	*	1.14E-04	9.04E-05		8.84E-05	8.08E-05	
Number of Languages	0.0526	0.0049	***	0.0150	0.0055	***	0.0298	0.0047	***
Latitude	-0.0045	0.0006	***	n/a	n/a		-0.0078	0.0010	***
Control of Corruption	0.0017	0.0003	***	n/a	n/a		0.0032	0.0004	***
Year 2000 Dummy	0.0085	0.0109		0.0187	0.0018	***	0.0185	0.0018	***
Year 2002 Dummy	0.0137	0.0108		0.0204	0.0018	***	0.0204	0.0018	***
Year 2004 Dummy	0.0292	0.0110	***	0.0331	0.0020	***	0.0319	0.0020	***
Adjusted R-squared	0.797			0.995			0.602		

Dependent Variable: Control of Corruption

	Pooled estimator			*Fixed effects*			*Random effects*		
	Coefficient	St. Error		Coefficient	St. Error		Coefficient	St. Error	
Constant	-0.5714	0.0579	***	-0.1286	0.0845	*	-0.6729	0.1003	***
GDP per capita	4.49E-05	3.32E-06	***	1.30E-05	1.71E-05		6.08E-05	5.25E-06	***
Fuel Exports per capita	-1.17E-06	2.95E-07	***	-8.37E-07	4.41E-07	**	-1.02E-06	3.06E-07	***
Ores/Mineral Exports per capita	1.14E-05	1.99E-06	***	-3.51E-06	3.07E-06		4.32E-06	2.13E-06	**
Forestry Production per capita	0.0421	0.0124	***	0.0503	0.0342	*	0.0694	0.0186	***
Regulatory Quality	0.5196	0.0336	***	0.1393	0.0352	***	0.2397	0.0305	***
Largest Ethnic Group	0.2092	0.0821	***	n/a	n/a		0.3412	0.1453	***
Civil War Dummy	-0.1095	0.0453	***	n/a	n/a		-0.1890	0.0803	***
Adjusted R-squared	0.868			0.982			0.607		

***, **, * indicate significance at the 1, 5, and 10% level.

In my core model, I addressed the issue of possible heterogeneity across time periods by including period effects in the HDI equation. Using a Wald test, I was able to reject the null hypothesis that period effects belong in the control of corruption equation. I also addressed the issue of possible heterogeneity across countries by including time-invariant variables such as latitude, number of languages, ethnicity, and a civil war dummy. The effects captured by these variables address the observed heterogeneity across countries.

Using the results from Table 7, I tested to see whether or not there was additional unobserved heterogeneity in the data not accounted for in my core model. The pooled estimates in Table 7 represent a restricted version of each equation, assuming no unobserved heterogeneity across observations. The fixed effects estimates represent an unrestricted version of each equation, allowing for unobserved heterogeneity across observations. Because the time-invariant variables were dropped from the fixed effects equation, the resulting fixed effect estimated for each country includes the effect of both observed and unobserved heterogeneity across countries.

To conduct the test for the presence of unobserved heterogeneity, I compared the sum of squared residuals from each restricted equation to the sum of squared residuals from each unrestricted equation using an F-test. These results clearly indicate that unobserved heterogeneity does exist (Table 8). I also compared the fixed effects estimates with the random effects estimates using a Hausmann (1978) test. The outcome supports the use of fixed effects over random effects. The outcome also implies that the unobserved heterogeneous effects are correlated with other variables included in the model, so that the pooled estimator is also likely inconsistent.

Table 8. Panel methods: Hypothesis tests results

	Pooled Estimator vs. Fixed Effects Estimator (F-test)	Random Effects Estimator vs. Fixed Effects Estimator (Hausmann test)
Human Development Index	F-statistic: 135.77 Degrees of freedom: 258, 99 Reject H_0	Chi-square statistic: 132.86 Degrees of freedom: 6 Reject H_0
Control of Corruption	F-statistic: 23.38 Degrees of freedom: 259, 99 Reject H_0	Chi-square statistic: 81.64 Degrees of freedom: 5 Reject H_0
Null Hypothesis (H_0)	Unobserved heterogeneity does not exist	Unobserved heterogeneity is uncorrelated with other variables in the model

These results indicate that the fixed effects estimator is the most appropriate estimator in this context. The random effects and pooled estimators are inconsistent. Despite this fact, I have chosen to use a pooled estimator in my model. If I were to use the fixed effects estimator, I would not be able to estimate coefficients on the time-invariant variables in my model, something which I would like to do.

