DOES MINERAL RESOURCE DEPENDENCE FOSTER CORRUPTION?

by

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ABSTRACT

It has been argued in the literature that natural resource dependence causes rent-seeking behavior that leads to corruption. This paper's empirical tests of cross sectional mineral dependence, economic development and corruption data show a clear negative relationship between aggregate measures of mineral dependence and a corruption control index across 176 countries. Disaggregating the data by mineral commodity and level of development, the results indicate that only in the case of less developed mineral fuel exporting countries does mineral dependence lead to higher levels of corruption. For the other mineral industries, nonfuel mining appears to have a positive impact on corruption control only in the most developed countries.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

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SECTION 1

INTRODUCTION

At the earliest stages of global economic development, natural and mineral resource abundance played a fundamental role in determining the group that comprises the world's richest countries. However, in the modern age, many countries rich in mineral wealth have failed to prosper where less endowed countries have. Coined the resource curse theory, this hypothesis has been supported by a number of empirical studies, including a series by Sachs and Warner (2001) which showed that far from a guarantee for a country's economic success, natural resource dependence, as measured by export percentage of GDP, has a robust negative relationship with economic growth. There are many hypotheses the attempt to explain the resources curse. The institutions hypothesis of economic development put forth by Engerman and Sokoloff (1997) and supported by Easterly and Levine (2002) and others, proposes that mineral endowments influenced the institutions that were initially established in European colonies. States that began with mineral or other extractive resources developed rent-seeking institutions typically associated with corruption. Dutch disease and increased exposure to terms of trade shocks are offered as two results of mineral dependence that cause low growth. Persistent misappropriation of rents and corruption are also suggested as possible explanations of the resource curse (Auty, 1993; Sachs and Warner, 2001).

Corruption is not a new phenomenon; in fact, it has probably existed as long as there have been human institutions. What is relatively new is the economic, political and moral concern over the effects of corruption on development, growth and democracy. The increased attention paid to corruption by economists in the past few decades is no doubt a result of an increasingly globalized economy in which distaste for public and private sector corruption is steadily rising.

A large body of research explores the link between mineral dependence and corruption and whether the extraction of mineral resources cripples institutions, particularly by creating an environment where corruption can thrive. Given the uniqueness of the mining industry, Leite and Wiedmann (1999) argue that the windfall gains from mineral resource abundance lead to rent-seeking and corruption. Establishing a direct causal link between mining and corruption would help explain the results of the empirical research that finds mineral dependent economies have lower levels of economic growth than those countries with marginal mineral sectors. This paper will build upon the theoretical and empirical corruption literature to test whether corruption levels can be explained beyond levels of economic development by mineral dependence.

Mineral dependence is characterized in the empirical literature as mineral exports as a percentage of total exports, minerals as a percentage of gross domestic product (GDP), mineral sector contribution to government revenue or some combination of the three (Auty, 1993; Leite and Weidmann, 1999). Data limitations often preclude commodity level analyses that can consider mineral rents. Because the availability of rents tends to induce rent-seeking behavior that is typically associated with corruption (Krueger, 1974; Tirole, 1998), the diversity of mineral commodities in their ability to generate rents should lead to different levels of corruption. Therefore, the empirical analysis of minerals and corruption in Section 3 considers mineral rents in addition to mineral dependence and their relationship to observed levels of corruption.

Although the World Bank and others define corruption as the use of public resources for private gain, corruption is not a uniquely public sector phenomenon. Corruption can take many forms with varying degrees of severity: gifts, bribes for basic government issued documents and licenses, preferential contracts, government theft and embezzlement are just a few examples. Corruption, in some cases, could be considered a black market for government services that are otherwise very inefficiently provided. Framing corruption as a principal-agent problem with incomplete information provides more general description (Banfield, 1975): when an individual, in the illegal pursuit of his

self-interest, betrays the interests of the principal and affects a third party in the process. Corruption is many times a cooperative process that can involve large segments of society; individuals make decisions as to whether to engage in corruption based on the societal norms.

Section 2 discusses the treatment of corruption in the literature with respect to efficiency and growth and mineral resources. Section 3 provides a theoretical justification for the specification of the econometric model in Section 4 that tests empirical relationship between mineral dependence and corruption. Section 5 includes a discussion of the empirical results and Section 6 concludes with the implications of the results on policy and suggestions for further research.

SECTION 2

CORRUPTION, GROWTH AND MINERAL RESOURCES

This section reviews the literature on corruption and its impact on efficiency and growth and how corruption opportunities can be created by the mineral industry. This section focuses on the economics of corruption rather than on the societal determinants of the phenomenon.

2.1 Characterizations of Corruption

Shleifer and Vishny (1993) characterize corruption as the sale by government officials of administrative rights for personal gain. Corruption at the government level can be caused by rent-seeking behavior on the part of government officials in the granting of administrative rights but can also include preferential hiring decisions and illegal use of state resources. Where potential rents exist, firms and individuals will engage in rent-seeking behavior incurring administrative or strategic costs to maintain monopoly position (Tirole, 1998). Krueger (1974) characterized rent-seeking behavior at the government level as rents derived from trade restrictions, specifically on imports. When these rents exist to the importer, they allocate resources toward securing these rents sometimes in the form of bribes. While the availability of rents and rent-seeking behavior may generate incentives for corrupt practices, weak institutions and low levels of political accountability for government officials enable and perpetuate corruption. Kahn and Jomo (2000, p.10) propose that the availability of mineral and agricultural resource rents in Malaysia and access to lands under the control of the state led to a rent-seeking colonial regime that was neither fair nor efficient and was kept in place even after independence. The persistence of this rent-seeking colonial institutional structure is found to be a major determinant of the poor growth results of developing countries (Engerman and Sokoloff; 1997; Easterly and Levine, 2002). Low

public sector wages further encourage rent-seeking behavior at all levels, reinforcing existing levels of corruption.

A theoretical explanation for why corruption tends to persist is furnished by a model that describes the equilibrium proportion of corrupt officials. There is a high benefit to an honest official when the proportion of corrupt officials is very low but this declines as the share of corrupt officials increases and eventually becomes negative. For the corrupt official, the benefit of corruption is low when honesty prevails. As the proportion of corrupt officials increase there is an increase in benefit until the point where the share of corrupt officials is high enough to bid down the corruption payment. The result of this model is three equilibria; two stable ones where all of the officials are honest or they are all corrupt. The third is some mix of honest and corrupt whereby any deviation i.e. a marginal honest or corrupt official will move the equilibrium to one of the stable outcomes (Andvig, 1991).

2.2 Corruption and Efficiency

Because the magnitude and effects of corruption will be determined by the particular institutional and incentive structures in place (Khan and Jomo, 2000: p. 10), models of corruption developed in the literature have different forms and some opposing outcomes. While corruption can be considered a tax on investment (Leite and Wiedmann, 1999), several studies suggest that it is more costly to society than its more benign cousin. In the case of import restrictions, competitive rent-seeking imposes an additional welfare cost than would a tariff alone (Krueger, 1974). There are also additional costs associated with keeping the corruption a secret (Shleifer and Vishny, 1993). In a model of corruption and property rights presented by Acemoglu and Verdier (1998), an important function of bureaucracies is the enforcement of property rights. They argue that when corruption among bureaucrats compromises their abilities to enforce these contracts there is a resulting detrimental effect on investment because entrepreneurs can not make credible promises to each other.

