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OIL GREASING THE WHEELS: WHEN DO
NATURAL RESOURCES BECOME A BLESSING?

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Abstract

This paper considers theoretically and empirically natural resources' effect on growth using a two sector-model (resource and non-resource). Governments tax the non-resource sector and choose institutional quality, which determines productivity in the non-resource sector and the governments' ability to appropriate resource rents. Resource booms harm institutions. Their effect on growth depends on relative sector sizes: when rents are relatively substantial, governments incur the cost of corrupting institutions and the loss of taxes from the non-resource sector for a bigger share of rents. The results are confirmed using cross-country panel data: countries in the bottom quintile of the manufacturing-share of value-added are cursed by resources, other countries are blessed.

ملخص

تناقش هذه الورقة نظرياً وتجريباً تأثير الموارد الطبيعية على النمو باستخدام نموذج لقطاعين (قطاع ذي موارد وقطاع بلا موارد) وتستقطع الحكومات الضرائب من القطاع عديم الموارد متوخية نظام الجودة الذي يحدد الإنتاجية في القطاع عديم الموارد الطبيعية وكما يحدد قدرة الحكومات على تخصيص إيجارات الموارد الطبيعية. ويؤدي ازدهار الموارد الطبيعية إلى الإضرار بالمؤسسات بحيث يتفاوت تأثيره على النمو حسب حجم كل قطاع فإذا زادت الإيجارات نسبياً تكبدت الحكومات الخسائر الناجمة الفساد داخل المؤسسات وضياع حصيلة الضرائب من القطاع عديم الموارد الطبيعية بسبب تحمل تلك الحكومات حصة أكبر من الإيجارات. وتتأكد النتائج باستخدام قائمة للبلدان المختلفة تظهر المعلومات المتعلقة بتلك البلدان: فنجد أن البلدان الخمسة في قاع القائمة والتي تساهم بحصة في القيمة المضافة للصناعات، نجدها تعاني من نقمة الموارد الطبيعية، بينما البلدان الأخرى تنعم بتلك الموارد.

1. Introduction

Historians were the first to note that natural resources could constitute a burden on a country instead of a blessing: the prosperity of the Spanish Empire, built on the gold and silver which flowed in the sixteenth century from the mines of Mexico and Potosí, was short-lived, as it led to rapid price increases and brought about the decay of agriculture and manufacturing in the mainland. Economists and political scientists also concur that countries with an abundance of natural resources (particularly minerals and fossil fuels) often tend to fare worse than countries that are less resource-rich. Rather than fueling growth and development, natural resource wealth can become the cause of economic stagnation, corruption, and civil war.

On the other hand, there are noted exceptions to the “curse of natural resources”: Norway, Alaska, and Canada have fared well, despite the abundance of their natural resource endowments.

This paper presents a political economy model of the effect of natural resource wealth on economic growth and on the quality of institutions. The implications of the model are then tested using a cross-country panel dataset of 143 countries. There are strikingly few models in the economics literature that are able to account for natural resources both as a curse and as a blessing. This paper presents a model that does capture both cases, and makes predictions about when we should observe each case. While recent work has sought to explain whether resources constitute a curse or a blessing by incorporating institutional variables in models of political economy,¹ the scope of the models revolves around differences in institutions, which are posited to be exogenous to resource wealth. The model in this paper does not appeal to *ex ante* institutional differences (as do, for instance, Robinson *et al.*, 2003) but rather, such differences arise from differences in the sectoral composition of the economy and the relative sizes of the various sectors. That is, rather than treating institutions as exogenous to the model, the model endogenizes institutional quality and shows how institutions can be affected by natural resource wealth.

The basic finding of the model is that a resource boom is a blessing when the government has substantial non-resource revenues, and a curse when resource rents constitute the better part of government revenues. Furthermore, in countries where the relative sizes of resource sectors are equal, a resource boom is likelier to benefit the country with the better initial institutions, as in Robinson *et al.* (2003); however, contrary to their findings, the result here derives from the assumption that institutional quality is productive only in the non-resource sector; in the resource sector, it affects the government’s ability to appropriate a portion of resource rents, not the overall level of resource rents. This assumption is consistent with the finding in the public policy literature, as well as in case studies of resource-rich countries, that resource rents are, by their nature, easier to distort and expropriate as government revenue than is taxation in the non-resource sector. Thus the basic intuition behind the result is that when resource rents are substantial, the potential for diverting more of those rents toward government consumption makes the government willing to incur the cost of corrupting institutions, despite the ensuing reduction in tax revenues from the non-resource sector. By recognizing that rents are, with the complicity of multinational extraction companies, easier to obscure than tax revenues, the model offers a formalization of the curse and blessing phenomena that is consistent with the rentier state hypothesis, and provides theoretical grounding for the mechanisms underlying the hypothesis.

Using a panel of cross-country data on corruption, growth, and natural resource wealth for 143 countries, we run regressions for the growth rate of GDP per capita and for institutional quality to test the main theoretical findings of the model. We introduce an interaction term between the relative sizes of the resource and non-resource sectors in order to allow for the effect of natural resources to depend on the size of the productive sector; and we consistently find that the

¹ See e.g. Robinson *et al.* (2003), Hodler (2004) and Lam and Watchekon (2003).

coefficient on the interaction term is positive and significant. The results are robust to using different measures of resource wealth and to using fixed and random effects and instrumental variables. The empirical analysis constitutes an improvement over standard empirical analyses of growth, because it adds measures of resource wealth and corruption to growth regressions. It represents an improvement on empirical work on natural resources because it uses a measure of resource abundance, rather than the more rampant measure of resource dependence that has been used in the literature so far. Furthermore, it spans a longer time period and allows us to run fixed and random effects models in addition to the standard cross-sectional analysis run in the natural resource literature. Finally, in its examination of the effect of the relative size of the non-resource sector on the impact of resources on growth, it offers new insight into the mechanism of the resource curse and the conditions for its occurrence.

The paper is organized as follows: section 2 establishes the existence of a resource curse by surveying the empirical literature on the cross-country analysis of growth and development, then reviews the literature in political economy for institutional explanations of the resource curse. Section 3 sketches the model. Section 4 starts by describing the data then presents empirical results, including tests of the main findings of Section 3. Section 5 concludes.

2. Related evidence and theory

2.1 Evidence

It has become conventional wisdom that resources are a curse for developing countries. As Mehlum *et al.* (2002) point out, the Asian tigers (Korea, Taiwan, Hong Kong, and Singapore), are all resource-poor, while growth losers (Nigeria, Zambia, Sierra Leone, Angola, Saudi Arabia, and Venezuela), are all resource-rich. Natural resource abundance, as measured by the resource concentration of exports, tend to reduce a country's long-term growth rate (Sachs and Warner, 1995; Gylfason *et al.*, 1999; Sala-i-Martin, 1997). The result also holds when attention is restricted to particular resources (see e.g. Olsson, 2004, for the case of diamonds, and Humphreys, 2005, for the case of fossil fuels). Furthermore, Kronenberg (2004) notes that the curse of natural resources extends to transition economies.

Looking at other outcome variables, we find persistent evidence of the curse: Ades and Di Tella (1999) show evidence of natural resources increasing corruption; Ross (1999, 2001) maintains that resource-dependent countries have a larger share of their population living in poverty and a lower score on the United Nations Human Development Index (HDI) and are less likely to be democratic; Collier and Hoeffler (2000) find that resource abundance significantly increases the risk of violent civil conflict.

This finding is not universal, however. The effect of natural resources on growth is reversed in Papyrakis and Gerlach (2003) when controls are included for corruption, investment, openness, and terms of trade. However, the indirect effect of resources on growth using these controls as possible transmission channels is negative. Finally, Hodler (2004) notes that the effect of natural resources on GDP and on growth is significant and negative only in ethno-linguistically fractionalized countries and not in homogeneous ones.

Further, there are cases where natural resources appear to be a blessing. The experiences of Norway, the United States, Australia, Canada, and the United Kingdom suggests that in none of these countries were natural resources a burden. Norway was Europe's poorest country in 1900, but is now one of the richest (Mehlum *et al.*, 2002). Since the discovery of oil and gas in the 1970s, it has surpassed Sweden and Denmark in terms of GDP per capita (Røed Larsen, 2002). In 2002, it stood at the top of the UN's ranking of countries in the Human Development Index (UNDP, 2002).

Similarly, Alaska has experienced growth rates in personal income and employment much greater than the average rates for the U.S. since the 1960s (Goldsmith, 2003).

The Shetland Islands invested the proceeds from the signature bonus for allowing oil drills in 1973 in a public trust fund, the Shetland Islands Council Charitable Trust. Thus the level of rents is inevitably observable and verifiable. The Council disburses around £15 million per year for community projects, out of a total that today stands at £150 million (Christian Aid Report, 2003).

