

THE QUALITY OF POLITICAL INSTITUTIONS AND THE CURSE OF NATURAL RESOURCES*

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We propose a theoretical model to explain empirical regularities related to the curse of natural resources, which emphasises the behaviour and incentives of politicians. We extend the standard voting model to give voters political control beyond the elections. This gives rise to a new restriction that policies should not give rise to a revolution. Our model clarifies when resource discoveries might lead to revolutions, namely, in countries with weak institutions. It also suggests that for bad political institutions human capital depends negatively on natural resources, while for high institutional quality the dependence is reversed. This finding is corroborated in cross-section regressions.

Until World War II the economics profession tended to believe that natural resources were an unqualified blessing for the nation that owned them. However, in the post World-War II period, the evidence against this belief started accumulating: many resource rich countries grew very slowly and economists started to talk about the curse of natural resources. There is a large number of empirical papers which find evidence of this curse (Sachs and Warner, 1995, 1997, 1999, 2001; Strauss, 2000; Gylfason, 2004; Mehlum *et al.*, 2006). Some authors (Sala-i-Martin, 1997 and Doppelhofer *et al.*, 2000) have even classified natural resources as one of the ten most robust variables with a significantly negative effect on growth in empirical studies.

To summarise, there seems to be an empirical consensus on the following:

FACT 1. *The curse of natural resources: countries rich in natural resources grow slower on average than natural resource poor countries.*

However, there are many important outliers. Some resource rich countries have grown very fast (e.g., Botswana,¹ Canada, Australia, Norway) while others have grown very slowly (e.g., Nigeria, Zambia, Sierra Leone, Angola, Saudi Arabia, Venezuela).² It seems fair to claim that:

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¹ Acemoglu *et al.* (2003) show that Botswana has the highest per capita growth of any country in the world in the last 35 years. The natural resources of Botswana are diamonds. This country had very bad starting conditions for growth (extremely low education levels, bad infrastructure etc.) but 'good' institutions.

² Some countries which have been fairly rich in resources in 1970 that grew rapidly in the next 20 years are Malaysia, Mauritius and Iceland (Sachs and Warner, 2001). Gylfason (2001) additionally lists Indonesia and Thailand as countries attaining both long-term investment exceeding 25% GDP and per capita GNP growth exceeding 4% per year on average from 1970 to 1998. Also the so-called Scandinavian catch-up in the late nineteenth century was based on natural resources.

FACT 2. *The cross-country evidence is inconsistent with a monotonic effect of resources on development/growth: (Robinson et al., 2006)*

We therefore need to understand when natural resources are a blessing and when they are a curse. The empirical literature has taken a step in this direction and it defines policy failure as the prime cause of the underperformance of resource rich countries. It also points to a reason why these policy failures occur. Namely:

FACT 3. *The quality of institutions is decisive in determining whether natural resources are a blessing or a curse.*³

Institutions are linked to the behaviour of politicians, as they limit their discretion and define the policy space. The quality of institutions is also indicative of the level of democracy of a country. More democratic countries tend to have better institutions and are therefore less likely to be cursed by natural resources. But empirical findings also suggest a reverse causality known as the political Dutch disease:⁴

FACT 4. *Natural resources have anti-democratic properties: oil and mineral wealth tends to make states less democratic (Ross, 2001; Lam and Wantchekon, 2002; Jensen and Wantchekon, 2004; Bulte and Damania, 2008).*

Moreover, in countries with weak institutions natural resources are one of the main sources of civil war and revolution.

FACT 5. *Many revolutions are linked to rents derived from natural resources (Collier and Hoeffler, 1998). In particular, oil, gemstones, minerals and other lootable resources are associated with civil conflict while agriculture is not.*⁵

The theoretical contribution of the present article is threefold:

- (1) We propose the first theoretical model that incorporates and explains the five empirical facts outlined above.
- (2) We present an *explicitly political model* which emphasises the behaviour and incentives of politicians. This is key, since there is a clear understanding that the behaviour of government/politicians is fundamental to explain the economic performance in resource abundant countries (Newberry, 1986, p. 334).

³ Mehlum *et al.* (2006) show that the effect of resources on growth is positive (negative) when institutions are good (bad) using Sachs and Warner's (1995) data. The same paper, as well as Boschini *et al.* (2007), shows that the direct negative effect is stronger for minerals than other resources and institutions are more decisive for the effect of minerals than other resources.

⁴ The usual argument explaining why natural resources harm democratisation is based on the incumbent's discretion over the distribution of natural resources. A noticeable exception is Morrison (2007) who argues that even in an ideal scenario where natural resources are funnelled away from non-democratic governments toward the citizens, natural resources would still hinder democratisation. His model is based on Acemoglu and Robinson's (2006) theory of democratisation in which the distributional struggle between the poor and the rich is a reason for democratisation. Morrison shows that natural resources reduce the need for redistribution by the rich: if the natural resource revenue is high enough, the poor may no longer prefer a positive tax rate.

⁵ For an overview on the empirical literature on the link between civil unrest and natural resources see Ross (2004).

- (3) We extend the standard voting model to give voters political control beyond the elections. Democratic institutions are often imperfect and electoral competition could be weak. But in our model, as in reality, citizens have instruments in addition to elections that allow them to avoid policies which could cause them big welfare losses. We introduce these considerations in the model by assuming that citizens can initiate a revolution.⁶ This gives rise to a new restriction into our political economy model: policies should not give rise to a revolution. We will refer to this new constraint as the *no-revolution constraint*.

The existing theoretical literature concentrates mainly on explaining the ‘curse’⁷ (Fact 1)⁸ and suggests ways to avoid it.⁹ This line of research ignores the role of government and therefore cannot explain why governments do not choose the good policies in the first place.¹⁰ We need explicitly political models to understand when natural resources are a blessing and when they are a curse.

To our knowledge the first explicitly political model in this area was developed by Robinson *et al.* (2006). Their model explains empirical Facts 2 and 3. In their article there are two periods, with elections at the end of the first period. In the first period, natural resources are discovered. The incumbent government has to decide which proportion of the resources to extract immediately and how much to leave for the following period. The government can consume the resource income, or use it to influence election outcomes by offering employment in the public sector, which is relatively inefficient. The main result of the article is that politicians tend to overextract resources in the first period because they only care about the future resources if they remain in power. Moreover, the public sector will be inefficiently large. Institutions are decisive for the overall impact of resource booms because they determine the extent to which political incentives can really influence policy outcomes.

While the size of the public sector and the extraction path of natural resources are clearly relevant issues, there are other important channels from natural resources to growth that are unexplored by Robinson *et al.* (2006); in particular, human capital accumulation or education. One danger of natural resources (Gylfason, 2001) is the neglect of education, since the country can live well over an extended period even with

⁶ It need not be violent, although we will assume it causes some economic disruption. General strikes are an example of voters’ control beyond the elections.

⁷ For a list of explanations for the natural resource trap and their empirical support, see Strauss (2000).

⁸ There is no generally accepted explanation for the curse so far. The one with maybe most empirical support is the ‘Dutch disease’ explanation which goes as follows: the discovery and exploitations of natural resources like oil typically leads to large profits. These profits encourage entry into the industry at the expense of other sectors, expand national income and increase demand with a resulting inflationary pressure. At the same time more foreign currency enters the country which appreciates the real exchange rate. Export profits in the non-boom sector fall sharply which attracts even more capacity into the boom sector. The long-run results once the boom is over are stagflation and an over-valued real exchange rate.

The Dutch disease is preventable by good policies; e.g. Indonesia avoided the disease after its oil discovery by consistently devaluing its currency.

⁹ See, e.g., Birdsall *et al.* (2000).

¹⁰ Rent-seeking and corruption are explanations that have been put forward. In these models the state is an aggregator of pressure from interest groups (Becker-Olson approach) which as Robinson *et al.* (2006) pointed out ignores incentives of politicians who often have a large amount of autonomy from interest groups.

a weak commitment to education. But since we know that increased education is conducive to higher growth levels (Barro, 2001; Barro and Lee, 2001; Gylfason and Zoega, 2004), this reduced commitment to education will cost those countries in terms of long-run growth. For this reason, it is difficult to explain the higher persistence of growth in resource-rich Scandinavia than in Latin America (especially resource-rich countries such as Argentina and Chile) without remarking on the educational gap that emerged between the two groups of countries over the period 1870–1910 and which remained large throughout the twentieth century (Bravo-Ortega and De Gregorio, 2002).

In this article we build an explicitly political model to explain when natural resource discoveries lead to higher or lower education levels. We are only interested in publicly owned resources,¹¹ such as oil, gas and minerals.¹² Politicians are purely self-interested and would like to consume the returns from the resource wealth themselves but political pressure obliges them to redistribute at least a part of it to voters. This redistribution can take the form of:

- (i) a direct transfer or
- (ii) a subsidy for the investment in human capital, which has a positive spillover on the entire population.

The incumbent government faces political pressure from two sources: an election and the possibility of a revolution. We model political opposition by the existence of a competitive fringe. Additionally, we assume that political transitions are not without costs. These costs depend on the quality and transparency of political institutions and the level of human capital of the fringe players. The efficiency of the fringe increases in human capital. For low levels of education the fringe will always be less efficient than the incumbent at managing natural resources. Whether or not this situation can be reversed for highly educated fringe players crucially depends on the quality of political institutions. Hence, the function characterising the efficiency of the fringe players gives us a measure for institutional quality.¹³

Besides the political competition there is always a possibility of a revolution. If the revolution is successful, natural resources fall into the hands of the voters who divide the gains equally among themselves. These gains now depend on the management

¹¹ Bulte and Damania (2008) present an explicitly political model in which resources are not publicly owned. In the resource sector entrepreneurs claim a fraction of the resource stock and extract from their private sub-stock. In their model entrepreneurs decide whether to enter resource extraction which has diminishing returns or manufacturing which has increasing returns. Hence moving into manufacturing yields external benefits. Production in both sectors requires a sector specific semi-public good provided by a purely self-interested government. To get this good the sectors offer payments/bribes to the government, who decides how much of the good to produce in return. The government might be challenged by a political opponent. The manufacturing sector bribes too little and hence gets too little of the sector-specific good, since firms do not internalise the spill-over benefits from production. As in our article, the stronger the potential rival, the more the incumbent government has to take welfare maximising considerations into account to remain in power. As a result the resource curse emerges if there is no credible opposition or political transaction costs are high. With strong political competition the government cannot stray far from the income maximising path and hence resource booms are not detrimental for growth.

¹² In all petrostates the government maintains explicit legal ownership of below-ground reserves irrespective of surface property rights; see footnote 12 in Lam and Wantchekon (2002). Most OPEC governments put the resources under national control in particular in the 1960s and 1970s.

