Diamonds Are a Dictator's Best Friend: Natural Resources and the Tradeoff between Development and Authoritarianism

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Abstract

We link together economic development, democratisation and natural resources to answer three questions: what is the theoretical link between democracy and economic development? Why might enfranchised minorities refrain from maximal repression of their subjects' capacity to overthrow them? And do natural resources have a negative effect on economic development and democracy, and if so then why? Our answers revolve around a country's capacity to coordinate and its repression by an authoritarian regime. We predict a negative effect of natural resources on the probability of democratisation and on economic development in authoritarian regimes, but not on economic development in a democracy. We find reasonable empirical support.

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Introduction

This paper seeks to link together three variables to answer three questions. The variables are the level of economic development, the political system (i.e., democracy vs. authoritarian regime), and natural resources.

The background to the first question is the extensive literature on the empirical relationship between economic development and democracy. The fulcrum is the observation, spotted as early as Lipset (1959) and reinvigorated by Przeworski *et al* (2000) and Boix and Stokes (2003), that there is a strong positive correlation between the probability of a country being a democracy and the level of *per capita* income. Surprisingly, the literature has offered very little by way of complementary theory *in response* to the plethora of empirical findings. One goal of this paper is to offer the beginnings of an answer to the question: what is the theoretical link between democracy and economic development?

The second question is a response to a perceived omission from the sociology and political science literatures on political transition. Most modern democracies were at some point authoritarian regimes characterised by a minority elite being in control. The eventual transition occurred because the relative power of the unenfranchised increases. Yet if the elite were previously in control, then why did they not pre-emptively strike down the power accumulation by the unenfranchised? Are the pre-emptive strikes always as powerful as they can be, or are there reasons why an enfranchised minority would voluntarily refrain from pre-emptively repressing power accumulation by their subjects?

The third question is drawn from the literature on natural resources. While, at first sight,

natural resources seem to be blessings for the countries that have them, casual observation of regions such as the Middle East suggest that they may be more like a poisoned chalice. Do natural resources have a negative effect on economic development and democracy, and if so then why?

The flavour of our argument is as follows: coordination capital, loosely definable as a society's capacity to coordinate, is a link between democratisation and development. Authoritarian regimes realise this, and this implies a tradeoff between repressing and fostering coordination capital: the more they encourage it, the better the economic performance of their subjects, and hence the tax revenue of the regime, but the greater the pressure on the regime to democratise. However authoritarian regimes also realise that income from natural resources is comparatively insensitive to coordination capital and the economic performance of the population at large, but dependent on their being in power. Consequently, authoritarian regimes with more natural resources find it optimal to be more repressive of coordination capital, damaging economic performance and decreasing the probability of transition to democracy.

We test these predictions and find reasonable support.

This paper is organised as follows. Section I is the paper's main model. Section II is a general ancillary model. Section III ties the two models together by presenting special cases of the ancillary model. Section IV is the empirics and we conclude in section V.

I – Basic Model

In this section, we will present a simple model that predicts:

- A negative effect of natural resources on the probability of democratisation
- A negative effect of natural resources on economic performance in authoritarian regimes
- No effect of natural resources on economic performance in democracies

The Model

A. Primitives

There is a dictator with the following utility function:

$$U_D = \sum_{t=0}^{\infty} p_t T_t$$

p_t is the probability of being in power in period t. Once the dictator loses power, he or she never regains it. Let π_t denote the probability of being in power in period $t+1$ given that the dictator is in power[2] up to period t.

T_t is net tax revenue in period t. It can be divided into two components: $T_t = T_{t,NR} + T_{t,R}$. The first is tax revenue from natural resources, and the second is the remainder.

Let $y_t = y_{t,NR} + y_{t,R}$ denote national output *per capita* (assume there is a unique consumption good), which is the sum of output *per capita* from natural resources and the remainder. Henceforth, we refer to these as natural resource income and regular

2 For the purposes of this paper, we dismiss the possibility that a dictator is succeeded by another dicatator. We assume that authoritarian regimes are replaced by democratic ones.

income, respectively.

Assumption I.1a: $T_{t,NR}=\tau y_{t,NR}$

Assumption I.1b: $T_{t,R}=\tau y_{t,R}$

Thus, we assume that taxes are just an exogenous, constant, linear function of the respective output *per capita*.

The dictator choice variables are repression[3] in every period, $\{r_t\}_{t=0}^{\infty}$. Repression[4] affects contemporaneous values of (π_t, y_t) , which are otherwise time invariant functions:

$$\pi_t=\pi(r_t), \quad y_t=y(r_t)$$

Assumption I.2: π_t is increasing in r_t

Thus, repression increases the probability of remaining in power.

Assumption I.3a: $y_{t,NR}$ does not vary with r_t

Assumption I.3b: $y_{t,R}$ is decreasing in r_t

Thus, repression decreases output *per capita* (and hence taxes), but only via its effect on regular income.

Assumption I.4: $y_{t,NR}=y_{NR}\ \forall\ t$

Thus, natural resource income is constant over time.

3 Do not interpret 'repression' as torture, imprisonment, heavy-handed policing etc. Rather, think of it as some sort of retarding variable.

4 We assume that repression is bounded from below by zero.

B. The Dictator's Problem

We can rewrite the dictator's problem in value function form:

$$v(y_{NR}) = \max_{r} \left\{ \tau y_{NR} + \tau y_R(r) + \pi(r) v(y_{NR}) \right\}$$

This exposes the dictator's tradeoff: increasing repression yields a higher probability of remaining in power, but it decreases tax revenue when in power. Solving it yields the following first- and second-order conditions[5]:

$$\text{F.O.C.:} \quad \tau y_R' + \pi' v = 0$$

$$\text{S.O.C.:} \quad \tau y_R'' + \pi'' v < 0$$

C. Comparative Statics

Let $\bar{r}$ denote the unique solution to the dictator's problem. Let $\bar{\pi} = \pi(\bar{r})$ and $\bar{y}_R = y_R(\bar{r})$.

Proposition I.1: $\frac{\partial \bar{r}}{\partial y_{NR}} > 0$

Proof: if we differentiate through the F.O.C. with respect to y_{NR} and rearrange, we have:

$$\frac{\partial \bar{r}}{\partial y_{NR}} = -\frac{v'\pi'}{\tau y_R'' + \pi'' v} > 0 \quad \textit{Q.E.D.}$$

Thus, increasing natural resource income leads to an increase in optimal repression.

Let $\bar{\rho} = 1 - \bar{\pi}$, i.e., it is the probability of democratisation. We can now state the two main results of this paper.

5 We detail in the appendix all the technical assumptions that we are making, e.g., differentiability etc.

Proposition I.2a: $\frac{\partial \bar{\rho}}{\partial y_{NR}} < 0$

Proposition I.2b: $\frac{\partial \bar{y}_R}{\partial y_{NR}} < 0$

Proof: Both these follow immediately from *proposition I.1*. *Q.E.D.*

Increasing natural resource income has two effects: firstly, it leads to a lower probability of democratisation, and secondly, it leads to lower regular output *per capita*. Both follow from the positive effect of natural resources on optimal repression.

D. Intuition

The intuition is very straightforward. When the dictator's income from natural resources increases, the value of staying in power at the margin increases as that part of income is not affected by repression. Natural resources mean that the dictator need not rely so heavily on the economic activity of his or her subjects for his or her own welfare, and so the cost of repressing their capacity to organise insurgency is smaller. Therefore, it is optimal to increase repression in response, and consequently, the probability of democratisation and regular income decrease.

E. Democracies and Repression

We will discuss later exactly what we mean by a democracy and how we believe democracies make policy decisions. For now, we make the following assumption.

Assumption I.4: Democracies always pick $\bar{r} = 0$

Corollary I.1: In a democracy, $\frac{\partial \bar{y}_R}{\partial y_{NR}} = 0$

Combining this with *proposition I.2b*, we have that increasing natural resources has a larger negative impact on regular tax revenue that in authoritarian regimes than in democracies (the latter being zero).

Summary

Suppose that there is some factor – call it factor X – that:

1. Increases regular income, y_R
2. Increases the probability of democratisation, ρ
3. Does not affect income from natural resources, y_{NR}
4. Can be influenced by the government (via repression, if you will)

Then the model above tells us that ρ and y_R are both decreasing in y_{NR} in authoritarian regimes, while y_R does not vary with y_{NR} in democracies. The purpose of the next two sections is to suggest such a factor X that satisfies these conditions.

II – A Model of Coordination

We here formalise a simple model of coordination. The concept of coordination has several interpretations in game theory. We focus on coordination as the pooling of any private information that the players of a game might have, allowing all the players to condition their actions on *all* the information available to at least one player. We gauge a group of players' capacity to coordinate in a game by the cost that must be borne by them to pool the private information.

This model will be the bedrock of our construction of a factor X that will satisfy the conditions laid out in the summary to section I.

1. Primitives

A. Setup

Set of players: N

Set of actions: A_i for each player $i \in N$. Let $A = \underset{i \in N}{\times} A_i$.