With the knowledge that my pooled estimates may be inconsistent, I estimated my system using fixed effects, in order to judge the degree to which the inconsistency might affect the results. The results of this estimation are provided in Table 9.

When I compared the results from the fixed effects estimator to the results from the pooled estimator, I discovered that for most variables, there is little difference between the estimates from the two estimators, which suggests that the impact of the asymptotic bias on the pooled estimator is small. However, the coefficient obtained on the ores and minerals variable appears to be highly sensitive to the panel estimation technique that is employed. This highlights the need for further research on the resource curse using panel data.

Table 9. Estimation of the system using fixed effects

Systems Estimation
Method: Generalized Method of Moments (N=364)
Heteroskedasticity-Consistent Standard Errors

Dependent Variable: Human Development Index

	Coefficient	St. Error	
Constant	n/a		
Inverse of Investment per capita	0.2034	0.7217	
Openness	1.47E-04	9.21E-05	*
Number of Languages	n/a		
Latitude	n/a		
Control of Corruption	0.0553	0.0343	***
Year 2000 Dummy	0.0186	0.0019	***
Year 2002 Dummy	0.0214	0.0019	***
Year 2004 Dummy	0.0339	0.0020	***
Adjusted R-squared	0.994		

Dependent Variable: Control of Corruption

	Coefficient	St. Error	
Constant	n/a		
GDP per capita	5.59E-06	1.50E-05	
Fuel Exports per capita	-7.46E-05	2.96E-05	***
Ores/Mineral Exports per capita	-3.06E-04	1.73E-04	**
Forestry Production per capita	5.32E-02	2.97E-02	**
Regulatory Quality	0.1429	0.0347	**
Largest Ethnic Group	n/a		
Civil War Dummy	n/a		
Adjusted R-squared	0.982		

***, **, * indicate significance at the 1, 5, and 10% level.

Although the coefficients on the investment and GDP per capita variables were insignificant when estimated using fixed effects, this is likely a result of the persistence of these variables. Levels of investment and income are very stable across short periods of time, and this panel spans a relatively short period (7 years). As a result, the investment and GDP variables may be almost time invariant – suggesting that it is difficult to isolate their impact on the dependent variables from the fixed effects (which is why their coefficients are insignificant).

The fixed effects estimator is consistent, but this consistency comes at a high cost. Using a fixed effects estimator would require me to incorporate the effects of any time-invariant variables into the fixed effect constant for each country. Because I am interested in obtaining coefficient estimates on these time-invariant variables, I am willing to tolerate some asymptotic bias in exchange for parameter estimates. Overall, it appears that that the impact of the asymptotic bias on the pooled estimator is relatively small, with the exception of the sign on ores and minerals exports per capita.

7.2 Balanced vs. Unbalanced Panel

To ensure that the results I obtained earlier were not affected by the use of an unbalanced panel, I re-estimated the model using the same dataset, but only included observations where data for all four years was available. This reduced the total number of observations from 366 to 296, and reduced the number of included countries from 102 to 74. Appendix B provides a list all of the countries included in the original sample. Any country with fewer than four observations was dropped to create a balanced panel.

The results obtained using a balanced panel are provided in Table 10 and are very similar to the results obtained using an unbalanced panel (Table 2). The coefficient on the openness variable doubled, but all other coefficient estimates were remarkably similar. The coefficient on largest ethnic group was no longer significant, but this could be a direct result of the decrease in the available number of observations. The coefficient estimates might also be influenced by which observations were dropped in order to balance the panel. It does not appear that there is any systematic bias in which countries were dropped. For example, developed countries such as Canada and Belgium were dropped, but so were less developed countries such as Cambodia and Ecuador. Baltagi and Chang (2000) show that based on root mean square error criterion, in the context of systems estimation, using an unbalanced panel is preferable to dropping observations just to balance the panel.

