Power Struggles and the Natural Resource Curse

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Abstract

Empirical evidence suggests that the natural-resource curse operates through the behavior of the political elite, yet there are few models that convincingly illustrate the mechanism at work. I present a model where natural-resource abundance generates power struggles, thereby increasing the effective discount rate of the governing group. As a result, the elite makes fewer investments in the long-run development of the country.

1 Introduction

Many observers have remarked that an abundance of valuable mineral resources, or a climate suitable for the growth of cash crops, often fail to lead to higher living standards, and in some cases positively appear to cause lower average incomes and higher rates of poverty. An often-cited example is Nigeria, which since the discovery of its extraordinary oil reserves has experienced zero growth in per-capita income, while the fraction of the population living on less than 1 dollar per day has gone from 36 to 70 percent [Sala-i-Martin and Subramanian (2003)].[1] Such examples have lead economists to suspect that an abundance of natural resources can sometimes be more a curse than a blessing.

The possible existence of a natural resource curse is a puzzle, of course, because under free disposal a country should have the option of leaving the resources untapped, and proceed as if they did not exist. Put another way, it is of course perfectly conceivable that a country will entirely squander its resource wealth, but this in itself does not mean that the country's population should be left worse off for it.

In this paper I present a new model of the natural resource curse, which delivers strongly non-monotonic patterns in the relationship between natural resource endowments and the growth rates and long-run levels of GDP per capita and consumption. The essential idea of the model is that natural resources are more easily appropriated by the governing elites than other sources of wealth, such as the output of the industrial sector. As a result, countries with large amounts of natural resources experience power struggles, in the sense that potential challengers have a stronger incentive to seek to replace the existing government by means of *coup d'etats,* or other forms of forced change in leadership. The greater probability of losing power to a successful challenger reduces the effective rate of return to investing in the country's development for the existing elite, and may induce them to undersupply human capital, infrastructure, contractual enforcement, and the rule of law.

Nigeria is endowed with vast oil wealth (8th largest oil exporter in the world), and any group of individuals winning control of the state becomes the recipient of an immense fortune. Not surprisingly, then, Nigera has had eight successful coups since its indepencence in 1960, the last one in 1993.[2] This is more than two per decade, and I am not counting the

[1] Clearly these patterns imply an enormous increase in inequality, with vast gains at the top.

[2] There were two succesful coups in 1966, and others in 1975, 1976, 1983, 1985, 1990,and 1993. There has been a long (by Nigerian standards) coup-free spell since 1993, and indeed two rounds or more-or-less regular elections in 1999 and 2003. Judging, by newspapers account, however, the bitterness of the emerging rivalries to succeed president Obasanjo in 2007 (assuming he steps down as coinstitutionally mandated on completiuon of his second term), coupled with widespread distrust in the fairness of the electoral process, as well as continues tension in the oil producing regions, still threaten to give rise to extra-constitutional grabs for power.

many failed coups, nor the war in Biafra. Hence, a ruler of Nigera in the first four decades of independence faced an extraordinarily short horizon. To the extent that these rulers were motivated by self interest, it made little sense to use the oil wealth as a springboard to industrialization and development, whose benefits would accrue to future leaders. Instead, they tried to "get rich quick" and accummulated personal riches (mostly in foreign bank accounts) that, at least in the case of the latest dictator, Sani Abacha, are known to have been in the billions of dollars.

Most existing economic models developed to tackle the resource-curse puzzle present some version of the *Dutch disease* effect, in which a natural-resource windfall leads to a real-exchange rate appreciation.[3] If the tradable sector is a somehow "special" source of growth, perhaps because of learning by doing, the exchange-rate overvaluation may usher in slower growth than before the windfall. Slower growth, however, does not mean negative growth, so some considerable further stretching of the story is needed to explain why windfalls would be sometimes followed by falling incomes and higher poverty rates. While higher prices of non-tradable goods may negatively affect some sectors of the population, it is hard to believe that real-exchange rate appreciation is quantitatively important enough to cause growth disasters such as Nigeria's. More generally, there is little empirical support for the Dutch-disease channel [e.g. Gelb (1988)].

Political scientists have long held the view that the reasons for the resource curse are to be found in the behavior of those who control the state, but few of the proposed explanations are modelled formally, as here, and as a result the set of assumptions that are needed to make the story work is not always transparent.[4] Formalized political-economy arguments are presented by Tornell and Lane (1999), Robinson et al. (2002), and Hodler (2005). Tornell and Lane exploit some counter-intuitive properties of Nash equilibria to generate a more-than-proportional increase in the rate of mutual taxation among "powerful groups" in response to an increase in the resource base. In order to shield themselves from this enhanced taxation, the powerful groups *shrink* the resource-extracting sector. While the shrinkage of the natural resource sector is what generates the growth decline, this feature of the model appears *prima facie* counterfactual. In Robinson et al. an abundance of natural resources increases the current government's incentive to boost public employment in order

[3]Rajan and Subramanian (2005) recently found some evidence that aid causes real appreciation and a relative shrinkage of the labor-intensive tradable sector in aid-receiving countries.