2.2 Theory

The questions of central concern in this paper are: (1) under what conditions are natural resources detrimental to growth; and (2) what is the mechanism underlying the relationship, whether positive or negative, between natural resources and growth? The review of the theoretical literature on natural resources is restricted to models that are able to capture both curse and blessing.²

Several models explain the effect of natural resources on growth by assuming ex-ante structural differences between cursed and blessed economies in the production function or preferences. Torvik (2002) presents a model of rent-seeking where an increase in resource endowment shifts entrepreneurs from the productive sector to the rent-seeking sector; it becomes a curse when we assume a demand externality in the production sector, and it is otherwise a blessing. In Dal Bó and Dal Bó's (2004) model of social conflict, the sign of the effect of a resource boom hinges on the relative factor intensity of the extractive and productive industries. The differential effect of resources is generated by assuming differences in governments' preferences in Lam and Watchekon's (2003) model of political Dutch disease.³

A second type of models posits ex-ante institutional differences (in the quality of institutions) to obtain the desired non-monotonicity in the effect of resources on growth. Mehlum *et al.* (2002) construct a model that has two sectors: a "grabbing" sector and a "productive" sector where an institutional quality parameter measuring the "efficiency" of the grabbing sector determines the ultimate effect of natural resources.⁴

Olsson (2004) focuses on the case of conflict diamonds and puts forth a predatory-prey model of a formal production sector and a natural resource sector. What determines whether diamond wealth will ultimately lead to a curse or a blessing for an economy is the quality of its property rights institutions, which are exogenously given. Robinson *et al.* (2003) present a model of the political economy of clientelism, where politicians offer citizens public employment in return for their votes. A natural resource boom is the more likely to lead to a decrease in overall income, the more able is the incumbent to affect election outcomes through the promise of public sector employment.⁵

In Hodler (2004), the economy is comprised of rival groups that allocate their endowments between a productive sector and a rent-appropriation sector. Unlike Olsson (2004) and Robinson *et al.* (2003), his institutional variable (property rights) is endogenous and depends on the level of

² The idea of the curse of natural resources is commonly associated with the literature on the Dutch disease. Standard models of the Dutch disease can, at best, explain a slowdown in growth. Without additional assumptions, they cannot account for negative growth, and therefore cannot capture both effects of the resource (curse and blessing).

³ In Lam and Watchekon (2003), a resource curse afflicts countries governed by dynasties with a weak bequest motive.

⁴ The economy in Mehlum *et al.* (2002) admits two classes of equilibria: a production equilibrium characterized by a resource blessing, and a grabbing equilibrium where resources are a curse. Which equilibrium the economy ends up in is a function of the "institutional quality" parameter.

⁵ The effect of a resource boom in Robinson *et al.* (2003) is twofold: on the one hand, it makes governments attach greater value to being in office, and therefore more willing to dispense public sector jobs for votes; on the other hand, it makes the extraction path of the resources more efficient.

rent-appropriation activity. However, in Hodler (2004), a necessary condition for natural resources to have any “corrupting” effect is that the country be fractionalized into rival groups, while a country with a “homogenous” population will only benefit from natural resources.

In the model developed in section 3, I follow Hodler (2004) in that I abstract from any differences in the initial quality of institutions, and try instead to generate the difference in institutional development as an effect of a resource boom. Thus, Algeria is not assumed to be more clientelistic than Alaska based on the *post hoc* observation of its overall performance, nor is there a need to conjecture essential differences in the governments’ preferences across the two countries to obtain different outcomes. Rather, the differential effect of oil ultimately stems from more primitive differences between the two countries: Alaska follows a path of transparency in government decisions because of the size of its resource boom relative to the size of its productive sector, whereas Algeria does not.

3. The model

3.1 Primitives

The economy consists of two sectors: a private productive non-resource sector with output Y , and a natural resource sector with rents R .

There are three types of agents in the model: an incumbent government, a political candidate, and a continuous mass N of identical citizens. The political candidate can opt not to run for office and instead be a voting citizen. The game is played in a single period and consists of four stages:

- i.* At the beginning of period t , the incumbent government observes the level of rents R_t and picks institutional quality $Z_t \in [0,1]$ at a cost $c(Z_t - Z_{t-1})$ and a tax rate τ_g . Z_t determines the quality of institutions in period t , output in the non-resource sector $Y_t = Z_t K_t^\beta$, and the level of government appropriation of resource rents $(1 - Z_t)R_t$.
- ii.* In response to the incumbent’s offer τ_g , the political candidate decides whether to run for office and what tax rate τ_c to offer if s/he decides to run.
- iii.* If the candidate’s tax rate is preferred ($\tau_c \leq \tau_g$), nature determines whether the candidate’s campaign survives until elections. Otherwise, the candidate loses.
- iv.* The winner of the election gets his/her utility.

At stage *i*, the incumbent government chooses institutional quality $Z_t \in [0,1]$ which represents government investment in (or divestment from) countercorruption measures, and a tax rate τ_g where the g subscript refers to government. In period t , government faces a convex cost c to changing institutions from their level in period $t-1$, where c is:

$$c(Z_t - Z_{t-1}) \equiv \theta (Z_t - Z_{t-1})^2 \text{ with } \theta \in \mathbb{R}^+$$

We assume that there is a cost to changing the institutional status quo, be it in favor of better or worse institutions, in order to reflect the fact that an institutional culture can become entrenched and difficult to change. It is costly to fight corruption because it requires building confidence in the system, investing in institutions promoting transparency, auditing, respect for property rights, the rule of law, and general public order. Similarly, it is costly to promote a more corrupt culture because these same institutions would need to be dismantled or undermined (whether through coercion and violence, or bribes and incentives).

Institutional quality affects output in the non-resource sector by determining the productivity of capital: the flip-side of institutions that allow the government to operate with little respect for the rule of law in the natural resource sector is that confidence in the rule of law is compromised

across the board, and the non-resource sector is likely to suffer. The non-resource good Y is produced using private capital input $K \in [\underline{K}, \bar{K}]$ according to the following production function:

$$Y = ZK^\beta$$

Institutional quality also determines the fraction of the natural resource rents that the government can appropriate as revenue, $(1-Z)R$. The measure of institutional quality Z effectively determines the extent to which government can steal with impunity: the more corrupt is the system, the larger is the portion of natural resource wealth that the government can seize while shielding itself from public scrutiny and accountability and circumventing the rule of law.

We assume that the government utility is proportional to its revenue, so the government seeks to maximize revenue. The payoff to the government if it remains in power is:

$$U_{gov}(R_t, K_t | \tau_g < \tau_c) = \tau_g N Z_t K_t^\beta + (1 - Z_t) R_t - \theta (Z_t - Z_{t-1})^2$$

The remaining fraction of rents is distributed to the public, but we assume that there is a fixed marginal cost of distributing resource rents and a fraction $(1-q)$ of the resources distributed is lost in the distribution process, reflecting the processing, administrative, and bureaucratic costs of transferring rents to citizens. We assume that $q > (1/2)$.⁶

We abstract from savings and leisure, so citizens invest their entire stock of capital K in the productive sector to produce Y . Citizens have the following utility function:

$$U = (1 - \tau) Z K^\beta + \frac{q Z R}{N} \quad (1)$$

The first term represents after-tax income from the non-resource good, the second term is the share of the natural resource rents that consumers get, net of appropriation and distribution costs.

The political race is structured as follows: given the government's choice of institutional quality Z_t (stage i) and its offer of a tax rate τ_g (stage ii), the candidate decides at stage iii whether to run, and when she decides to run, what tax rate to offer τ_c (where the c subscript refers to the challenger). If the politician decides to run for office, she incurs a cost C and forgoes her utility from being a private citizen given in equation (1). She effectively gives up her right to participate in the private production of the non-resource good Y and the share of the natural resource she would be entitled to as a citizen. So the return to a failed campaign is $-C$. Let p be the probability that the political challenger wins the election, provided the tax rate she offers is the one that the citizens prefer. The probability p represents the uncertainty around the rival politician's candidacy, including the credibility and effectiveness of her campaign, the entrenchment of the incumbent, and its ability to force her out of the race.⁷

We make two additional "tie-breaking" assumptions for convenience: (1) if the challenger offers the same tax rate as the incumbent, voters pick the challenger; and (2) in the case where the challenger is indifferent between running and not running for office, she chooses not to run.

⁶ There is reason to believe that the administrative costs of large scale cash transfer programs in developing countries can be kept to a minimal percentage of GDP: the non-contributory old age pension programs in Brazil and South Africa (which reach 5.3 million Brazilians and 1.9 million South Africans) estimate administrative costs at 1% of GDP in Brazil (Schwarzer and Querino, 2002) and 1.4% in South Africa (Committee of Inquiry, 2002).

⁷ There are two sources of incumbency advantage in the model: (1) the incumbent gets to determine the level of institutional quality Z_{t-1} in the first stage; and (2) even when the incumbent offers the less competitive of the tax rates, it has a chance of winning the election. There is no symmetric probability of the challenger winning when it offers a higher tax rate than the government's.