Table 10. Estimation of core model using a balanced panel

Systems Estimation
Method: Generalized Method of Moments (N=296)
Heteroskedasticity-Consistent Standard Errors

Dependent Variable: Human Development Index

	Core Model	
	Coefficient	St. Error
Constant	0.7233	0.0148***
Inverse of Investment per capita	-9.4008	1.2668***
Openness	2.93E-04	8.16E-05***
Number of Languages	-0.0033	6.33E-04***
Latitude	0.0013	2.11E-04***
Control of Corruption	0.0581	0.0041***
Year 2000 Dummy	0.0183	0.0104**
Year 2002 Dummy	0.0225	0.0112**
Year 2004 Dummy	0.0262	0.0108***
Adjusted R-squared	0.808	

Dependent Variable: Control of Corruption

	Core Model	
	Coefficient	St. Error
Constant	-0.4921	0.0703***
GDP per capita	6.40E-05	5.56E-06***
Fuel Exports per capita	-1.61E-04	2.37E-05***
Ores/Mineral Exports per capita	0.0010	1.68E-04***
Forestry Production per capita	0.0370	0.0112***
Regulatory Quality	0.4144	0.0556***
Largest Ethnic Group	0.0219	0.1088
Civil War Dummy	-0.0998	0.0478**
Adjusted R-squared	0.845	

***, **, * indicate significance at the 1, 5, and 10% level.

7.3 Fractional Dependent Variables

The Human Development Index is a special type of dependent variable as its values range between zero and one. Ideally, this information should be taken into account when creating an econometric model. One common way of incorporating this information is to transform dependent variables that take this form (such as proportions) into their log odds ratio.

I computed the log odds ratio of the Human Development Index and re-estimated the core model. Because of the non-linear nature of the new dependent variable, the coefficients from these estimations cannot be directly compared to the estimated coefficients from the core model. However, by examining the signs of the coefficients, it is possible to determine if the inferences that are drawn would change under this estimation technique. Algebraically, an increase in the level of a variable corresponds to an increase in the log odds ratio of that variable.[5] Therefore, any variable that has a positive impact on the HDI should have a positive impact on the log odds ratio of the HDI. Therefore, if the results of the log odds estimation are similar to the core estimation, then the signs of the coefficients in the HDI and corruption equations should stay the same.

As shown in Table 11, all but one of the signs on the coefficients are as expected. Although the coefficient on the openness variable has the wrong sign, it is statistically insignificant.

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[5] This can be proved by showing that the derivative of $\log(x/(1-x))$ is positive when $0<x<1$. Log odds ratios cannot be computed for variables outside this range, as it is not possible to take the log of a negative number.

Table 11: Core model estimated using log odds ratio of HDI

Systems Estimation
Method: Generalized Method of Moments (N=366)
Heteroskedasticity-Consistent Standard Errors

Dependent Variable: Log odds ratio, Human Development Index

	Core Model	
	Coefficient	St. Error
Constant	1.0976	0.0765***
Inverse of Investment per capita	-37.9976	4.7364***
Openness	-1.28E-04	5.21E-04
Number of Languages	-0.0201	0.0032***
Latitude	0.0093	0.0011***
Control of Corruption	0.4869	0.0231***
Year 2000 Dummy	0.0861	0.0545*
Year 2002 Dummy	0.1166	0.0559**
Year 2004 Dummy	0.2278	0.0543***
Adjusted R-squared	0.822	

Dependent Variable: Control of Corruption

	Core Model	
	Coefficient	St. Error
Constant	-0.5673	0.0582***
GDP per capita	5.93E-05	5.64E-06***
Fuel Exports per capita	-1.51E-04	2.49E-05***
Ores/Mineral Exports per capita	0.0010	1.55E-04***
Forestry Production per capita	0.0411	0.0105***
Regulatory Quality	0.4363	0.0468***
Largest Ethnic Group	0.1296	0.0904*
Civil War Dummy	-0.0910	0.0424**
Adjusted R-squared	0.860	

***, **, * indicate significance at the 1, 5, and 10% level.

Paolino (2001) argues that, while the log odds ratio transformation accounts for the bounded nature of the dependent variable, this approach can cause other problems.[6] The relative inefficiency of the log odds ratio transformation may be responsible for the insignificant coefficient on the openness variable.