[4]I don't have the space for a comprehensive survey of the political-science literature on the natural-resource curse. Briefly, some argue that states with abundant natural resources have less need to "grow" the non-resource sector for tax revenue purposes, or that they are better able to mollify dissent (while my model if anything predicts the opposite). Others argue that resource-controlling elites resist development because it would create alternative power groups who could challenge their status. See Ross (2001) for references and several other versions of these hypotheses.

to secure re-election. While bloated public employment is a frequent characteristic of natural-resource abundant countries, I am not sure that one can realstically explain the magnitude of the Nigerian disaster just by an increase in public-sector employment. Hodler develops a model where natural resources lead to fighting among groups. Fighting in turn is assumed to reduce the protection of property rights, and through this to reduce private investment.[5] My model is somewhat complementary to his, in that it focuses on the effects of resource abundance on public – as opposed to private – investment. Furthermore, while open conflict, when it occurs, is certainly one of the reasons for growth disasters in resource-rich countries, there are many examples of curses occurring in countries that are mostly at peace. The Nigerian civil war lasted only three years (1967-1970), while all the coups and counter-coups were mainly "palace" affairs that *per se* had probably relatively little resonance outside of the factions involved.[6,7]

2 Natural Resources and Development Policy

2.1 Model

I study a two-period economy. In both periods there are two activities that generate flows of consumption goods. The first activity is the exploitation of the economy's natural resources. I have mainly in mind mineral extraction, but agriculture, especially as concerns cash crops such as coffee and cocoa, may also fit the model. The per-period flow of resources from natural-resource extraction is A, and is exogenous. Hence, it operates as an endowment.

The second good-producing activity consists of small scale, rudimentary activities, such as own-consumption agriculture or the provision of artisanal services. I call this the primitive sector. Each agent in the economy can start a primitive activity. I assume that the

[5]Caselli and Coleman (2006) also present a model where natural-resource abundance can lead to fighting, and lower incomes.

[6]While not specifically focused on explaining the resource curse, Acemoglu, Robinson, and Verdier (2004) is also related. It argues that abundant natural resources provide kleptocratic rulers with the resources to buy off the opponents. In a sense my point is the opposite: natural-resource abundance increases the threat on the incumbent. One of the extensions I present below allows for the "buy off" mechanism and shows that my results are robust.

[7]There is also a sizable cross-country empirical literature on the natural-resource curse, including Sachs and Warner (1995), Leite and Weidmann (1999), Bravo-Ortega and De Gregorio (2001), Isham et al. (2003), and Sala-i-Martin and Subramanian (2003). The results reported by these authors are very consitent with my model. However, it seems to me that measuring natural resource wealth by the share of natural-resource exports in GDP is heroic, as much resource wealth is stolen, unreported, or exists mostly in present-value form. Furthermore, using this variable in the right hand side of a growth regression is subject to well rehersed endogeneity and omitted-variable criticisms. For these reasons, I don't emphasize this literature nor do I attempt to add to it.

output from a primitive operation depends on two things: the effort e_t exerted by the agent engaged in this activity; and the economy-wide stock of a reproducible input h_t provided by the government. I will refer to h_t as human capital, but it stands for a much broader set of determinants of productivity influenced by the government, such as infrastructure, the level of efficiency in the provision of government services, or even the quality of contract enforcement and applicability of the rule of law. For simplicity I assume that the production function is linear: if x_t is the output of an agent who engages in the primitive activity, then $x_t = \rho_x h_t e_t$, where ρ_x is an exogenous parameter.

In the second period a third type of economic activity is also possible: industrial production. Industrial production is more efficient and larger-scale than the primitive activity, but it requires managerial talent. If a talented agent hires l_t workers to work for him in an industrial enterprise, and the aggregate effort exerted by his workers is e_t, his output is $y_t = \rho_y h_t l_t e_t$. To capture the superiority of industrial over primitive production I assume $\rho_y > \rho_x$.[8]

Of course what is really important here is not so much that resource extraction uses *no* human capital (government infrastructure, services), but that it is less intensive in these inputs than the non-extractive activities.[9] The population has size N, where N is large in a sense to be implicitly defined later.

The amount of the reproducible resource h_t is exogenous in period 1 but endogenous in period 2. In particular, h_2 depends on the government's investment I in period 1: $h_2 = h_1 + I$. The key idea here is that the government is the provider of some critical inputs that are indispensable for industrialization. For example, with credit constraints it is unlikely that a poor economy will be able to generate rapid increases in human capital through private provision of education, and a minimum level of human capital is almost certainly a key requirement for industrialization. A similar necessary role is played by public infrastructure, efficient government, and application of the rule of law.

The government has two sources of revenue. First, it is the direct recipient of the income flow from the natural resource. This is literally true in the case of mineral resources, where governments either directly sell licenses to foreign mining companies (which is the most common case), or operate the extractive activity directly through a government-owned company. In the case of cash crops the government's control of the revenue typically takes place

[8]Allowing for industrial production in the first period would not change the qualitiative results, but would complicate the analysis considerably. In particular, it would introduce complex strategic considerations for the talented agent in period 1, who may decide not to set up a firm in order not to reveal his identity to the government.

[9]The point here is that all the government needs to do to exploit its country's natural resources is to issue a license to a foreign-owned mining company.

through export taxes, which are easy to levy, government monopoly ownership of marketing boards that export the cash crop, which act as monopsonists vis-a-vis the domestic producers, or government monopoly on foreign-currency holding coupled with over-valued official exchange rates, which forces producers to yield their foreign-currency revenues at artificially reduced values of the domestic currency.

The second source of government revenue is taxes on the income generated by the private sector either with the primitive or with the industrial technology. In particular the government is recipient of a fraction $\tau_t < 1$ of $x_t + y_t$. The key idea we wish to introduce is that industrial output is a more elastic tax base than natural resources, and the government cannot appropriate the totality of it without inducing greatly reduced effort, evasion, and diversion to the black economy. I capture this in a particular stark manner by assuming that the Laffer curve is a step function: any agent's effort e_t is equal to 1 as long as $\tau_t \leq \tau$, and drops to 0 as soon as $\tau_t > \tau$. τ should therefore be interpreted as the revenue-maximizing tax rate, or the argmax of the private-output Laffer curve. Of course it would be trivial to endogenize τ, but this would generate no new insight. In sum, I wish to capture the fact that natural resource revenues are a less elastic tax base than industrial output, and hence they will be taxed at a higher rate. That natural resources are taxed at a 100% tax rate is of course not essential for the argument.