Uncertainty: each player $i \in N$ receives two-shocks: $\epsilon_i \in E_i \subseteq \mathbb{R}^{L_E}$ and $\theta_i \in \Theta_i \subseteq \mathbb{R}^{L_\Theta}$. Let $E = \underset{i \in N}{\times} E_i$ and let ϵ be an element of this set; let $\Theta = \underset{i \in N}{\times} \Theta_i$ and let θ be an element of this set. ϵ_i is observed privately, while θ_i is unobserved.

Beliefs: each player $i \in N$ has beliefs $\mu^i_{X|Y}(x|y)$ where X and Y are random variables, x and y are realisations, respectively, or those random variables.

Preferences: each player $i \in N$ has a von Neumann-Morgenstern utility function $u_i : A \times \Theta \times E_i \to \mathbb{R}$.

Repetition: We can treat this as a stage game of a repeated game.

B. Strategies

Definition II.1: An *uncoordinated strategy* for player $i \in N$ is a function $s_i : E_i \to A_i$, i.e., it is a rule specifying which action to take conditional on private information.

Let S_i be the set of uncoordinated strategies for player $i \in N$ and let $S = \underset{i \in N}{\times} S_i$.

Definition II.2: A *coordinated strategy* for player $i \in N$ is a function $\sigma_i : E \to A_i$, i.e., it is a rule specifying which action to take conditional on the pooled private information of all the agents.

Let Σ_i be the set of coordinated strategies for player $i \in N$ and let $\Sigma = \underset{i \in N}{\times} \Sigma_i$.

C. Preference Ordering

Under uncoordinated strategies, a player $i \in N$ evaluates outcomes according to:

$$U_i(s) = \int_{z \in E_i} \int_{y \in E_{-i}} \int_{x \in \Theta_{-i}} u_i(s_i(z), s_{-i}(y), z, x) \mu^i_{\Theta_i, E_{-i} | E_i}(x, y | z) \, dx \, dy \, \mu^i_{E_i}(z) \, dz$$

Under coordinated strategies, a player $i \in N$ evaluates outcomes according to:

$$V_i(\sigma) = \int_{y \in E} \int_{x \in \Theta_{-i}} u_i(\sigma_i(y), \sigma_{-i}(y), y_i, x) \mu^i_{\Theta_i | E}(x | y) \, dx \, \mu^i_E(y) \, dy_i \, dy_{-i}$$

2. Analysis

A. Equilibrium

Definition II.3a: Let Q_s be the set of Nash equilibria with uncoordinated strategies (which we will refer to as uncoordinated Nash equilibria).

Definition II.3b: Let Q_σ be the set of Nash equilibria with coordinated strategies (which we will refer to as coordinated Nash equilibria).

Definition II.4a, II.4b: Let $Q_s^E \subseteq Q_s$ be the set of uncoordinated Nash equilibria that are efficient *with respect to the set of uncoordinated Nash equilibria*. Similarly define Q_σ^E for coordinated equilibria.

Assumption II.1: In the case of multiple Nash equilibria, the equilibrium that will prevail will be Pareto efficient (within the class of equilibria).

Thus, we are using Pareto dominance within the class of equilibria as a solution criterion.

Assumption II.2: For every element of Q_s^E, there exists an element of Q_σ^E that Pareto dominates it.

Thus, allowing agents to condition on all privately observable shocks rather than their own one only allows an equilibrium in which everyone is better-off. Information dissemination helps.

Assumption II.3: Q_s^E and Q_σ^E are both singletons. Denote their respective elements by $\bar{s}^E$ and $\bar{\sigma}^E$.

This assumption is not necessary, but it simplifies the exposition. It means that there is a unique efficient Nash equilibrium that will be the outcome of the game under uncoordinated strategies, there will be a unique efficient Nash equilibrium that will be the outcome of the game under coordinated strategies, and the coordinated equilibrium Pareto dominates the uncoordinated one.

Remark: $U_i(\bar{s}^E) \leq V_i(\bar{\sigma}^E) \ \forall \ i \in N$

Players prefer being able to play the game under coordinated strategies rather than uncoordinated ones.

B. Coordinating

Definition II.5: A coordinating device is a mechanism which makes ϵ public information (common verifiable), and hence allows for coordinated strategies.

Remark: Were a coordinating device costless, it would always be desirable.

Assumption II.4: It costs each agent $i \in N$ an amount c_i to create the coordinating device, and all agents must pay for the coordinating device to work.

The assumption that everyone must pay is merely for simplicity of exposition and is not essential to the logic of the model.

Assumption II.5: c_i is a random variable but it's realisation is known and is common knowledge before any decision about the coordination device is made. It is distributed independently of (E, Θ) .

C. When Will Players Coordinate?

Lemma II.1: *Ex post*, the players will create the coordination device if and only if:

$$U_i(\bar{s}^E) \leq V_i(\bar{\sigma}^E) - c_i \ \forall \ i \in N$$

Lemma II.2: *Ex ante*, the players will create the coordination device with probability:

$$Pr\left[U_i(\bar{s}^E) \leq V_i(\bar{\sigma}^E) - c_i \ \forall \ i \in N\right]$$

Corollary II.1: If the game and Nash equilibria are symmetric, and if $c_i = c \ \forall \ i \in N$, then the *ex ante* probability of creating the coordination device is:

$$F_c\left(V(\bar{\sigma}^E) - U(\bar{s}^E)\right)$$

Summary

This model is no more than a way of articulating how uncertainty can be a barrier to economic performance (in the form of higher payoffs). Coordination is defined as the potentially costly resolution of the uncertainty.

III – Constructing Factor *X*

This section has six subsections. They deal in sequence with the four conditions that factor *X* must satisfy as laid out in the summary of section I. The last section is a discussion of democracy.

1. Coordination and Economic Performance

A. Overview

There exist many models from the growth literature that can be adapted into the framework laid out in section II. One such model is Greenwood and Jovanovic (1990), which builds on Townsend (1978). The authors view coordination via a financial intermediary as useful because it allows for the allocation of resources to their most profitable use. We will set aside the risk-sharing benefits and focus on the advantages of information dissemination.

B. Model

Actions: Each player $i \in N$, $A_i = [0,1]$.

Uncertainty: θ_i is distributed independently and identically across agents. $\forall\, i \in N$, $Var(\theta_i|\epsilon_i) > 0$ but $Var(\theta_i|\epsilon) = 0$.

Beliefs: Rational expectations

Payoffs: $u_i = E\left[\log((1-a_i)\delta + a_i\theta_i)\right]$

Coordination device: there is a homogeneous cost c faced by everyone.

Players have one unit of capital which they can invest in either a safe asset or a risky

one. They are risk averse. Conditional on either coordinated or uncoordinated strategies, behaviour is non-strategic and equilibrium corresponds to unilateral optimisation by each player.

Coordination allows the players to expose the value of θ prior to their investment decision, and so they can guarantee themselves a return of $max\{\delta, \theta_i\}$. Therefore the coordinated Nash equilibrium Pareto dominates the uncoordinated one.

C. Interpretation

Greenwood and Jovanovic interpret coordinated strategies as arising from a sophisticated financial sector, which in turn is the result of networks being established by the players. They argue that the networks have three advantages: firstly, the dissemination of useful information about the uncertain return. Secondly, the diversification of idiosyncratic risk. Thirdly, the facilitation of smoothing over time via borrowing and lending. We have not modelled the latter two, but extending what we already have is straightforward.

2. Coordination and Democratisation

A. Overview

Ginkel and Smith (1999) present a game-theoretic model of revolution. Their main motivation is analysing the effect of repression and offering concessions on the probability of revolution, but their model touches upon the issues of coordination that interest us. What we present looks very little like their model, but it is inspired by it and follows from their verbal rather than mathematical discussion of the role of coordination.

B. Model

Actions: For each player $i \in N$, A_i = {Revolt (*R*), Do not revolt (*D*)}

Uncertainty: $\theta_i = t \in [0,1] \ \forall \ i \in N$, ϵ_i is correlated with t , $t|\epsilon$ is degenerate and $Var(t|\epsilon_i) > 0 \ \forall \ i \in N$

Beliefs: Rational expectations

Payoffs: $u_i(a,t) = \begin{cases} \delta_s(1-t) + \delta_f t & a = (R, \ldots, R) \\ 0 & o/w \end{cases}$ where $\delta_s > 0 > \delta_f$

Let $\underline{t}$ solve $\delta_s(1-t) + \delta_f t = 0$. Assume that

- $Pr\left[E[t|\epsilon_i] \leq \underline{t}\right] = 0 \ \forall \ i \in N$ [#]
- $Pr[t \leq \underline{t}] > 0$ [*]

Coordination device: there is a homogeneous *ex ante* random cost c faced by everyone.

The uncoordinated equilibrium is for all players to not revolt. The coordinated equilibrium is for all players to revolt if and only if $t \leq \underline{t}$. Clearly, the latter dominates the former.