7.4 Choice of Dependent Variable

There is no universally accepted measure of economic development. The Human Development Index is a composite index comprised of income, education and health indicators. To test whether or not my results were sensitive to my choice of dependent variable, I estimated the model using real GDP per capita (in purchasing power parity terms) as my dependent variable. In this estimation, the openness variable has an unexpected sign, and the number of languages variable is no longer significant. However, rents from fuel resources still appear to form an important part of the resource curse.

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[6] Instead of using the log odds ratio transformation, Paolino recommends using the beta distribution to form maximum likelihood estimates. The beta distributed maximum likelihood technique is more efficient than other approaches, particularly when the sample is large and the dependent variable has been transformed. However, estimation using this technique is beyond the scope of this thesis.

Table 12. Estimation using GDP per capita (PPP) as the dependent variable

Systems Estimation
Method: Generalized Method of Moments (N=366)
Heteroskedasticity-Consistent Standard Errors

Dependent Variable: GDP per capita (purchasing power parity)

	Core Model	
	Coefficient	St. Error
Constant	8503.3250	792.0786***
Inverse of Investment per capita	-118894.60	27084.30***
Openness	-16.6498	5.0818***
Number of Languages	-30.3539	25.6566
Latitude	53.7433	10.5883***
Control of Corruption	7245.5070	294.4215***
Year 2000 Dummy	387.9600	511.7695
Year 2002 Dummy	861.9204	511.0391**
Year 2004 Dummy	1575.1080	541.1803***
Adjusted R-squared	0.822	

Dependent Variable: Control of Corruption

	Core Model	
	Coefficient	St. Error
Constant	-0.5673	0.0582***
GDP per capita	5.93E-05	5.64E-06***
Fuel Exports per capita	-1.51E-04	2.49E-05***
Ores/Mineral Exports per capita	0.0010	1.55E-04***
Forestry Production per capita	0.0411	0.0105***
Regulatory Quality	0.4363	0.0468***
Largest Ethnic Group	0.1296	0.0904*
Civil War Dummy	-0.0910	0.0424**
Adjusted R-squared	0.860	

***, **, * indicate significance at the 1, 5, and 10% level.

7.5 Choice of Independent Variables

7.5.1 Resource abundance

In my framework, I measured resource abundance in terms of per capita exports or per capita production, depending on the availability of data for each resource type. In section 3.2, I described the problems associated with measuring resource abundance in terms of the relative share of income, exports or wealth that resources provide. To demonstrate how sensitive the results are to the specification of resource abundance, I re-estimated my model using a more conventional share of resource abundance, the share of natural resource exports in GDP. The regression results are shown in Table 13.

The results of this estimation are very similar to the results from the core model. The explanatory variables in both equations have the same signs, and their magnitudes are similar. However, if I were to use these results to try and evaluate the resource curse hypothesis, the results would be quite different. Measuring resource abundance by the share of natural resources in GDP does not yield significant results. In the core model, resource abundance in measured in terms of available resource rents per capita, and is broken out separately for different types of resources. This technique does yield significant results. Conclusions about the validity of the resource curse are clearly affected by how resource abundance is measured.

In this model, if resources are a curse, then the coefficient on the share of natural resource exports in GDP should be negative, and the coefficient on the control of corruption variable should be positive. If this were true, then the share of natural resource exports in GDP would lead to decreased control over corruption, which would lead to a lower value of the HDI. Using this model, I tested the null hypothesis that natural resources cause decreased control over corruption, and obtained a p-value of 0.61. The evidence is not strong enough to determine a conclusive relationship between the share of natural resource exports in GDP and control of corruption.

Table 13. Estimation using a conventional measure of resource abundance

Systems Estimation
Method: Generalized Method of Moments (N=366)
Heteroskedasticity-Consistent Standard Errors

Dependent Variable: Log odds ratio, Human Development Index

	Core Model	
	Coefficient	St. Error
Constant	0.7284	0.0148***
Inverse of Investment per capita	-9.2497	1.0850***
Openness	1.47E-04	9.77E-05*
Number of Languages	-0.0045	7.44E-04***
Latitude	0.0017	2.23E-04***
Control of Corruption	0.0528	0.0040***
Year 2000 Dummy	0.0083	0.0104
Year 2002 Dummy	0.0137	0.0108
Year 2004 Dummy	0.0291	0.0100***
Adjusted R-squared	0.798	