¹³ This assumption will be justified at length in the next Section.

skills of voters. We assume that voters are better at managing natural resources the higher their level of education.

We establish the following main results:

- (1) If the fringe wins the election, human capital increases with the amount of natural resources.
- (2) If the government wins the election, human capital is a non-increasing function of natural resources.
- (3) If the government does not have to worry about revolution, human capital is constant.
- (4) If revolution is a binding constraint, human capital decreases in natural resources.
- (5) Revolution is less likely to be a threat, the better are a country's political institution.
- (6) The probability that the incumbent is re-elected may increase with natural resources and this is more likely for countries with bad institutions.

These results confirm that our explicitly political model captures the five empirical facts mentioned above. Our model clarifies when resource discoveries might lead to revolutions (Fact 5), namely, in countries with weak institutions. In our model, natural resources may be bad for democracy because they can harm political turnover (Fact 4). Our model suggests a non-linear dependence of human capital on natural resources (Fact 2). For low levels of institutional quality human capital depends negatively on natural resources, while for high levels of institutional quality the dependence is reversed (Fact 3). Since natural resources are bad when the government wins the election and this probability may increase with natural resources, especially in countries with bad institutions, natural resources are a curse on average (Fact 1).

Empirical Facts 1 to 3 were stated in terms of growth. We do not model growth directly but use human capital/education instead, which is an established engine of growth (Barro, 2001). An explicitly dynamic model would allow study, for example, of the dynamics of capital accumulation, at the expense of a considerable complication in its exposition and development. Our model allows us to explain the empirical facts already discussed as arising from the effects of education on growth. In addition, our model yields direct predictions for the effect of natural resources on education, which can then be tested empirically. Existing empirical studies report conflicting results of the effect of natural resources on education.¹⁴ The most complete study is the one by Stijns (2004), who discusses the different indicators used for resource abundance and human capital accumulation and shows that the conclusion on the link between these two is sensitive to the indicators chosen. Simple correlation coefficients and regressions switch from positive to negative depending on which resource abundance and which human capital indicator is used. This evidence might

¹⁴ Gylfason (2001; 2004) establishes an inverse relationship of human capital measured as public expenditure on education, expected years of schooling for girls and gross secondary-school enrollment with the share of natural capital in national wealth. However, the results seem to be driven by very few countries.

be consistent with the non-linear dependence of human capital on natural resources predicted in our model. We provide preliminary evidence for this model prediction in OLS regressions where we split the sample into two groups, namely countries with good institutions and bad institutions.

The remainder of the article is organised as follows. Section 1 presents the model and solves it. Section 2 discusses the empirical implication of the model and presents some preliminary evidence. Section 3 concludes.

1. The Model

Assume a country owns a stock of natural resources that generates some rents. These resources are publicly owned and will therefore be managed by politicians. Politicians are motivated solely by self-interest, hence the government would like to keep the rents from the resources for itself but it will only be able to benefit from the resource discovery if it remains in power. There are two potential threats for the government's power: an upcoming election and the possibility of a revolution. Before the election the different political parties propose a contract to voters. The contract consists of a direct money transfer to voters and a per unit subsidy for human capital accumulation. Then the election takes place. Once the election outcome is known, investment in human capital is made. The contract proposed by the winning party will be implemented unless voters decide to instigate a revolution and the revolution is successful. A successful revolution means that citizens grab the natural resources and split the rents equally among themselves. Revolution also influences productivity in the private sector. We now describe the different steps in detail. We start with the electoral process.

In the elections, the government G faces the opposition of a competitive fringe. In other words, the opposition consists of several parties that compete among themselves. The unique policy issue is how to distribute the rents generated by the natural resource. We assume that the value of the resource rents depends on the winner of the elections: its value will be W if managed by the incumbent government and $\delta(e)W$ if managed by one of the fringe parties, where e stands for human capital and $\delta(e) \geq 0$ for all e . Furthermore, we assume that $\delta(0) = \underline{\delta} < 1$ and $\delta'(e) > 0$, i.e. for low levels of education the fringe is always less efficient than the government at managing natural resources but the competence of the fringe increases with human capital. The underlying idea of this assumption is that political transitions may handicap non-incumbent politicians. The incumbent party can obtain some advantages from being in government. For example, the whole apparatus of the state can be used by elected officials of this party to access information and other resources.¹⁵ In addition, the incumbent politicians may become more able over time by a simple learning by doing process.¹⁶ The size of the incumbency advantage depends on the quality of the political institutions. In some countries, basic institutions work independently of who is in office, while in other places even secretarial jobs depend on

¹⁵ See, e.g. Cox and Katz (1996), who document empirically the sources of incumbency advantage.

¹⁶ Padró-i-Miquel and Snyder (2006) demonstrate that legislators' 'Effectiveness never declines with tenure, even out to nine terms. The increase in effectiveness is not simply due to electoral attrition and selective retirement, but appears to be due to learning-by-doing.'

the party in power. In the latter case, which is also known as the ‘spoils system’, a change in government implies new workers in key jobs, which obviously leads to severe inefficiencies. A lot of information has to be rediscovered, many things have to be learned again.¹⁷

We assume that the incumbent’s advantage in the management of natural resources depends on the human capital of the new workers and on the transparency of institutions. With higher human capital and transparency it is harder to hide existing information to the newcomers in power. Hence, our function $\delta(\theta)$ measures the costs of political transitions¹⁸ and summarises the quality of a country’s political institutions.¹⁹ The better the institutions in a country, the better is the political competitive fringe at managing natural resources,²⁰ which for simplicity is the only task of politicians in our model. While our argument is more general (and it should be thought of in these general terms), the quality of institutions also affects the resource sector directly. In some countries, this sector is generally independent of the incumbent government, because resource extraction is handled by privately-owned multinational corporations, but there are other countries in which the firms are state-owned and employment in these firms might be subject to changes in government.²¹

There are two ways to transfer resource rents to voters,

- (i) via a direct (per capita) transfer w and
- (ii) via a per unit subsidy π for the investment in human capital.

¹⁷ Jonas and Jones (1956) cite arguments from the earliest study of turnover of state personnel by Professor Martin L. Faust against the spoils system.

‘The spoils system entails heavy turnover in personnel which periodically results in the scrapping of all or nearly all accumulated experience. It places inexperienced and incompetent persons in responsible administrative positions. Since it is predicated upon rewards and favours, it introduces favouritism and partiality in the conduct of the public business and limits the access to the public service of young people of capacity and promise. The spoils system renders impossible continuity in administrative policy and destroys morale within the service. It “leads to oligarchy and autocracy by helping bosses get control of the party machinery.” Moreover, the prevalence of the spoils system in state government makes difficult effective federal-state co-operation and at the same time encourages the growth of bureaucracy at both levels.’ (Jonas and Jones, 1956, p.755)

¹⁸ Notice that we do not exclude the possibility that the fringe might become more efficient than the government at managing natural resources: if political institutions are good $\delta(1) > 1$ but for countries with bad political institutions there will always be an efficiency loss. In this countries δ will be very bounded and low, i.e. $\delta(1) \ll 1$.

¹⁹ An alternative interpretation of the $\delta(\theta)$ function is that it captures the cost for the opposition to get access to power. In countries with worse institutions, the costs for the opposition to reach power are higher. It will then use part of the resource wealth to recover those costs once in power.

²⁰ To understand our assumption fully it will be useful to comment on what would happen in a dynamic extension of the model after a change in government. If the opposition wins, today’s incumbent party becomes part of tomorrow’s opposition and today’s fringe becomes the new incumbent. We argue that we can use the same assumptions about relative efficiency of (new) fringe and incumbent as in the static model. The old fringe party is now an incumbent and has gathered experience on making the institutions function with his team. He has privileged information and the incumbency advantage. The former incumbent (the new fringe player) does not keep his former efficiency advantage which was linked to his former superior information and some control over political institutions through their key workers. If he wins again, he will have to become familiar with the changes introduced by the opponent, and might need to replace key players who need to gain experience since the institutions evolved.

²¹ PeMex (Petroleos Mexico) is an example of a state owned firm in which employment depends on the party in power: Arellano Gault and Klingor (2004) refer to PeMEX as a politically sensitive agency.

The individual’s level of human capital e together with the average level of human capital \bar{e} and the past level of human capital e_p determine each individual’s marginal productivity (salary) ω in the following way (where we assume $\alpha + \beta < 1$):

$$\omega = k(e e_p)^\alpha (\bar{e} \bar{e}_p)^\beta.$$

Hence past level of human capital matters and there is a positive externality (spillover) for society as a whole if an individual invests in human capital. We justify/microfound our choice that past human capital enters in a multiplicative form in Appendix B. We assume that the monetary cost of acquiring a unit of human capital is λ . Given the promised transfers, the voter decides on his own level of human capital by maximising his utility. Hence, the program of the voter is:

$$\max_e U[w + k(e e_p)^\alpha (\bar{e} \bar{e}_p)^\beta - (\lambda - \pi)e]. \tag{1}$$

The first order conditions of this (concave) problem yield $\lambda - \pi = \alpha k e_p (e e_p)^{\alpha-1} (\bar{e} \bar{e}_p)^\beta$. Since all voters are identical we can assume that in equilibrium $e = \bar{e}$ and $e_p = \bar{e}_p$. Therefore

$$\lambda - \pi = \alpha \kappa e^{\alpha+\beta-1}, \tag{2}$$

where $\kappa = k e_p^{\alpha+\beta}$. Notice that with this definition κ incorporates all predetermined human capital. Hence, κ will be higher when human capital depreciates at a slower rate, or when a country has a larger level of development when discovering natural resources.

We will refer to (2) as the voter’s incentive compatibility constraint: it tells us the level of human capital of a voter given the size of the subsidy π . Using this constraint, we can talk directly about the level of human capital e resulting from the transfers instead of discussing the size of the subsidy π . Hence voter’s material utility can be rewritten as a function of the direct transfer w and the level of human capital e , namely

$$U[w + \kappa(1 - \alpha)e^{\alpha+\beta}]. \tag{3}$$

There is a continuum of voters with total mass n . Voters care about the promised utility by the competing parties but also have some ideological concerns. The fringe parties are perceived by voters as ideologically equivalent, hence we can assume that the equilibrium behaviour of fringe players will be identical (we focus on a symmetric equilibrium). From now on, all endogenous variables will be indexed by the political actor offering them. Thus, we have $\omega_i, w_i, e_i, \bar{e}_i, \pi_i$ with $i \in \{G, F\}$ where G stands for ‘Government’ and F for ‘Fringe’.