In assessing the efficiency effects of different types of corruption Bardhan (1997) considers the possibility that centralized or lump-sum corruption payments impose less distortion than do many small bribes at all levels of economic activity. While this may be true, the large corruption payments that go to Swiss bank accounts may not be preferable to supplementing the abysmally low wages received by petty public sector employees.

Another strand of the literature portrays corruption as grease of the squeaky wheels. Where there are distortions created from existing policies, corruption may actually improve welfare as measured by surplus (Huntington, 1968; Leff, 1964). In the case where there are competing bribes, only the lowest cost producer will be able to afford the highest bribe. Whether the government official pockets the surplus is of no consequence in the efficiency argument even though it is problematic otherwise. This efficiency breaks down however, when the bribers lack complete information on costs, when lobbying influence is a factor and when the bribe is used to limit competition (Bardhan, 1997) frequently resulting in the socially wasteful dissipation of rents (Tirole, 1998).

The value of relationships and reputations must also be considered, especially in those societies where the weakness of the official institutions creates a large positive externality to generating and maintaining personal networks where present value of a lower nominal bribe per period may be higher to that government official accepting the bribe due to other external benefits.

2.3 Corruption and Growth

When corruption takes the form of government theft, resources are diverted from public investment to private pockets, constraining potential growth by the value of lost resources (Congo, formerly Zaire being a prime example). While this behavior was accepted to a large extent by developed countries for geopolitical reasons, the consequences and impacts on growth are now being called into question. The empirical analysis by Mauro (1995) finds a subjective corruption index is negatively related to private investment and

growth. The study shows that a one-standard-deviation improvement in the corruption index is associated with a 1.3 percent increase in per capita GDP. However, Khan and Jomo (2000) warn that regressions are misleading because some countries may be worse off because of corruption but some may be experiencing extremely high growth because of corruption. Furthermore, corruption indices do not distinguish between corruption per transaction and total corruption and business people may deem corruption to be less serious if the system works to their benefit resulting in large profits.

2.4 Minerals and Corruption

From the literature, low public sector wages and weak institutions are identified as the principal factors that enable corruption. In weak states government officials may find it in their personal best interest to maintain the status quo of weak institutions when there are corruption opportunities generated by the large short term rents frequently observed in the mining industry. There are several key characteristics of the mining industry that, considered together, make it particularly susceptible to corruption when compared to other industries such as manufacturing: high levels of government involvement; limited supply and location of product; large capital investment requirements; volatile revenue streams stemming from price volatility; and high concentration of rents.

The mineral industry is unique with respect to other industries in that the primary product, the commodity, usually belongs to the State in its initial unextracted state. National government have an interest in gaining wealth from their resources, in protecting the environment and indigenous peoples and being able to supply domestic industry with inputs, especially in the case of a national security emergency. For these and many other reasons, the mineral industry is highly regulated by the State. Given the government's nearly exclusive control over the resource, officials in a mineral dependent economy may find many opportunities to engage in corruption from issuing of exploration permits to bidding between firms to produce a mineral deposit and to the collection of royalty payments.

The limited supply and fixed location of a mineral deposit can provide leverage to a corrupt official negotiating with mining company. Countries with a mineral product that is only found in a few places in the world will have considerable bargaining power with firms that want to develop the resource and can negotiate large benefits for the country (Rose-Ackerman, 1999: p 122). In Botswana, the productivity of its kimberlite diamond deposits enabled the government to negotiate a 50 percent share of diamond profits with DeBeers in 1975 (Acemoglu, Johnson and Robinson, 2003: p. 100). While many may argue that for the scale of human mineral consumption, the supply of most minerals is unlimited, high quality low cost mineral deposits, as in the case of Botswana's diamonds, are limited. And, unlike a manufacturing firm that can set up production virtually anywhere (Marshall, 2001), mining companies will sometimes have to contend with unscrupulous authorities in order to maintain market share. Similarly, unscrupulous mining companies may be willing to engage in corruption in order to secure a mineral deposit. Whichever side carries more of the ethical burden of a particular corrupt transaction, the mineral's physical and geographical characteristics provide ample opportunities for corruption.

In addition, mining tends to require very large foreign capital investment. Large capital investment combined with a large and potentially lengthy regulatory burden on mining companies makes a speedy progression over regulatory hurdles very valuable (Marshall, 2001). A mining company may want to pay a bribe and begin production immediately rather than allow interest payments to accrue while bureaucratic red tape delays production.

Volatile mineral prices or changes in the underlying supply and demand for the mineral production often leads to volatile resource revenues that weaken the government's ability to budget and weaken government institutions (Ross, 1999). Also large outflows of capital associated with mining companies may make relatively small corruption payments difficult to detect by the public.

The Ricardian rents generated from mineral production are a main reason for which mineral economies are considered as a distinct group (Gelb, 1988: p.32). Minerals that

consistently generate high rents may be singled out as causing corruption through the opportunities they provide for rent-seeking behavior in the society. Even within the same commodity there are different ore bodies and processing techniques that determine the size of the rents generated from extraction. High quality mineral deposits might likely foster a rent-seeking environment that would lead to corruption. Mineral rents can furnish regimes, such as that of the famed kleptocrat Mobutu Sese Seko of Zaire (1965-1997), with a concentrated source of revenue.

While the availability of rents generated from mining activity may induce corruption for the reasons mentioned above, the literature stresses the importance of institutions and the initial levels of corruption as key determinants as to whether mining rents will have positive or negative effects on corruption. In the book, Oil Windfalls: Blessing or Curse (1998), Gelb stresses the development outcome of mineral production is largely determined by the policy choices of the producer government. The stability of the government and its ability to make clear decisions with respect to natural resource extraction and the use of resources revenues will determine whether oil rents, in the case of Gelb's study, are absorbed to promote growth and development. Many of the lessons from oil economies are applicable to other mineral economies scaled relative to the level of rents generated from the particular mineral industry. If a country or government has a more long term view or a lower discount rate, it may decided that the optimal extraction of the country's resource should be slower than that of a government with a high discount rate that wants to get as much out of the country's mineral deposits as quickly as possible. The possibility of this choice in mineral economies also opens up the possibility of corruption in the levels of government that have access to mineral rents.

In a theoretical model of rent-seeking and resource booms, Baland and Francois (2000) illustrate that resource booms will only increase levels of rent-seeking when an economy's initial equilibrium is predominantly rent-seeking and not entrepreneurial. Empirical test of the theory find that countries such as Nigeria, Saudi Arabia, Kuwait and United Arab Emirates suffered from low growth rates from 1980-1993 subsequent to the oil

boom of the late 1970's, whereas Indonesia, Malaysia and Norway all grew at a much higher rate from 1980-1993, even though their pre-oil boom growth rates were comparable to those of the low performers.