The government is an individual who wishes to maximize the present value of his consumption. As a first approximation, this describes fairly accurately the people who inherited control of Sub-Saharan countries after colonization, and East-Asian countries after the end of World War II. It may not be a bad assumption for most Latin American countries, either. Of course in practice power was rarely fully concentrated in the hands of one individual, but rather in those of a small group of people. This distinction is immaterial here.

In period 1 the person in power is exogenously given. At the beginning of period 2, the talented among the rest of the population have a choice between producing with the primitive technology, hiring workers and producing with the industrial technology, or stage a coup to take control of the government. The key assumption is that those who have the personal energy, charisma, leadership skills, and contacts to organize a coup could also channel the same qualities into entrepreneurial activities. In order to simplify the analysis and avoid having to deal with strategic interactions among the talented agents I assume there is only one such agent. If this agent stages a coup, he succeeds with probability γ. If the coup fails, the coup leader incurs a cost $\tilde{D}$, which could be imprisonment, exile, or even death. The government of period 1 continues in power if the talented agent decides not to attempt a coup, or if a coup is attempted but fails. Otherwise the coup leader becomes the new government. All agents are risk neutral.

2.2 Analysis

The analysis begins with the occupational decision by the potential coup leader. The first thing to note is that if the talented agent does not stage a coup, he will always decide to become an industrialist. This is because as a monopsonist on the labor market he can hire the entire population and pay wages $w = \rho_x h_2$, so that his profits are $(\rho_y - \rho_x) h_2 N$, and since N is large this exceeds the income he can obtain from primitive production, $\rho_x h_2$. Hence, his choice is really between being an industrialist and being a coup leader.

If he stages a coup, the talented agent receives utility

$$\gamma [A + \tau \rho_x h_2 N] - (1 - \gamma) \tilde{D}.$$

The first term is the period-2 government revenue weighted by the probability of success in the coup, while the second term is the expected cost of a failed coup. Note that if he stages a coup there is no industrial production, so tax revenues from the private sector are all from the primitive technology. If he does not stage the coup the leader receives after-tax utility $(1 - \tau)\rho h_2 N$, where I have defined $\rho \equiv \rho_y - \rho_x$.[10]

By comparing these two expressions and rearranging we find that a coup takes place if and only if

$$\gamma\alpha - [(1 - \tau)\rho - \gamma\tau\rho_x] h_2 > (1 - \gamma) D, \tag{1}$$

where $\alpha = A/N$ is the flow of natural-resource revenues *per capita*, and $D = \tilde{D}/N$.[11] Note that the role of human capital depends on the magnitude of τ, γ, ρ, and ρ_x. In particular, the term $(1 - \tau)\rho h_2$ captures the opportunity cost of staging a coup, and is increasing in h_2,

[10] Implicitly I am assuming that potential coup leaders come from outside the ruling elite. The fact that coups are often conducted by military officers is not necessarily in conflict with this assumption. In particular, military coups are often staged by disgruntled factions in the military services that feel excluded from their fair share in the country's pie, which is the same as to say that they are not part of the ruling elite. Still, there are coups that are staged by individuals who are very close to the incumbent. Saddam Hussein's rise to power is a case in point. For my model to adequately explain the resource curse when coup-leaders come from inside the ruling elite there must be (i) an unequal sharing mechanism inside the elite (otherwise there would be no coups); and (ii) the sharing rule depends on the relative size of α and h. In particular, the sharing rule must become more equalitarian as the relative size of h increases (this makes the probability of a coup decreasing in h). The following setup should have these properties. Suppose that the elite is composed by a group of N ministers, of which one (the president) controls natural-resource revenues α, while all the others oversee different sectors of the economy (so that they control resources indexed by h). Suppose that there is a sharing rule inside the government represented by τ_t, where τ_t could be positive or negative (I discuss the negative τ_t case in section 3.1). Further, suppose that one of the ministers is a potential coup leader, but the president does not know which. Then the model is very similar to the one in the text and gives similar results.

[11] Since $\tilde{D}$ is the punishment for a failed coup leader it can be very large, so $D = \tilde{D}/N$ need not go to 0 as N becomes large.

and the term $\gamma\tau\rho_x h_2$ contributes to the return from staging a cup, and is also increasing in h_2. I make the following

Parametric Assumption 1: $(1-\tau)\rho > \gamma\tau\rho_x$,

which implies that the opportunity cost effect dominates over the return effect. I make this assumption because I think it is more plausible that economic development reduces the net incentive of potential coup leaders to challenge the dominant elite. Nevertheless, I should point out that, perhaps surprisingly, the model's broad implications for the relationship between resource-abundance and growth are very similar whether or not Parametric Assumption 1 holds or not. In particular, the growth rate is increasing in α at low levels of α and decreasing beyond a certain threshold. The mechanism is different,though.

With this assumption we can easily establish the following

Lemma 1: *a coup takes place in period* 2 *if and only if* $h_2 < h^*$, *where*

$$h^* = \frac{\gamma\alpha - (1-\gamma) D}{(1-\tau)\rho - \gamma\tau\rho_x}$$

This lemma shows that period-1 governments have (at least) one incentive to provide human capital: by increasing the opportunity cost of staging a coup, they can reduce the likelihood that a coup will take place, and are thus more likely to continue in power in period 2. Another key insight from Lemma 1 is that the required level of human capita is increasing in the natural resource α. The larger the revenue from the natural resource, the stronger the incentive for a potential coup-leader to stage a coup. As a result, the opportunity cost that discourages a coup is higher. Hence, the governments with more natural resources must make a greater industrialization effort if they are to avoid challenges to their power.[12]

In principle, the government may also increase the opportunity cost of staging a coup by reducing the tax rate τ in the second period. I assume this is not possible because the coup leader (implicitly) decides on whether to stage the coup before the government decides on the tax rate, so a promise of keeping taxes low would not be credible. Nevertheless, in the next section I discuss the case in which the government has commitment and chooses τ_t strategically, and argue that this need not change the qualitative results.