Given the Z_t offered by the government, if the politician decides to run and offers a tax rate τ_c that voters prefer to the incumbent's tax rate τ_g , her expected utility from candidacy is:

$$E[U(\text{Cand})|\tau_c \leq \tau_g] = p \left[\tau_c N Z_t K_t^\beta + (1 - Z_t) R_t - \theta (Z_t - Z_{t-1})^2 \right] - C$$

where p is the probability of winning (given that the government's rival offers the more favorable tax rate); the term in the square brackets is the utility from being in office, and C represents the disutility or cost of running for office.

3.2 The political candidate's problem

At stage iii, the politician decides whether to run for office. When she decides to run, she also chooses which tax rate τ_c to offer. If she decides to remain a private citizen (Cit) and not to run for office, her payoff is:

$$U(\text{Cit}) = (1 - \tau_g) Z_t K_t^\beta + \frac{q Z_t R_t}{N}$$

The expected payoff of political candidacy (Cand) if $\tau_c \leq \tau_g$ is:

$$E[U(\text{Cand})|\tau_c \leq \tau_g] = p \left[(1 - Z_t) R_t + \tau_c N Z_t K_t^\beta - \theta (Z_t - Z_{t-1})^2 \right] - C$$

Proposition 1

The optimal strategy for the rival is to run with a tax rate $\tau_c^* = \tau_g$ whenever Z_t and τ_g are such that:

$$\tau_g > \bar{\tau}(Z_t)$$

where

$$\bar{\tau}(Z_t) \equiv \frac{CN - pN(1 - Z_t)R_t + qZ_tR_t + NZ_tK_t^\beta + pN\theta(Z_t - Z_{t-1})^2}{N(Np + 1)Z_tK_t^\beta}$$

A proof of this proposition is provided in the Appendix.

3.3 The government's problem

The government choice variables are institutional quality Z_t and the tax rate τ_g . The government's problem is a constrained utility maximization over both Z_t and τ_g , where the government can either (1) preclude political competition by setting a tax rate $\tau_g \leq \inf\{\tau(Z_t), 1\}$ if $\tau(Z_t) > 0$, or it can (2) choose any tax rate $\tau_g > \tau(Z_t)$ if $\tau(Z_t) < 1$ or $\tau_g = 1$ if $\tau(Z_t) > 1$, but risk being ousted with probability $1-p$.

The government compares the utility it gets from these two optimization problems.

Case 1: Predatory taxation (no entry by the political candidate)

As the incumbent, the government can, much like a monopolist, offer a tax rate that is low enough to preclude entry by the challenger. Government maximizes utility subject to imposing a tax rate that would make it optimal for the political challenger not to run:

$$\begin{aligned} \max_{Z_t, \tau_g} U_{gov} &= (1 - Z_t)R_t + \tau_g N Z_t K_t^\beta - \theta(Z_t - Z_{t-1})^2 \\ \text{s.t. } 0 &\leq Z_t \leq 1 \\ U(\text{Cit}) &\geq \max_{\tau_c \leq \tau_g} U(\text{Cand}|\tau_g) \\ 0 &\leq \tau_g \leq 1 \end{aligned}$$

Given Proposition 1 above, this problem can be rewritten as:

$$\begin{aligned} \max_{Z_t, \tau_g} U_{gov} &= (1 - Z_t)R_t + \tau_g N Z_t K_t^\beta - \theta(Z_t - Z_{t-1})^2 \\ \text{s.t. } 0 &\leq Z_t \leq 1 \\ \tau_g &\leq \bar{\tau}(Z_t) \end{aligned}$$

In this constrained maximization, the optimal choice of Z_t is:

$$\begin{aligned} Z_t^* &= Z_{t-1} + \frac{NK_t^\beta - R_t(1-q)}{2\theta} \text{ if } Z_{t-1} + \frac{NK_t^\beta - R_t(1-q)}{2\theta} \in [0, 1] \\ &= 0 \text{ if } Z_{t-1} + \frac{NK_t^\beta - R_t(1-q)}{2\theta} < 0 \\ &= 1 \text{ if } Z_{t-1} + \frac{NK_t^\beta - R_t(1-q)}{2\theta} > 1 \end{aligned}$$

The optimal choice of τ_g is $\tau_g^* = \inf\{\bar{\tau}(Z_t^*), 1\}$. A solution for this problem exists if $\bar{\tau}(Z_t^*) \geq 0$.

In this case, where the government tax rate is prohibitive of entry by the political rival, government tax revenue is the following function of institutional quality:

$$REV(Z_t) = \frac{CN - pNR_t + Z_t \left(NK_t^\beta + (pN + q) R_t \right) + pN\theta (Z_t - Z_{t-1})^2}{1 + pN}$$

Note that the effect of institutional quality on tax revenue increases when the country experiences a resource boom:

$$\frac{\partial^2 REV(Z_t)}{\partial Z_t \partial R_t} = \frac{pN + q}{pN + 1} > 0 \quad (2)$$

The resulting utility for government when $0 \leq \bar{\tau}(Z_t^*) \leq 1$ and Z_t^* is interior is $U_{gov}^* \equiv U_{gov}(\tau_g^*, Z_t^*)$:

$$U_{gov}^* = \frac{NC + R_t(1 + 2pN) + (Z_{t-1} + \frac{NK_t^\beta - R_t(1-q)}{2\theta})[NK_t^\beta - R_t(1 - q + 2pN)] - \frac{(NK_t^\beta - R_t(1-q))^2}{4\theta}}{1 + pN} \quad (3)$$

Government utility is a quadratic and convex function of R_t , so while resource booms R_t may be initially harmful, they eventually become beneficial to the government.

Case 2: Political competition (entry-permissive taxation)

Alternatively, the government could pick the tax rate that maximizes its expected utility, while running the risk of being ousted by its rival:

$$\begin{aligned} \max_{Z_t, \tau_g} E[U_{gov}] &= (1-p) \left[(1-Z_t)R_t + \tau_g N Z_t K_t^\beta - \theta(Z_t - Z_{t-1})^2 \right] \\ \text{s.t. } 0 &\leq Z_t \leq 1 \\ 0 &\leq \tau_g \leq 1 \end{aligned}$$

The optimal strategy for the government in this case is to set τ_g^{**} and Z_t^{**} as follows:

$$\begin{aligned} \tau_g^{**} &= 1 \\ Z_t^{**} &= Z_{t-1} + \frac{NK_t^\beta - R_t}{2\theta} \text{ if } Z_{t-1} + \frac{NK_t^\beta - R_t}{2\theta} \in [0, 1] \\ &= 0 \text{ if } Z_{t-1} + \frac{NK_t^\beta - R_t}{2\theta} < 0 \\ &= 1 \text{ if } Z_{t-1} + \frac{NK_t^\beta - R_t}{2\theta} > 0 \end{aligned}$$

In this case where the tax rate is fixed at 1, expected government revenue from taxation is:

$$E[REV] = (1-p)N Z_t^* K_t^\beta$$

Note that in contrast with case 1 above, the effect of institutional quality on tax revenue is straightforward and does not depend on resource wealth:

$$\begin{aligned} \frac{\partial E[REV]}{\partial Z_t} &= (1-p)N Z_t^* K_t^\beta \\ \frac{\partial^2 E[REV]}{\partial Z_t \partial R_t} &= 0 \end{aligned} \quad (4)$$

The resulting utility of government when Z_t^{**} is interior is:

$$U_{gov}^{**} = (1-p) \left[R_t + \left(Z_{t-1} + \frac{NK_t^\beta + R_t}{4\theta} \right) (NK_t^\beta - R_t) \right] \quad (5)$$

When Z_t^{**} is interior, government utility is a concave quadratic function of R_t . Given the expression for Z_t^{**} and the government objective function above, this makes intuitive sense: an increase in R_t linearly reduces Z_t , which leads to a quadratic increase in revenues from resource rents, a linear decrease in tax revenue, and a possible initial reduction in the cost of changing institutions; but eventually, as Z_t drops further and further away from Z_{t-1} , to change institutions becomes increasingly costly and utility ends up suffering from resource booms.

Optimal Government Strategy

Note that because the political race is centered on the tax rate and not on institutional quality, the welfare consequences of the two cases make case 1 with “predatory” taxation unequivocally preferable for citizens who benefit from lower tax rates and higher institutional quality. This is

because in its choice of Z_t and τ_g , the government has to make sure a private citizen's payoff at least matches the payoff the political candidate can expect from running for office. Whereas in case 2, the government attempts to appropriate all of the non-resource sector, since its tax policy affects neither citizens' incentives (we have abstracted from leisure) nor the probability that it will remain in power (we have assumed that that probability is exogenous and equal to $1-p$).