Now to flesh out what is happening in the model. There is an authoritarian government. The players are the people, or the 'mob'. t measures the strength of the government, which is the probability that it will survive an attempted revolution. Should a revolution be successful, the mob get $\delta_s > 0$, and should it fail, they get $\delta_f < 0$, as compared to a reservation utility of zero earned by choosing not to revolt. $\underline{t}$ is the largest probability of victory by the government subject to the mob still wanting to revolt.

If agents do not coordinate, they don't know t when they choose whether or not to revolt. Moreover their private signal is not accurate enough for any individual agent to conclude that $t \leq \underline{t}$ no matter the value of signal (this follows from condition [#]). For example, if their own private information is useless (on its own), then $E[t|\epsilon_i] = E[t]$ and so $E[t] > \underline{t}$ is a sufficient condition. Therefore in the absence of coordination, revolutions never occur.

If agents coordinate their information, they can deduce the precise value of t and so they will initiate a revolution if and only if $t \leq \underline{t}$. By condition [*], this has positive probability. Thus the coordinated equilibrium dominates the uncoordinated one.

C. Interpretation

Coordination allows the mob to pin down when the government is vulnerable to revolution. Without coordination, the government is, on average, too strong for it to be worthwhile revolting.

For the mob to successfully mobilise against the government, it must look to:

> dissidents for information and leadership about the timing of protest participation... Given the limited amount of free press and other forms of information, the general public has little idea about whether the government can survive a major rebellion (1999: 293).

The authors go on to say:

> Why do repressive regimes last as long as they do in the face of massive public discontent? The simple answer to this question is information uncertainty... Little new information is ever generated unless actors take direct action... Yet there are great risks and costs in finding out this information... When this information suggests that revolutionary success is likely, weak governments facing open rebellion are liable to sudden collapse. With the informational uncertainties conquered, revolutionary participation

cascades, and the mob rapidly overthrows the government (1999: 303-4).

In their model, Ginkel and Smith take this coordination capacity as given. However with the simple adjustment applied by the framework that we have presented, the conclusion that coordination eventually leads to a successful revolution stands.

3. Reduced-Form Outputs of the Models

A. Games Being Played

Let $\{\Gamma_0, \Gamma_1, \ldots, \Gamma_G\}$ be a collection of stage-games played by the same group of players N, all of which take the coordination structure described in section II. Let $\{\Gamma_0^\infty, \Gamma_1^\infty, \ldots, \Gamma_G^\infty\}$ be infinitely-repeated versions of the same games. Let Γ_0^∞ be a game from section III.2, i.e., where the goal is the toppling of an authoritarian regime and its replacement by a democracy, and let $\{\Gamma_1^\infty, \Gamma_2^\infty, \ldots, \Gamma_G^\infty\}$ all be games that come from section III.1, i.e., where coordination aids apolitical economic performance.

B. Coordination

Let K be a variable that jointly determines the cost of coordination. We will refer to it as coordination capital.

Assumption III.1: $\forall\, i \in N, g \in \{1,2,\ldots,G\}$, $c_i^g = c_i^g(K)$

In each game $g \in \{0,1,\ldots,G\}$, c_i^g is the cost to player $i \in N$ of coordinating, which may be a random variable *ex ante*. Assumption III.1 is central. It amounts to claiming that there are inescapable economies of scope in coordination: at a sufficiently primitive level, it is impossible to affect coordination adversely in one game without adversely affecting coordination in other games. More on this later.

Assumption III.2: $K_1 > K_0 \Rightarrow \forall\ g \in \{0,1,\ldots,G\}, i \in N$ the distribution of c_i^g under K_0 first-order stochastically dominates the distribution of c_i^g under K_1 .

This, increasing K decreases the cost of coordination in all games for all agents.

Lemma III.1: Increasing K leads to higher equilibrium payoffs for all agents in all games.

Suppose that all payoffs are in terms of a unique consumption good. This allows us to draw a direct parallel between the equilibrium payoff of a player in a game and output *per capita* in section I.

Assumption III.3: All games are symmetric with symmetric Nash equilibria

This is purely for the simplicity of the exposition.

Definition III.1: $W = V(\bar{\sigma}^E) F_c\left(V(\bar{\sigma}^E) - U(\bar{s}^E)\right) + U(\bar{s}^E)\left[1 - F_c\left(V(\bar{\sigma}^E) - U(\bar{s}^E)\right)\right]$

(where we have suppressed dependence on game g)

Thus, W_g is the *ex ante* expected payoff of each player in game g in units of the unique consumption good.

Remark: Let $y = \sum_{g=1}^{G} W_g$

C. Transition

For an incumbent authoritarian regime, game Γ_0^∞ is a threat to its integrity. Every period, there is a possibility that the regime may fall and be replaced by a democracy. Let $1 - \pi_t$ be the probability that the regime falls in period t .

Lemma III.2: $\pi_t = \pi_t(K_t)$; π_t is decreasing.

Thus, the lower the cost of coordination, the less likely a regime is to survive to the next period.

Summary

K affects two variables:

1. It has a positive effect on income *per capita* y, and hence the total tax revenue of the government
2. It has a negative effect on π, the probability of survival of the authoritarian government.

E. Why the Economies of Scope?

The analysis rests on the assumption that there are inescapable economies of scope in coordination. Must this be the case? Is it not possible for an authoritarian regime to promote coordination devices only in the sphere of apolitical economic performance and to fully repress them in insurgent sphere?

History tells us otherwise. In his review of the literature on revolutions, Goldstone (2001) concludes that apolitical organisations are often the principal medium for effecting the coordination necessary for revolutions:

> Traditional mobilisation occurs within the context of local communities to which individuals have long-standing commitments, such as peasant villages or urban craft guilds... Traditional mobilisation may also take place in cities through traditional workers' guilds, or through religious communities.
>
> Informal mobilisations occurs when individuals' decisions to engage in protest actions are made... through loosely connected networks based on personal friendship, shared workplace, or neighbourhood...

Traditional and informal organisation are not inherently revolutionary in themselves...

One key finding is that revolutionary actors do not act, or even think of themselves as acting, alone. They are recruited through preexisting networks of residence, occupation, community, and friendship (2001: 151-3).

These preexisting, apolitical organisations and networks can be interpreted as formal and informal coordination devices whose initial intended goal is economic performance outside the political arena. However, as we argue elsewhere (Al-Ubaydli, 2005), economies of scope in coordination are intrinsic to such devices. If a group of neighbours organises neighbourhood watch meetings to deal with local crime, it is impossible for any external agent to *guarantee* that these meetings cannot also be used to organise political insurgency.

4. Coordination and Natural Resources

We will make the assumption that income from natural resources, y_{NR}, is completely insensitive[6] to K. Natural resource wealth, e.g., endowments of fossil fuels or precious minerals, is highly capital intensive with a majority of unskilled labour (Ross, 2001). The relatively low intensity of labour, unlike many agricultural products in developing economies, means that natural resources such as oil require little contact with the rest of the economy. They form revenue sources that are independent of the local economy (Crystal, 1990).

6 This assumption is too strong. A weaker assumption along the lines of natural resource income is *less* sensitive to coordination capital than the remainder of income is all that is required. We elaborate on this in the appendix.

Further support for this assumption is provided by Bueno de Mesquita *et al* (2003). They argue that the presence of natural resources means that authoritarian regimes do not need to rely on the economic activity of their citizens to acquire surplus (pp 94). This is the basic logic of the model in section I.

In reduced form, we are assuming that at least one of the games in the set $\{\Gamma_1^\infty, \Gamma_2^\infty, \ldots, \Gamma_G^\infty\}$ is a natural resource game.

Definition III.2: Let $G_{NR} \subset \{1,2,\ldots,G\}$ be the subset of natural resource games.

Remark: $W_g, g \in G_{NR}$ is invariant with respect to K

Definition III.3: $y_{NR} = \sum_{g \in G_{NR}} W_g$ and $y_R = \sum_{g \notin G_{NR}} W_g = y - y_{NR}$

5. The Government and Coordination

Coordination capital, our proposed factor *X*, simultaneously facilitates coordination in all games, political or not. The final piece of the jigsaw is to argue that the government can influence it. Communication is essential to coordination. If the state can repress communication, it can repress coordination. This requires coercive power.

A simple, if somewhat extreme, example is martial law. People's movements and communications are severely restricted under the threat of physically violent coercion. However this is not a realistic mechanism because the size of modern nations means that no state has the capacity to coerce people so extremely for any long period of time.

A more palatable option is to monitor and restrict organisations. Historically, such as during the emergence of civil society during the 19th century, states have targeted explicitly political organisations for repression (Sperber, 2000). However the conclusion

from the revolutions literature is that worrying about political organisations is not enough – revolutions are organised on the back of *apolitical* organisations, such as community associations or friendship groups. It may well be the case that in the absence of repression, insurgents prefer to mobilise themselves in political organisations, but if they are repressed they can still operate over apolitical networks, and this is a reality that theory and history forces the state to accept.