From the Lemma, it follows this simple

Corollary 1: *If* $\alpha \leq (1-\gamma) D/\gamma$ *a coup never takes place irrespective of the level of human capital* h_2.

Corollary 1 establishes that countries with very low endowments of natural resources will never experience coups. For countries with larger amounts of natural resources, instead,

[12]Parametric Assumption 1 is clearly the empirically relevant one, but interestingly the resoource-curse result emrges also when it is violated. If the assumption does not hold a coup takes place if if h_2 is *above* a threshold, and the threshold is *decreasing* in α. Hence, to avoid a coup governments *under-invest* in human capital, the more so the higher the resource endowment.

whether or not a coup takes place depends on the period-1 decision by the government on how much to invest in industrialization. We now turn to this decision.

The government's problem is to maximize, with respect to human-capital investment I, the objective

$$\alpha + \tau\rho_x h_1 + Z(\alpha + \tau\rho_y h_2) + (1 - Z)(1 - \gamma)(\alpha + \tau\rho_x h_2) - I,$$

where

$$Z = \begin{array}{l} 1 \text{ if } h_2 \geq h^* \\ 0 \text{ if } h_2 < h^* \end{array},$$

subject to

$$h_2 = h_1 + I$$

$$I \leq \tau\rho_x h_1 + \alpha$$

$$h_1, \alpha \quad \text{given.}$$

The first two terms of the government's objective function are the (exogenous) revenues in period 1. The second period's expected revenues depend on whether a coup takes place, as captured by the indicator function Z, and whether it is successful, as captured by the probability $1 - \gamma$. Note that without loss of generality I have assumed that there is no (behavioral) time discounting, though the probability of a coup acts as a stochastic discount factor. The last term reflects the investment cost. The first constraint simply repeats the production function for human capital. I have assumed for simplicity that the production function for h is linear, but I conjecture that assuming it to be concave (to reflect convex adjustment costs of investment) will reinforce my results.[13] The second constraint is the period-1 government budget constraint. Notice that I am implicitly ruling out government debt. In the next section I argue that the qualitative results would not change by allowing for government debt, as long as the government faces an upward sloping supply of funds.[14]

To see how the period-1 government solves this problem we first note that one unit of resources invested at time 1 yields a return of $\tau\rho_y$ units if the government expects no coup ($h_2 \geq h^*$), and $(1 - \gamma)\tau\rho_x$ if the government expects a coup ($h_2 < h^*$). I make the following additional parametric assumptions:

[13] This is because, as we have seen, a large α requires a larger investment effort for a coup-avoiding government, and with convex cost of adjustments high-α governments may be accordingly discouraged from providing the necessary amount of human capital.

[14] Another implicit assumption is that the government receives utility 0 in case of a succesful coup. This is the theoretical equivalent of former dictators going to live in exile in France on their period-1 gains (or, if not too unpresentable, becoming faculty members in US public-policy schools). As will be seen below even with these assumptions governments always do what they can to avoid a coup, so adding a utility cost from losing power (a few do get jailed or killed) should not change any of the qualitative results.

Parametric Assumption 2: $\tau\rho_y > 1$;

Parametric Assumption 3: $(1-\gamma)\tau\rho_x < 1$.

Now consider first a government who pursues a policy such that $h_2 \geq h^*$. Given Parametric Assumption 2 this government uses all of its first-period resources to encourage industrialization, or $I = \alpha + \tau\rho_x h_1$. As a consequence, we have $h_2 = h_1(1+\tau\rho_x)+\alpha \equiv h^h$ (for "high"). This policy is only *feasible*, of course, if $h^h \geq h^*$, i.e. if the maximum investment by the period-1 government yields a level of period-2 human capital sufficient to avoid a coup.

Next we look at a government who pursues a policy such that $h_2 < h^*$. Given Parametric Assumption 3 this government will make no investments in industrialization, or $I = 0$. Correspondingly, we have $h_2 = h_1$. This policy is obviously always feasible. Hence, if $h^h < h^*$ the government always gives up on industrialization, does not invest, and braces for a coup in the second period (which it hopes to survive). If, instead, $h^h \geq h^*$ industrialization and the prevention of a coup is a feasible alternative, and the government's choice depends on the utility associated with the two possible options. Notice, however, that by virtue of Parametric Assumptions 2 and 3 the industrialization and coup-prevention route always yields a higher present value of income for the government, and is therefore always preferred. Hence, we have the following

Lemma: *Whenever* $h^h \geq h^*$ *the period-1 government uses all its resources to develop the country, and no coup occurs in period* 2. *When* $h^h < h^*$ *the government makes no investment in industrialization and faces a coup in period* 2.

The key assumption is Parametric Assumption 3. With this assumption a government that does not expect to be able to avoid a coup renounces investment completely. Parametric Assumption 2 can actually be relaxed and still preserve all the basic qualitative results of the paper. I show this in Section 3.3.

In order to relate the government's policy to the amount of natural resources in the economy we make a last

Parametric Assumption 4: $\gamma / [(1-\tau)\rho - \gamma\tau\rho_x] > 1$.

Parametric assumption 4 is mostly a restriction on the relative magnitude of γ and ρ. it says that the probability of success of a possible coup is sufficiently large relative to the returns from investing in human-capital accumulation. It makes it relative harder for governments to generate enough human capital to neutralize the incentives for a coup.[15] With this parametric assumption we can use the definitions of h^h and h^* to state the following

Proposition: *If*

$$\alpha > \frac{(1-\gamma)\, D + h_1(1+\tau\rho_x)\,[(1-\tau)\rho - \gamma\tau\rho_x]}{\gamma - (1-\tau)\rho + \gamma\tau\rho_x} \equiv \alpha^* \tag{2}$$

[15] If Parameteric Assumption 4 does not hold then the policy of industrialization that defuses possible coups is feasible for all governments, irrespective of α. In this case there is no "natural resource" curse.

the period-1 government makes no investment in industrialization and faces a coup in period 2. *Otherwise the period-1 government uses all its resources to develop the country, and no coup occurs in period* 2.