Proposition 2

The government will choose to discourage the challenger from entering the political race by picking (Z_t^*, τ_g^*) over (Z_t^{**}, τ_g^{**}) when

$$(1 - Z_t^*) R_t + \tau_g^* N Z_t^* K_t^\beta - \theta (Z_t^* - Z_{t-1})^2 > (1 - p) \left[(1 - Z_t^{**}) R_t + \tau_g^{**} N Z_t^{**} K_t^\beta - \theta (Z_t^{**} - Z_{t-1})^2 \right] \quad (6)$$

A proof of this proposition is provided in the appendix.

Proposition 3

When both Z_t^* and Z_t^{**} are interior, the government will pick (Z_t^*, τ_g^*) over (Z_t^{**}, τ_g^{**}) when:

$$\begin{aligned} & \left(\frac{NK_t^\beta}{4\theta} + Z_{t-1} \right) NK_t^\beta p(1 - N + pN) + R_t Z_{t-1} (q - p - pN - p^2N) + R_t p(1 + N + pN) \\ & - \frac{NK_t^\beta R_t}{2\theta} (1 - q + 2pN) + NC + R_t^2 (2 + 5pN + q^2 - 2q - 4qpN - p - p^2N) > 0 \quad (7) \end{aligned}$$

Looking at the expression on the left of the inequality in equation (7), which is simply an expression of Δ_{gov} , we can see that it is a convex quadratic function of R_t . Its sign depends on the values of the parameters and of the state variables R_t , K_t and Z_{t-1} . The effect of changes in R_t on the government's choice of strategy is indeterminate and depends on the levels of the state variables and parameters. However, the signs of the second derivatives are known:

$$\frac{\partial^2 \Delta_{gov}}{\partial R_t^2} = \frac{1 - p + (1 - q)(1 - q + 2pN)}{2\theta} > 0$$

As the size of the resource sector grows, increases in resource rents become more likely to push the government in the direction of precluding participation by political rivals in the election. On the other hand, the cross derivative of Δ_{gov} is negative:

$$\frac{\partial^2 \Delta_{gov}}{\partial R_t \partial K_t} = - \frac{\beta(1 - q + 2pN)NK_t^{\beta-1}}{2\theta(1 + pN)} < 0$$

As the size of the non-resource sector grows, increases in natural resource rents are less likely to make the government move to a policy of precluding political competition.

3.4 Comparative Statics

Depending on whether condition (6) is met, we identify two distinct outcomes of the game, the first, associated with predatory taxation and (Z_t^*, τ_g^*) and the second, associated with political competition and (Z_t^{**}, τ_g^{**}) . We focus on the comparative statics for institutional quality and growth and present the qualitative results below, leaving the details of the quantitative differences between the two cases to the Appendix. The Appendix also derives comparative statics for output.

3.4.1 Institutional quality

Resources have a corrupting effect, whatever the level of non-resource wealth and whether condition (6) is met or not:

$$\frac{\partial Z_t^*}{\partial R_t} = -\frac{(1-q)}{2\theta} < 0 \quad (8)$$

$$\frac{\partial Z_t^{**}}{\partial R_t} = -\frac{1}{2\theta} < 0 \quad (9)$$

When the optimal government choice is an interior solution, increases in R_t are detrimental to the quality of institutions. The results in equation (8) are in line with charges of wasteful government spending and cronyism that are heard even in resource-rich industrialized countries.⁸

The size of the non-resource sector is protective of institutions (with a derivative identical to the one in case 1):

$$\frac{\partial Z_t^*}{\partial K_t} = \frac{\partial Z_t^{**}}{\partial K_t} = \frac{\beta N K_t^{\beta-1}}{2\theta} > 0 \quad (10)$$

Institutional quality is more likely to improve in countries where the resource sector is small relative to the non-resource sector, whether we are in a politically competitive equilibrium or not:

$$Z_t^* > Z_{t-1} \text{ if } R_t < \frac{N K_t^\beta}{1-q}$$

$$Z_t^{**} > Z_{t-1} \text{ if } R_t < N K_t^\beta$$

3.4.2 Growth

In order to examine the effect of resource booms on growth, let us start by defining the growth rate:

$$g_t \equiv \frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{N Z_t K_t^\beta + q Z_t R_t - N Z_{t-1} K_{t-1}^\beta - q Z_{t-1} R_{t-1}}{N Z_{t-1} K_{t-1}^\beta + q Z_{t-1} R_{t-1}}$$

Regardless of whether condition (6) is satisfied, the effect of a resource boom on growth goes from being positive at low levels of resource wealth, to becoming negative as the level of resource wealth exceeds a certain threshold. We examine this threshold for the case where the government's strategy is to offer a tax rate that is prohibitive of entry by the political rival (i.e. when condition (6) is met). A similar analysis for the case with political competition is provided in the Appendix.

When the government's tax offer precludes political competition, the effect of a resource boom on growth is:

$$\frac{\partial g_t^*}{\partial R_t} = \frac{\frac{\partial Y_t^*}{\partial R_t}}{Y_{t-1}} = \frac{(2q-1)N K_t^\beta - 2q(1-q)R_t}{2\theta Y_{t-1}} + \frac{q Z_{t-1}}{Y_{t-1}} \quad (11)$$

⁸ *The Economist* (December, 2005) reports that officials in Alberta, Alaska, and Norway have been known to use oil funds for politically popular causes.

A resource boom is a blessing when $\frac{\partial g_t^*}{\partial R_t} > 0$, i.e. when $R_t < \frac{(2q-1)NK_t^\beta + 2\theta qZ_{t-1}}{2q(1-q)}$. Otherwise, a

resource boom is a curse and $\frac{\partial g_t^*}{\partial R_t} \leq 0$. The prior institutional environment Z_{t-1} makes any

resource boom more likely to be a blessing, which concurs with the findings of Robinson *et al.* (2003) about the effect of institutions on the growth impact of natural resources.

The non-resource sector acts as a “buffer” (and leads to an increase in $((\partial g_t)/(\partial R_t))$):

$$\frac{\partial^2 g_t^*}{\partial K_t \partial R_t} = \frac{\beta(2q-1)NK_t^{\beta-1}}{2\theta Y_{t-1}} > 0 \quad (12)$$

The sign of effect of the size of the non-resource sector on growth is positive and does not depend on condition (6):

$$\frac{\partial g_t^*}{\partial K_t} = \frac{\partial g_t^{**}}{\partial K_t} = \frac{\beta NK_t^{\beta-1}}{Y_{t-1}} \left(Z_t + \frac{NK_t^\beta + qR_t}{2\theta} \right) > 0 \quad (13)$$

The oil-rich countries of the Gulf seem to fit the predictions of “predatory taxation.” The rule of the governments of Saudi Arabia, the United Arab Emirates, Qatar, and Bahrain has been largely uncontested; and with no individual income taxes, and until recently, universal and complete state-financed health care coverage, these governments have fiscal profiles that correspond to the optimal government strategy identified in the model where taxes are reduced in order to prohibit political competition. These same countries, with enormous resource sectors and relatively insignificant non-resource sectors, have trailed behind resource-poor countries in terms of real per-capita growth rates and development indicators.

3.4.3 Summary

The comparative statics for institutional quality have the same signs, regardless of whether or not the political race is contested: institutional quality is enhanced by the size of the non-resource sector and harmed by the size of the resource sector. Furthermore, institutions are likelier to erode when the sectoral composition of the economy is largely biased in favor of the resource sector. Resource booms are beneficial for growth up to a certain level of R_t , after which increases in the size of the resource sector relative to the size of the non-resource sector become counterproductive. The threshold level of R_t depends on whether the tax rate offered by the government allows political competition: it is increasing in the size of the non-resource sector when government prohibits entry, and decreasing in the size of the non-resource sector when government allows political competition. The effect on growth of the size of the non-resource sector is positive, regardless of whether the political candidate runs for elections or not.

4. Empirical Evidence

The theoretical model presented in section 3 suggests the following hypotheses: first, institutional quality is negatively affected by resource wealth and protected by the relative size of the non-resource sector. Second, institutional quality is more likely to deteriorate in countries where the size of the resource sector is large relative to the non-resource sector. Third, the effect of natural resource wealth on growth depends on the government’s optimal strategy: if the political candidate is unable to compete with the incumbent government, the main effect of resources on growth is negative, but it is reversed as the size of the non-resource sector increases. If, on the other hand, the political race is contested, the main effect of natural resources on growth is

positive, and it is reduced and becomes negative as the size of the non-resource sector increases. The non-resource sector is protective of growth.

4.1 The data

We use a panel of 143 countries from 1980 to 1995, in five-year intervals. An interval width of five years is chosen to minimize idiosyncratic year-to-year variations and attempt to capture long-term trends in growth. The data used here come from multiple sources. Table 1 provides summary measures for variables. The data contain four broad categories of variables: data on the relative sizes of sectors, data on political and institutional environment, macroeconomic data, and measures of human capital.