This point was appreciated by the post-revolutionary Russian government that banned the formation of *any* form of organisation for the fear that insurgency may grow from it (Smith, 2000). Crystal (1995) applies the same reasoning to explain why monarchs in the Persian Gulf over the last 30 years have been deeply suspicious of all organised groups. Even seemingly innocuous associations such as sports and student clubs have been either banned or infiltrated by the state with the explicit goal of retarding coordination.

Coordination capital, K , can therefore be repressed.

Remark: $K = K(r), \quad K' < 0$

6. Coordination and Democracy

A. Definition of Democracy

Following Becker (1958), assume that everyone in the polity has the same preferences. This implies that *there is complete agreement among people on what they would ideally want from a state that treats its citizens symmetrically*. We will assume that state policies are always symmetric[7].

7 We are aware that much of the fruitful analysis comparing authoritarian regimes with democracies is based on analysing how democracies deal with heterogeneous desires from within society. We waive this added layer of complexity to keep the difference that we are most interested in clear, which is that authoritarian regimes extract more surplus than democracies.

Becker's approach to democracy is to treat it as a competitive political market vis-a-vis an authoritarian regime, which is a monopoly. States are capable of implementing desirable policies from the perspective of their subjects, i.e., they are of value to society[8]. Authoritarian regimes, because they are protected by barriers to entry in the political marketplace, can deviate from the set of policies that the polity regards as optimal[9]. One such way is by over-taxing[10]. In a democracy, on the other hand, were a government to deviate from the optimal mandate, it would be removed from office in the same way that a firm would go bankrupt in a competitive market if it was inefficient or if it tried to over-charge. A democracy is a correctly functioning electoral system with perfect information on policies and costless removal and election of officials.

Thus democracies are more desirable to their subjects than authoritarian regimes because they are more sensitive to the desires of the subjects. That is why we can assume that, under this definition of democracy, repression will be zero in a democracy (assumption I.4).

B. Maintaining a Well-Functioning Democracy

As pointed out by Przeworski *et al* (2000), being a democracy in the long-run requires more than just transition *to* democracy, it requires sustained avoidance of transition *back to* authoritarianism. However it turns out that the mechanisms that bring about the fall of an authoritarian regime in the first place are strongly related to the mechanisms that lead to the sustenance of a democracy, i.e., coordination.

We have defined coordination as the pooling of useful private information. Hardin

8 We do not explicitly model these functions, but they are implicit. Imagine that the government needs to tax to provide a public good that the people cannot provide themselves.

9 Recall that given Becker's assumptions, these are uniquely defined.

10 By over-taxing, we mean in net terms, i.e., given the services they provide, the governments are taxing too much (possibly because the leadership is retaining them or distributing them as patronage payments). This need not mean that the *absolute* level of taxes is higher.

(1995) and Weingast (1997) take a different angle: they focus on coordination as a capacity to secure Pareto efficient equilibria when inefficient ones exist[11]. In our presentation, coordination is a response to uncertainty about exogenous variables, while Hardin and Weingast treat it as a response to uncertainty about the actions of other players.

Both Hardin and Weingast argue that their notion of coordination is essential in a democracy as, building on the Beckerian view, for a democracy to function properly, citizens must police the state. Should the government deviate from the optimal mandate, citizens must express their discontent and be prepared to do so violently should the need arise. Critically, *they must act in concert*, since nobody acting is also an equilibrium (albeit an inefficient one) – hence the coordination problem.

Democracy is therefore defined by the existence of a coordinate device that specifies the limits on the state in a widely accepted and unambiguous manner that citizens will act upon. We do not model these coordination devices here, but we believe that they are strongly related to the coordination devices we consider in our treatment. For example, Rabin (1994) argues that direct verbal communication can ensure efficient equilibria when there is a possible of inefficient ones. Since the coordination devices that we consider require some sort of communication, there are economies of scope between the two. For more on the relationships, see Al-Ubaydli (2005).

C. The Costs of Coordination and the Incidence of Democracy

In all models of the state, including Ginkel and Smith (1999), Hardin (1995) and Weingast (1997), the state derives some of its power from its capacity to exercise violent coercion. Ultimately, this threat of violence is essential to an authoritarian state's

11 Thus they do not use Pareto dominance as a solution criterion.

capacity to coerce its subjects. Policing the state, which is the path to democracy, is easier when the cost to the state of violent coercion is higher. This suggests that, *ceteris paribus*, democracy should be more likely to arise when violent coercion is more difficult.

This point is made by Dahl (1989), and he illustrates it with some examples throughout history as military technology has changed. The proliferation of the feudal system, a relatively authoritarian form of government, throughout the medieval era corresponded to the mounted knight being an elite and effective military unit. The system's demise and ultimate replacement by more representative forms of government, argues Dahl, was partially a consequence of longbows, and later muskets, diminishing the supremacy of the mounted knight. Swiss cantons remained relatively democratic throughout the period because the mountainous geography nullified the advantage of steeds. In the modern era, the development of heavy artillery has shifted the balance back in favour of elites.

Violent coercion is an important weapon of the state in surplus extraction, and violent insurgency is an important weapon of the people in policing the state. Consequently, military technology has an important role to play in balancing these two forces.

Summary

All the ingredients are now complete. Coordination capital, K, satisfies the four conditions set out in the summary of section I:

1. Increases regular income, y_R
2. Increases the probability of democratisation, ρ
3. Does not affect income from natural resources, y_{NR}

4. Can be influenced by the government via repression, r

We now proceed to the empirical testing of our model.

IV – Empirics

1. Econometric Specification

Symbol	Meaning
i	Country
t	Time period
D	Political system: 1 = democracy, 0 = authoritarian
r	Repression
X	Exogenous control variables
y_R	Regular income
y_{NR}	Natural resource income
η	Error

The model presented in section I is unaffected by the introduction of exogenous variables if they are constant. Assume that at the beginning of each period, the dictator observes the values of $\{X_{it}, y_{NR,it}\}$ and assumes that they will be constant with certainty for the infinite future. Thus, all changes in the values of these variables come as shocks in a world of complete certainty.

A. Repression

The basic comparative static underlying our model is that repression is increasing in natural resources in authoritarian regimes and not in democracies. Linearising, we have:

$$r_{it} = \lambda_0 + \gamma_0 D_{it} + \lambda_1 y_{NR,it} + \lambda_2 (y_{NR,it} - \bar{y}_{NR})^2 + \gamma_1 D_{it} y_{NR,it} + X_{it}\beta + \eta_{it}$$

We estimate this model using OLS. The quadratic term is present to ensure that the interaction term does not merely proxy for correlation between democracy and natural resources. It is deviated from the mean to allow interpretation of λ_1 as the effect of natural resources at the mean of the sample.

Our basic specification includes no variables in the *X* term.

Definition IV.1: The data offers *strong* support for our repression predictions if it allows us to conclude that:

$$\lambda_1 > 0 \ , \ \ \lambda_1 + \gamma_1 = 0$$

Definition IV.2: The data offers *weak* support for our repression predictions if it allows us to conclude that:

$$\lambda_1 > 0 \ , \ \ \gamma_1 < 0$$

The motivation behind entertaining weak support is that there may exist factors external to our model that lead to effects of natural resources that are *common* to both authoritarian and democratic regimes. Trivially, strong support implies weak support.

Repression is difficult to measure (see below). However, we can exploit the fact that, according to our model, it is an indirect function of natural resources. Consequently, we test hypotheses about democratisation and economic performance firstly under the assumption that we do not have a measure of repression, and can only proxy for it by natural resources. Subsequently, we reintroduce our measure of repression as an explanatory variable and look to see if it decreases the size and significance of the effect of natural resources.

B. Democratisation

Since the probability of democratisation is decreasing in repression, we have:

$$Pr[D_{it} = 1 | D_{i,t-1} = 0] = f\left[\gamma y_{NR,it} + X_{it}\beta + \eta_{it}\right]$$

Where f is a strictly increasing function.

We estimate this model as a probit (the results we obtain are not affected by the use of a hazard analysis).

Following the most recent econometric analysis of democratisation (Papaioannou and Siourounis, 2005), the variables we include in the *X* term in our basic specification are: literacy, education, urbanisation and radios.

Definition IV.3: The data offers support for our democratisation predictions if it allows us to conclude that $\gamma < 0$

C. Economic Performance

Since regular income is decreasing in repression, linearising, we have:

$$y_{R,it} = \lambda_0 + \gamma_0 D_{it} + \lambda_1 y_{NR,it} + \lambda_2 (y_{NR,it} - \bar{y}_{NR})^2 + \gamma_1 D_{it} y_{NR,it} + X_{it}\beta + \eta_{it}$$

We estimate this using OLS.

The variables we include in the *X* term in our basic specification are: education and physical capital *per capita*.

Definition IV.4: The data offers *strong* support for our economic performance predictions if it allows us to conclude that:

$$\lambda_1 < 0 \ , \ \ \lambda_1 + \gamma_1 = 0$$

Definition IV.5: The data offers *weak* support for our economic performance predictions if it allows us to conclude that:

$$\lambda_1 < 0 \ , \ \ \gamma_1 > 0$$

2. Data

Precise descriptions of the data used and its sources can be found at the end of the paper.