This is the sought-for result: under Parametric Assumptions 1-4 governments with a lot of natural resources fail to industrialize, while countries with low levels of natural resources do industrialize. Furthermore, the former experience considerable political instability, while the latter experience stable government.

We now turn to the living-standards of the population. I am not particularly interested in the welfare of the elites, whether political or economic, so I exclude the talented agent and compute the consumption level of the rest of the private citizens. Taking into account that with no coup private citizens receive their reservation wage, we have

$$C = \begin{cases} (1-\tau)\rho_x[(1+\rho_x\tau)h_1+\alpha] & \text{if } \alpha \leq \alpha^* \\ (1-\tau)\rho_x h_1 & \text{if } \alpha > \alpha^* \end{cases}$$

The following corollary is therefore immediate:

Corollary 2: *Per-capita consumption outside the elite is increasing with* α *for* $\alpha \leq \alpha^*$*, and constant for* $\alpha > \alpha^*$*. Per-capita consumption is always higher for* $\alpha \leq \alpha^*$ *than for* $\alpha > \alpha^*$

In other words the discovery of natural-resource wealth makes private citizens worse off. Clearly including the talented agent among the private citizens in the no-coup case would only reinforce the result.

The calculation of GDP is complicated by the fact that in the data much of the extracted natural resource wealth is unreported, as governments typically have the decency of pretending that they are not plundering the country's wealth. Nevertheless, in theory at least GDP will be

$$\text{GDP} = \begin{cases} \alpha + \rho_y[(1+\tau\rho_x)h_1+\alpha] & \text{if } \alpha \leq \alpha^* \\ \alpha + \rho_x h_1 & \text{if } \alpha > \alpha^* \end{cases}$$

Both expressions are increasing in α, so *within* the set of "low resource" $[\alpha \leq \alpha^*]$ and *within* the set of "high resource" $[\alpha > \alpha^*]$ countries more natural resources translate into higher (theoretical) GDP. Nevertheless, it is immediate to see by inspection of the GDP formulas that there is a *discrete fall* in GDP as α crosses into the "high resource" region.

Corollary 3: *Long-run GDP is increasing with* α *for* $\alpha < \alpha^*$ *and for* $\alpha > \alpha^*$*. Per-capita GDP falls discretely at* $\alpha = \alpha^*$.

Hence, even if GDP was perfectly measured, we should observe several natural-resource rich countries that are poorer than resource-poor countries. Taking into account that much of the GDP of resource-rich countries goes unreported, the result should be even starker in the data (and it is).

These results have counterparts in terms of consumption and GDP *growth*. In particular, it is immediate that high-α economies experience absolutely *no growth* in either their private citizens's consumption, nor in GDP. Instead, low-α economies experience investments in human capital and growth, the more so the larger α (because a larger α increases the period-1 government resources for investment). In particular,

$$\frac{\text{period 2 consumption}}{\text{period 1 consumption}} = \begin{cases} 1 + \frac{\alpha + \tau\rho_x h_1}{h_1} & \text{if } \alpha \leq \alpha^* \\ 1 & \text{if } \alpha > \alpha^* \end{cases}$$

and

$$\frac{\text{period 2 GDP}}{\text{period 1 GDP}} = \begin{cases} \frac{\alpha + \rho_y[(1+\tau\rho_x)h_1 + \alpha]}{\alpha + \rho_x h_1} & \text{if } \alpha \leq \alpha^* \\ 1 & \text{if } \alpha > \alpha^* \end{cases}$$

Hence, we have

Corollary 4: *Private-sector consumption growth is increasing in α for $\alpha < \alpha^*$, and falls to zero for $\alpha \geq \alpha^*$. GDP growth is positive for $\alpha < \alpha^*$, and falls to 0 for $\alpha \geq \alpha^*$. For $\alpha < \alpha^*$ GDP growth may be either decreasing (if $(1-\tau)\rho_x\rho_y - \rho < 0$) or increasing with α.*

Hence, we may observe some positive or negative association between growth and natural-resource endowments for low values of α, but between low-resource and high-resource countries the association between GDP growth and natural resources should be strongly negative. This seems likely to be empirically accurate.

3 Extensions

3.1 Commitment

In the model of the previous section I assumed that the continuing period-1 government levies the revenue-maximizing tax rate τ on industrial output in period-2. However, since the level of period-2 taxes affects the potential coup leader's decision, it is conceivable that the government may wish to lower taxes, or even subside the industrial sector, in order to defuse a possible coup. I argued that a similar policy is likely to lack credibility. Nevertheless, it is of theoretical interest to see what happens if the period-1 government had an additional instrument, i.e. tax policy. Hence in the appendix I study the decisions of a government who also (credibly) chooses tax rates τ_1 and τ_2 at the beginning of each period.

The upshot of the analysis in the appendix is that governments of high-resource countries may be able to avoid a coup for a larger set of values of α. Even though they cannot set taxes at τ and avid a coup, they can set them at a lower value and avoid a coup. When they can do so, it is still worthwhile for them to invest in development, so the curse does not kick in. However, for α large enough the cost of buying off the potential coup leader becomes too large, and the government gives up both on buying him off and on developing the country. As a result, Corollaries 2, 3 and 4 still hold in slightly modified form.

3.2 Debt

It should be fairly obvious that the mechanism highlighted in the previous section will continue to work even if the government can tap into foreign financial markets to finance development. All that is needed is that the government faces an upward sloping supply curve of funds. The point is that governments with large endowments of natural resources must borrow very large amounts in order to avoid a coup. If the supply curve is upward sloping this drives up the interest rate to the point where the returns from investing in human capital fall once again below 1. As a result, even governments that can borrow may fail to develop their countries if the natural-resource endowment is "too large."