The electoral process is a version of the probabilistic voting model and works in the following way:

Voters are located in the interval $[0,1]$. The utility of a voter $v \in [0,1]$ when offered a policy that delivers ‘material’ utility U_G from the government is denoted

$$u(v, U_G) = U_G - \theta v.$$

The utility of a voter $v \in [0,1]$ when offered a policy that delivers ‘material’ utility U_F from the competitive fringe is denoted

$$u(v, U_F) = U_F - \theta(1 - v),$$

where θ denotes the strength of purely ideological concerns.

In addition, in every election there is an unexpected 'aggregate shock' $\varepsilon \sim U[-A, A]$ to the utility that shifts preferences of all the voters in favour or against the incumbent. We add this shock to the preferences toward the incumbent. $u(v, U_G) + \varepsilon$. The proportion of voters preferring G over F is then:

$$\min \left[\max \left(0, \frac{1}{2} + \frac{U_G - U_F}{2\theta} + \frac{\varepsilon}{2\theta} \right), 1 \right].$$

Thus, the *ex ante* probability that the incumbent wins the election, given promises U_F, U_G is:²²

$$\Pr \left\{ \min \left[\max \left(0, \frac{1}{2} + \frac{U_G - U_F}{2\theta} + \frac{\varepsilon}{2\theta} \right), 1 \right] \geq \frac{1}{2} \right\}.$$

Hence, the incumbent wins for all $\varepsilon > \varepsilon_1$, where ε_1 makes

$$\frac{1}{2} + \frac{U_G - U_F}{2\theta} + \frac{\varepsilon_1}{2\theta} = \frac{1}{2}.$$

Thus, $\varepsilon_1 = -(U_G - U_F)$. The probability of winning for the incumbent is equal to

$$\Pr[\varepsilon > \varepsilon_1 = -(U_G - U_F)] = \min \left[\max \left(0, \frac{A - \varepsilon_1}{2A} \right), 1 \right] \quad (4)$$

$$= \min \left[\max \left(0, \frac{1}{2} + \frac{U_G - U_F}{2A} \right), 1 \right]. \quad (5)$$

The incumbent cannot win if $\frac{1}{2} + [(U_G - U_F)/2A] < 0$, which implies that $A < -(U_G - U_F)$. On the other hand, the incumbent wins with probability 1 for $A < (U_G - U_F)$.

After the election results, the citizens decide whether or not to take part in a revolution.²³ If a revolution takes place, it happens after the acquisition of human capital. We assume that a revolution is costly (its cost for each participant is c)²⁴ and it is successful with probability q . In the case of a successful revolution, the citizens manage the natural resources and obtain an equal split of the resource rents.²⁵ We assume that a revolutionary government will affect both the returns from natural resources and the

²² Here we make the assumption that half of the votes are necessary to win the election. By lowering the proportion of votes necessary to stay in power we could reproduce any democratic form of government and even a dictatorship since any dictator will require a minimal support to stay in power. These lower values would not change the qualitative results of the paper.

²³ We think of a revolution as a threshold public good problem. It can be successful only when at least x people revolt. This modelling choice leaves open the question of the revolutionaries' identities. In our model there is a natural candidate: the group of voters ideologically most distinct from the winning party.

²⁴ This parameter is meant to capture all costs that occur because there is a revolution whether or not it is successful and it is assumed to be constant for simplicity. This cost can include forgone production during revolution and actual fighting costs.

²⁵ In other words, we assume that the revolutionaries are 'fair' because resource rents are split among all citizens. By not allowing revolutionaries to steal from the people, we sidestep the potential infinite regress problem of revolution against the revolutionaries themselves. In any case, it would be easy to handle formally other ways to share resources after a revolution. For example, assume resources were shared only among the x people who actually revolt. The only change needed in the model would be to replace the $R(W/n)$ function defined below by $R(W/x)$. This would entail no qualitative changes in our results, as it would simply make the constraint more likely to bind, like an increase in q or a decrease in c .

productivity in the private sector and that (similarly to the fringe politicians) the management skills of revolutionaries increase with human capital. This is described by the function $\gamma(e)$ with $\gamma'(e) > 0$.²⁶ If the revolution fails, the original contract proposed by the winner of the elections is imposed. Before analysing the model further we summarise the timing of the model.

Timing of the model

- (1) Resource discovery.
- (2) The incumbent and the fringe opposition offer contracts (w, π) to voters.
- (3) Nature chooses the aggregate preference shock toward the incumbent.
- (4) Voting takes place.
- (5) The election outcome becomes known and human capital is acquired.
- (6) Citizens decide whether or not to participate in a revolution.
- (7) If not enough people participate in a revolution, the contract proposed by the winning party is implemented. If enough people participate in a revolution, nature determines whether or not it is successful (probability q).
 - If successful, citizens manage the natural resources themselves and divide the rents equally among themselves. The management skills of revolutionaries affect both the returns to natural resources and the productivity of the private sector. There are no subsidies to human capital accumulation, so when production restarts after the revolution, citizens have to pay for the entire costs of extra human capital accumulation and their choice determines the postrevolutionary human capital e_R .
 - If the revolution fails, the original contract of the election winner is imposed.

Given these assumptions, political parties want to avoid the revolution. The *no-revolution constraint* requires that the promised contracts have to be at least as good as the outcome of the revolution, i.e.

$$U[w + \kappa(1 - \alpha)e^{\alpha+\beta}] \geq qU\{\gamma(e)[W/n + \kappa(1 - \alpha)e_R^{\alpha+\beta}]\} + (1 - q)U[w + \kappa(1 - \alpha)e^{\alpha+\beta}] - c,$$

where e_R is determined by the solution to the problem (1) defined earlier on with $\pi = 0$. Since $\gamma(e)$ is predetermined by the human capital choice before the revolution, it is a constant from the point of view of revolutionaries, and hence the first order condition determining e_R is $\alpha k e_P (e_R e_P)^{\alpha-1} (\bar{e}_R \bar{e}_P)^\beta = \lambda$, where \bar{e}_R is the average level of human capital after a successful revolution which in equilibrium (since everybody is identical) is e_R . So $\lambda = \alpha k e_R^{\alpha+\beta-1}$ and $e_R = (\alpha k / \lambda)^{\frac{1}{1-\alpha-\beta}}$. So therefore we can write

$$W/n + \kappa(1 - \alpha)e_R^{\alpha+\beta} = R(W/n).$$

Notice that $R'(W/n) = 1$. The no revolution constraint simplifies to:

²⁶ It is very likely that after a revolution citizens who manage the natural resources themselves do not entirely rely on former experts. This is captured by the $\gamma(e)$ function that parallels the $\delta(e)$ function. Alternatively, we could assume that the management skills for natural resources of revolutionaries are independent from natural resources, but the more educated they are, the lower the cost of revolution or the higher the probability of success.

$$U[w + \kappa(1 - \alpha)e^{\alpha+\beta}] \geq U[\gamma(e)R(W/n)] - \frac{c}{q}.$$

We first observe that:

LEMMA 1. *Revolution is a potential threat only to the incumbent government.*

Proof. First notice that competition among the fringe players drives their profits down to zero. The equilibrium offer by the fringe can thus be obtained by maximising the consumers' utility subject to the resource constraint (what we call the fringe programme). To see why in equilibrium the fringe does not take the no-revolution constraint into account, suppose that the solution to the above described fringe programme (call it Programme 1) does not satisfy the no-revolution constraint (the only problematic case). Then one could obtain an alternative solution by imposing the constraint (call this the solution to Programme 2). But the solution to Programme 2 can only decrease the utility of agents (with respect to the solution of Programme 1), which can only worsen the constraint, leading to a contradiction. The government, on the other hand, does keep some of the resource rents for itself. Therefore revolution might be a threat for the government.

We will now formally state the maximisation problems of the fringe players and of the government.

1.1. *The Fringe Problem*

Due to competition among fringe players, the fringe maximises the consumers' utility subject to the resource constraint $\delta(e_F)W/n - w_F - \pi_F e_F \geq 0$. Using the incentive compatibility constraint of voters (2), the resource constraint can be rewritten as $\delta(e_F)W/n - w_F - \lambda e_F + \alpha \kappa e_F^{\alpha+\beta} \geq 0$ and we can talk about the fringe choosing e_F instead of π_F . Hence the fringe problem is:²⁷

$$\max_{e_F, w_F} U[w_F + \kappa(1 - \alpha)e_F^{\alpha+\beta}]$$

subject to

$$\delta(e_F)W/n - w_F - \lambda e_F + \kappa e_F^{\alpha+\beta} \geq 0.$$

Since there is competition among fringe players, the resource constraint has to be satisfied with equality, therefore the fringe problem becomes:

$$\max_{e_F, w_F} U[\delta(e_F)W/n - \lambda e_F + \kappa e_F^{\alpha+\beta}].$$

The first order condition is

$$\delta'(e_F)W/n + (\alpha + \beta)\kappa e_F^{\alpha+\beta-1} - \lambda = 0. \quad (6)$$

In this way, we have that

²⁷ Profits should really be multiplied by $\min\{\max[0, 1/2 + (U_F - U_G)/2A], 1\}$ but notice that since $\min\{\max[0, 1/2 + (U_F - U_G)/2A], 1\}$ is a probability, it is always bigger than zero. Thus, it never affects whether the constraint is binding or not.

$$\frac{\partial e_F}{\partial W/n} = \frac{-\delta'(e_F)}{(\alpha + \beta)(\alpha + \beta - 1)\kappa e_F^{\alpha+\beta-2} + \delta''(e_F)W/n}.$$

Since we know that if the decision is optimal $(\alpha + \beta)(\alpha + \beta - 1)\kappa e_F^{\alpha+\beta-2} + \delta''(e_F)W/n \leq 0$ (to guarantee the satisfaction of second order conditions), then if $\delta'(e_F) \geq 0$, the effect of increasing W in e_F is positive. We summarise this observation in:

PROPOSITION 1. *When the fringe wins the election, human capital is positively related to the amount of natural resources.*

The underlying intuition is simple. In order to have a chance to win the elections the fringe maximises the voters' utility but it is restricted by the resource constraint. This constraint becomes looser the higher the efficiency of the fringe in managing natural resources. This, in turn, is a skill that depends positively on human capital.

Things look very different if the incumbent government wins the election.