Not all data are available for all countries, but all models are estimated for data between 1975-2000 for up to countries.

We transform every series using logarithms or exponentials so that it is defined on the entire real line.

Tables A1-A3 in the appendix detail the countries in our data set, the number of observations on each and whether or not each country democratised.

The most controversial data we use is that on repression of coordination, which we compute as the negative of a series on civil liberties. Freedom House construct the index based on four checklists: (A) Freedom of expression and belief, (B) Associational and organisational rights, (C) Rule of law, and (D) Personal autonomy and individual rights. It is the second, (B), that we find most relevant as a measure of repression of coordination because it is based on the answer to the following questions:

1. Is there freedom of assembly, demonstration, and open public discussion?
2. Is there freedom of political or quasi-political organisation? (NB: this includes political parties, civic organisations, *ad hoc* issue groups, etc.)
3. Are there free trade unions and peasant organisations or equivalents, and is there effective collective bargaining? Are there free professional and other private organisations?

Clearly, given the other components of this index, it is at best a partial measure.

3. Robustness Strategy

We expose each basic model we test to five classes of robustness test. The strategy is first-order in the sense that we test each form individually – we do not simultaneously test for robustness in two dimensions.

A. Non-linearity

We repeat each basic regression/probit in two ways: firstly, by dropping all quadratic terms, and secondly, by including quadratic terms for all explanatory variables. We check to see if our conclusions in the basic model are affected by these two respecifications.

B. Temporal and Regional Dependence

The data is 1975-2000. We divide this into five five-year periods: 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-2000. After estimating each model for the pooled data set, we then reestimate it five times, each time *excluding* the data from one of the five periods. This is to see if our conclusions depend on the inclusion of any given time period.

The data is also composed of nine regions. We reestimate the basic model nine times, each time by *excluding* one region to see if our results depend upon the inclusion of any region.

C. Definition of Democracy

There is not only one way to code countries as either democracy or authoritarian. We have two such methods. We take the definition by Papaioannou and Siourounis (2005) as the benchmark, and we reestimate each basic model using the Boix and Stokes

(2004) definition.

D. Effects

All our models involve estimates from a pooled panel under the assumption of spherical errors. We relax the latter assumption by estimating a *random effects* version of each basic model.

Moreover, we also reestimate each basic model in three ways: firstly, with country-dummies (fixed effects), secondly, with regional dummies, and thirdly, with time dummies. Finally, we reestimate the original model with random effects and all the types of dummies.

E. Other Explanatory Variables

In each of our three basic models, we have a group of additional explanatory variables that either common sense or other models in the literature suggest should be included in the regressions. Further, in the democratisation and economic performance models, we check too see whether the addition of repression affects the size and significance of the effect of natural resources.

We reestimate each basic model with every permutation of the potential additional regressors.

4. Descriptive Statistics

Tables A1-A6 in the appendix summarise some of main features of the dataset. The number of countries and years of data available depends on the model being estimated because some data series have limited availability. Tables A1 and A2 detail the episodes of democratisation used in the democratisation model; at the beginning of the

sample, there are 58 authoritarian regimes, of which 31 democratise by the end. Central and South America exhibit a particularly large propensity to democratise, as compared to a relatively low incidence in Africa and the Middle East.

Table A3 shows the data set used for the economic performance model. There are 24 countries that are authoritarian throughout, 27 that are democratic throughout and 44 that democratise at some point. Approximately half of the country-year observations are democratic vis-à-vis authoritarian.

Table A4 shows the distribution of natural resources *per capita* in the sample used for economic performance testing. As expected, the Gulf authoritarian states of Bahrain, Kuwait and the UAE are among the best endowed. However in general, natural resources are not significantly correlated with political system (in fact, democracies have slightly higher endowments).

Table A5 breaks down the principal natural resources in the 20 countries that have the largest amount of natural resources *per capita*. The list is dominated by petroleum and natural gas, but countries such as Botswana and South Africa find themselves well-endowed with a variety of precious minerals.

Finally, in table A6 we detail the major producers (in absolute terms) of the most important natural resources. The list is dominated by Australia, Canada, China, Russia and the US, which translates to a large amount of natural resource *per capita* for all but China (Russia is not in our data sample).

5. Results

A. Repression

Table 1 below shows the regression results from our basic specification:

[Insert Table 1 here]

Given that the dependent variable only takes on seven qualitative values, it is only sensible to interpret the sign of the estimated coefficients. The estimates indicate support for the weak and not the strong repression predictions: natural resources have a positive and significant effect on repression (the negative of civil liberties) in authoritarian regimes and a negative and significant interaction term with democracies. However the sum is significantly different from zero.

Table 2 below examines the robustness of the basic results:

[Insert Table 2 here]

Basically, the conclusion of weak support is robust in every dimension. The only exception is that if we drop Islamic countries, the coefficients are no longer significant. Otherwise, a few of the specifications, notably fixed effects, lead to strong support.

The series we have on repression we have is by no means an accurate measure since the civil liberties index is composed of other subindices that are less relevant. We found several alternative measures of a society's capacity to coordinate and ran the regressions in table 1. They were (*per capita*): newspapers, internet connections, radios and mobile telephones (all data from the World Bank World Development Indicators). We do not present the results here, but generally speaking, even when controlling for education and literacy, there was still weak support for the repression predictions, i.e., the effect

of natural resources on them was less negative (or more positive) in democracies than in authoritarian regimes.

B. Democratisation

Table 3.1 below shows the probit results from our basic specification:

[Insert Table 3.1 here]

Natural resources have a significant and negative effect on the probability of democratisation (i.e., a significant and positive effect on the expected survival time of the regime), although the effect is not particularly large.

Table 3.2 below shows the same probit but with our measure of repression added as an explanatory variable:

[Insert Table 3.2 here]

As predicted, the size and significance of the effect of natural resources diminishes, becoming insignificant statistically. This is further support for our predictions.

Table 4 below examines the robustness of the results:

[Insert Table 4 here]

Again, the results are robust to practically all the alternative specifications. The only exception is the inclusion of regional dummies, which renders the coefficient on natural resources insignificant.

C. Economic Performance

Table 5.1 below shows the regression results from our basic specification:

[Insert Table 5.1 here]

Similar to the repression results, the data offers weak support for the economic performance predictions: natural resources have a negative and significant effect on economic performance in authoritarian regimes, the interaction term with democracies is positive and significant, but the sum is significantly different from zero. This is possibly as a consequence of other reasons, such as Dutch Disease, for expecting a negative effect of natural resources on economic performance regardless of political system. Note, however, the the estimated magnitude of the effect of natural resources is quite small, with an estimated elasticity of less than 10%.

Table 5.2 below is the same regression with repression included as an explanatory variable:

[Insert Table 5.2]

While not eliminating the significance or effect of natural resources, the inclusion of repression does decrease both, which is further support for our predictions.

Table 6 below examines the robustness of our basic results:

[Insert Table 6 here]

The results are robust without exception, with fixed and random effects leading to strong rather than just weak support for the predictions.

In a sample of many countries over many years, it is difficult to get an insight into what is driving the results. We can provide some visual intuition in figure 1:

[Insert Figure 1 here]

We define $TFP_i = y_{R,i} - \hat{y}_{R,i}$ where the fitted values come from the basic regression minus all natural resource terms and all interaction terms. Figure 1 above shows a weak negative relationship. Loosely speaking, our prediction is that if we separate out the above scatter into democracies and authoritarian regimes, any relationship should be more negative for the latter than the former. Figures 2 and 3 confirm this:

[Insert Figure 2 and Figure 3 here]

There seems to be a reasonably strong negative relationship in the case of authoritarian regimes, while in for democratic regimes, one struggles to find any relationship. These results, however, are only for one cross-section which is based on averaging a 25 year time series, and so they should be seen as nothing more than suggestive.

Summary

The model's predictions are that natural resources have a negative impact on democratisation, and that they have a negative impact on economic performance in authoritarian regimes but not in democracies. Using data on a panel of about 100 countries in the period 1975-2000, our empirical results are reasonably supportive of the model's predictions. The results show considerable degrees of robustness to a variety of alternative specifications.

V – Conclusion

What is the link between democracy and development? We have provided a model that argues that a society's capacity to coordinate has a positive impact on its economic performance and on its capacity to depart from authoritarianism to democracy. We have also discussed, without modelling, why coordination is also important for the sustenance of democracy too.

Why might authoritarians limit the repression of factors that might lead to the downfall of their regime? Because one of those factors – coordination – also has a bearing on the economic performance of their subjects, and hence on the amount of surplus that the authoritarian can extract. The more income available to the authoritarian from natural resources, the more willing they are to repress coordination as the lower the cost to doing so.

Why might natural resources have a negative effect on economic development? Because in authoritarian regimes, they encourage dictators to repress factors that jointly increase output and the probability of their regime falling, which is the heart of the relationship between economic development and democratisation.