In an empirical study of the incidence of civil war in Africa, Collier and Hoeffler (2002) find that mineral dependence provides an accessible source of financing for rebel groups, leading to political instability and conflict. Increases in the ratio of primary commodity exports such as oil, diamonds and metals to GDP increase the risk of violent conflict. When the ratio of primary commodity exports to GDP surpasses 26 percent, the risk of conflict begins to decline, but Collier and Hoeffler (2002) find that few countries fall in this range. Persistent instability and uncertainty weaken institutional capacity and high levels of corruption are just one signal of overall institutional breakdown.

The availability of mineral rents can promote entrepreneurial activity and increase over all income in the ideal scenario, promote rent-seeking in a less than ideal scenario and in the very worst case where institutions are very weak, rent-seeking can take the form of armed conflict with devastating impacts.

SECTION 3

MODELING MINING AND CORRUPTION

The following section will provide a theoretical justification for the specification used in the empirical portion of the paper. It will begin with a theoretical individual corruption decision then it will relate the availability of rents to rent-seeking and corruption. Finally, it will look closely at the mining sector in its ability to generate rents with respect to exports.

3.1 Individual Corruption Decision

Clearly there are many ways of describing corruption and many possible channels through which mineral resources may have a relationship to corruption. The modeling of corruption in the economic literature reflects this diversity. However, underlying many of the theoretical characterizations of corruption is a principal-agent problem (Banfield, 1975; Tirole, 1996). Other theoretical characterizations of corruption include efficiency wage analysis (Ades and Di Tella, 1999), government official as the monopolist of government property (Shleifer and Vishny, 1993) and a general equilibrium optimal control problem for corruption and growth (Leite and Weidmann, 1999; Ellis and Fender 2000).

This presentation of an individual's utility maximization uses the efficiency wage analysis introduced in Becker's (1968) seminal article modeling crime and punishment. The simple model will show how the decision to engage in a corrupt transaction is determined by the availability of mineral rents, the probability of detection and the severity of the penalty. Other characteristics of the mining industry, particularly the market structure of certain minerals, will be considered only in how they might affect the institutional parameters. For example, it may be that the mining industry generates the kind of networks described by Cartier-Bresson (2001) that protect its members from punishment and engender corruption in the society at large, reflected by a low probability of detection.

The supply of corruption payments will depend upon individuals and firms deciding to offer illegal payments to other individuals or firms, resulting in an outcome that is more beneficial than obeying the law. If a firm supplies a corruption payment, the benefits from engaging in corruption should maximize profits. The demand for corruption will depend upon individual utility maximization decisions. Corruption will occur when the corrupt transaction provides a larger payoff to the individual than the case of no corruption given the size of a corruption payment and given the present value of future income, $\sum_{t=1}^{s} \frac{w}{(1+\delta)^t}$ where w is the wage, δ is the discount factor, t is a discrete measure of time and s is the expected number of working years.

The expected value of the corruption wage, $E(\omega)$, will depend upon the legal wage, w, the size of the corruption payment, b, the probability of detection, $1 \geq \lambda \geq 0$, and the size of the penalty, $z(b,\ldots) > 0$,[1] which is a function of b and other variables, K.[2]

$$E(\omega) = (1-\lambda) \cdot \left(w + b + \sum_{t=1}^{s} \frac{w}{(1+\delta)^t} \right) - \lambda \cdot z \qquad (1)$$

$$E(\omega) = (1-\lambda) \cdot (w+b) - \lambda \cdot z + (1-\lambda) \cdot \sum_{t=1}^{s} \frac{w}{(1+\delta)^t} \qquad (2)$$

[1] The sign of $\partial z / \partial b$ is unknown. The penalty may not have a continuous relationship with the size of the bribe. It may be increasing for b of a certain size and decreasing in others. For instance, very high level or very high b corruption may get different treatment than low level corruption.

[2] If someone has a personal moral cost associated with corruption, then it will be independent of the probability of getting caught and will lower the value of the expected wage directly. In this model, I assume that the moral cost is zero but, when looking at policies, you may want to find examples of societies that have succeeded in instilling a moral aversion to corruption in people.

An individual will not engage in corrupt activities as long as her current wage and the present value of lost future wages in the case that she were caught exceed the expected value of the bribe:

$$w + \sum_{t=1}^{s} \frac{w}{(1+\delta)^t} > \left(\frac{1-\lambda}{\lambda}\right) \cdot b - z.^{3} \qquad (3)$$

Increases in the legal wage, legal enforcement efforts and the size of the penalty as well as a decrease in the discount rate should help maintain the relationship in Equation 3, where the individual chooses not to engage in corruption. An increase in the size of the bribe and a decrease in the length of time that the individual expects to earn wage w may change the sign of in Equation (3), meaning that the individuals finds that corruption maximizes her utility.

The characteristics of the society in which this individual resides are embodied in the parameter λ and the function $z(\cdot)$. The existence of corruption in a society depends on various—and often unquantifiable—determinants under the headings of institutional quality and societal norms. The parameter λ measures one aspect of institutional quality, legal enforcement.[4] The function $z(\cdot)$ is meant to capture all of the external costs incurred by being caught including financial costs, costs to reputation.

3.2 Mining and Corruption

Analyzing the relationship between mining and corruption using the individual model, we must ask how does mining affect any of the variables in the individual's

[3] Whenever the penalty is greater than the bribe value times the net odds of escaping detection, $z > \left(\frac{1-\lambda}{\lambda}\right) \cdot b$, the individual's utility will not be maximized by engaging in corruption.

[4] It could be said that a person could get caught but then not punished but in this case I mean to say the chances that an individual is caught and punished.

corruption decision. The individual in the previous section can be anyone in the economy that earns a wage: a public official or a private sector employee.

If considering the wage, it will depend upon whether the individual works in the mining sector. The size of the payment, b, will depend on the availability of rents to whomever is making the bribe; more available rents increases the upper limit on b. In this case, if the mining sector generates economic rents, then it can induce corruption in the society by increasing the opportunity for high corruption payments.

Whether mining affects λ or $z(\cdot)$ is a fundamental question that may be more difficult to answer; does the mineral sector itself, irrespective of its ability to generate rents, is either corrupt or cause corruption to be more acceptable in society by lowering the penalty, z, or cause authorities to be less vigilant (or more permissive) by reducing the chances of getting caught, λ? Though the questions regarding the relationship between the mining sector and societal outcomes are best analyzed at the country level, the value of a cross sectional empirical study that relates mineral rents to corruption is its results can be used to make relative comparisons across countries and to support or refute other hypothesis at the regional or national levels.

The availability of mineral rents from which corruption payments could be generated will depend on the mineral endowment of the country and the costs of production. The following description of a country's mineral endowment highlights two components relating to concentration of a mineral economy that are not addressed in the regression analysis due to data limitations but can be easily assessed at the country level. There are n mineral deposits where Q_i is the total amount of mineral produced from the ith deposit and m firms. Low values of n indicate high concentration of the mineral resource and low values of m indicate high concentration of ownership.