1.2. *The Government Problem*

The government maximises its own utility subject to the no-revolution constraint:

$$\begin{aligned} & \max_{e_G, w_G} (W/n - w_G - \lambda e_G + \alpha \kappa e_G^{\alpha+\beta}) \\ & \times \min \left(\max \left\{ 0, \frac{1}{2} + \frac{U[w_G + \kappa(1 - \alpha)e_G^{\alpha+\beta}] - U_F}{2A} \right\}, 1 \right) \end{aligned}$$

subject to

$$U[w_G + \kappa(1 - \alpha)e_G^{\alpha+\beta}] \geq U[\gamma(e_G)R(W/n)] - \frac{c}{q}.$$

In order to derive some analytical results, we further assume that $U(x) = \ln(x)$. Then

$$\begin{aligned} & \max_{e_G, w_G} (W/n - w_G - \lambda e_G + \alpha \kappa e_G^{\alpha+\beta}) \\ & \times \min \left(\max \left\{ 0, \frac{1}{2} + \frac{\ln[w_G + \kappa(1 - \alpha)e_G^{\alpha+\beta}] - U_F}{2A} \right\}, 1 \right) \end{aligned}$$

subject to

$$w_G + \kappa(1 - \alpha)e_G^{\alpha+\beta} \geq \gamma(e_G)R(W/n) \exp\left(-\frac{c}{q}\right).$$

We have to distinguish two cases:

- (i) the no-revolution constraint does not bind at the optimum and
- (ii) the no-revolution constraint binds at the optimum.

The next two Propositions treat the two different cases in turn.

PROPOSITION 2. *The human capital induced by the unconstrained solution to the government problem is*

$$e_G^* = \left[\frac{\kappa(\alpha + \beta)}{\lambda} \right]^{\frac{1}{1-\alpha-\beta}}. \quad (7)$$

Therefore, if the government wins the election and revolution is no threat, human capital does not depend on the exact level of natural resources.

Proof. See Technical Appendix

In other words, if revolution is no threat, the government will induce e_G^* . Any additional transfers to voters will be via the direct subsidy w_G .²⁸ To understand this result notice that the government trades off higher returns when in power with a higher probability to stay in power. For this reason, the government wants to give the voters the highest utility at the lowest possible cost. This is achieved by inducing the level of human capital defined by (7) which corresponds to its socially efficient level, the one that internalises the positive externality for society of individual human capital investment.

If revolution is a threat, subsidising human capital accumulation has an additional effect: it increases the skills of a future revolutionary government. This creates a complication for the government. On the one hand subsidising human capital is good for the government; it increases the efficiency of the economy and voters' utility, which is especially important since there is the competitive pressure from the fringe. On the other hand, increasing the skills of revolutionaries makes revolution more attractive, and this runs against the government's interest. Therefore, when the pressure of revolutionaries is sufficiently high, or the one from the fringe is sufficiently low, the government prefers to lower human capital when natural resources increase. This is summarised in the following:

PROPOSITION 3. *If revolution is a threat, human capital may decrease in natural resources. It will certainly decrease if there is sufficient uncertainty in the electoral process (high A) or if uneducated citizens are reasonably good at managing natural resources (high $\gamma(0)$) or if the opposition is very weak ($\delta(e_F)$ low and with a low upper bound).*

Proof. See Technical Appendix.

Notice that the Proof of Proposition 3 derives exact conditions (A.7 and A.9) for high A or high $\gamma(0)$.²⁹ These conditions are sufficient but not necessary for $\partial e_G / \partial W/n < 0$.³⁰

²⁸ Notice that the way the model is set up, w_G can be negative. Hence, if W/n were too small to induce e_G^* , the government would raise the missing money by taxing voters via w_G . If for some reason transfers had to be nonnegative, then if W/n were too small to induce e_G^* , the government would use all returns from natural resources to subsidise education and human capital would increase for low levels of W/n until it reached e_G^* .

²⁹ It is easy to see that both Conditions (A.7) and (A.9) are satisfied more easily for higher revolutionary success probabilities q and lower revolutionary costs c . Moreover, returns to human capital enter Condition (A.7). The higher these returns (higher α or higher κ or lower λ), the tighter is Condition (A.7).

³⁰ If these conditions are violated, we cannot sign $\partial e_G / \partial W/n$ analytically but in all simulations we have undertaken we still observed $\partial e_G / \partial W/n < 0$ when our assumptions were violated.

1.3. *When Does The Government Worry About Revolution?*

Propositions 2 and 3 tell us that the variation of human capital with the amount of natural resources depends critically on whether the no-revolution constraint binds. Hence, we need to understand the conditions under which the no-revolution constraint is binding. We now explore this issue.

Rewriting the first order conditions for the unconstrained solution allows us to calculate unconstrained w_G .

$$0 = -\left\{ \frac{1}{2} + \frac{\ln[w_G + \kappa(1 - \alpha)e_G^{\alpha+\beta}] - U_F}{2A} \right\} + \frac{W/n - w_G - \kappa\beta e_G^{\alpha+\beta}}{2A[w_G + \kappa(1 - \alpha)e_G^{\alpha+\beta}]}.$$

The solution is:

$$w_G^* = \exp \left[\text{LambertW} \left(\left\{ \frac{W/n + [1 - (\alpha + \beta)]\kappa e_G^{*\alpha+\beta}}{-\kappa(1 - \alpha)e_G^{*\alpha+\beta}} \right\} \exp^{A-U_F-1} \right) - A + U_F + 1 \right] \tag{8}$$

where $\text{LambertW}(\cdot)$ is the *Lambert W* function³¹ and $e_G^* = [\kappa(\alpha + \beta)/\lambda]^{1/(1-\alpha-\beta)}$. To understand when revolution is a concern, we have to check whether w_G^* and e_G^* violate the no-revolution constraint, i.e. we have to compare w_G^* with

$$NR(e_G^*) \equiv [\gamma(e_G^*)R(W/n)] \exp\left(-\frac{c}{q}\right) - \kappa e_G^{*\alpha+\beta} (1 - \alpha) \tag{9}$$

where $R(W/n) = W/n + \kappa(1-\alpha)e_R = W/n + \kappa(1-\alpha)(\alpha\kappa/\lambda)^{(\alpha+\beta)/(1-\alpha-\beta)}$. The unconstrained solution holds whenever $w_G^* > NR(e_G^*)$.

We are now in a position to perform a comparative statics analysis (using numerical simulations where necessary) to get some insight about when revolution is a concern. We will always vary the value of W/n and some other exogenous variable simultaneously. Similarly, the Figures we show depict the value of w_G^* and of $NR(e_G^*)$, as a function of W/n and some other exogenous variable. Both w_G^* and $NR(e_G^*)$ increase in W/n ; while $NR(e_G^*)$ is a linear function of W/n , w_G^* is convex in W/n . We group these other exogenous variables into four categories depending on their economic meaning. For the simulations we use the functions³² $\gamma(e) = 10^{-4} + e^2$, and $\delta(e) = \hat{\delta}e^{\alpha+\beta}$. The basic parameters, which are then varied individually (along with W/n) to observe the different comparative statics, are: $(\alpha, \beta, \hat{\delta}, \lambda, A, c/q, \kappa) = (0.5, 0.2, 0.15, 1, 1, 1, 2)$.

- (1) *The function $\delta(e)$ is a measure of institutional quality.* Better political institutions (higher $\delta(e)$ functions) allow the fringe to offer a higher utility U_F to voters. Hence, the government has to react with a higher direct transfer w_G^* which implies that the no-revolution constraint will bind less often. In other words, the revolutionary threat vanishes with better institutions.
- (2) *The variables c/q and $\gamma(e_G)$ determine the strength of the threat of revolution.* The larger is this threat, the more likely is the no-revolution constraint to bind: $NR(e_G^*)$ increases with those variables while w_G^* is unaffected. In other words, as

³¹ The *Lambert W* function, also called the *Omega function* or *product log*, is the inverse function of $f(w) = w \exp^w$.

³² We tried other functional forms, in particular $\delta(e) = \hat{\delta}$, and the qualitative results in terms of comparative statics are similar.

the citizens become better at managing natural resources (high $\gamma(e_G)$ for all e_G), the no-revolution constraint becomes more relevant. Similarly, for low values of c/q (the cost of revolution is low and/or the probability of success is high) the no-revolution constraint will always bind. For sufficiently high c/q revolution is never an issue; it is simply too costly or too unlikely to be successful. For intermediate values of c/q the constraint binds for low values of W/n , while for high values of W/n we get the unconstrained solution. Recall that w_G^* is a convex function of W/n . More resources make the fringe a more serious competitor. The government has to react with higher direct transfers which make it less likely that the no-revolution constraint is violated. Figure 1 shows the impact of c/q on both w_G^* and of $NR(e_G^*)$ and illustrates graphically the previous discussion.

- (3) *The variables κ , λ , α and β determine the returns and costs of investment in human capital.*
- (a) The effect of a change in κ , which increases (linearly) the marginal return to human capital, depends crucially on the function $\gamma(e)$. An increase in κ , leads to higher e_G^* and thus an increase in $\gamma(e_G^*)$. Both the unconstrained transfer w_G^* and $NR(e_G^*)$ increase with κ (and with W/n). Whether or not the latter increases more strongly, depends on $\gamma(e)$.
- (i) For low $\gamma(e)$, the no-revolution constraint never binds. The management skills of revolutionaries are simply too low.

Changes in NR and c , Red = wG , Green = Constraint

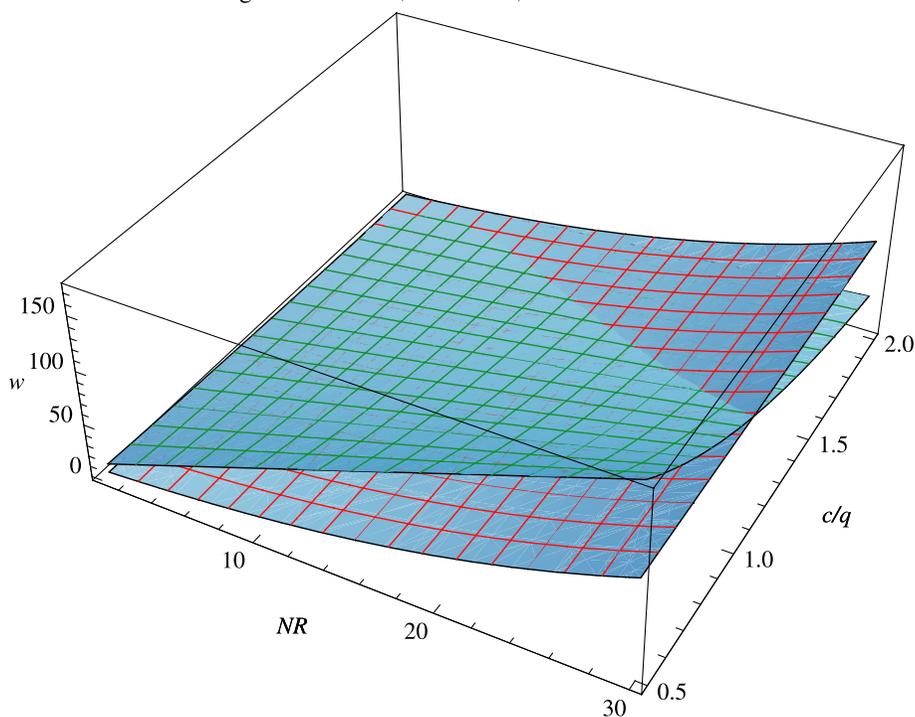


Fig. 1. *Impact of c/q on w_G and $NR(e_G)$*

- (ii) Suppose $\gamma(e)$ is sufficiently large. For low κ , the no-revolution constraint never binds. For high κ the constraint binds. An increase in κ leads to higher e_R^* and e_G^* , which has an indirect effect on $NR(e_G^*)$ by increasing $\gamma(e_G^*)$: the management skills of revolutionaries improve. This additional effect becomes more important with a higher κ , and hence revolution becomes more likely. Figure 2 shows the impact of κ on both w_G^* and of $NR(e_G^*)$ and illustrates the previous discussion graphically.³³
- (b) The parameter λ measures the individual’s marginal cost to acquire human capital. The effects of changing λ are, thus, the reverse effects of changing κ (which, remember, is a proportionality constant on human capital returns). More precisely:
 - (i) For low $\gamma(e)$ the no-revolution constraint never binds.
 - (ii) If $\gamma(e)$ is sufficiently large, the no-revolution constraint binds when both λ and W/n are sufficiently low and it does not bind if either λ or W/n are sufficiently high. Figure 3 shows the impact of λ on both w_G^* and of $NR(e_G^*)$.