We have presented reasonable evidence of the negative impact of natural resources on the probability of democratisation, and of the relatively negative impact of natural resources on economic performance in authoritarian regimes vis-a-vis democracies. However the evidence is far from conclusive, and we would benefit from the availability of a larger dataset, particularly in the time dimension.

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Description of Variables

Political system:

- Description
  - A binary variable taking the value '1' for a democracy and '0' for an authoritarian regime
- Source
  - Two different series; the first is from Papaioannou and Siourounis (2005), which is based on *Polity* and *Freedom House* indices. The second is from Boix and Stokes (2004)

Natural resources:

- Description
  - Value added from mining and quarrying activities *per capita* at 1995 US$ PPP
  - Mining and quarrying is defined as: Extraction, dressing and beneficiating of minerals occurring naturally: Solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Mining includes underground and surface mines, quarries and wells and all supplemental activities for dressing and beneficiating ores and other crude materials, such as crushing, screening, washing, cleaning, grading milling, flotation, melting, pelleting, topping and other preparations needed to render the material marketable.
- Source
  - UN statistical database

Income:

- Description
  - GDP *per capita* at 1995 US$ PPP
- Source
  - World Bank World Development Indicators

Repression/Civil liberties:

- Description
  - An index of civil liberties (or it's inverse in the case of repression)
  - Index is composed of four subindices
    - Freedom of expression and belief; associational and organisational rights;

rule of law; and personal autonomy and individual rights

- Source
  - Freedom House

Political liberties:

- Description
  - An index of political liberties
  - Index is composed of three subindices
    - Electoral process; political pluralism and participation; and functioning of government
- Source
  - Freedom House

Education:

- Description
  - Average years of schooling in total population
- Source
  - Barro and Lee (2001)

Literacy:

- Description
  - Literacy rate for the population over 15 years
- Source
  - World Bank World Development Indicators

Capital stock:

- Description
  - Physical capital *per capita*
- Source
  - Investment data obtained from World Bank World Development and transformed into capital stock via method in Hall and Jones (1999)

Urbanisation:

- Description
  - Share of total population living in areas defined as urban
- Source

- World Bank World Development Indicators

Radios:

- Description
  - Radios per 1000 people
- Source
  - World Bank World Development Indicators

Trade:

- Description
  - Imports plus exports as a share of GDP
- Source
  - Penn World Table

Common law and legal origin:

- Description
  - Five possibilities: (1) Common law, (2) French civil law, (3) German civil law, (4) Scandinavian civil law, (5) Socialist/Communist law
- Source
  - La Porta *et al* (1999)

Region:

- Description
  - The region to which the country belongs
- Source
  - CIA world factbook

Islam:

- Description
  - A dummy variable that takes the value '1' if over 50% of the population was Muslim in 1980
- Source
  - Alesina *et al* (2003)

Tables and Figures

Explanatory Variable		Estimated Coefficient	P-Value
Raw Terms	Constant	3.23	<1%
	Natural Resources (A)	-0.04	<1%
	Natural resources squared	-0.02	<1%
Interaction Terms	Constant	1.73	<1%
	Natural Resources (B)	0.24	<1%
Net effect of natural resources in democracies (A+B)		0.2	<1%
R-Squared	63%		
# Obs.	2880		

Table 1: A pooled OLS regression where the dependent variable is civil liberties (a negative measure of repression of coordination). The sample is of approximately 120 countries over the period 1975-2000. The dependent variable takes only seven values (1-7). 'Natural resources' is in log form. The squared term is deviated from the sample mean, which means that the coefficient on the term of degree one is the estimate of the partial derivative of civil liberties with respect to natural resources at the mean. Interaction variables are the stated variable multiplied by a democracy dummy.

Alternative model		Strong support	Weak support
Drop time period	1975-79	No	Yes
	1980-84	No	Yes
	1985-89	No	Yes
	1990-94	No	Yes
	1995-00	No	Yes
Drop region	Africa	No	Yes
	Asia	No	Yes
	E. Europe	No	Yes
	W. Europe	No	Yes
	L. America	No	Yes
	N. America	No	Yes
	Oceania	No	Yes
	Middle East	No	Yes
	Islam	No	No
Definition of democracy		No	Yes
Effects	Fixed effects	Yes	Yes
	Random effects	No	Yes
	Time dummies	No	Yes
	Regional dummies	No	Yes
	All	Yes	Yes
Additional explanatory variables	Literacy, education, income, political liberties, legal origin	For most permuations	Virtually all permuations
Functional form	Drop quadratic	No	Yes

Table 2: Robustness of results used to test the model's hypotheses from table 2. PL stands for political liberties. The column 'Sign Violation' lists the alternate specifications that result in estimates of the signs on the coefficients that do not support our model's predictions. 'Significant Violation' lists the specifications that agree in terms of sign but not in terms of statistical significance.

Explanatory Variable	Estimate of Elasticity of Expected Regime Survival Time	P-Value
Natural resources	0.27	<5%
Literacy	-1.77	<5%
Education	0.41	59%
Urbanisation	-0.48	42%
Radios	0	92%
Psuedo R-Squared	7%	
# Obs.	815	

Table 3.1: A pooled probit with democratisation being the dependent variable. We calculate the expected survival time of an authoritarian regime at the mean of the sample's explanatory variables. The estimated probit coefficients are used to evaluate the elasticity of the expected survival time with respect to each explanatory variable. See the appendix for more details on this calculation.

Explanatory Variable	Estimate of Elasticity of Expected Regime Survival Time	P-Value
Natural resources	0.25	14%
Literacy	-2.23	<5%
Education	1.42	16%
Urbanisation	-0.3	70%
Radios	0	97%
Civil liberties	-4.98	<1%
Psuedo R-Squared	26%	
# Obs.	815	

Table 3.2: The same probit as in table 4.1 but with civil liberties added as an explanatory variable.

Alternative model		Support
Drop time period	1975-79	Yes
	1980-84	Yes
	1985-89	Yes
	1990-94	Yes
	1995-00	Yes
Drop region	Africa	Yes
	Asia	Yes
	E. Europe	Yes
	W. Europe	Yes
	L. America	Yes
	N. America	Yes
	Oceania	Yes
	Middle East	Yes
	Islam	Yes
Definition of democracy		Yes
Effects	Fixed effects	Inestimable
	Random effects	Yes
	Time dummies	Yes
	Regional dummies	No
	All	No
Additional explanatory variables	Trade, income, legal origin	Always
Functional form	Drop quadratic	Yes

Table 4: Robustness of results used to test hypotheses in table 4.1.

Explanatory Variable		Estimated Coefficient	P-Value
Raw Terms	Constant	1.16	<1%
	Natural Resources (A)	-0.09	<1%
	Natural resources squared	-0.01	<1%
	Education	0.13	<1%
	Physical capital	0.79	<1%
Interaction Terms	Constant	-0.2	<1%
	Natural Resources (B)	0.07	<1%
Net effect of natural resources in democracies (A+B)		-0.02	<1%
R-Squared	94%		
# Obs.	2189		

Table 5.1: A pooled OLS regression where the dependent variable is the log of per capita income that is not from natural resources. Results are to two decimal places. All explanatory variables are in logarithms and so estimated coefficients represent elasticities. The higher-order terms for natural resources are deviated from the mean but not for education and physical capital. The chosen specification is based on tests of non-linearity.

Explanatory Variable		Estimated Coefficient	P-Value
Raw Terms	Constant	1.18	<1%
	Natural Resources (A)	-0.08	<1%
	Natural resources squared	-0.01	<1%
	Education	0.12	<1%
	Physical capital	0.77	<1%
	Civil liberties	0.05	<1%
Interaction Terms	Constant	-0.26	<1%
	Natural Resources (B)	0.06	<1%
Net effect of natural resources in democracies (A+B)		-0.03	<1%
R-Squared	94%		
# Obs.	2167		

Table 5.2: The regression from table 6.1 with repression added as an explanatory variable.

Alternative model		Strong support	Weak support
Drop time period	1975-79	No	Yes
	1980-84	No	Yes
	1985-89	No	Yes
	1990-94	No	Yes
	1995-00	No	Yes
Drop region	Africa	No	Yes
	Asia	No	Yes
	E. Europe	No	Yes
	W. Europe	No	Yes
	L. America	Yes	Yes
	N. America	No	Yes
	Oceania	No	Yes
	Middle East	No	Yes
	Islam	No	Yes
Definition of democracy		No	Yes
Effects	Fixed effects	Yes	Yes
	Random effects	Yes	Yes
	Time dummies	No	Yes
	Regional dummies	No	Yes
	All	No	Yes
Additional explanatory variables	Literacy, legal origin	No	All permutations
Functional form	Drop quadratic	No	Yes
	All quadratic	No	Yes

Table 6: Robustness of the hypotheses to variations on the specification in table 6.