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Firm k's mineral revenues are equal to:

$\sum_{i=1}^{n} q_{ki} \cdot Q_i \cdot p_i$ where q_{ki} is the proportion of the total mineral production from the ith deposit controlled by firm k and p_i is the market price of a unit the ith deposit

and $1 \geq q_{ki} \geq 0$ for all k and i and $\sum_{k=1}^{m} q_{ki} = 1$.

Total mineral exports are described as:

$$X_{Mineral} = \sum_{k=1}^{m} \sum_{i=1}^{n} q_{ki} \cdot Q_i \cdot p_i \tag{4}$$

$$R_{Mineral} = \sum_{k=1}^{m} \sum_{i=1}^{n} q_{ki} \cdot Q_i \cdot (p_i - c_i) \tag{5}$$

$R_{Mineral}$ are economic rents generated by the mining sector. The variable c_i is the cost of producing the ith deposit.

Let β be an index of corruption and I an index of institutional quality:

$$\beta = f(M, I) \tag{6}$$

The variable M is a measure of mineral dependence, either $\frac{X_{Mineral}}{X}$, $\frac{X_{Mineral}}{GDP}$ or $\frac{R_{Mineral}}{GDP}$. The function f is assumed to be linear. A square term on natural resources may be appropriate to pick up any nonlinear relationship between natural resources and corruption, as is done in the conflict–natural resource literature (Soysa and Neumayer, 2003).

SECTION 4

EMPIRICAL STUDY OF MINERAL DEPENDENCE AND CORRUPTION

This section provides a brief overview of mineral economies and mineral and institutional data source. It then tests for an empirical relationship between mineral dependence and corruption in the entire data sample and in various sub-samples of countries including mineral and nonmineral economies and high and low .

4.1 Description of the Data

The data set used in the regression analysis contains 176 countries for which governance indicators and mineral dependence data are available. The World Bank classification of a mineral economy is one for which minerals comprise 10 percent of GDP and 40 percent of total export revenues (Table 4.1). By this classification there are 32 countries that can be classified as mineral economies, of which 22 exporters of petroleum or natural gas.

Table 4.1 shows the export percent of total exports and export percent of GDP. Also included in Table 4.1 are the mineral economies two primary mineral export commodities and their Human Development Indicator (HDI) rank. The United Nations (UN) compiles an index of economic development based on per capita income, life expectancy at birth and education levels. The countries are then ranked, 1 being the highest level of human development. The UN classifies the top 55 countries as having "High Human Development." Of the sample of 176 countries, 30 percent have "High Human Development" whereas of the mineral economy sub-sample, only 20 percent fall in the top 55 countries. Sub-Saharan African countries, on the other hand, are over-represented with 47 percent of the mineral economy sub-sample compared to 27 percent of the entire sample.

Though most of the mineral economies listed in Table 4.1 export many mineral commodities, the primary source of export revenues come from a limited number of mineral commodities including: petroleum, natural gas, diamonds, bauxite, copper, gold and iron ore. Mineral fuels, such as petroleum and natural gas, and diamonds are considered separately from other minerals in the regression analysis due to their unique ability to generate high economic rents. With the exception of alluvial diamonds, all other mineral products are capital intensive and for those mineral economies that are Least Developed Countries (LDC's), mineral production generally requires a significant degree of foreign involvement.

The regression analysis uses 2002 data for several measures of mineral dependence including: mineral exports as a share of GDP and mineral exports as a percentage of total exports. Mineral rents are not considered explicitly, but fuel products and diamonds are treated as separated variables in order to capture the effect of mineral rents on corruption. Mineral export data are compiled from the United Nations Conference on Trade and Development (UNCTAD) Commodity Handbook. The "Fuels" data include petroleum and petroleum products as well as all other mineral fuels classified under the Standard International Trade Classification (SITC) code 3, such as natural gas, coal and electric current. Diamonds are not included in the mineral data set, but are monitored separately by UNCTAD. Diamond data are for diamonds, worked or unworked but not mounted or set (SITC 7102). Other minerals or "Ores" include crude minerals (excluding coal, petroleum and precious stones), metalliferous ores and metal scrap, and iron and steel (SITC codes 27 + 28 + 68).

Table 4.1. Mineral Economies

Country	Code	HDI Rank	Mineral Percent of Exports	Mineral Percent of GDP	Top Two Mineral Export Commodities (Export Value)						
					Petroleum	Natural gas	Diamonds	Bauxite	Copper	Gold	Iron ore
Angola	AGO	164	98.5	81.4	◢		♦				
Nigeria	NGA	152	95.7	45.9	◢	◥					
Qatar	QAT	44	92.5	63.4	◢	◥					
Azerbaijan	AZE	89	92.3	38.8	◢	◥					
Saudi Arabia	SAU	73	90.2	37.9	◢	◥					
United Arab Emirates	ARE	48	90.0	74.9	◢	◥					
Libya	LBY	61	88.8	32.0	◢	◥					
Venezuela	VEN	69	87.0	20.0	◢	◥					
Bahrain	BHR	37	86.5	70.1	◢	◥					
Iran	IRN	106	85.9	24.0	◢	◥					
Congo	COG	140	84.1	70.6	◢						
Oman	OMN	79	81.3	38.5	◢				❖		
Botswana	BWA	125	79.4	40.5			♦		❖		
Sudan	SDN	138	79.1	10.3	◢						▲
Sierra Leone	SLE	175	77.1	13.1			♦				
Gabon	GAB	118	77.0	46.2	◢						
Kazakhstan	KAZ	76	75.4	34.7	◢	◥					
Norway	NOR	1	67.6	31.8	◢				❖		
Zambia	ZMB	163	66.6	18.0					❖		
Mali	MLI	172	65.0	20.2						□	
Mozambique	MOZ	170	64.4	14.2							
Russian Federation	RUS	63	62.7	23.2	◢	◥					
Cambodia	KHM	130	57.3	30.4							▲
Algeria	DZA	107	57.2	21.2	◢	◥					
Congo (DR)	ZAR	167	55.7	10.0					❖		
Guinea	GIN	157	55.0	15.4				●			▲
Equatorial Guinea	GNQ	116	53.2	85.0	◢						
Trinidad and Tobago	TTO	54	52.0	28.6	◢	◥					
Chile	CHL	43	42.2	14.8					❖		
Namibia	NAM	124	41.2	22.2			♦		❖		
Ecuador	ECU	97	41.1	12.7	◢						
Mongolia	MNG	117	40.5	25.9	◢						

Sources: UNCTAD Commodity Yearbook 1995-2000 and Handbook of Statistics, UNCTAD Handbook of Statistics On-Line, CIA World Factbook and United Nations Human Development Report.