3.3 Case $\tau\rho_y < 1$

I now argue that the qualitative results of the paper can still hold true even if Parametric Assumption 2 is violated, or $\tau\rho_y < 1$. In this case the direct internal rate of return to the government from investing in human capital is less than the opportunity cost. Nevertheless, investment may still make sense if it allows the government to stay in power, therefore paying off indirectly. It is clear, however, that if $\tau\rho_y < 1$ the government will invest only up to h^*, if at all, since all investments in excess of this are a waste of resources from the government's point of view. It is also clear that if a government invests less than up to h^* it makes no investments at all. Hence, for governments such that $h^h < h^*$ nothing changes, while governments such that $h^h \geq h^*$ will make investments $I = h^* - h$ if and only if

$$\alpha + h_1 - (1 - \tau\rho_y)h_2^* \geq (1 - \gamma)(\alpha + \tau\rho_x h_1), \tag{3}$$

where the left hand side is the government's present value of income when investing (and therefore avoid a coup), and the right-hand side is income when not investing (I have already eliminated identical additive terms from both sides). In the appendix, I prove the following result.

If $\tau\rho_y < 1$ and $\gamma \leq (\rho + \tau\rho_x - 1) / (\tau\rho_x)$ the period-1 government makes no investment in industrialization and faces a coup in period 2 if $\alpha > \alpha^*$, and invests resources $I = h^* - h_1$ otherwise. If $\tau\rho_y < 1$ and $\gamma > (\rho + \tau\rho_x - 1) / (\tau\rho_x)$, the period-1 government makes no investment in industrialization and faces a coup in period 2 if the following condition holds:

$$\alpha > \min(\alpha^*, \alpha_2^*),$$

where α_2^* is defined in the appendix.

Increases in α increase the first-period government payoffs both under investment and under no investment. When the condition $\gamma \leq (\rho + \tau\rho_x - 1) / (\tau\rho_x)$ holds the payoff under investment is always higher than under no investment (i.e. it always pays to avoid a coup), so we obtain the same result as under $\tau\rho_y > 1$: only governments that cannot mobilize enough resources to clear the h^* threshold are subject to the resource curse. When condition $\gamma \leq (\rho + \tau\rho_x - 1) / (\tau\rho_x)$ is violated then the payoff under investment exceeds the payoff under no investment only for $\alpha \leq \alpha_2^*$. Part of the intuition is that increases in α make it more costly to mobilize enough investment to avoid a coup and if α is too large the government will rather take its chances and try to survive a coup. This is more likely to be true when γ is large, so that a very large investment is needed to deter a coup. In this case, if $\alpha_2^* < \alpha^*$, even governments who do have enough resources to provide enough human capital to avoid a coup may decide not to do so. Qualitatively, however, the resource-curse still operates: development-investments are increasing in α for low α, and fall to zero beyond a certain threshold.

3.4 Endogenous γ

In this section I consider the robustness of my results under the assumption that the government period-1 decisions have some impact on the probability that a coup is successful, γ. In particular, the government can invest some of its resources on counter-insurgency infrastructure, such as a secret police, equipment for the army, infiltration of opposition groups, etc. As with everything else, we assume for simplicity that the technology is linear:

$$\gamma(C) = \max\left[\gamma_0 - \delta C, 0\right],$$

where C is the government spending on counter-insurgency. Of course the marginal return to counter-insurgency operations becomes zero when the probability of a successful coup is zero.

It is clear that the coup leader's problem is unchanged, and that Lemma 1 and Corollary 1 still go through. In particular, the threshold value of h that insures that no coup takes place is $h^*(\gamma)$. The government's problem is now to maximize, with respect to human-capital investment I, and counter-insurgency measures C, the objective

$$\alpha + \tau\rho_x h_1 + Z(\alpha + \tau\rho_y h_2) + (1 - Z)(1 - \gamma)(\alpha + \tau\rho_x h_2) - I - C,$$

where

$$Z = \begin{matrix} 1 \text{ if } h_2 \geq h^*(\gamma) \\ 1 - \gamma \text{ if } h_2 < h^*(\gamma) \end{matrix},$$

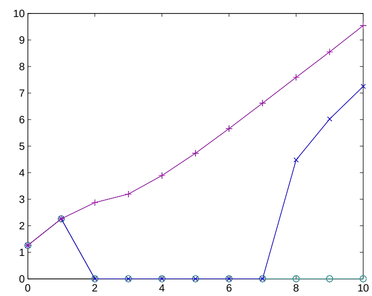

Figure 1: Investment when γ is endogenous

subject to

$$h_2 = h_1 + I$$

$$\gamma = \min\left[\gamma_0 - \delta C, 0\right]$$

$$I + C \leq \rho\tau h_1 + \alpha$$

$$h_1, \alpha \quad \text{given.}$$

It turns out that the solution to this problem is fairly complicated, because changes in C have a number of ambiguous effects on the probability of a coup and on the return to investment by the government. An increase in C reduces the probability of a coup, by reducing γ, but could also potentially increase it because it reduces the resources available for investment, thereby potentially decreasing h_2. Furthermore, while the reduction in γ increases the government's rate of return to investment, it also reduces the base on which this return will be earned, compounding the ambiguity in the government's incentive to invest. Rather than providing a formal treatment of this case, which would be highly taxonomic, I therefore present some numerical experiments.