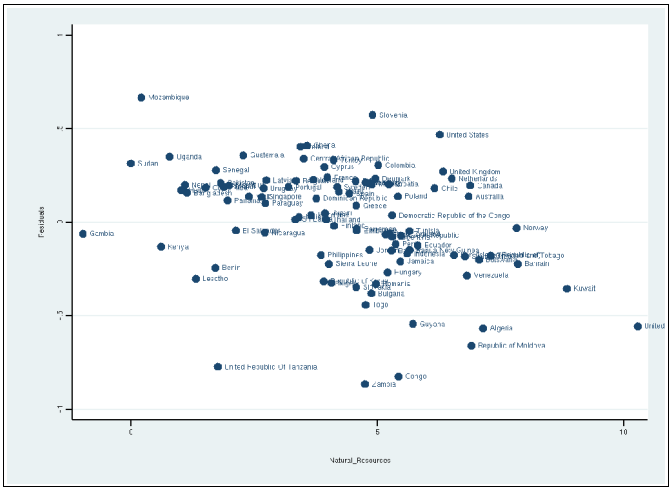

Figure 1: Scatter-plot of TFP and natural resources. Data comes from a cross-section generated by taking averages of each country's values of explanatory variables in the period 1975-2000.

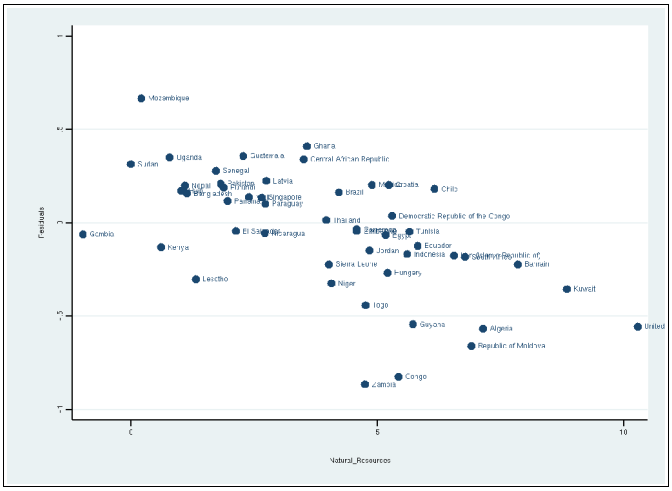

Figure 2: Figure 1 for authoritarian regimes only, defined as countries that were authortarian regimes for at least half the period 1975-2000.

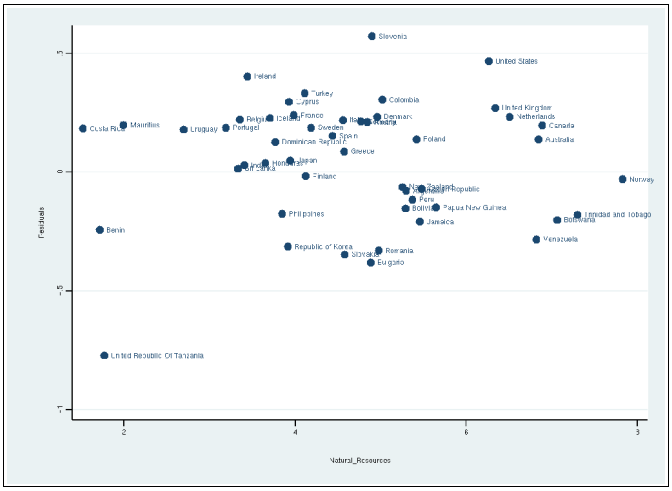

Figure 2: Figure 1 for democracies only, defined as countries that were democracies for at least half the period 1975-2000.

Appendix

Technical Conditions on Model in Section I

Differentiability: Assume that all functions are twice continuously differentiable in their arguments

Boundedness: Assume that π and y are both bounded from above.

Relaxing the Assumption on Natural Resource Income

Assumption I.3a in the paper is that coordination capital (or its repression) has no effect on the income from natural resources. This is possibly too strong. Here we attempt to relax the assumption – we are simply trying to capture the idea that if the income from natural resources is *less* sensitive to coordination capital (and its repression) than regular income, it should be the case that repression is increasing in natural resources.

$f(n,r)$ = income from natural resources

$g(r)$ = regular income

$y = g(r) + f(n,r)$ = total income

r = repression

n = natural resources

Make the following assumptions about partial derivatives:

$$f_n > 0,\ f_r \leq 0,\ g' < 0,\ \pi' > 0$$

The problem:

$$v(n)=\max_{r}\left\{f(n,r)+g(r)+\pi(r)v(n)\right\}$$

Let a bar over a variable denote that it is at its optimal value given the problem above (with the exception of v, which is already a maximum by definition).

The first-order condition is:

$$\bar{f}_r+\bar{g}'+\bar{\pi}'v=0$$

The second-order condition is:

$$\bar{f}_{rr}+\bar{g}''+\bar{\pi}''v<0$$

We wish to see how repression varies with natural resources:

$$\frac{\partial \bar{r}}{\partial n}=-\frac{\bar{\pi}'v'+\bar{f}_{rn}}{\bar{f}_{rr}+\bar{g}''+\bar{\pi}''v}$$

$$\frac{\partial \bar{r}}{\partial n}>0\Leftrightarrow\bar{\pi}'v'+\bar{f}_{rn}>0$$

But:

$$\bar{\pi}'=-\frac{\bar{f}_r+\bar{g}'}{v},\quad v=\frac{\bar{f}+\bar{g}}{1-\bar{\pi}}$$

And by the envelope theorem:

$$v'=\frac{\bar{f}_n}{1-\bar{\pi}}$$

So:

$$\bar{\pi}'v'=-\frac{\left(\bar{f}_r+\bar{g}'\right)\bar{f}_n}{\bar{f}+\bar{g}}$$

Thus:

$$\frac{\partial \bar{r}}{\partial n} > 0 \Leftrightarrow \bar{f}_{rn} > \frac{\left(\bar{f}_r + \bar{g}'\right)\bar{f}_n}{\bar{f} + \bar{g}}$$

$$\Leftrightarrow \frac{\bar{r}\,\bar{f}_{rn}}{\bar{f}_n} > \frac{\left(\bar{f}_r + \bar{g}'\right)\bar{r}}{\bar{f} + \bar{g}}$$

Now define the following elasticities:

$$\epsilon_{fr} = \frac{r}{f} f_r \leq 0, \quad \epsilon_{gr} = \frac{r}{g} g' < 0, \quad \epsilon_{f_n r} = \frac{f}{f_n} f_{nr}$$

Thus:

$$\frac{\left(\bar{f}_r + \bar{g}'\right)\bar{r}}{\bar{f} + \bar{g}} = \frac{\bar{f}}{\bar{f} + \bar{g}} \bar{\epsilon}_{fr} + \frac{\bar{g}}{\bar{f} + \bar{g}} \bar{\epsilon}_{gr}$$

So:

$$\frac{\partial \bar{r}}{\partial n} > 0 \Leftrightarrow \bar{\epsilon}_{f_n r} > \frac{\bar{f}}{\bar{f} + \bar{g}} \bar{\epsilon}_{fr} + \frac{\bar{g}}{\bar{f} + \bar{g}} \bar{\epsilon}_{gr} \qquad [\#]$$

Note that if $f_{nr} \geq 0$, then condition [#] will always be satisfied.

If $f_{nr} < 0$, then we can restate [#] as:

$$\frac{\partial \bar{r}}{\partial n} > 0 \Leftrightarrow \|\bar{\epsilon}_{f_n r}\| > \frac{\bar{f}}{\bar{f} + \bar{g}} \|\bar{\epsilon}_{fr}\| + \frac{\bar{g}}{\bar{f} + \bar{g}} \|\bar{\epsilon}_{gr}\| \qquad [\$]$$

Where all the elasticities are negative.

Let us interpret [$] in words: repression is decreasing in natural resources if and only if the elasticity of the marginal effect of natural resources on income from natural resources (f_n) with respect to repression is less than a convex combination of the

elasticity of income from natural resources with respect to repression and the elasticity of regular income with respect to repression.

The first easy point to make is that if $\epsilon_{fr}=0$ then $\epsilon_{f_nr}=0$, and so [$] is satisfied. More generally, we wish to argue along the lines that both of these elasticities are small compared to ϵ_{gr} and so [$] will be satisfied.

An interesting example is Cobb-Douglas, whereby $\epsilon_{fr}=\epsilon_{f_nr}$ and so $\epsilon_{gr}>\epsilon_{fr}$ is sufficient for [$] to be satisfied.