There are several indices of corruption available that attempt to measure some aspects of corruption for purposes of risk assessment and research. Mauro (1995) uses the nine of Business International's indices on 56 country risk factors to assess the relationship between corruption, institutional quality and growth. Transparency International's Corruption Perception Index (CPI), The International Country Risk Guide's (ICRG) Corruption in Government and World Bank's Control of Corruption are other corruption indicators that have been developed and are used in business and research. The different

series' tend to be consistent in terms of ranking the least corrupt countries, but the difference in ranking diverges for the countries with higher levels of corruption. Finland is the top ranked country in both the CPI and the World Bank's Control of Corruption (Kaufmann, Kraay, Mastruzzi, 2004) indicators. Countries such as the United Kingdom, Sweden and the United States fall within one percentage point in a percentile ranking of the countries in either index. Lower ranked countries can have relative positions that are vastly different: Ethiopia falls in the 27th percentile in the CPI measure of corruption and in the 46th percentile in the Control of Corruption indicator of corruption.

The following regression analysis uses the Control of Corruption indicator from the Governance Indicators series compiled by the World Bank. Using data from 25 sources from 18 organizations including international organizations, risk-rating agencies and think tanks, Kaufmann, Kraay and Mastruzzi (2004) create a set of six indicators for 199 countries that assess relative institutional quality. The indicators contain 250 individual measures from three broad areas: the process by which government is selected; the effectiveness of government in designing and implementing policies; and the respect of the citizens for the state and governing institutions. The institutional indicators include Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption.

- "Voice and Accountability" includes indicators measuring characteristics of the political process, civil liberties and political rights. These indicators measure citizen participation and the independence of the media given its role in providing citizens a tool for holding their leaders accountable.
- "Political Stability and Absence of Violence" comprises indicators that assess the likelihood that the government will be overthrown or destabilized by violent or unconstitutional means.
- "Government Effectiveness" encompasses the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the

civil service from political pressures and the credibility of the government's commitment to policies.

- "Regulatory Quality" assesses the quality of policies relating market transactions, international trade and business development.
- "Rule of Law" includes indicators measuring citizens' confidence in and compliance with societal rules. Crime, judiciary quality and contract enforceability are included in this measure.
- "Control of Corruption" measures corruption perceptions of the use of public power for private gains. The index includes different characterizations of corruption including elite or high-level corruption and the frequency of payments required to speed up or enable access to government services.

The indicator values range from –2.5 to 2.5 with estimated errors. Lower numbers are associated with lower levels of institutional quality. For the following regression analysis, the indicators have been rescaled from 0 to 10 to keep all data positive. There is a clear positive relationship between Control of Corruption and Rule of Law and Control of Corruption and Political Stability (Figure 4.1).

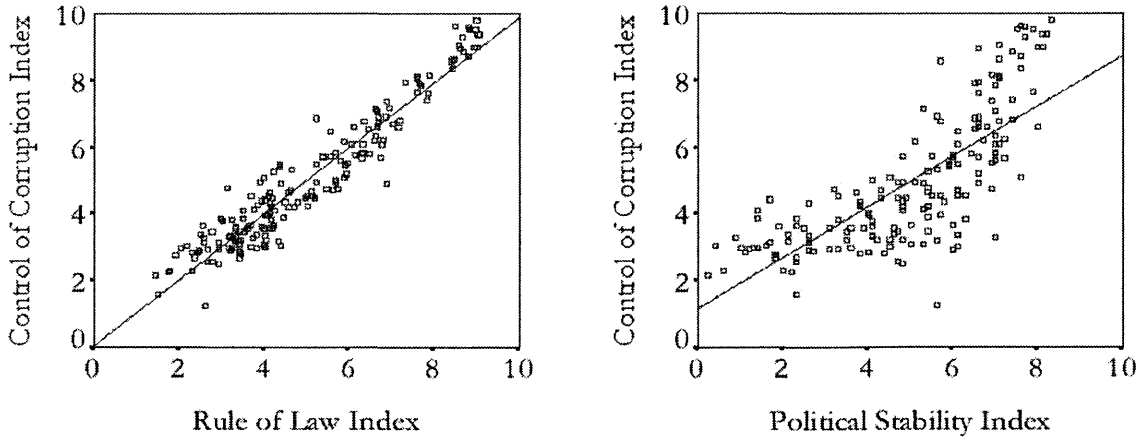

Figure 4.1. Control of Corruption, Rule of Law and Political Stability Indices

Table 4.2 illustrates the high correlations between the institutional quality indicators. Identifying strength or weakness in one institutional factor, such as rule of law or political stability will provide a 60 to 90 percent indication of the level of corruption.

Table 4.2. Correlation Matrix for Institutional Indicators

	RL	GE	RQ	VA	PS
Control of Corruption	0.956	0.948	0.894	0.764	0.746
Rule of Law (RL)		0.957	0.928	0.817	0.801
Government Effectiveness (GE)			0.931	0.776	0.757
Regulatory Quality (RQ)				0.852	0.738
Voice and Accountability (VA)					0.701
Political Stability (PS)					1

1. Pearson Correlations
2. Correlations significant at the 1% significance level (2-tailed).
3. N=176

In their study on natural resources, corruption and growth, Leite and Weidmann's (1999) use Rule of Law and Political Stability as institutional control indicators. They also include a "Trade Openness" variable that can also be considered an institutional variable as it measures the relative trade restrictiveness between countries. The regression presented in this paper does not include the institutional indicators as control variables because it would be difficult, especially given their high correlations, that each indicator is independently determined. The Rule of Law and Control of Corruption indicators are correlated 96 percent; though each indicator is comprised of independent sub-measures, both Rule of Law and Control of Corruption are indicators relating to the third broad category of citizens' respect for institutions. If mineral dependence does in fact influence levels of corruption, then it is likely that it will also affect the country's capacity to enforce the law. Government Effectiveness and Regulatory Quality indicators are also highly correlated with control of corruption. Mineral dependence has been shown in the literature to increase political

instability (Collier and Hoeffler, 2002) and to reduce accountability in the Rentier-State framework where tax revenues are dwarfed by mineral rents and the government is less accountable to the people (DiJohn, 2002). Neither the Political Stability nor the Voice and Accountability indicator can be considered strictly exogenous.

4.2 Regression Analysis

Given the difficultly of identifying a truly independent institutional factor, it may be desirable to consider the economic development as a control variable. Resource production today will affect the current level of economic output to an extent, but the starting point in any given time period from which an economy can grow or decline, has already been determined by past performance. Current levels of economic development, as measured by per capita GDP are used in the regression analysis to test whether corruption can be explained by natural resource dependence beyond levels of development.

The statistical relationship between the mining indices introduced in Section 3 and the Control of Corruption indicator can be tested with the linear regression:

$$\beta_i = \alpha_0 + \alpha_1 F_i + \alpha_2 O_i + \alpha_3 D_i + \alpha_4 \ln GDP\ Per\ Capita_i + \varepsilon_i \qquad (7)$$

where subscript i is for country i, β_i is the Control of Corruption value, F_i is a measure of mineral dependence for petroleum and other mineral fuels, O_i is a measure of mineral dependence for nonfuel minerals (excluding diamonds), and D_i is a measure of diamond dependence. The log of per capita GDP controls for the level of development under the assumption that corruption is concave in per capita income; an increase in per capita income at a low level of per capita income will have a greater impact on corruption control improvements than will an increase of the same size at a higher level of per capita income.