The key variable that turns out to matter is the elasticity of the success probability of a coup to counter-insurgency spending, δ. Figure 1 shows the total investment by the government as a function of α, for three different values of δ, holding constant all other parameters. We see that when δ is very small (circles), so that counter-insurgency is ineffective, the result is the same as in the baseline model: development policy is increasing in natural-resource abundance at low levels of α, but falls to zero above a certain threshold. If δ is intermediate ("x"), so that counter-insurgency is somewhat effective, but not too much, development-policy follows a U-shaped pattern. As before, it increases in α and falls to 0 initially. However, for very large natural-resource endowments, public investment begins to

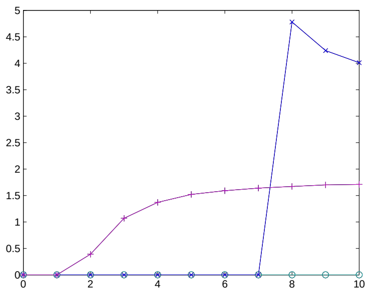

Figure 2: Counter-insurgency spending

increase again. The intuition for this is that if the period-1 government has truly vast resources to spend on counter-insurgency, it becomes possible for it to entirely avoid any coups. Given that there is no coup, it then becomes possible and profitable to invest the balance of the country's resources in industrial development. Finally, for δ very large ("+"), and therefore counterinsurgency very effective, the government can nip all coups in the bud at very little expense, and can therefore benefit from high returns from industrial developments at all levels of α.

To reinforce this intuition I show in Figure 2 the amounts of counter-insurgency spending as a function of α and δ. There is never any counter-insurgency spending when δ is very small. For δ intermediate, the government gives up on counter-insurgency for all but the highest values of α. Finally, when δ is very high the government begins spending in counter-insurgency for all values of α such that a coup would occur with $C = 0$. Notice that the required spending is much higher when δ is intermediate than when δ is high. Figure 3 shows the function Z, representing the probability of staying in office. A government with an effective counter-insurgency technology is always certain of staying in office, and a government with a poor counter-insurgency technology is always subject to coup attempts for all values of α above the threshold of the baseline model. A government with intermediate counter-insurgency technology is certain of staying in office for α very low and α very high, but subject to coups for intermediate values of α.

Finally, turning to economic outcomes, the growth rate of the economy obviously closely resembles the patterns in Figure 1. We therefore find that the extension with endogenous γ generates an additional, significant restriction on the ability of the model to generate a resource curse. In particular, countries with high levels of natural resources will grow less than countries with low levels only if the efficiency of their counter-insurgency technology is not too high. Furthermore, even if the counter-insurgency technology is sufficiently inefficient

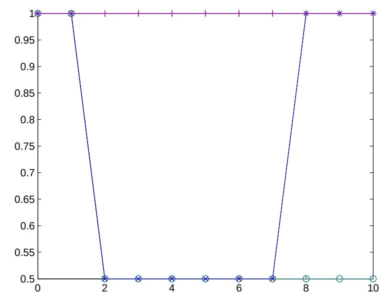

Figure 3: Probability of staying in power with endogenous γ

that a resource curse occurs at intermediate values of α, countries with huge endowments may still grow faster than countries with lower α, i.e. the growth rate is U-shaped in α.

These restrictions may afford opportunities for further tests of the theory, if reasonable proxies for cross-country variation in the effectiveness of counter-insurgency could be found. Two possibilities comes to mind. First, some countries may have a geographical set-up that makes counter-insurgency harder. For example, a lot forest cover or a very mountainous profile may make it difficult to conduct search and destroy operations that are typical of counter-insurgency campaigns. This is often cited as a source of instability in Columbia. Second, a high degree of physical homogeneity within the population makes it difficult to target rebel groups, that are often organized along ethnic lines [Caselli and Coleman (2006)].

4 Discussion

This paper is very much written with Sub-Saharan Africa in mind. Almost all of the countries in this continent are rich in natural resources, whether oil, minerals, or cash crops. And the vast majority have been riven, since independence, by repeated coups.

Consider the ten Sub_sagharan African countries with the largest populations (as of 2000). 5 have very substantial natural resource wealth: Nigeria (oil), South Africa (precious minerals), Uganda (minerals) largest

Nigeria, the largest country in Sub-Saharn Africa, is a clear case: it has vast oil reserves and serial non-constiutional changes in government (on top of civil, ethnic, regional, and religious conflict, much of which probably fuelled by competition over the country resources). Needless to say, it also had an appalling growth performance, even by the standards of the region.[16]

[16]Number and dates of coups. Dates of the oil discovery and peak dates for oil revenues (make point that

Most of the other large countries with abundant mineral wealth fit the pattern: South Africa, Uganda, Ghana and Cote d'Ivoire, for example, all have experienced violent political struggles, so that the governing elites have typically had highly uncertain planning horizons. The case of Cote d'Ivoire is particularly striking because this country was a model of political stability until the 1990s, and only experienced its first coup in 1999, after the discovery of offshore oil deposits. Equally striking, among the large Sub-Saharn African countries the only two that have never had a coup

Conclusions

Recent policy attempts to deal with the natural-resource curse take it for granted that the problem is with the incentives of the political elite. In this sense, policy is running ahead of theoretical work. But the implications of this paper are encouraging for the ongoing policy initiatives. For example, the UK government has instigated an Extractive Industries Development Initiative (EITI), in which participating governments and oil companies agree to disseminate detailed information on quantities extracted, revenues, and royalties paid to the government. The World Bank has made it a condition for financing the Chad-Cameroon oil pipeline that the money paid to the government is put into an escrow account and its destination scrutinized by an oversight committee.[17] The IMF is also pressuring program countries to be more open about the uses of their resource revenues.

If these initiatives have the effect of reducing the amount of resource royalties that the ruling elite can appropriate for its own benefit, then they may temper the negative effects of resource windfalls. The particular way in which this works, according to the model of this paper, is that less appropriability lessens the incentives for potential challengers to stage a *coup d'etat*. This increases the current elite's chances of staying in power, and with it the rate of return on development investments.

Appendix 1: Equilibrium with Commitment

It is immediately obvious that $\tau_1 = \tau$: there is no strategic reason to lower taxes in the first period. In period 2, there is clearly also no reason to lower τ if $h^h \geq h^*$. Hence, the only case where the question arises is in period 2 when $h^h < h^*$. If the government does lower τ_2, the optimal choice of τ_2 is the highest value that insures no coup. Using equation 1, this value is

frequency of coups intensified thereafter). Compute growth rate post-independence and post-oil boom.