Dependent Variable: Control of Corruption

	Core Model	
	Coefficient	St. Error
Constant	-0.4904	0.0600***
GDP per capita	6.24E-05	4.59E-06***
Natural Resources Exports / GDP	-0.0011	0.0021
Regulatory Quality	0.5097	0.0519***
Largest Ethnic Group	0.1028	0.0895
Civil War Dummy	-0.1029	0.0430***
Adjusted R-squared	0.839	

***, **, * indicate significance at the 1, 5, and 10% level.

As I have shown in the core model, the effects of natural resource abundance vary across resource types. Comparing the results of the core model to the estimation using a more conventional measure of resource abundance highlights the need to specify the relationship that the resource curse hypothesis should try to model very carefully. This analysis has highlighted how sensitive conclusions about the resource curse hypothesis are to how natural resource abundance is measured.

7.5.2 Conflict

In the framework I have presented, I have included a variable that indicates whether or not a country experienced civil war (i.e. an internal conflict with at least 1,000 deaths per year) in any of the years during the period 1980-1999. While the Correlates of War project[7] provides a wealth of data on international and internal conflicts, data at the country level are difficult to find. Most available datasets have extensive information on observations of particular conflicts, not country-level or time series indicators for particular countries. Moreover, defining how conflict should be measured also causes difficulty. For example, how many deaths must occur (or what other conditions must be met) for a particular uprising or rebellion to be considered an internal conflict?

The indicator that I used to measure the presence of civil war was derived from data available from Fearon (2005). While I would have preferred to obtain country-level indicators of conflict over a longer time span, it was difficult to find complete, reliable data in a format that could facilitate regression analysis. The coefficient I obtained on the civil war dummy should be interpreted with caution. While this variable serves as a proxy for the likelihood that internal conflict occurred within a country during the period under investigation, the indicator is a rough approximation and the results may be sensitive to its measurement and definition.

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[7] The Correlates of War project offers a variety of data and information on its website, which can be accessed at http://www.correlatesofwar.org/

8 Conclusion

8.1 Summary of Methods

In this thesis, I took a new approach to evaluating the natural resource curse hypothesis. Traditional models of the natural resource curse have focussed on using the share of primary product exports in GDP to explain differences in growth rates of GDP across countries. Instead of evaluating the relationship between resource dependence and economic growth, I expressed the resource curse as the potential for resource rents to lead to corruption and rent seeking, which in turn affects the standard of living in a given country.

Some of the most notable differences between my methods and those of previous researchers include:

i. I incorporated the mechanism through which I expect the resource curse to operate (rent seeking and corruption) explicitly into my model.
ii. Resource abundance is measured in per capita terms, rather than as the relative share of resources in GDP.
iii. Different types of natural resources are treated separately.
iv. My data are from a relatively recent time period (1998-2004), and I have pooled data from multiple years to obtain more reliable estimates.
v. The complicated relationship between natural resource abundance and overall standards of living is estimated using a systems estimator.

8.2 Summary of Findings

Using the technique described above, I found that different types of natural resources have different impacts on standards of living across countries. Rents from fuel resources appear to be negatively related to control of corruption, but rents from forestry resources and control of corruption appear to have a positive relationship. The relationship between rents from ores and mineral resources and control of corruption appears to be positive, but this result may not be robust to changes in panel data estimation techniques.

Control of corruption and the Human Development Index have a strong positive relationship.

From these findings, I conclude the following:

i. Different types of natural resources must be treated separately when addressing the validity of the resource curse hypothesis. The different properties of different types of natural resources affect the characteristics of their associated resource rents.

ii. Fuel resources are associated with increased rent-seeking and corruptive behaviours, suggesting that fuel resources may be considered a "resource curse".

iii. Forestry resources are associated with decreased rent-seeking and corruptive behaviours, suggesting that these resources might be considered a blessing, rather than a curse.

iv. The relationship between ores and mineral resources appears to be positive, suggesting that these resources are also a blessing. However, this result is sensitive to panel data estimation techniques, and warrants further study.

v. Through their impact on rent-seeking and corruptive behaviours, rents from fuel resources negatively impact overall standards of living across countries, as measured by the Human Development Index. This effect can be mitigated, however, through improved institutional quality.