Upon inspection, there is no clear relationship between mineral dependence and corruption (Figure 4.2).

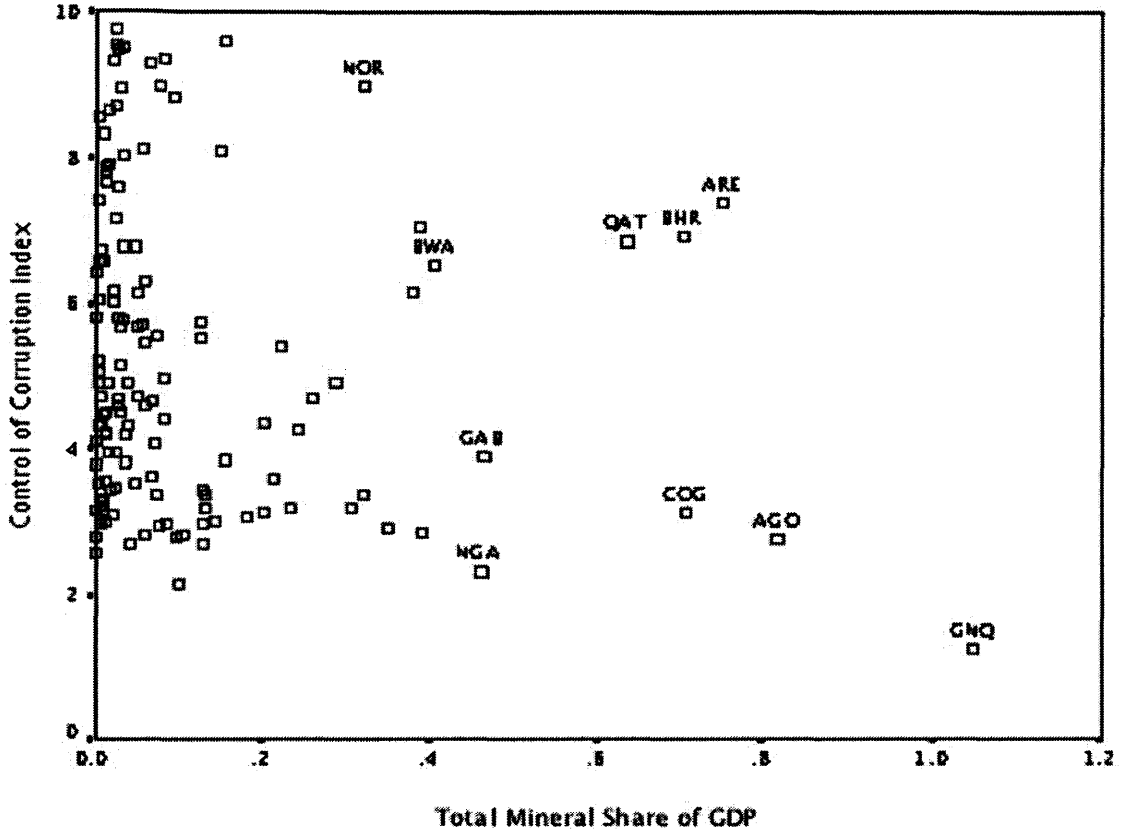

Figure 4.2. Mineral Dependence and Control of Corruption

Table 4.3. Regression Output, Control of Corruption[1, 2, 3, 4, 5]

Explanatory Variables	1	2	3	4	5
Per Capita GDP	1.452 ***	1.411 ***	1.487 ***	1.458 ***	1.509 ***
	(0.079)	(0.082)	(0.078)	(0.079)	(0.078)
Mineral Export Ratio to GDP		-0.835 **			
		(0.327)			
Fuel Export Ratio to GDP			-1.575 ***		
			(0.634)		
Nonfuel Mineral Export Ratio to GDP			5.227 **		
			(2.260)		
Diamond Export Ratio to GDP			0.948		
			(2.625)		
Mineral Percentage of Total Exports				-0.891 *	
				(0.596)	
Fuel Percentage of Total Exports					-1.292 ***
					(0.343)
Nonfuel Mineral Percentage of Total Exports					1.361 **
					(0.672)
Diamond Percentage of Total Exports					0.305
					(0.979)
Constant	-7.317 ***	-6.833 ***	-7.618 ***	-7.296 ***	-7.726 ***
	(0.675)	(0.709)	(0.668)	(0.672)	(0.676)
Adjusted R^2	0.664	0.685	0.685	0.668	0.698

1. White Heteroskedasticity-Consistent Standard Errors & Covariance
2. Coefficient significant at the 1%, 5% and 10% significance levels are indicated by ***, ** and *.
3. Standard error in parenthesis
4. Removed outlier Equatorial Guinea for all regressions. When Equatorial Guinea was included in Regression 7, the coefficient on the mineral dependence variable was -1.815 and with a standard error of 0.552.
5. When Botswana is removed, coefficients on Diamond Export measures are negative but still insignificant.

Regressions 1-5 in Table 4.3 test the relationship between corruption and two measures of mineral dependence controlling for levels of economic development: the ratio of mineral exports to GDP and mineral exports as a share of total exports. The diamond variable in each category of mineral dependence is included separately because diamonds are monitored separately and generate consistently high rents compared to other nonfuel minerals. Regression 1 establishes the positive relationship between economic development

and the control of corruption. An increase in the log of per capita GDP by one will increase the Control of Corruption indicator by 1.5 points. From the correlation coefficient, economic development explains 66 percent of the Control of Corruption indicator.

Regressions 2 and 4 show significant, albeit small, negative coefficients on aggregate mineral dependence.[5] A ten percent increase in aggregate mineral dependence will result in an approximately a one percent decline in the Control of Corruption indicator. Mineral dependence can explain 2 to 3 percent of the Control of Corruption index when controlling for economic development.

Separating the mineral data into fuels, nonfuel minerals (excluding diamonds) and diamonds in Regressions 3 and 5, the coefficient on fuel exports is negative and significant at the one percent confidence level. A 10 percent increase in fuel exports results in a decline in the Control of Corruption indicator of over one percent. The coefficients on both measures of nonfuel mineral dependence (excluding diamonds) are significant and positive. Since countries tend to be 2 to 3 times more dependent on fuels than on nonfuel minerals,[6] the aggregate coefficient remains negative even with a positive coefficient on nonfuel mineral.

The coefficients on the diamond variable are not significantly different from zero. When the unusually strong performer, Botswana, is removed, coefficients on diamond export measures are negative but still insignificant.

To test whether high levels of mineral dependence or development influence the sign or magnitude of the coefficients on the overall sample, the regression were run on four sub-samples of the original data set (Tables 4.4 and 4.5): mineral economies (as defined in Section 4.1); nonmineral economies; high human development economies (as defined in Section 4.1); and middle and low human development economies.