Changes in NR and k , Red = w_G , Green = Constraint

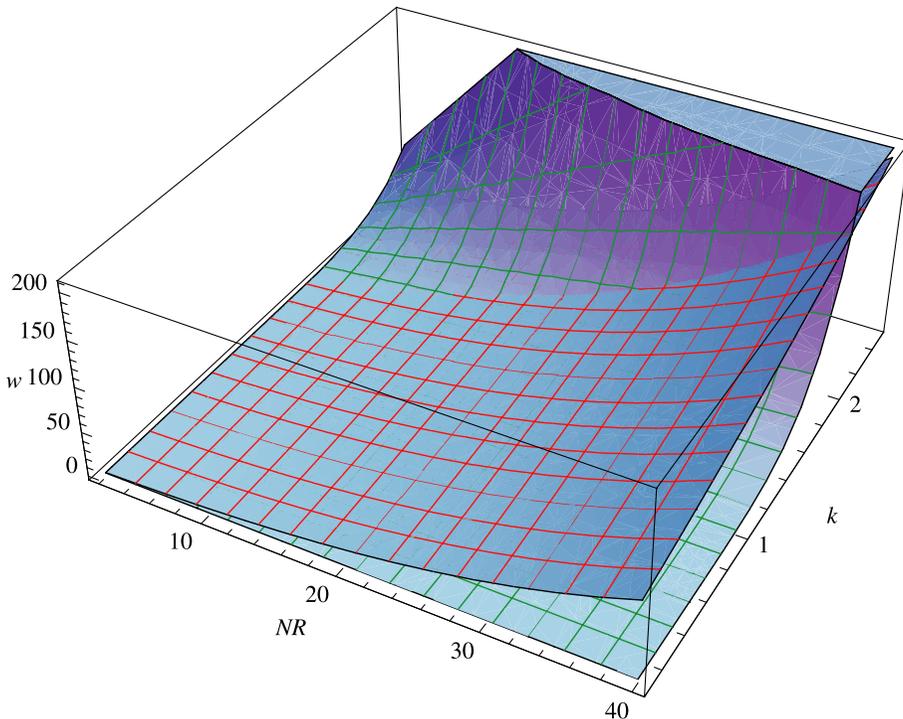


Fig. 2. Impact of k on w_G and $NR(e_G)$

³³ Figure 2 shows that there is an area of κ in which for low W/n the no-revolution constraint binds while it does not for high W/n . The intuitions is the same as in the previous case (intermediate values of c/q) in that more resources make the fringe a more serious competitor and therefore the unconstrained transfer is less likely to violate the no-revolution constraint.

- (c) The parameters α and β determine the returns to scale of human capital. We assume $\alpha + \beta < 1$, hence returns to scale will always be decreasing. Since varying β leads to the same qualitative results than varying α , we will express the whole discussion in terms of varying α . For low W/n , the no-revolution constraint always binds. For high W/n , only the unconstrained solution holds. For intermediate values of W/n , the constraint binds for high α but not for low α . The intuition is as follows. Whether or not revolution is a threat depends on how worried the government has to be about the fringe. As before, a high (low) W/n makes the fringe a more (less) serious competitor, hence revolution is less (more) likely to be a problem. For intermediate values of W/n , an additional effect kicks in. Here, the fringe dominates the threat of revolution for low α , leading to low government skills of revolutionaries $\gamma(e_G^*)$. As α increases, revolutionaries become more effective both in managing natural resources and the production sector, so revolution becomes the real threat. Figure 4 shows the impact of α on both w_G^* and of $NR(e_G^*)$ and illustrates the previous discussion graphically.
- (4) *The aggregate shock A to voters' preferences measures the extent to which policies matter for winning the elections.* The bigger the shock, the less important are the promised utilities to voter. For very low A , we always have the unconstrained solution. When A increases, the constraint starts to bite for low W/n but not for high W/n (which again makes the fringe a serious threat). For high A , the no-

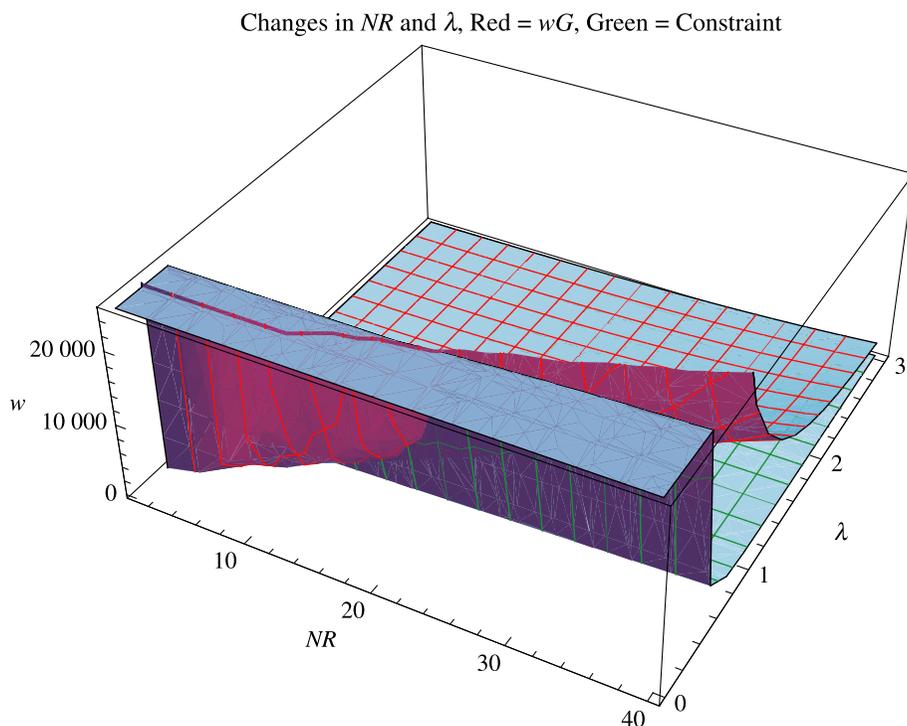


Fig. 3. *Impact of λ on w_G and $NR(e_G)$*

revolution constraint always holds. This happens because w_G^* decreases with A , since promised utilities have a smaller effect on the probability of winning the elections, while $NR(e_G^*)$ is independent of A . Figure 5 shows the impact of A on both w_G^* and of $NR(e_G^*)$ and illustrates the previous discussion graphically.

1.4. Determining the Winner of the Elections

The probability that the government wins the election is directly related to $U_G - U_F$. To gain some insight on how the probability to win an election changes with the amount of natural resources, we will discuss the case when the no-revolution constraint does not bind. From (8) we can conclude that

$$U_G - U_F = \text{LambertW}\left(\left\{W/n + [1 - (\alpha + \beta)]\kappa e_G^{\alpha+\beta}\right\} \exp^{A-U_F-1}\right) - A + 1.$$

Since the LambertW function is increasing, we only have to look at the derivative of its argument. Thus we have

$$\text{sign} \frac{\partial(U_G - U_F)}{\partial(W/n)} = \text{sign} \left[\exp^{A-U_F-1} \left(1 - \left\{W/n + [1 - (\alpha + \beta)]\kappa e_G^{\alpha+\beta}\right\} \frac{\partial U_F}{\partial W/n} \right) \right] \quad (10)$$

$$= \text{sign} \left(1 - \frac{\left\{W/n + [1 - (\alpha + \beta)]\kappa e_G^{\alpha+\beta}\right\} \delta(e_F)}{\delta(e_F)W/n - \lambda e_F + \kappa e_F^{\alpha+\beta}} \right). \quad (11)$$