Democratisation Tables

Region	Countries	Democratisations	Observations
Africa	22	7	267
Asia	7	3	119
Caribbean	2	2	35
Central America	6	6	119
Eastern Europe	5	4	57
Middle East	6	1	91
South America	8	6	90
Western Europe	2	2	37
Total	**58**	**31**	**815**

Table A1: Regional summary of panel used in democratisation probits

Country	Region	Democratise	Observations
Algeria	Africa	No	12
Benin	Africa	No	11
Burundi	Africa	No	1
Cameroon	Africa	No	23
Central African Republic	Africa	No	23
Congo	Africa	No	13
Egypt	Africa	No	11
Ghana	Africa	1996	19
Kenya	Africa	No	25
Lesotho	Africa	1993	19
Mali	Africa	1992	16
Mozambique	Africa	1994	15
Niger	Africa	No	26
Senegal	Africa	No	23
South Africa	Africa	1994	20
Sudan	Africa	No	26
Togo	Africa	No	26
Tunisia	Africa	No	25
Uganda	Africa	No	16
United Republic Of Tanzania	Africa	1995	6
Zambia	Africa	1991	13
Zimbabwe	Africa	No	24
Bangladesh	Asia	1991	10
Indonesia	Asia	No	17
Nepal	Asia	1991	17
Pakistan	Asia	No	22
Philippines	Asia	No	10
Thailand	Asia	1992	17
Vietnam	Asia	No	1
Dominican Republic	Caribbean	1978	4
Haiti	Caribbean	1994	20
El Salvador	Central America	1994	20
Guatemala	Central America	1996	22
Honduras	Central America	1982	4
Mexico	Central America	1997	23
Nicaragua	Central America	1990	16
Panama	Central America	1994	20
Bulgaria	Eastern Europe	1990	11
Croatia	Eastern Europe	No	7
Greece	Eastern Europe	1975	1
Hungary	Eastern Europe	1990	16
Romania	Eastern Europe	1990	1
Bahrain	Middle East	No	14
Iran (Islamic Republic of)	Middle East	No	24
Jordan	Middle East	No	22
Kuwait	Middle East	No	11
Turkey	Middle East	1983	5
United Arab Emirates	Middle East	No	1
Argentina	South America	No	2
Bolivia	South America	No	2
Brazil	South America	1990	5
Chile	South America	1990	16
Ecuador	South America	1994	20
Paraguay	South America	1993	19
Peru	South America	1980	6
Uruguay	South America	1985	10
Portugal	Western Europe	1976	2
Spain	Western Europe	1978	4

Table A2: Breakdown of democratisations summarised in A1

Region	Always Authoritarian		Democratise		Always Democratic	
Africa	Algeria Burundi Cameroon CAR Congo, Rep. Congo, DR. Egypt Gambia	Kenya Niger Sierra Leone Sudan Togo Tunisia Uganda Zimbabwe	Benin Ghana Lesotho Mali Mozambique	Senegal South Africa Tanzania Zambia	Botswana	Mauritius
Asia	Pakistan	Singapore	Nepal Philippines	South Korea Thailand	Japan	Sri Lanka
Caribbean			Dominican Rep. Haiti	Trinidad & Tobago	Jamaica	
Central America			El Salvador Guatemala Honduras	Mexico Nicaragua Panama	Costa Rica	
Eastern Europe	Moldova		Bulgaria Croatia Czech Rep. Greece Hungary	Latvia Poland Romania Slovakia Slovenia		
Middle East	Bahrain Iran Jordan	Kuwait UAE	Turkey		Cyprus	
North America					Canada	USA
Oceania					Australia New Zealand	Papua New Guinea
South America			Argentina Bolivia Brazil Chile Ecuador	Guyana Paraguay Peru Uruguay	Colombia	Venezuela
Western Europe			Portugal	Spain	Austria Belgium Denmark Finland France Germany Iceland	Ireland Italy Netherlands Norway Sweden UK

Table A3: Panel used in repression and economic performance models

Range (1995 US$ per capita, PPP)	Members	
	Authoritarian	**Democratic**
1000 and above	Algeria Bahrain Kuwait UAE	Botswana Norway Trinidad & Tobago
500-1000	Iran Moldova South Africa	Australia Canada Netherlands UK USA Venezuela
200-500	Chile Congo, Dem. Rep. Congo, Rep. Guyana Indonesia Poland Tunisia	Czech Rep. Ecuador Jamaica Papua New Guinea Peru
150-200	Croatia Egypt Hungary	Argentina Bolivia Colombia New Zealand
100-150	Jordan Mexico Togo Zambia	Austria Bulgaria Denmark Germany Romania Slovenia
75-100	Cameroon Zimbabwe	Greece Italy Slovakia Spain
50-75	Niger Sierra Leone South Korea Thailand	Brazil Cyprus Finland France Japan Sweden Turkey
25-50	Central African Rep. Ghana Philippines	Belgium Dominican Rep. Honduras Iceland India Ireland Sri Lanka
25 or less	Bangladesh Benin Burundi El Salvador Gambia Guatemala Haiti Kenya Latvia Lesotho Mali Mozambique Nepal Pakistan Panama Paraguay Senegal Singapore Sudan Tanzania Uganda	Costa Rica Mauritius Nicaragua Portugal Uruguay
Total	51	47

Table A4: Distribution of mean (over time) natural resources *per capita* by political system. NB: countries that switch regime are classified by the regime they spend the majoirty of the sample in.

Country	Principal Natural Resources
UAE	Petroleum, natural gas
Kuwait	Petroleum, natural gas
Bahrain	Petroleum, natural gas
Norway	Petroleum, natural gas, iron ore, copper, lead, zinc, titanium, pyrites, nickel
Trinidad and Tobago	Petroleum, natural gas
Algeria	Petroleum, natural gas, iron ore, phosphates, uranium, lead, zinc
Botswana	Diamonds, copper, nickel, salt, soda ash, potash, coal, iron ore, silver
Moldova	Lignite, phosphorites, gypsum, limestone
Canada	Iron ore, nickel, zinc, copper, gold, lead, molybdenum, potash, diamonds, silver, coal, petroleum, natural gas
Australia	Bauxite, coal, iron ore, copper, tin, gold, silver, uranium, nickel, tungsten, mineral sands, lead, zinc, diamonds, natural gas, petroleum
Venezuela	Petroleum, natural gas, iron ore, gold, bauxite, other minerals, diamonds
South Africa	Gold, chromium, antimony, coal, iron ore, manganese, nickel, phosphates, tin, uranium, gem diamonds, platinum, copper, vanadium, salt, natural gas
Iran	Petroleum, natural gas, coal, chromium, copper, iron ore, lead, manganese, zinc, sulphur
Netherlands	Natural gas, petroleum, peat, limestone, salt, sand and gravel
UK	Coal, petroleum, natural gas, iron ore, lead, zinc, gold, tin, limestone, salt, clay, chalk, gypsum, potash, silica sand, slate
USA	Coal, copper, lead, molybdenum, phosphates, uranium, bauxite, gold, iron, mercury, nickel, potash, silver, tungsten, zinc, petroleum, natural gas
Chile	Copper, iron ore, nitrates, precious metals, molybdenum
Ecuador	Petroleum
Guyana	Bauxite, gold, diamonds
Tunisia	Petroleum, phosphates, iron ore, lead, zinc, salt

Table A5: Principal natural resources for the 20 countries with the highest natural resources *per capita* in the sample. Source: CIA Factbook.

Natural Resource		Biggest	2nd	3rd	4th	5th
Fuels	**Petroleum**	Saudi Arabia	Russia	USA	Iran	Mexico
	Natural Gas	Russia	USA	Canada	UK	Algeria
	Coal	China	USA	Australia	India	Russia
Metals	**Aluminium**	China	Russia	Canada	USA	Australia
	Copper	Chile	USA	Indonesia	Peru	Australia
	Gold	South Africa	Australia	USA	China	Peru
	Iron ore	China	Brazil	Australia	India	Russia
	Lead	China	Australia	USA	Peru	Canada
	Platinum	South Africa	Russia	Canada	USA	
	Silver	Peru	Mexico	China	Australia	Canada
	Zinc	China	Australia	Peru	Canada	USA
Industrial minerals	**Diamonds**	Congo (DR)	Australia	Russia	Botswana	South Africa
	Sulphur	USA	Canada	Russia	China	Japan

Table A6: Top five producers (in absolute terms) of the major natural resources. Source: US Geological Survey Minerals Yearbook.

Elasticities in Tables 4.1 and 4.2

The probability of democratisation for an observation with covariates X is $p = p(g(X))$. Given that the country is an autocracy, the expected life of the autocracy is:

$$t(X) = \frac{1 - p(g(X))}{p(g(X))}$$

Want to evaluate $\frac{\partial \log t(\bar{X})}{\partial \log X_i} = \frac{\bar{X}_i}{t(\bar{X})} \frac{\partial t(\bar{X})}{\partial X_i}$.

$$\frac{\partial t(X)}{\partial X_i} = \frac{\partial t(X)}{\partial p} \frac{\partial p(g(X))}{\partial g_i(X_i)} \frac{\partial g_i(X_i)}{\partial X_i}$$

$\frac{\partial p(g(\bar{X}))}{\partial g_i(X_i)}$ is given by the Stata output (marginal effects evaluated at mean).

$\frac{\partial t(\bar{X})}{\partial p(g(X))} = -\frac{1}{(p(g(\bar{X})))^2}$ which is also given by the Stata output (probability evaluated at mean).

$\frac{\partial g_i(\bar{X}_i)}{\partial X_i}$ can also be deduced from that Stata output (we are given the means of each variable).