4.1.1 Measuring natural resources

The main empirical results are generated using data on oil abundance (per-capita reserves and per-capita production) from Humphreys (2005). The advantage of these variables is that they capture exogenous resource wealth, which is the measure used in the model in section 3. While it may be argued that production measures are not completely determined by natural resource wealth, and may to some extent be considered choice variables which could be correlated with omitted variables also affecting growth, the same cannot be said of per-capita oil reserves. Oil reserves are simply a measure of the physical stock of oil wealth, therefore a measure of resource abundance.

In the analysis that follows, it is primarily this resource abundance measure of oil reserves per capita that will be used as a proxy for oil wealth. Reserves average 970 barrels per head in our data, with a standard deviation of 6,080 barrels per capita, whereas production averages 0.05 barrels per head per day, with a standard deviation of 0.21. The robustness of the results will be checked by using alternative measures of oil wealth and natural resource wealth.

The measure of natural resources most commonly used in the empirical literature, following Sachs and Warner's (1995) seminal work on the resource curse, is the fraction of primary commodities in exports. An observed negative correlation between the real growth rate of GDP and the percentage of primary commodities in exports would not constitute evidence that resource abundance leads to a curse; rather, it suggests that resource dependence is associated with a lower growth rate of income. Because this measure is expressed as a proportion of exports, it can be interpreted as an indicator of sectoral dependence, or the sectoral concentration of economic activity. In this sense, the resource fraction of exports is itself an "outcome," a measure of the degree of "resource dependence," which is itself a symptom of natural resources being a curse. Insofar as we think dependence is bad for growth, using measures of resource dependence does not inform the question of whether changes in natural resource abundance are harmful or beneficial to the economy. The goal is, in other words, to understand the conditions under which resource abundance translates into resource dependence.

Oil reserves and oil production are positively correlated (with a correlation of 0.74), which is not surprising. Our alternative measure of resource wealth is the share of mining and quarrying in value added, which has a correlation of 0.5 with oil reserves and of 0.71 with oil production.

4.1.2 Measuring the size of the non-resource sector

The principal features of the non-resource sector that are relevant in the model are: that its productivity is positively affected by improvements in the quality of institutions, and that, unlike in the resource sector, where institutions, regardless of institutional quality, determine what the government can appropriate, the government cannot simply appropriate a proportion of the returns of the non-resource sector. Both of these features apply to the manufacturing sector, we therefore use measures of the fraction of total value added in manufacturing as a proxy for the size of the non-resource sector. The data are taken from the World Bank's World Development Indicators (WDI) and the United Nations Aggregate Accounts Statistical Database. As shown in

Table 1, the average share of manufacturing in value added is 17 percent with a standard deviation of 8 percent. Our alternative measures of non-resource wealth include non-mining and quarrying value added, which has a mean of 90 percent and a standard deviation of 15 percent in our sample and the manufacturing share of export, which averages 40 percent with a standard deviation of 29 percent.

4.1.3 Measuring institutional quality

The dataset contains three variables that describe the political and institutional environment: control of corruption, political instability, and civil liberties. The control of corruption variable averages data from Transparency International's Corruption Perception Index (TIC index), the Kaufman *et al.* (2005) Governance Matters V (KKM index) measure of the control of corruption, and Easterly's (1999) Life During Growth study. The TIC index ranks more than 150 countries in terms of perceived levels of corruption, as determined by expert assessments and opinion surveys. The corruption variable in the Governance Matters V study measures the extent of corruption, conventionally defined as the exercise of public power for private gain. It is based on scores of variables from polls of experts and surveys. Easterly's (1999) measure of corruption is based on Political Risk Services data for 1982 and 1990. The counter corruption variable is used as our measure of institutional quality, as it determines both the ease with which government can steal rents from the resource sector and the overall productivity of the productive sector. The counter corruption index goes from 0 to 10, where 10 represents the highest quality of institutions and 0 the worst institutional quality. The average score in the data is 5.11 with a standard deviation of 2.41. Canada gets a score of 10 in 1990, while in the same year, the Democratic Republic of the Congo scores 0. In the analysis below, control of corruption is used to measure institutional quality.

TIC is highly correlated with KKM (0.96).⁹

4.1.4 Other variables

The remaining variables are chosen in accordance with the literature on growth regressions. We use two variables to control for the political climate. Political instability is taken from Barro and Lee (1994). Political instability is measured as the average of revolts and assassinations per capita per year. It has a mean of 0.23 and a standard deviation of 0.49. Sri Lanka scores 0.1 in 2000. Civil liberties is an index from 1 to 7 (where 1 is most free) constructed by Freedom House. Sweden and Austria score 1 in 2000, whereas Morocco scores 4.6 and Jordan 5.6 in the same year. The average civil liberties index in our data is 3.82 with a standard deviation of 1.83.

Variables measuring macroeconomic conditions include GDP per capita, its growth rate, government consumption, and government spending on education, all expressed as fractions of GDP. These variables are collected from the WDI database and the Penn World Tables (version 6.2).

Data on human capital include population growth and life expectancy from the WDI database, and the average years of secondary education and higher education by gender (Barro and Lee, 2000).

4.2 Corruption as the mechanism of the curse:

In this section, we present evidence in support of equations (8) and (10). Table 2 presents the result from regressions of our counter corruption index on a set of regressors in an attempt to test the comparative statics on insitutional quality. The model tested here is of the following

⁹ There is no overlap, in our data, between the KKM and Easterly measures or the TIC and Easterly measures.

form:

$$\text{Cont_corrupt}_{i,t} = a_0 + a_1 \text{Cont_corrupt}_{i,t-1} + \kappa_1 Z_{i,t-1} + \kappa_2 X_{i,t-1} + \eta_{i,t} \quad (14)$$

$\text{Cont_corrupt}_{i,t}$ is the counter corruption measure in country i in year t , the variables of interest are the respective sizes of the natural resource sector and the non-resource sector. $Z_{i,t}$ is a vector of the variables of interest, which include a measure of the size of the natural resource sector and a measure of the size of the non-resource sector, in accordance with equations (8) and (10). $X_{i,t}$ is a set of control variables common to all regressions in Table 2, including government consumption as a fraction of GDP, the log of life expectancy, fixed-effects for year and geographical region, a measure of political stability, and a measure of civil liberties. Panels 2, 3 and 4 in Table 1 provide summary statistics on the variables included in $X_{i,t}$. $\eta_{i,t}$ is an error term.

Table 2 presents the results from running regressions of equation (14) under a variety of assumptions. Using per-capita oil reserves as a proxy for the size of the natural resource sector gives results that are generally consistent with the conclusions of the comparative statics from the government's optimal choice of institutional quality, as can be seen from Table 2. The OLS regressions in Table 2 correct for country-level clustering of the standard errors. Clustering yields consistent, though inefficient, estimates, which are robust to any correlation between observations within a country. Column (1) shows a significant and negative effect of resource wealth on institutional quality as measured by counter corruption policies: an increase in resource wealth of 1,000 barrels per head (which is about equivalent to a move from Mexico to Iran, in 1995) reduces the counter corruption score by 0.05 (which is tantamount to a move from Mexico to China in 1995). These results are qualitatively and quantitatively preserved in column (2), where we add a measure of political stability to the regressors. In column (3), the robustness of the result is also checked when educational attainment data is also included: the resource curse effect is now substantially larger, and a move from Mexico's oil wealth to Iran's is associated with a reduction in the counter corruption score of 0.75 points, which would put Mexico roughly at the level of Belarus. However, it should be noted that because of the limited availability of educational attainment data, the number of observations is substantially smaller.

The next three columns of Table 2 repeat the specification of the first column using alternative measures of the variables of interest to check the robustness of the result. When the share of value added in mining and quarrying is used as a measure of resource wealth instead of oil reserves in column (4), natural resource wealth still has a significant and corrupting effect. Now, the effect on the quality of institutions of an increase in extraction from Mexico's level to Iran's (roughly an increase in mining's share of value added by about 15 percent) is associated with a reduction in the quality of institutions by 0.45 points, which would bring Mexico's score down to Iran's. Column (5) uses the manufacturing share of exports instead of the manufacturing share of value added as a measure of the size of the non-resource sector. The coefficient on the lag of per-capita oil reserves is still significant, negative, and close in magnitude to the coefficient estimated by OLS in the first column. The coefficient on manufacturing's share of exports is positive. The move from Mexico's oil wealth to Iran's in 1995 is associated with a reduction in Mexico's counter corruption score by 0.4 points, which would put it at the same level as Kyrgyzstan. The last column in Table 2 uses oil production per capita per day and the manufacturing share of exports instead of our original variables. The significance of the "curse" coefficient is preserved: now the reduction in Mexico's counter corruption score, for moving to a level of oil production per capita per day similar to Iran's, is 0.07, which would put Mexico close to Vietnam.

The coefficient on natural resource wealth is consistently negative and significant in Table 2, providing evidence in support of the result in equation (8) of the model. We now move to testing the comparative static results found in equations (11) and (12).