[5] When institutional control variables are included, coefficients on mineral dependence are not significant.
[6] Average dependence ratio is the average fuel dependence of the 176-country sample divided by the average nonfuel mineral (excluding diamond) dependence of the same sample.

Table 4.4. Control of Corruption: Mineral Economies and Nonmineral Economies[1, 2, 3]

Explanatory Variables	Mineral Economies			Nonmineral Economies		
Per Capita GDP	1.07 ***	1.209 ***	1.392 ***	1.491 ***	1.507 ***	1.507 ***
	(0.237)	0.252	0.239	0.085	0.087	0.088
Mineral Export Ratio to GDP		-1.781 *			-2.472	
		1.234			2.885	
Fuel Export Ratio to GDP			-1.422 *			-5.194
			1.126			3.64
Nonfuel Mineral Export Ratio to GDP			8.275 **			3.043
			3.892			5.463
Diamond Export Ratio to GDP			2.571			0.045
			3.499			12.253
Constant	-4.58 **	-5.113 **	-7.353 ***	-7.583 ***	-7.656 ***	-7.684 ***
	(1.991)	(1.990)	1.986	0.73	0.736	0.743
Adjusted R^2	0.404	0.444	0.576	0.686	0.688	0.692

1. White Heteroskedasticity-Consistent Standard Errors & Covariance
2. Coefficient significant at the 1%, 5% and 10% significance levels are indicated by ***, ** and *.
3. Standard error in parenthesis

The "Mineral Economies" regressions in Table 4.4 show the coefficients on the regressors have the same signs and are similar in magnitude to the regressions on the entire sample, Regressions 2 and 3. The correlations are about 20 percent lower than those of the entire sample, reflecting the increased variability between the "Mineral Economies" data points. The coefficients on mineral dependence for "Nonmineral Economies" are not significantly different from zero.

Table 4.5. Control of Corruption: High HDI and Low HDI[1, 2, 3]

Explanatory Variables	Top 55 HDI			Bottom 121 HDI		
Per Capita GDP	2.174 ***	2.178 ***	2.162 ***	0.645 ***	0.709 ***	0.742 ***
	0.225	0.227	0.225	0.118	0.115	0.115
Mineral Export Ratio to GDP		-0.4			-1.836 ***	
		0.91			0.552	
Fuel Export Ratio to GDP			-1.034			-2.422 ***
			0.966			0.572
Nonfuel Mineral Export Ratio to GDP			8.115 *			1.215
			4.774			2.182
Diamond Export Ratio to GDP			0.828			3.42
			64.981			2.248
Constant	-13.944 ***	-13.956 ***	-13.913 ***	-1.136	-1.484 *	-1.8 **
	2.184	2.2	2.179	0.938	0.906	0.919
Adjusted R^2	0.634	0.635	0.658	0.204	0.274	0.327

1. White Heteroskedasticity-Consistent Standard Errors & Covariance
2. Coefficient significant at the 1%, 5% and 10% significance levels are indicated by ***, ** and *.
3. Standard error in parenthesis

For the 55 countries with the highest HDI rank in Table 4.5, the log of per capita GDP is the only significant determinant of the Control of Corruption score. An increase in the log of per capita GDP by one will increase the Control of Corruption indicator by 2.2 points. Nonfuel mineral dependence is significant at the 10 percent level of significance and as in the overall sample, about 60 percent of the Control of Corruption score is explained by the log of per capita GDP. For the less developed countries, the coefficients on both GDP and fuel dependence are significant. The coefficient on fuel dependence is negative and significant at the 1 percent significance level with a magnitude approximately twice that of the coefficient on fuel dependence for the entire sample. However, the correlation is only about 30 percent. The coefficients on nonfuel mineral dependence and diamonds do not differ significantly from zero.

SECTION 5

DISCUSSION

In the aggregate, mineral dependence can explain 2 to 3 percent of the Control of Corruption index when controlling for economic development. Although the negative impact of mineral dependence on corruption appears small, when considered in the context of economic growth, past and present, the relationship between mineral dependence and the control of corruption over time may be understated by these results. If corruption has a negative impact on economic growth and if lower levels of economic development are associated with higher levels of corruption, then if it is found that current mineral dependence increases corruption, it can be inferred that past mineral dependence lowered growth through corruption, resulting in lower levels of development and higher levels of corruption in the present.

When disaggregated by mineral commodity groups and split in to sub-samples, the results indicate other relationships between mineral dependence and corruption beyond the simple finding that mineral dependence is linked to higher levels of corruption. Mineral economies vary widely in terms of levels of corruption and institutional quality. Norway and Equatorial Guinea are at the two ends of the spectrum. But what the results do seem to indicate is that for less developed countries, the rents generated from the production and sale of mineral fuels lead to higher levels of corruption. In the other mineral industries, the effect mineral dependence on corruption is not significant across countries. In the most developed countries, nonfuel mining appears to have a positive impact on corruption control, explaining the positive coefficients on the "Ores" term in Regressions 3 and 5. Perhaps the increased public scrutiny of the mining industry has had spillover effect into the rest of the economy. More likely, the positive coefficient on nonfuel minerals in the "High Human Development" group may demonstrate that only those countries with solid

institutions and low levels of corruption have been able to achieve the highest levels of development by effectively using their mineral resources.

The regressions in Section 4 describe the relationship between aggregate mineral dependence and corruption but do not look at the concentration of mineral resources in each country or the concentration of ownership of the mineral resources. The geologic distribution and the market structure of the commodity would need to be considered in order to evaluate any link between mineral concentration and corruption.

An inherent drawback of using any social indicators in a regression analysis is that it provides a linear measurement of issues that are usually multidimensional. As corruption manifests itself in many different ways, how a particular corruption index weighs each aspect of corruption will determine a country's relative ranking, which may differ between indicies.[7] Corruption indices do not distinguish between centralized and decentralized corruption nor do they provide a good measurement of any underlying structural dimensions that may have an impact on future levels of corruption. In fact, a country where corruption payments are high may be less corrupt than one with a lower level of total payments but where corruption is so pervasive that is halts all economic activity.

[7] See Appendix.

SECTION 6

CONCLUSIONS AND FURTHER RESEARCH

While mineral dependence alone may provide incentives for corrupt practices on the part of businesses and public officials, it is important to remember that the "mineral industry" is not monolithic. The oil industry deservedly gets special consideration by scholars and policy makers. In anecdotal, theoretical and empirical studies, countries with oil or other mineral fuel products are growth failures unless they begin with strong institutional foundations. Countries with nonfuel mineral industries—which receive little high profile attention—are often considered in the same terms as the oil producing nations as breeding grounds for corruption. However, this characterization may not reflect reality. The mining of ores for the production of most metals is a very high cost, risky business that doesn't generate long-run rents the way petroleum production does. Even with the increased bargaining power of domestic official given the constraints imposed on mining companies by the size and location of deposits, nonfuel mining companies simply do not have the resources to bribe officials on the same scale as petroleum producing companies.