8.3 Suggestions for Future Research

While this research focussed on a relatively short time horizon, as more data become available, it would be interesting to study how natural resource abundance impacts long term changes in the standard of living across countries. This could be done by using a panel of data that spans a longer time horizon and has longer intervals between periods.

As I discussed in Chapter 4, I originally wanted to measure standards of living by a weighted index of GDP and some measure of income inequality. Although it may be challenging to find consistent and complete data sets on income inequality, development economists might be able to suggest other variables that could be used as proxies or instruments for income inequality.

On the technical side, it would be useful if there were more research on the resource curse that used panel data. Specifically, it would be interesting to see more studies that show whether or not the validity of the resource curse claim is impacted by the decision to use cross-sectional or panel data. In the context of panel estimation, future research might be aimed at investigating whether the pooled estimator, random effects estimator, or fixed effects estimator is most appropriate.

As for the econometric specification, it would be worthwhile for other researchers to explore the possibilities of non-linear functional forms and non-constant parameters across sub-samples of observations. It would also be interesting to consider an alternative specification, in which the dependent variable involved predicting the factors that cause countries to transition from high levels of corruption and low levels of human development to low levels of corruption and high levels of human development. This type of analysis would require data that spans a relatively long duration, so that it would be possible to examine how countries have changed their relative corruption and human development levels over time.

8.4 Concluding Remarks

Natural resources provide a valuable flow of income to several countries around the world. Throughout history, some resource-rich countries have grown rapidly and achieved high standards of living, while others have experienced corruption, civil war and widespread poverty. The relationship between natural resource abundance and overall standards of living is extremely complicated, and, before making any general claim about whether or not natural resources are a curse or a blessing, researchers should spend a great deal of time considering the various mechanisms through which resource rents may help or hinder economic development.

If resource rents are invested into infrastructure and social programs that increase long-term economic growth and distribute wealth to those in need, then resource rents have the potential to increase overall standards of living within countries. However, if resource rents are captured by special interest groups and dissipated through corruption and rent-seeking behaviour, resource rents may lead to lower overall standards of living and increased income inequality within countries. The capacity for resource rents to improve, rather than inhibit, economic development depends in large part on the role of government institutions and the nature of the resources generating the rents.

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Appendix A: Data Definitions

Human Development Index

- Weighted index comprised of GDP per capita (purchasing power parity), adult life expectancy at birth, adult literacy rate, and combined gross school enrolment rate
- Source: United Nations Human Development Reports, selected years

Investment per capita

- Gross capital formation (constant 2000 US$) per capita
- Source: World Bank Development Indicators

Openness

- Trade volume expressed as a percentage of GDP
- Source: World Bank Development Indicators

Number of Languages

- Number of languages in Ethnologue that exceed minimum threshold (1% of population or 1 million speakers)
- Country observations are time invariant
- Source: Fearon and Laitin, 2003

Control of Corruption

- Measures the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interest
- Ranges from about -2.5 to +2.5 (higher values are associated with less corruption)
- Source: World Bank Governance Indicators

Latitude

- Latitude of the country's capital city
- Seconds of latitude were converted into fractions of a minute and expressed as decimal values
- Source: CIA World Factbook

GDP per capita

- GDP per capita (constant 2000 US$)
- Source: World Bank Development Indicators

Fuel Exports per capita

- Measures the relative abundance of resource rents from petroleum
- Measured in constant 2000 US $
- Derived from % of fuel exports in merchandise exports, merchandise exports (current $), population, and export deflator[8]
- Source: Derived from variables available from World Bank Development Indicators

Ores and Minerals Exports per capita

- Measures the relative abundance of resource rents from minerals and metals
- Measured in constant 2000 US $
- Derived from % of ores and minerals exports in merchandise exports, merchandise exports (current $), population, and export deflator
- Source: Derived from variables available from World Bank Development Indicators

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[8] Export deflator was derived by dividing a country's current $ value of total exports by the constant 2000 US$ value of total exports

Forestry Production per capita

- Measures the relative abundance of resource rents from forestry
- Measured by cubic meters of roundwood produced per capita
- Derived from roundwood production (millions of cubic meters) and population
- Source: Derived from variables available from United Nations Common Database and World Bank Development Indicators

Largest Ethnic Group

- Measures the size of a country's largest ethnic group, as a share of the country's total population
- Source: Fearon and Laitin, 2003
- Data available at: http://www.stanford.edu/~jfearon/
- Country observations are time invariant