[17]Whether these initiatives are credible is another matter. In early 2006 the World Bank pulled the plug on the Chad project because of the government reneged on the safeguards the financing was conditioned upon. But by then most of the pipeline was already in place.

seen to be[18]

$$\tau_2^A = \frac{(1-\gamma)\,D - \gamma\alpha + \rho h_2}{(\rho + \gamma\rho_x)h_2}. \tag{4}$$

Hence, the period-2 tax rate is decreasing in the level of natural-resource income (A stands for "appeasement"). Also, as long as $\gamma\alpha > (1-\gamma)\,D$ it is increasing in the level of period-2 human capital, h_2. Since $\gamma\alpha > (1-\gamma)\,D$ is implied by the fact that we are studying the case $h_2 < h^*$, a higher period-2 human capital is always associated with higher taxes whenever $\tau_2^A < \tau$. Note that τ_2^A could be negative: this can be interpreted as the government redistributing some of the natural resource revenue, in order to forestall a coup. Even so, this policy of appeasement is always affordable.[19]

So when will the period-2 government choose low taxes? To answer this question we have to compare the government's utility under appeasement with its utility under $\tau_2 = \tau$. The government's utility under appeasement (ignoring common constants) is $\alpha + \tau_2^A \rho_y h_2 - (h_2 - h_1)$. To compute this we must figure out how much development-investment will be undertaken by a government who plans to appease the potential coup leader. Plugging in (4) and taking the derivative with respect to h_2 we find that this is $\rho\rho_y/(\rho + \gamma\rho_x) - 1$, where the first term is the marginal return to investment (under appeasement) and the second term is the marginal cost.

Parametric assumption 5: $\rho\rho_y/(\rho + \gamma\rho_x) - 1 \geq 0$

(I state this as an assumption, but in extensive numerical experiments I have never found an instance where $\rho\rho_y/(\rho + \gamma\rho_x) - 1 < 0$ was consistent with PAs 1-4, so in future drafts I plan to prove formally that PA5 is actually not an assumption, but a lemma. Note that if $\rho\rho_y/(\rho + \gamma\rho_x) - 1 < 0$ then $h_2 = h_1$ whenever $h^h < h^*$, so we would always have a curse for α large enough.)

Given Parametric Assumption 5, the appeasing government is also always an investing government: it will set $h_2 = h^h$. The non-appeasing government sets $\tau_2 = \tau$ and (always subject to $h^h < h^*$) faces a coup. Expecting a coup, it sets $h_2 = h_1$. Hence, appeasement will prevail if

$$(\alpha + \tau_2^A \rho_y h^h) - (\alpha + \tau\rho_x h_1) \geq (1-\gamma)(\alpha + \tau\rho_x h_1),$$

which after substitutions and rearrangements becomes

$$(1-\gamma)\,D\rho_y + [\rho(1+\tau\rho_x)\rho_y - (2-\gamma)(\rho+\gamma\rho_x)\tau\rho_x]\,h_1 \geq [(\rho+\gamma\rho_x)(1-\gamma) - (\rho-\gamma)\rho_y]\,\alpha.$$

[18] In deriving equation 4 we have assumed that the succesful coup leader will levy the same tax rate as the incumbent. This is because if the government truly has a commitment technology to a fixed period-2 tax rate, this commitment must bind any successor as well.

[19] To see this notice that under appeasement the period-2 budget constraint is $\alpha + \tau_2\rho_y h_2 \geq 0$. Plugging in the expression for τ_2 a few lines of algebra show that this always holds.

Numerical searches show that the expression in brackets on the left hand side is always positive when Parametric Assumptions 1-4 hold, while the expression in brackets on the right hand side could be either positive or negative. Assuming the former, then we have that for α small enough the government appeases and invests, and for α large enough the government does not appease and does not invest. Defining $\tilde{\alpha}$ the threshold defined by the last equation, we therefore have that a resource curse takes place if

$$\alpha > \max(\tilde{\alpha}, \alpha^*).$$

In this region α is too high to avoid a coup when $\tau_2 = \tau$ ($\alpha > \alpha^*$) and it is even too high to make it worthwhile for the incumbent government to buy off the potential coup leader ($\alpha > \tilde{\alpha}$).

5 Appendix 2: Case $\tau\rho_y < 1$

Plugging in the expression for h^* into (3) and rearranging we have

$$\left[1 - \frac{(1-\tau\rho_y)\gamma}{(1-\tau)\,\rho - \gamma\tau\rho_x}\right]\alpha + h_1 + \frac{(1-\tau\rho_y)\,(1-\gamma)\,D}{(1-\tau)\,\rho - \gamma\tau\rho_x} > (1-\gamma)(\alpha + \tau\rho_x h_1).$$

These are two linear expression in α. The left-hand-side intercept is clearly higher, so this condition for investment is always fulfilled if the slope of the left side is steeper than the slope of the right side. On the other hand if the right-hand-side's slope is steeper then there is a threshold for α, α_2^*, such that the government only invests is $\alpha \leq \alpha_2^*$. With a few manipulations one sees that the left-hand-slope is steeper if

$$\frac{\rho + \tau\rho_x - 1}{\tau\rho_x} > \gamma.$$

Also, when the latter is not satisfied, one can find the α that equalizes the two sides of the equation and one obtains α_2^* as:

$$\alpha_2^* = -\frac{[(1-\tau)\,\rho - \gamma\tau\rho_x]\,[1-(1-\gamma)\tau\rho_x]\,h_1 + (1-\tau\rho_y)\,(1-\gamma)\,D}{[\rho + \tau\rho_x - \gamma\tau\rho_x - 1]\,\gamma}$$

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