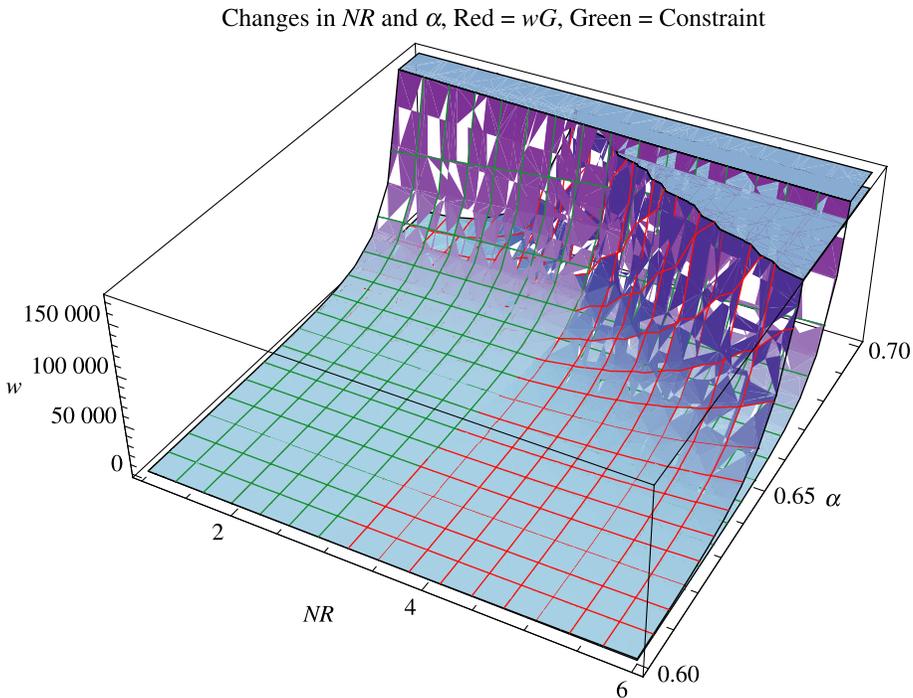


Fig. 4. Impact of α on w_G and $NR(e_G)$

Changes in NR and A , Red = wG , Green = Constraint

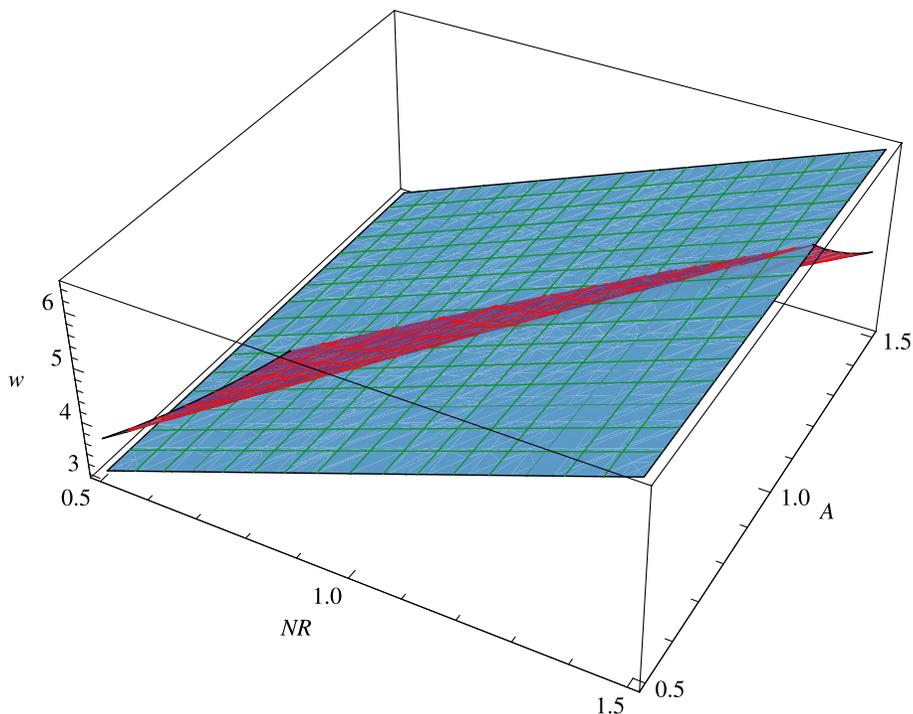


Fig. 5. Impact of A on w_G and $NR(e_G)$

Whether this sign is positive or negative, hence whether the probability that the government wins the election is increasing or decreasing, generally depends on the parameters of the model. However, a couple of things can be deduced from this expression. For $W/n = 0$ we know from (6) that³⁴

$$e_F = \left[\frac{(\alpha + \beta)\kappa}{\lambda} \right]^{\frac{1}{1-\alpha-\beta}}.$$

Clearly, if $(\alpha + \beta)\kappa/\lambda$ is low enough, (11) is positive. On the other hand, for very large W/n , when the variation of e_F is smaller than that of W/n , then (11) will asymptote

³⁴ Here we make use of the assumption that direct transfers w can be negative. If negative w were not allowed, then for $W/n = 0$ neither the fringe nor the government would subsidise human capital accumulation. Hence we would observe e_B , the level of human capital after a revolution. In this case (11) would simplify to

$$\begin{aligned} \text{sign} \frac{\partial(U_G - U_F)}{\partial(W/n)} &= \text{sign} \left\{ 1 - \frac{[1 - (\alpha + \beta)]\kappa e_R^{\alpha+\beta} \delta(e_R)}{-\lambda e_R + \kappa e_R^{\alpha+\beta}} \right\} \\ &= \text{sign} \left\{ 1 - \frac{[1 - (\alpha + \beta)]\kappa e_R^{\alpha+\beta} \delta(e_R)}{(1 - \alpha)\kappa e_R^{\alpha+\beta}} \right\} \\ &= \text{sign} \left\{ 1 - \frac{[1 - (\alpha + \beta)]\delta(e_R)}{(1 - \alpha)} \right\} > 0. \end{aligned}$$

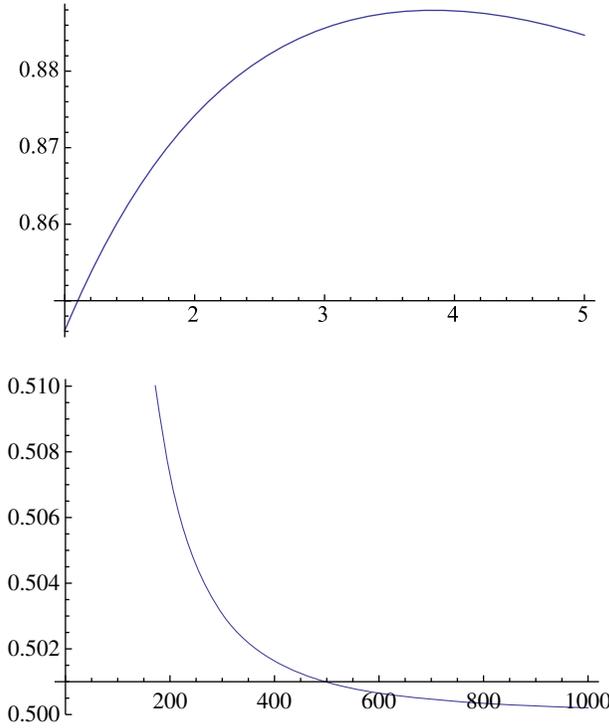


Fig. 6. *Impact of W/n on Probability of Winning Elections by Incumbent*

to zero. From this argument it is not clear whether it could ever be decreasing. To confirm that in fact it can, we perform a numerical simulation using the same basic parameter values and functional forms as in Sub-section 1.3. The result of this simulation is shown in Figure 6. The Figure displays the two features we uncovered analytically and also shows that for sufficiently high W/n the sign is negative.

The fact that the derivative can be both positive and negative reflects that two economic forces are at work. On the one hand, as resources increase, the government can pay higher direct transfers w_G , thus increasing its chances of winning. On the other hand, the fringe can also offer better terms, especially through the channel of human capital e_F , which also enhances its probability of winning and makes the fringe a better administrator of natural resources. While direct transfers enter in the utility of voters linearly, the expressions depending on human capital are concave. Therefore, the effect of higher direct transfers will dominate in the beginning since it hits the margin directly from the beginning, whereas the effect of human capital needs more natural resources to have the same marginal impact.

Clearly, by bounding the $\delta(e)$ function one could ensure that (11) is never negative, which seems to be the relevant case according to the empirical evidence. Recall that we interpreted the $\delta(e)$ function as a proxy for institutional quality. A low and bounded $\delta(e)$ corresponds to a country where institutions are weak. and the fringe cannot manage natural resources as efficiently as the government even for high levels of

education. In this case, finding natural resources increases the chances that the incumbent government stays in power. Strong institutions make it less likely that natural resources will allow the incumbent to become more entrenched.

2. Empirical Evidence

Our theoretical model can capture the five empirical regularities outlined in the Introduction. It tells us when natural resources lead to a revolution, namely in countries with bad political institutions (Fact 5).³⁵ It can explain when natural resources are a blessing and when they are a curse (Fact 2) and it captures the importance of the quality of institutions (Fact 3). While for the opposition's policy human capital is increasing in natural resources, the incumbent's policy reaction to human resources depends on the quality of institutions. When institutions are good, political competition forces the incumbent to choose the subsidy for human capital so that individuals internalise its positive spillovers on society. When institutions are bad, the incumbent's main worry is the revolutionary threat and he often prefers to keep education low to minimise this threat. Hence, with bad institutions human capital is lower if the incumbent wins the election. Moreover, the incumbent is likely to win the elections if institutions are bad. A further result of our model is that natural resources may be bad for political turnover, particularly in countries with bad political institutions (Fact 4). If the majority of countries with natural resources have bad institutions, we will observe that natural resources are negatively correlated with growth on average (Fact 1: *the curse*).

Our model goes beyond these five regularities by specifying mechanisms that cause these regularities. Hence our model delivers specific predictions which should be confronted with the empirical evidence. While a full-fledged empirical analysis is beyond the scope of this article, we present some evidence that is in line with our model predictions.

2.1. *Natural Resources, Institutional Quality and Human Capital*

According to our theory the institutional quality of a country affects how human capital changes with natural resources. For countries with bad institutions, there are two reasons to expect a negative relationship between human capital and natural resources:

- (i) The amount of natural resources and human capital is a decreasing function of natural resources when the incumbent is in power.
- (ii) The likelihood that the incumbent stays in power always increases in the amount of natural resources.

For countries with good institutions, there are better chances for the opposition to win the election, in which case human capital grows with natural resources. On the other hand, if the incumbent is re-elected, there is no effect of natural resources on

³⁵ Observe that in our model revolution never occurs in equilibrium against an incumbent. Nevertheless our model can guide us about the possibility of revolution: obviously adding some noise would lead to occasional violations of the no revolution constraint and it would result in a revolution. According to our model this is more likely to happen in countries with weak institutions.

human capital. So on average we should expect a positive effect of natural resources on human capital but this positive effect should be less pronounced than the negative effect with bad institutions.

To provide some preliminary evidence we use the simplest method possible to test this prediction, namely we split the sample into two groups: countries with bad institutions and countries with good institutions and then regress human capital on natural resources and other controls.³⁶ Our econometric model can be formulated as

$$H_i = \begin{cases} \alpha_0 r_i + \beta_0 Z_i + \varepsilon_i & \text{if } I_i \leq \xi \\ \alpha_1 r_i + \beta_1 Z_i + \varepsilon_i & \text{if } I_i > \xi \end{cases}, \quad (12)$$

where H_i is human capital in country i , r_i are natural resources in country i , Z_i are additional controls and I_i is a variable (ordered and categorical in our data) denoting the quality of institutions in country i . Our theory predicts that $\alpha_0 < 0$ and that $\alpha_1 > 0$.