4.3 Effect of natural resources on growth

Table 3 reports the coefficients and results from growth regressions of the form:

$$\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \alpha_0 + \alpha_1 \ln(y_{i,t-1}) + \gamma Z_{i,t-1} + \alpha X_{i,t-1} + \mu_i + \epsilon_{i,t} \quad (15)$$

where i stands for country i and t represents the time period. Equation (15) is an augmented version of a Barro and Sala-i-Martin (1995) growth regression, where variables measuring natural resource wealth, the relative size of the non-resource sector, and corruption are also included. $y_{i,t}$ is real per-capita GDP in country i at time t , $Z_{i,t}$ is a vector of the variables of interest, which include measures of the control of corruption, a measure of the size of the natural resource sector, a measure of the size of the non-resource sector, and an interaction between the sizes of the two sectors in accordance with equations (11) and (12) in the model. $X_{i,t}$ is a vector of regressors common to all regressions reported in Table 3, including initial GDP per capita (in log form), life expectancy, population growth, government consumption expenditures, and measures of institutional quality and civil liberties. Finally, μ_i represents country level effects that are time-invariant and $\epsilon_{i,t}$ is an error term.

Table 3 presents the results from running regressions of equation (15) under a variety of assumptions. $Z_{i,t}$ includes the lag of oil reserves per capita as a measure of the size of the resource sector, the fraction of value-added in manufacturing as a measure of the non-resource sector, and an interaction between the two in order to test the validity of equation (12). Column (1) runs a simple OLS regression, treating the data as cross-sectional data, with standard errors clustered on country, to correct for any country-level heteroskedasticity in the error term. The coefficients of interest, namely the main effect of oil reserves and the interaction effect of oil and manufactures, are highly significant and consistent with the comparative statics equations (11) and (12): resources have a significant negative effect on growth that can be mitigated, even reversed, when the non-resource sector is large enough (both significant). Both the negative coefficient on oil reserves and the positive coefficient on the interaction term are highly significant (1 percent). Any country with manufacturing value-added exceeding 7.5 percent (which is the 20th percentile of manufacturing value-added, close to the figure for Kuwait in 1996) is blessed by increases in oil wealth per capita, whereas countries where manufacturing value added falls below this threshold will be cursed. The next two columns check the robustness of this result to including additional regressors relevant to growth, measuring political stability and educational attainment that were excluded in column (1) because the unavailability of data on these variables greatly reduces the number of observations of the main regression.¹⁰

Column (2) adds to the regressors in column (1) a measure of political stability. The results are qualitatively similar to OLS, but the threshold level of manufacturing value-added is slightly higher, at close to 8 percent, which is closer to the figure for Nepal in 2002. Column (3) adds measures of educational attainment to the regressors in column (1). The main results of a negative and significant main effect of resources and a significant and positive interaction effect still persist. The new threshold is lower at around 6.7 percent.

The first three columns fail to control for country-level effects, so that μ_i is simply included in the error term. Columns 3-6 repeat the analysis taking into account the panel structure of the data. The random effects regression in column 3 yields results very close to those in column 1, providing further confirmation of the findings in equations (11) and (12), where natural resources are a curse when the relative size of the non-resource sector is small, and a blessing otherwise. The threshold in manufacturing exports per capita that shields countries from experiencing

¹⁰ All the results in Table 3 are qualitatively unchanged when only regional and year dummies and initial GDP are included in the $X_{i,t}$ vector.

resource booms as curses is very in random effects, at around 7.3 percent. Column 5 also recovers the results found in column 2, with a new threshold of manufacturing value added closer to 8 percent. Finally column 6 also parallels the results found in column 3 and yields a threshold of 6.6 percent.

The coefficient of counter corruption is positive and significant across the various models in Table 3, which is consistent with the prediction from the model in equation (11).

Table 4 further checks the robustness of the findings in Table 3 to using different assumptions about the distribution of the variables and alternative measures of resource and non-resource wealth. Columns 1 and 2 rerun the main OLS and RE regressions in columns 1 and 4 of Table 3 using an instrumental variables (IV) approach in order to address the potential endogeneity of some of the regressors. The regressors that are treated as endogenous to growth are manufacturing value added, oil reserves per capita, civil liberties, initial per-capita GDP, and government consumption. Following Barro and Sala-i-Martin (1995), lagged values are used as instruments. We also use oil production per capita per day as an instrument for oil reserves. The magnitude of the coefficients in column (1) and (2) is slightly higher than in the OLS regression, and the significance lower as is expected in an IV regression, but the implied threshold of 8 percent manufacturing value-added, beyond which natural resource wealth becomes a blessing, is close to the one calculated using the coefficients in Table 3.

Column 3 of Table 4 runs a fixed effects regression which, unlike the RE regressions run in Table 3, do not require that the country-level disturbances be uncorrelated to the regressors. The coefficient on the main effect of resources is highly significant and negative, the interaction term is highly significant and positive. The implied threshold is still 8 percent. A Hausman test (not reported) favors the random effects model at the 5 percent level of significance.

The following columns in Table 4 check the robustness of the results in Table 3 to alternative measures of the main variables of interest. Columns 4 and 6 use the share of value-added that is not from mining and quarrying as a measure of the size of the non-resource sector. The two coefficients of interest are significant at the 10 percent level in OLS, and the implied threshold of non-mining value-added beyond which resources are no longer harmful is just under 40 percent, which is close to the figure for Bulgaria in 1997. The results are more significant (1 percent level) in the RE effects model of column 6 and the implied threshold is slightly higher, at 42.5 percent, corresponding to the statistic for Oman in 1990.

Columns 5 and 7 report the results from OLS and RE regressions respectively using oil production per capita per day as a measure of resource wealth instead of oil reserves. The results using this alternative measure of resource wealth are comparable to the main results in Table 3, with the estimated threshold of the manufacturing share of value added at 6.8 percent in OLS and 7 percent in RE.

5. Conclusion

This paper develops a model of the effect of natural resources on growth that determines the conditions under which natural resources are detrimental to growth. Unlike the models in the literature, the model presented here does not rely on *ex ante* institutional differences to explain why some countries are “cursed” while others are “blessed.” Instead, the model endogenizes institutions and looks at the effect of resource wealth on institutional quality. Governments tax the non-resource sector and choose institutional quality, which determines both the productivity of the non-resource sector and the possibility of funneling resource rents away from the public, for the government’s own consumption.

We find that institutional quality suffers from resource booms, which in turn reduces growth. For a given increase in resource rents, this negative effect is more likely to offset the positive effect of

the resource boom when the size of the resource sector is large, relative to the size of the non-resource sector.

The empirical findings are in line with the predictions of the model about the effect of the relative sizes of the sectors on institutional quality, and the result is robust to a variety of measures of the key variables, and to changes in the econometric approach adopted to estimate the parameters. Thus, resources are found to be detrimental to institutional quality. Natural resources slow down growth in economies with few alternatives to the resource sector, and lead to more rapid growth when the non-resource sector is large: countries above the 20th percentile for the manufacturing share of value-added will experience resource booms as a blessing, while countries below that threshold suffer from resource booms.

The fiscal profile of governments in the oil-rich Arabian gulf countries also fits the results of the model regarding government's choice of taxation levels: the Kingdom of Saudi Arabia, the United Arab Emirates, Qatar, and Bahrain have no individual income tax, and until recently these countries provided universal and complete health care coverage that was state-financed. These same countries, with enormous resource sectors and insignificant non-resource sectors, have trailed behind resource-poor countries in terms of growth rates.

In order to avoid some of the limitations and measurement problems endemic in cross-country data, we have tried to limit our attention to regressors that are relatively easier to measure (the relative sizes of the natural resource and the non-resource sectors), and we have used alternative measures for each of these variables in order to test the robustness of our main results.

The model is intended to provide a framework to ground the empirical analysis. Thus the model is a static one-shot game. A more elaborate model with multiple periods would allow us to exploit the longitudinal aspect of the data more effectively.

Although it is beyond the scope of the goals we set out in this paper, the model provides some comparative statics of the evolution of institutions over time as a function of a country's natural and other resources, which could be tested using time series data. Finally, an avenue for empirical research that we are currently pursuing, which would address some of the complications inherent in cross-country research and provide a further test of the model, is to apply the empirical analysis using county- or state-level data from the United States. To the extent that there is regional variation in institutional quality, it would be informative to know whether differences in local resource wealth and non-resource wealth can account for regional institutional differences in the U.S., while abstracting from some of the more idiosyncratic heterogeneity that afflicts cross-country data.

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Table 1: Descriptions and Summary Statistics for Key Variables Used

The data are in five year intervals from 1980 to 1995.