Another important conclusion from the analysis is the effect of mineral dependence on corruption levels cannot be generalized across countries. It should be expected that the mining industry will behave just as any other industry in countries with high levels of human and economic development and any windfall gains or rents will tend to be utilized in a lawful, uncorrupt manner. In the countries of concern, mineral rents are more likely to be squandered due to a host of institutional pathologies.

Even with the empirical results linking corruption to mining, corruption is a chronic problem that cannot be attributed to a single factor in a single time period. If Nigeria were to run out of oil tomorrow, it is likely that levels of corruption would remain the same relative to the lower available rents. As long as a country's institutions are poor, high levels of corruption should be expected. Policies that encourage diversification and competition

will likely have positive effects on corruption reduction but may be difficult to implement in states, particularly petroleum exporting states, where the government's interest is to neither diversify nor open up to competition.

Although national governments will ultimately have the responsibility of reducing corruption in their own countries, the onus of reducing corruption should be shared with those countries with stronger institutions or a "comparative advantage" with respect to institutional quality. Through the late 1990s, Australia, Austria, Belgium, France, Germany, Luxembourg, Netherlands, Portugal, New Zealand and Switzerland all had provisions in their tax codes that made bribes to foreign public officials tax deductible, like any other business expense (Milliet-Einbinder, 2000).[8] Recent initiatives in the OECD countries to eliminate bribery have been well received but remain difficult to enforce.

In future studies, the relationship between corruption and mineral rents and resource rents in general could be tested explicitly using the mineral rent data from the World Bank's Adjusted Net Savings data set. The Adjusted Net Savings exercise attempts to provide a sustainability indicator that includes human capital investments, pollution and natural resource depletion. Included are calculations of energy, mineral and forestry rents for a sample of 148 countries. If rents in general are found to foster corruption, then policy makers will know to focus on any high rent mineral operation, irrespective of the commodity.

Given the mineral industry's wide reaching effects on institutions, further research should focus on qualitative assessments of the mineral industry in some of the less researched countries from which industry and country specific policy can be designed.

Policy makers should continue to pursue programs that address both the supply and demand of corruption in mineral economies. Supply controls would either reduce or redistribute the mining rents through diversification initiatives or promote increased competition in the mining sector. The demand for corruption is more difficult to target

[8] By 2003, the 1999 OECD Convention on Combating Bribery of Foreign Public Officials in International Business Transactions was ratified by all 30 OECD member-countries and four non-members [OECD Policy Brief, 2003].

with policy measures because it involves a shift in the culture of the society. However, encouraging steps are being taken by the international community to implement rigorous institutional reforms that create disincentives for individuals to engage in corruption in mineral and nonmineral economies alike.

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APPENDIX

CORRUPTION INDICIES

Corruption indices such as Transparency International's Corruption Perception Index (CPI) and the World Bank's Control of Corruption indicator compile an index of relative corruption across countries based on survey data and some criteria by which they weight the responses.

But even at the most simple level, there at the minimum, two distinct ways to look at corruption in a society: what proportion of people in a group take part in some form of corruption and what is the value (or cost in this case if we agree that corruption is costly) of the corruption. A linear representation will fail to convey important information regarding the nature of the corruption in a country or society.

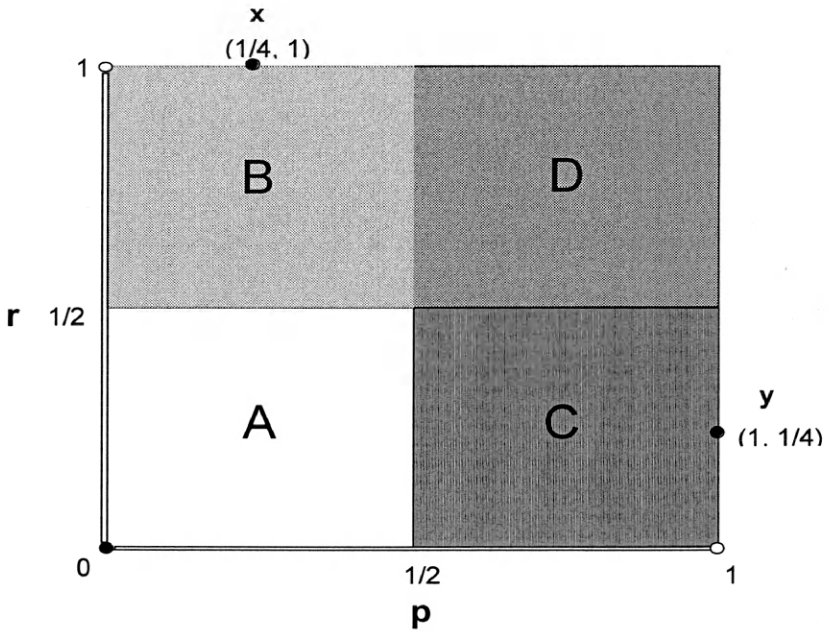

Figure A1. Two-Dimensional Representation of Corruption

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Suppose there are two measures of corruption within a given group, called *society*. The first measure, $p \in [0,1]$, is the proportion of the population that engages in corrupt transactions: a measure of pervasiveness. The second, $r \in [0,1]$, is the portion of available rents in society, that is any residual resources after accounting for the costs of production, that is used put toward some corrupt end rather than one that within the norms (conventions: social, legal) of the society: a measure of costliness.[9]

Figure 1 is a two dimensional representation of the pervasiveness and costliness of corruption. A vector, $\beta := [p \quad r]$ maps a country's corruption in space. Note: $p = 0 \Leftrightarrow r = 0$, so all point on the axes, other than the origin, must be excluded from the set of possible ordered pairs. There are four broad regions, A, B, C and D:

A: Corruption is not pervasive and not costly.

B: High level corruption: large sums, few entities.

C: Everybody is corrupt but payment are small on average.

D: completely pervasive and all rents are directed toward corrupt transactions.

An index I would assign weights α and $(1-\alpha)$ to p and r and all points would get mapped to a linear index $I = \alpha \cdot p + (1-\alpha) \cdot r$.

Consider points x and y in Figure 1. Society x is characterized by high levels of corruption undertaken by very few members of society, whereas in society y everyone is engages in corruption but at very low levels. Now consider three indices:

1. $\alpha = 1/2 \quad x = 5/8, y = 5/8$
2. $\alpha = 1/3 \quad x = 3/4, y = 1/2$
3. $\alpha = 2/3 \quad x = 1/2, y = 3/4$

Each index ranks the societies in a different order. In index 1, with equal weights on p and r, the two societies have the same index value. Index 2 shows society x as more corrupt whereas index 3 shows society y.

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[9] I am not making a judgment on how corruption can help or hurt a society's productive capacity or economy, I am just saying that any rents generated will go into extra-legal channels in the case where r=1.

This is the problem when you can actually measure p and r with certainty. When unable to even if survey methodology is sound, this problem will still exist.