2.1.1. Data

In our regression human capital will be measured by the average years of school in the total population age 25 and over (see Barro and Lee, 2001). The additional controls are the log of GDP (*lgdp*), the total fertility rate (births per woman) and the Gini coefficient as a measure of inequality.³⁷

We now turn to the more delicate data choice: the data for natural resources and the measure for institutional quality. The data typically used in growth regressions and which produces the natural resource curse is either some primary export variable (first used by Sachs and Warner (1995)) or Gylfason and Zoega's (2006) natural capital share.³⁸ However, these data typically include natural resources that are not owned by the state. Even the World Bank's 'Ores and Metals Exports' variable is not adequate for our purpose since it includes items such as crude fertilisers and scrap metal (de Soysa and Neumayer, 2007). The data from fuel exports and non-fuel mineral exports are also problematic since they count exported petroleum products that were exclusively made from imported oil (c.f. Ross, 2006). We therefore opt for a new measure of natural resource rents which is part of the World Bank's Dataset on genuine savings, also called adjusted net savings. In particular we use the log of total oil and gas rents. Following de Soysa and Neumayer (2007) we argue that rents from production are a

³⁶ An alternative approach used in an earlier version of this article (Cabralés and Hauk, 2007) is to regress human capital on natural resources and the cross product of natural resources and institutional quality. Our theory would predict a negative coefficient for natural resources by itself and a positive coefficient for the cross product. The disadvantage with this approach is that it suffers from an endogeneity problem since institutional quality enters the regression directly and might be endogenous to human capital. Lacking a good instrument for institutional quality we prefer to split the sample, which allows us to side-step the endogeneity problem.

³⁷ The data source for GDP and fertility are the World Development indicators while the Gini coefficient is taken from the UNDP Human development reports at: <http://hdrstats.undp.org/en/indicators/161.html>

³⁸ Gylfason and Zoega (2006) constructed this measure from World Bank Data. Natural capital is the sum of 'subsoil wealth', timber, non-timber benefits of forests, cropland, pasture land and the opportunity cost of protected areas. In turn, subsoil wealth is the present value of a constant stream of economic profits on 'resource rents' on various fuels and minerals; that is, gross profit on extraction less depreciation of capital and normal return on capital.

relatively more comprehensive measure of the relative economic importance of natural resources than exports for judging arguments about state capacity and the effect of the quality of political institutions. It is exactly the rents generated by the natural resources which might be stolen by politicians or weaken the political institutions.³⁹

As a proxy for the quality of political institutions we use those indices of the World Wide Governance indicators (WGI) that we believe capture our delta-function more closely. Each index ranges from -2.5 to $+2.5$ where positive numbers indicate a higher quality.⁴⁰ In particular we use *regulatory quality*, *government effectiveness*, *control of corruption* and the average of these 3 indices. *Regulatory quality*, which captures the perception of the ability of the government to implement sound policies, proxies our $\delta(\cdot)$ function because a country with good regulation is likely to be one with a good civil service: professional, unpoliticised and useful. In such a country, the political turnover is less costly, as the experience of the incumbent is less likely to matter and politicians can dedicate themselves simply to set priorities. That is a good approximation for a $\delta(\cdot)$ function with values close to 1, which implies a smaller advantage of the incumbent, come election time. *Government Effectiveness* measures bureaucratic quality and is an indicator of whether bureaucracies are autonomous and free from political pressure and have an established mechanism for recruitment and training. High government effectiveness translates into a high $\delta(\cdot)$ function since institutions work independently of who is in power. *Control of corruption* measures corruption within the political system. The index is low if people assume positions of power through patronage rather than ability.

2.1.2. Results

Letting

$$d_i(\xi) = \begin{cases} 0 & \text{if } I_i \leq \xi \\ 1 & \text{if } I_i > \xi \end{cases}$$

our empirical model can be written

$$H_i = \alpha_0 r_i + \beta_0 Z_i + (\alpha_1 - \alpha_0) d_i(\xi) r_i + (\beta_1 - \beta_0) d_i(\xi) Z_i + \varepsilon_i.$$

Following Hansen (2000) we first estimate the threshold value ξ by doing OLS regressions with fixed values for ξ and then we choose the value of ξ whose regression yields the minimum mean squared error.⁴¹ These regressions are for the year 2000.⁴² Then the estimates for $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the OLS estimates corresponding to the chosen $\hat{\xi}$.

³⁹ Several authors (Brunnschweiler and Bulte, 2008; Brunnschweiler, 2008) have argued that mineral reserves could be an exogenous measure of resource abundance. Using a measure of subsoil wealth developed by the World Bank these authors show that the natural resource curse disappears: natural resources always enhance growth. However, as Torvik (2009) points out these measures are not really exogenous and likely to be biased against the resource curse: countries with good institutions are likely to have explored and found more of their resources than countries with bad institutions, hence well-functioning countries will be measured as more resource abundant than countries with bad institutions.

⁴⁰ For an exact definition of what enters in each index see Appendix B.4 in Kaufmann *et al.* (2009). The data can be downloaded at <http://www.govindicators.org>

⁴¹ We first discretise in steps of size 0.1. Then, we check that the mean square error (MSE) is basically concave and finally we discretise more finely around the best values of the MSE until we find the best possible partition given our finite number of countries.

⁴² We have done several robustness checks for different years all leading to similar results.

Due to data availability we have 59 countries in our regression. Our classification of countries into countries with good institutions and bad institutions varies slightly depending on the index of institutional quality used.⁴³ Table 1 reports 4 different regressions for 4 different classification systems. t-values are given in parenthesis. * means significant at 10%, ** significant at 5% and *** significant at 1% .⁴⁴ Average is the average of control of corruption (*control corr*), government effectiveness (*G effective*) and regulatory quality (*reg quality*).

In all four regressions, resource rents are significantly negative when institutions are bad and positive when institutions are good, as predicted by our theory. The results for *average* and *control corr* coincide because the best sample split coincides for both variables.

Table 1
OLS Results

	log oilgasrent	log GDP	fertility	gini	constant
<i>control corr</i> < 0.6	-0.2567558*** (t:-2.75)	2.432888*** (t:3.19)	-0.7009585** (t:-2.55)	-0.0144494 (t:-0.50)	6.146173* (t:1.88)
<i>control corr</i> > 0.6	0.2686322*** (t:2.98)	-0.3345005 (t:-0.23)	2.332274*** (t:3.01)	-0.1182178** (t:-2.03)	5.321225 (t:0.87)
<i>G effective</i> < 0.6	-0.2295497** (t:-2.27)	1.846915** (t:2.16)	-0.744716*** (t:-2.6)	-0.0096643 (t:-0.30)	7.198659** (t:2.10)
<i>G effective</i> > 0.6	0.1751051* (t:1.87)	0.9811655 (t:1.02)	0.6156938 (t:0.97)	-0.0615654 (t:-1.25)	2.746324 (t:0.61)
<i>reg quality</i> < 0.7	-0.2556269*** (t:-2.66)	2.425444*** (t:3.1)	-0.7003917** (t:2.51)	-0.0140163 (t:-0.47)	6.124106* (t:1.84)
<i>reg quality</i> > 0.7	0.2795367*** (t:3.22)	-0.8152988 (t:-0.68)	2.398259*** (t:3.18)	-0.1344277*** (t:-2.63)	7.601011 (t:1.58)
<i>average</i> < 0.65	-0.2567558*** (t:-2.75)	2.432888*** (t:3.19)	-0.7009585** (t:-2.55)	-0.0144494 (t:-0.50)	6.146173* (t:1.88)
<i>average</i> > 0.65	0.2686322*** (t:2.98)	-0.3345005 (t:-0.23)	2.332274*** (t:3.01)	-0.1182178** (t:-2.03)	5.321225 (t:0.87)

Note. t-values shown in parenthesis

⁴³ The countries are grouped as follows. We will start with the division for average = 0.65 and then point out the changes.

39 countries in our sample are qualified as having bad institutions using average < 0.65, namely Algeria, Argentina, Bangladesh, Benin, Bolivia, Brazil, Bulgaria, Cameroon, China, Colombia, Congo, Dem. Rep. Congo, Croatia, Czech Republic, Ecuador, Egypt, Ghana, Guatemala, India, Indonesia, Iran, Jordan, Korea, Malaysia, Mexico, Pakistan, Papua New Guinea, Peru, Philippines, Poland, Romania, Slovak Republic, South Africa, Syria, Thailand, Trinidad and Tobago, Tunisia, Turkey, Venezuela.

20 countries are classified as having good institutions (average > 0.65), namely: Australia, Austria, Canada, Chile, Denmark, Finland, France, Greece, Hungary, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Slovenia, Spain, United Kingdom, United States.

For *control corruption* < 0.6 the classification (and hence the result) does not change.

For *government effectiveness* < 0.6 no country moves to the group with bad institutions but the Czech Republic, Korea, Malaysia, Poland and South Africa move to the group with good institutions.

When looking at *regulatory quality* < 0.65 Slovenia move to the group with bad institutions but the Czech Republic moves to the group with good institutions.

⁴⁴ As Hansen (2000) notes, the standard error for $\hat{\alpha}_i$ and $\hat{\beta}_i$ in the OLS with the estimated $\hat{\xi}$ are asymptotically valid but may underrepresent true sampling variance in small samples. He suggests using as confidence intervals the union of the confidence intervals for all the values of ξ within its own 95% confidence interval. Given that the coefficient for our natural resources variable (log oilgasrent) is significant even for values of ξ rather far away from our chosen estimate, the results under that alternative procedure would still yield a significant coefficient.

Post regression estimates strongly reject the hypotheses

- (i) that the resource rents parameters in the different groups are jointly zero and
- (ii) that they are equal to each other at significance levels always less than 2%.

This means that natural resources matter and that their effect differs depending whether institutions are good or bad. Our regressions suggest that in countries with good institutions natural resources enhance education. In countries with bad institutions natural resources are detrimental to education.

Our model predicts that when the government is very likely to win the election, natural resources are bad for human capital accumulation. This situation happens for bad democratic institutions or in non-democratic regimes. Andersen and Silje (2008) provide additional indirect evidence for this prediction. Revisiting the seminal growth analysis of Sachs and Warner (1995, 1997), they find that the resource curse is explained by the poor performance of resource abundant presidential and non-democratic regimes – there is no resource curse in democracies with a parliamentary form of government.

2.2. *Natural Resources Harm Political Turnover*

It is widely thought that resource wealth, especially oil, is a curse for democracy (Ross, 2001; Jensen and Wantchekon, 2004; Tsui, 2009). These studies report a negative statistical relationship between different measures of resource abundance and democracy. Tsui (2009) exploits variation in the timing and size of oil discoveries to identify the impact of oil wealth on democracy and finds that discovering oil significantly decreases a country's 30-year change in democracy, as measured by the Polity Index and the negative impact of oil discovery is bigger the less democratic the country was before it found oil. Aslaksen (2009) shows that levels of oil systematically predict both levels and changes in democracy in a sample of up to 156 countries between 1972 and 2002. Ross (2001) finds that the negative impact of oil on democracy is stronger in oil-poor countries than in oil-rich countries prior to the new discovery. These studies can be seen as indirect evidence for our model. Our model predicts that oil harms democracy by making political turnover less likely, especially in countries with bad institutions. Moreover, the incumbent's probability to win the elections increases more sharply for initial resource discoveries. Hence, a serious test of our model would require to study re-election probabilities with respect to natural resources and institutional qualities. We leave a careful study of this implication for future research. However, we report two empirical and two case studies and that are in line with our model prediction.