Regulatory Quality

- Measures the ability of government to formulate and implement sound policies and regulations that permit and promote private sector development
- Ranges from about -2.5 to +2.5 (higher values are associated with better regulatory quality)
- Source: World Bank Governance Indicators

Civil War Dummy

- Indicates whether or not a country had a civil war (internal conflict with at least 1,000 combat-related deaths per year) during the period 1980-1999
- Source: Derived from Fearon dataset (2005)
- Data available at: http://www.stanford.edu/~jfearon/

Appendix B: Countries Included in the New Framework

In total, there were 102 countries included in the sample and 366 observations. The countries included in the sample cover a wide range of both developed and developing countries from all continents around the world. Countries with observations for all of the four time periods were included in the balanced panel estimation.

Country Name and Number of Observations

Albania	4	Ghana	2	Pakistan	4
Algeria	4	Guatemala	4	Panama	4
Argentina	4	Guinea	2	Paraguay	4
Armenia	3	Guyana	3	Peru	4
Australia	4	Honduras	4	Philippines	4
Azerbaijan	3	Hungary	4	Poland	4
Bangladesh	4	India	4	Portugal	4
Belarus	4	Indonesia	4	Romania	4
Belgium	3	Iran, Islamic Rep.	4	Russian Federation	4
Benin	3	Israel	4	Senegal	4
Bolivia	4	Japan	4	Slovenia	4
Botswana	2	Jordan	4	South Africa	4
Brazil	4	Kazakhstan	3	Sri Lanka	2
Bulgaria	4	Kenya	4	Sudan	2
Burkina Faso	4	Korea, Rep.	4	Swaziland	2
Cambodia	3	Kyrgyz Republic	3	Sweden	4
Cameroon	2	Latvia	4	Syrian Arab Republic	4
Canada	3	Lebanon	4	Tanzania	4
Chile	4	Lithuania	4	Thailand	4
China	4	Macedonia, FYR	3	Togo	4
Colombia	4	Madagascar	4	Trinidad and Tobago	4
Costa Rica	4	Malawi	4	Tunisia	4
Cote d'Ivoire	3	Malaysia	4	Turkey	4
Croatia	4	Mali	2	Turkmenistan	1
Czech Republic	4	Mauritius	4	Uganda	4
Ecuador	3	Mexico	4	Ukraine	4
Egypt, Arab Rep.	4	Moldova	4	United Kingdom	4
El Salvador	4	Mongolia	3	United States	4
Estonia	4	Morocco	4	Uruguay	4
Ethiopia	1	Mozambique	2	Venezuela, RB	4
Finland	4	Netherlands	4	Vietnam	3
France	4	New Zealand	4	Yemen, Rep.	4
Gabon	3	Nicaragua	4	Zambia	4
Gambia, The	2	Norway	4	Zimbabwe	3

Appendix C: Countries Included in Traditional Framework

The following 88 countries were included in the estimation described in section 5.3.

Albania	Estonia	Lithuania	Russian Federation
Algeria	Finland	Macedonia, FYR	Senegal
Argentina	France	Madagascar	Serbia and Montenegro
Australia	Gabon	Malawi	Slovak Republic
Azerbaijan	Georgia	Malaysia	Slovenia
Bangladesh	Grenada	Mauritius	South Africa
Belarus	Guatemala	Mexico	Sweden
Belgium	Honduras	Moldova	Syrian Arab Republic
Bolivia	Hong Kong, China	Morocco	Tanzania
Brazil	Hungary	Netherlands	Thailand
Bulgaria	Iceland	New Zealand	Togo
Burkina Faso	India	Nicaragua	Trinidad and Tobago
Canada	Indonesia	Norway	Tunisia
Chile	Iran, Islamic Rep.	Oman	Turkey
China	Israel	Pakistan	Uganda
Colombia	Japan	Panama	Ukraine
Costa Rica	Jordan	Paraguay	United Kingdom
Croatia	Kenya	Peru	United States
Czech Republic	Korea, Rep.	Philippines	Uruguay
Ecuador	Kyrgyz Republic	Poland	Venezuela, RB
Egypt, Arab Rep.	Latvia	Portugal	Yemen, Rep.
El Salvador	Lebanon	Romania	Zambia