Variable	Description	Mean	Std. Dev.	Min	Max	N	Source
<u>Panel 1: Natural Resource Wealth</u>							
Oil res/cap	Thousand barrels per cap	0.97	6.08	0	63.58	307	Humphreys
Oil prod/cap	Barrels per cap per day	0.05	0.21	0	1.99	307	Humphreys
Min VA	Mining and quarrying share of value added	9.79%	15.05%	0	70.05%	206	UN
Manuf VA	Manufacturing share of value added	17.74%	8.54%	0	62.31%	308	WDI, UN
Mfc share export	Manufacturing share of exports	40.01%	29.02%	0	95.9%	271	WDI, UNCTAD
Non min VA	Share of value added outside of mining and quarrying	90.21%	15.05%	29.95%	100%	206	UN
<u>Panel 2: Political Environment</u>							
Counter corruption	0-10, where 0 is most corrupt, 10 least corrupt	5.11	2.41	0	10	313	TI (GRI, Easterly)
Political Instab	Average of assass+revol/person per year	0.28	0.23	0	1	212	Barro & Lee (BL), GRI
Civil lib	1-7, 1=most freedom	3.82	1.83	1	7	310	Freedom House, BL
<u>Panel 3: Macroeconomic Variables</u>							
Log(gdp/cap)	In constant 2000 U.S.\$	8.10	1.27	4.73	10.75	313	WDI, PWT
Growth (GDP/cap)	5-year growth rate of real GDP/cap	7.7%	22.3%	-47.8%	189%	313	WDI, PWT
G-cons/Y	Government consumption (%GDP)	18.59%	6.55%	5.19%	43.84%	313	WDI,PWT
<u>Panel 4: Human Capital</u>							
Pop growth	Population growth rate	1.97	1.52	-2.02	11.51	313	WDI
Sec ed male	Average years of sec ed in male population	1.75	1.23	0.10	6.02	244	BL
Sec ed fem	Average years of sec ed in female population	1.37	1.15	0.04	5.11	244	BL
High ed male	Average years of higher ed in male population	0.34	0.30	0.00	1.80	244	BL
High ed fem	Average years of higher ed in female population	0.22	0.23	0.00	1.39	244	BL
Life exp male	Life expectancy for males	61.56	10.20	29.45	76.39	313	WDI
Life exp fem	Life expectancy for females	66.34	11.45	34.05	82.84	313	WDI

Table 2: Regressions of control of corruption index *

Dependent Variable: control of corruption index

Variables	(1) OLS	(2) OLS	(3) OLS	(4) RE	(5) RE	(6) RE
Lag oil res/cap	-4.71*	-5.01**	-75.05**		-3.91*	
	(2.01)	(1.54)	(18.92)		(1.91)	
Lag oil prod/cap						-2.18*
						(1.01)
Min VA				-0.03+		
				(0.02)		
Manuf VA	-1.68	-1.70	-2.33	0.95		
	(1.60)	(1.54)	(1.42)	(3.42)		
Mfc share export					0.14	-0.17
					(0.59)	(0.63)
<u>Political Envir</u>						
Counter corrupt _{t-1}	0.40**	0.29**	0.27**	0.25*	0.43**	0.41**
	(0.08)	(0.08)	(0.07)	(0.12)	(0.08)	(0.07)
Political instab		-4.38**				
		(0.78)				
<u>Macro variables</u>						
Log(GDP/cap)	0.78**	0.49*	0.73*	1.50**	0.76**	0.88**
	(0.26)	(0.24)	(0.33)	(0.31)	(0.26)	(0.25)
G-cons	-3e-3	-0.02	-0.02	0.03	-0.02	-0.02
	(0.02)	(0.02)	(0.03)	(0.04)	(0.02)	(0.02)
<u>Human Capital</u>						
Log(life exp fem)	-4.52	-2.34	-11.96+	-13.57	-8.28	-9.12
	(6.58)	(6.01)	(6.55)	(9.67)	(6.67)	(6.53)
Log(life exp mal)	4.10	1.57	12.30+	11.27	8.49	9.14
	(6.88)	(6.02)	(6.84)	(9.54)	(7.12)	(6.94)
Sec ed fem			0.98+			
			(0.52)			
Sec ed mal			-0.31			
			(0.42)			
High ed fem			-0.66			
			(1.53)			
High ed mal			0.36			
			(1.30)			
Constant	-0.74	5.58	-2.82	1.31	-3.28	-3.13
	(6.57)	(5.48)	(6.74)	(12.65)	(5.67)	(5.59)
N	98	98	82	52	100	100
Countries	98	98	82	52	100	100
R2	0.72	0.79	0.82	0.76	0.74	0.75

* Standard errors in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%

Data are for 1985 and 2000. All regressors are at time t unless otherwise indicated. All regressions include fixed effects for geographical region and year.

Table 3: Regressions of real per-capita GDP growth*

Dependent Variable: growth (real GDP /capita)

Variables	(1) OLS	(2) OLS	(3) OLS	(4) RE	(5) RE	(6) RE
Lag oil res/cap	-1.81** (0.28)	-1.25** (0.27)	-1.49** (0.30)	-1.84** (0.24)	-1.25** (0.28)	-1.52** (0.35)
Manufac VA	-0.27 (0.20)	-0.18 (0.22)	-0.07 (0.21)	-0.21 (0.20)	-0.17 (0.23)	1e-3 (0.19)
Lag oil*Mfc	24.15** (2.16)	15.93** (2.43)	22.3** (2.50)	25.32** (3.20)	16.0** (2.26)	23.0** (2.85)
<u>Political envir</u>						
Cont corrupt	0.02* (0.01)	0.03** (0.01)	0.02** (0.01)	0.02* (0.01)	0.03** (0.01)	0.03** (0.01)
Civil lib	-0.02* (0.01)	-0.01 (0.01)	-0.02+ (0.01)	0.03** (0.01)	-0.01 (0.01)	-0.03* (0.01)
Pol instab		-0.08 (0.17)			-0.09 (0.16)	
<u>Macro variables</u>						
Log(gdp/cap)	-0.13** (0.03)	-0.15** (0.04)	-0.19** (0.06)	-0.16** (0.04)	-1.56** (0.05)	-0.23** (0.09)
G-cons	-4e-3* (2e-3)	-0.01* (3e-3)	-3e-3 (0.01)	-5e-3* (2e-3)	-5e-3* (2e-3)	-4e-3 (3e-3)
<u>Human Capital</u>						
Pop growth	-0.01 (0.01)	-0.01 (0.01)	-2e-3 (0.01)	2e-3 (0.01)	-3e-3 (0.01)	0.01 (0.01)
Life exp mal	-0.02+ (0.01)	-0.03* (0.01)	-0.02+ (0.01)	-0.03* (0.01)	-0.03* (0.01)	-0.03+ (0.02)
Life exp fem	0.03** (0.01)	0.03** (0.01)	0.03* (0.01)	0.03* (0.01)	0.04* (0.01)	0.04* (0.02)
Sec ed male			-0.02 (0.03)			0.05 (0.04)
Sec ed fem			0.09+ (0.05)			0.12* (0.06)
High ed male			-0.06 (0.09)			-0.12 (0.11)
High ed fem			-0.10 (0.14)			-0.05 (0.16)
Constant	0.81* (0.31)	1.03* (0.39)	1.39** (0.52)	0.99** (0.37)	1.05* (0.42)	1.70* (0.66)
N	302	201	237	302	201	237
Countries	138	133	95	138	133	95
R2	0.30	0.29	0.30	0.29	0.29	0.29

* Standard errors in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%

Data are at five-year intervals for the years 1980 to 2000. All regressions include fixed effects for geographical region and year.

Table 4: Alternative approaches to regressions of real per-capita GDP growth*

Dependent Variable: growth (real GDP /capita)