On the empirical side Omgba (2009) and Crespo Cuaresma *et al.* (2010) use a survival model to study the link between oil and duration in office. Both studies find a robust positive relationship between these variables. Omgba (2009) looks at different political regimes but concentrates on 26 North and Sub-Saharan African oil-producing countries in the period 1958–2000 and analyses 101 occupancies of power and their link to oil rents. Crespo Cuaresma *et al.* (2010) study the link between oil and the duration of dictatorship with a dataset on 106 dictators. Their empirical findings indicate that dictators in countries which are relatively better endowed in terms of oil stay longer in office: in particular, a higher level of oil production increases the

log-time to failure for the considered dictators. These empirical findings are clearly consistent with our theory. So are the following case studies.

The first case study, by Esanov *et al.* (2004), examines the transition experience of former communist countries. The article analyses the progress made in the energy-rich states of the Commonwealth of Independent States (CIS), Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan (AKTU for short) in which the president has direct control over key natural resources and contrasts their development to that in the resource-poor countries at the CIS periphery. It is shown that progress in key reforms has lagged behind in the energy-rich states. This might be linked to political turnover during the early transition period. The authors point out that Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan all have heads of state who were high communist officials during Soviet times. In the latter three countries these heads of state already stood at the helm of their country at the time of independence. In contrast, the western CIS (and eastern Europe) were by and large characterised by a much higher degree of government turnover during the initial years of transition.

A second case study looks at Sub-Saharan Africa. Lam and Wantchekon (2002) argue that resource abundance can potentially explain Bratton's (1998) findings about the second period elections in 16 Sub-Saharan African Countries in 1995–7 following the founding elections (first competitive multiparty elections) that took place in the period from 1989 to 1994. Consistently with our theory that natural resources make the incumbent more entrenched by increasing his win probabilities, Bratton (1998) observes a decline in the rate of leadership alternation (37% to 6.6%) and an increase in the mean of winner's vote share (61.4% to 69.1% for presidential elections and 62.7% to 72.0% in parliamentary elections).

2.3. *The Revolutionary Threat Vanishes with Good Institutions*

Our model predicts that revolutions or civil war linked to natural resources are more likely to occur in countries with bad institutions. The empirical literature of the link between civil war and natural resources is huge and controversial. While it is beyond doubt that there is a statistical relationship between civil war and natural resources, the causal direction is under dispute and the empirical literature has also failed to establish the causal mechanism that links mineral wealth to war. There are many competing theories: mineral wealth could foster conflict by funding rebel groups (Collier and Hoeffler, 2004), by weakening state institutions (Fearon and Laitin, 2003; Snyder and Bhavnani, 2005) and by making the state a more attractive target for rebels (Fearon and Laitin, 2003), to name just a few; see Ross (2006) for more details. Our model adds yet another theory: the possibility of political protest acts as a constraint on the greed of politicians but this constraint will only be relevant if institutions do not already fulfil this role. While we are not aware of any empirical study testing this theory, a simple look at countries that have suffered wars related to natural resources reveals that these countries typically score badly in institutional quality. Political (in)stability, which measures the threat of political unrest and the potential use of violence is often even seen as part of the definition of institutional quality: for instance, it is one of the World Wide Government Indicators suggested by Kaufmann *et al.* (2009).

3. Conclusion

In this article we have presented a formal political-economy analysis of the impact of natural resources on human capital accumulation. In our model, citizens exert control over politicians via an election and can always initiate a revolution if they are dissatisfied with the proposed policies. Since it is a well-documented fact that natural resources have led to civil unrest, it is important to incorporate this possibility into the model.⁴⁵ To our knowledge this is the first article to allow simultaneously for political competition, elections and revolution.⁴⁶ We propose to model the possibility of revolution by introducing a new constraint into the model, which we denote the *no-revolution constraint*. Under this constraint politicians select their policies so that there are no sufficiently large sectors of the population who want to block those policies by starting a revolution. In the context of natural resources, this constraint can be taken literally. However, we would like to emphasise that this constraint might be introduced in many other models: the economic literature is full of policy recommendations which no sane politician has dared to implement even if a majority of the population would benefit from them. This sounds contrary to both economic and political theory but we argue that there are good practical reasons for the outcome that the models overlook.

These policy recommendations arise in models where the policy resulting from the voting mechanism (e.g., the policy preferred by the median voter) would harm a sizable proportion of the population. Such policies are not implemented because the sector that would be harmed has pressure instruments on top of their votes to block them and these pressure instruments can be modelled by the no-revolution constraint.⁴⁷ Hence, the importance of our proposed modelling innovation lies far beyond the topic studied.

In terms of the topic we study, our contribution is to incorporate the five empirical facts on natural resources presented in the introduction simultaneously. We do so by linking natural resources to education which is an established engine for growth. These empirical facts were stated in terms of growth, so we give some evidence that they also hold if we use education. In particular, we test our model prediction that the quality of

⁴⁵ There is a growing theoretical literature relating power struggles to natural resources, however in this literature people either have no democratic control over rulers (e.g. Olsson (2007) who sets up a predator-prey model in which rebels choose between peaceful production and predation on natural resources controlled by the ruler; or Wick (2008) using a Stackelberg model with limited endowments), or it is the political elite which is initiating the revolution (Aslaksen and Torvik, 2006; Caselli, 2006).

⁴⁶ Introducing revolution in political economy models is not an innovation *per se*. Acemoglu and Robinson (2001) explain the 'extension of the franchise' in precisely this way. But notice that in their work, revolution is a threat from citizens 'excluded' from the vote, who thus have no alternative. In our work, 'revolution' is an added tool for all citizens, not an alternative when there is not a chance to vote. Acemoglu and Robinson (2006) do include the possibility of revolting in democracy. However, this possibility does not operate as a constraint for the government. It is simply a binary choice for the poor (already the median voter and thus the tax setters in the democracy). The article closest to ours is Ellman and Wantchekon (2000) who study electoral competition under the threat of political unrest. As in our model the decision whether to respond with riots (disruptive interference) is made after elections have taken place and the possibility of riots affects the platform choice of parties.

⁴⁷ One example of such a policy recommendation is the abolition of capital taxes. Lucas (1990) has shown that the optimal capital tax is zero. It has also been shown that the representative consumer would vote for a capital tax of zero. Even in a model with heterogeneous agents (Garcia-Milà *et al.*, 2010) the median voter is likely to vote in favour of abolishing capital taxes. This, however, can harm as much as a third of the population. This part of the population would probably go to great lengths in order to avoid the zero capital tax.

institutions is decisive whether natural resources are a blessing or a curse in terms of human capital accumulation in cross-country regressions.

Some authors have suggested that the size of a country matters for the effect of natural resources. This is captured in our model, where country size is measured by n . Increasing n has the same effect as decreasing natural resources W .

In our model, the income of the government stems only from natural resources. In a more complete model the government could also receive income by taxing productive activity. This is one of the extensions we would like to study in the future. The existence of productive activity has an effect on the incentives of politicians to encourage human capital accumulation: better education should enhance productive activity, which in turn enables the government to extract more taxes. But better education also strengthens the opposition and the ability of citizens to engage in a successful revolution. We expect that the incumbent government will prefer not to enhance education, since education weakens its political position and it is easier for them to increase their income from natural resources than by taxing productive activity. Natural resources are easily appropriated by corrupt politicians.

Some ‘unnatural’ resources, like foreign aid, are also easy to appropriate. Is there a link between natural resources and foreign aid? Can our model make predictions about the effects foreign aid might have on education or growth? The answer is yes. Once foreign aid is granted, it is very difficult for international institutions to avoid that politicians steal it. Empirical evidence suggests that only a small percentage of the aid actually reaches its desired objective. In Uganda only 13% of foreign aid granted for education in 1991–1995 actually reached primary schools (Reinikka and Svensson, 2004). The evidence for other African countries is similar. As with natural resources the quality of institutions is crucial in limiting stealing from foreign aid. But similarly to natural resources, foreign aid tends to be detrimental to democracy: studying 108 recipient countries of foreign aid in the period 1960 to 1999 Djankov *et al.* (2005) find a negative effect of foreign aid on democracy which is much bigger than the negative effect of natural resources. Like natural resources foreign aid can be the cause of civil war and revolution.⁴⁸

Given these empirical similarities between the effects of natural resources and foreign aid, we can use our model to make predictions about when foreign aid is a blessing and when it is a curse. In countries with good institutions, foreign aid will enhance growth, while the opposite will happen in countries with bad institutions. Typically it is the latter group of countries that receives foreign aid. Our model recommends that only poor countries that have good institutions should be granted foreign aid.

Additional Supporting Information may be found in the online version of this article:

A. Proofs.

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⁴⁸ Maren (1997) provides evidence that the cause of the civil war in Somalia was the control over foreign aid.

Appendix

B: *The Effect of Past Human Capital*

In this Appendix we use a Mincerian framework to derive our functional form for how past human capital enters a worker's productivity level. To simplify notation we abstract from average level of human capital. We assume that the human capital H of a worker can be expressed as:

$$H = \exp(\text{Years of education})^\alpha$$

$$\ln H = \alpha(\text{Years of education}).$$

This functional form is justified because $\log \text{wage}$ (which is the measure of human capital) is found empirically to be a linear function of the years of education; see e.g. Heckman *et al.* (2008) following a tradition since, at least, Mincer (1974). With this in mind, we write the programme of the voter as:

$$\max_E U[w + k \exp(E + E_P)^\alpha - (\lambda - \pi) \exp(E)].$$

To see that we can actually write this as our problem with the e written in multiplicative form, we first digress to show that the optimal value in $\exp(E)$ is equivalent to the one of $e = \exp(E)$. Let $\max_E F[\exp(E)]$, the FOC is $F'[\exp(E)] \exp(E) = 0$. Let $\exp(e) = E \max_e F(e)$. The FOC is $F'(e) = 0$. So the difference is that with the problem defined with respect to E we have $F'(e)e = 0$. Thus the only thing we miss is an equilibrium in $e = 0$, which would not be stable anyway.

Now $\max_E U[w + k \exp(E + E_P)^\alpha - (\lambda - \pi) \exp(E)]$ can then be written by the previous argument as

$$\max_e U[w + ke^\alpha e_P^\alpha - (\lambda - \pi)e]$$

$$\max_e U[w + \kappa e^\alpha - (\lambda - \pi)e].$$

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