Variables	(1) IV	(2) RE-IV	(3) FE	(4) OLS	(5) OLS	(6) RE	(7) RE
<i>Lag oil res/cap</i>	-2.22 (2.56)	-2.22 (2.51)	-1.68** (0.56)	-1.64+ (0.959)		-2.49** (0.78)	
Lag oil prod/cap					-0.33* (0.14)		-0.37** (0.12)
<i>Manuf VA</i>	-0.43 (0.41)	-0.43+ (0.26)	-0.08 (0.26)		-0.27 (0.19)		-0.24 (0.19)
<i>Lag oil res*Mfc</i>	27.87 (30.52)	27.87 (30.95)	21.25** (8.14)				
Lag oil prod*Mfc					4.84* (2.04)		5.30* (2.07)
Non-min VA				0.12 (0.11)		0.07 (0.12)	
Lag oil*non-min VA				4.12+ (2.46)		5.86** (2.07)	
<u>Political envir</u>							
Cont corrupt	0.02* (0.01)	0.02** (0.01)	0.01 (0.02)	0.01 (0.09)	0.02* (0.01)	0.01 (0.01)	0.02* (0.01)
<i>Civil lib</i>	-0.02 (0.01)	-0.02 (0.01)	-0.02 (0.02)	-0.02+ (0.01)	-0.02+ (0.01)	-0.02* (0.01)	-0.02+ (0.01)
<u>Macro variables</u>							
<i>Log(gdp/cap)</i>	-0.12** (0.03)	-0.12** (0.02)	-0.48** (0.12)	-0.07** (0.02)	-0.13** (0.04)	-0.09** (0.03)	-0.15** (0.05)
<i>G-cons</i>	-3e-3 (2e-3)	-3e-3 (2e-3)	-0.01 (0.01)	-1e-4 (2e-3)	-3e-3+ (2e-3)	-1e-3 (2e-3)	-4e-3* (2e-3)
<u>Human Capital</u>							
Pop growth	-0.01 (0.01)	-0.01 (0.01)	0.01 (0.02)	-5e-3 (0.01)	1e-3 (0.01)	-5e-3 (0.01)	0.01 (0.01)
Life exp mal	-0.02 (0.01)	-0.02+ (0.01)	-0.02 (0.03)	-0.01 (0.01)	-0.02+ (0.01)	-0.01 (0.01)	-0.03* (0.01)
Life exp fem	0.02+ (0.01)	0.02** (0.01)	0.01 (0.02)	0.01* (7e-3)	0.03* (0.01)	0.02* (0.01)	0.03* (0.01)
Constant	0.68** (0.22)	1e-4 (1e-4)	4.18** (0.98)	0.29 (0.21)	0.73* (0.34)	0.50+ (0.27)	0.87* (0.40)
N	271	271	302	200	302	200	302
Countries	118	118	138	95	138	95	138
R2	0.33	0.33	0.48	0.36	0.28	0.30	0.31

* Standard errors in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%

Data are at five-year intervals for the years 1980 to 2000. All regressions include fixed effects for geographical region and year. In IV regressions, variables in italics are treated as endogenous and lagged values of the variables are used as instruments.

Appendix

1. Proofs

1.1 Proposition 1. The politician's problem when she decides to run is:

$$\begin{aligned} \max_{\tau_c} E[U(\text{Cand})] &= p \left((1 - Z_t)R_t + \tau_c N Z_t K_t^\beta - \theta(Z_t - Z_{t-1})^2 \right) - C \\ \text{s.t. } \tau_c &\leq \tau_g \end{aligned}$$

The optimal strategy for the politician when she decides to run is:

$$\tau_c^* = \tau_g$$

The politician will decide to run with a tax rate τ_c^* if the expected utility from running exceeds the utility from being a citizen

$$p \left[(1 - Z_t)R_t + \tau_g N Z_t K_t^\beta - \theta(Z_t - Z_{t-1})^2 \right] - C > (1 - \tau_g)Z_t K_t^\beta + \frac{qZ_t R_t}{N}$$

It is easy to see that it is optimal for the politician to run with a tax rate τ_c^* whenever τ_g exceeds $\tau(Z_t)$ which is defined as the tax rate that makes the politician indifferent between running and not running:

$$\bar{\tau}(Z_t) \equiv \frac{CN - pN(1 - Z_t)R_t + qZ_t R_t + N Z_t K_t^\beta + pN\theta(Z_t - Z_{t-1})^2}{N(Np + 1)Z_t K_t^\beta}$$

1.2 Proposition 2.

The government compares the payoffs from precluding entry and the payoffs from allowing it. If the government chooses to preclude entry, its utility is $U_{\text{gov}}^*(Z_t^*, \tau_g^*)$ over the ranges of R_t and K_t in \mathbb{R}^+ and $Z_{t-1} \in [0, 1]$ that make $\tau(R_t, K_t, Z_t^*) \geq 0$. If it chooses to allow entry, its utility is U_{gov}^{**} over R_t and K_t in \mathbb{R}^+ and $Z_{t-1} \in [0, 1]$. It is straightforward to see that equation (6) simply substitutes in the expressions for $U_{\text{gov}}^*(Z_t^*, \tau_g^*)$ and $U_{\text{gov}}^{**}(Z_t^{**}, \tau_g^{**})$, and proposition 2 states that the government will choose to preclude entry whenever $U_{\text{gov}}^* > U_{\text{gov}}^{**}$.

1.3 Proposition 3.

Let us define as Δ_{gov} the difference between U_{gov}^* and U_{gov}^{**} :

$$\Delta_{\text{gov}} \equiv U_{\text{gov}}^* - U_{\text{gov}}^{**}$$

Substituting in for U_{gov}^* and U_{gov}^{**} from equations (3) and (5) respectively in the expression for Δ_{gov} , it is easy to see that equation (7) states that $\Delta_{\text{gov}} > 0$.

2 Comparative statics

2.1 Case 1: predatory taxation

Output. Overall output in period t is:

$$Y_t = N Z_t K_t^\beta + q Z_t R_t$$

The effect on income of a resource boom when equation (6) is satisfied, is:

$$\frac{\partial Y_t^*}{\partial R_t} = qZ_{t-1} + \frac{NK_t^\beta(2q-1) - 2R_tq(1-q)}{2\theta} \quad (16)$$

So resource booms have a positive effect (blessing) on income if $R_t < \frac{(2q-1)NK_t^\beta + 2\theta qZ_{t-1}}{2q(1-q)}$ and are a curse on income otherwise. The effect of resources on income is improved by increases in the size of the non-resource sector:

$$\frac{\partial^2 Y_t^*}{\partial R_t \partial K_t} = \frac{\beta(2q-1)NK_t^{\beta-1}}{2\theta} > 0 \quad (17)$$

The size of the non-resource sector has a positive effect on output:

$$\frac{\partial Y_t^*}{\partial K_t} = \beta NK_t^{\beta-1} \left(Z_t + \frac{NK_t^\beta + qR_t}{2\theta} \right) > 0 \quad (18)$$

2.2 Case 2: political competition

Growth. When the government's political rival enters the political race (that is when equation (6) is not satisfied), the effect of a resource boom on growth is:

$$\frac{\partial g_t^{**}}{\partial R_t} = \frac{qZ_{t-1}}{Y_{t-1}} - \frac{(1-q)NK_t^\beta + 2qR_t}{2\theta Y_{t-1}} \quad (19)$$

An increase in resources leads to a rise in the growth rate when $R_t < \theta Z_{t-1} - \frac{(1-q)NK_t^\beta}{2q}$ otherwise, it leads to a drop in growth. So when R_t is sufficiently small, the increase in resource rents outweighs the effect of the deterioration of institutions and the overall effect of an increase in natural resource wealth is positive. As R_t exceeds $\theta Z_{t-1} - \frac{(1-q)NK_t^\beta}{2q}$, the negative effect of resources on institutions starts to dominate and the net effect of a resource boom is a curse. Furthermore, it is worth noting that when comparing countries with similar K_t and R_t , a resource boom is likelier to benefit the country with the better initial institutional setup Z_{t-1} , which is in line with the result of Robinson *et al.* (2003) about resources being more likely to benefit countries that are less clientelistic.

The size of the non-resource sector leads to a decrease in the effect of natural resources on growth:

$$\frac{\partial^2 g_t^{**}}{\partial K_t \partial R_t} = -\frac{\beta(1-q)NK_t^{\beta-1}}{2\theta Y_{t-1}} < 0 \quad (20)$$

Why would countries with a larger non-resource sector be more prone to be cursed by natural resources? Resource booms have two effects on output and growth in case 2: a direct positive effect of an increase in resource rents and an indirect negative effect through institutional quality. Institutional quality, as we have defined it, is a productivity factor in the non-resource sector. Its effect is therefore amplified by increases in the size of the non-resource sector. By contrast, the negative effect of resources on institutions is less severe in case 1, as can be seen from comparing

equations (8) and (??). The non-resource sector has a positive effect on institutions which counteracts the deleterious effect of resources and, in case 1, is able to dominate.

$$\frac{\partial g_t^{**}}{\partial K_t} = \frac{\beta N K_t^{\beta-1}}{Y_{t-1}} \left(Z_t + \frac{N K_t^\beta + q R_t}{2\theta} \right) > 0 \quad (21)$$

The effect is positive if $2\theta Z_{t-1} + N K_t^\beta > (1-q)R_t$, otherwise it's negative.

[c] *Output.* The effect on output of a resource boom when equation (6) is not satisfied, is:

$$\frac{\partial Y_t^{**}}{\partial R_t} = q Z_{t-1} - \frac{(1-q)N K_t^\beta + 2q R_t}{2\theta}$$

Resource booms have a positive effect (blessing) on income if $R_t < \theta Z_{t-1} - \frac{N K_t^\beta (1-q)}{2q}$ and are a curse otherwise. The size of the non-resource sector negatively affects the effect of a resource boom on output:

$$\frac{\partial^2 Y_t^{**}}{\partial R_t \partial K_t} = -\frac{\beta(1-q)N K_t^{\beta-1}}{2\theta} < 0$$

The non-resource sector is protective of output:

$$\frac{\partial Y_t^{**}}{\partial K_t} = \beta N K_t^{\beta-1} \left(Z_t + \frac{N K_t^\beta + q R_t}{2\theta} \right) > 0$$