European Economic Review 54 (2010) 608–621

Contents lists available at ScienceDirect

European Economic Review

journal homepage: www.elsevier.com/locate/eer

Natural resources, democracy and corruption

Sambit Bhattacharyya [a], Roland Hodler [b,c,*]

[a] Arndt-Corden Division of Economics, Research School of Pacific and Asian Studies, Australian National University, Australia
[b] Department of Economics, University of Melbourne, Australia
[c] OxCarre, University of Oxford, UK

ARTICLE INFO

Article history:
Received 12 August 2008
Accepted 20 October 2009
Available online 30 October 2009

JEL classification:
D7
O1

Keywords:
Natural resources
Democracy
Political institutions
Corruption

ABSTRACT

We study how natural resources can feed corruption and how this effect depends on the quality of the democratic institutions. Our game-theoretic model predicts that resource rents lead to an increase in corruption if the quality of the democratic institutions is relatively poor, but not otherwise. We use panel data covering the period 1980–2004 and 124 countries to test this theoretical prediction. Our estimates confirm that the relationship between resource rents and corruption depends on the quality of the democratic institutions. Our main results hold when we control for the effects of income, time varying common shocks, regional fixed effects and various additional covariates. They are also robust across different samples, and to the use of various alternative measures of natural resources, democracy and corruption.

1. Introduction

The finding that natural resources are a curse rather than a blessing may seem paradoxical at first and has led to an extensive literature.[1] One of the main hypotheses put forward is that natural resource riches breed corruption, which, in turn, lowers economic performance (e.g., Leite and Weidmann, 2002; Sala-i-Martin and Subramanian, 2003; Isham et al., 2005).[2] In this paper, we take a closer look at the relationship between natural resources and corruption. In particular, we investigate both theoretically and empirically whether and how the quality of the democratic institutions affects this relationship.

In the theoretical part, we present a game between politicians and the people. There are some "good" politicians who act in the people's best interest and possibly many more "bad" politicians who primarily care about the revenues they can generate by corrupt activities. The people prefer to have a good politician as their president. This provides an incentive for a bad incumbent president to mimic a good president and not to engage in corruption in order to improve the chances that he can remain in power. In equilibrium, a bad incumbent mimics a good incumbent if and only if the democratic institutions are sufficiently sound, i.e., if and only if there is a sufficiently large difference between the probability that he can stay in office when supported by the people and the probability that he can stay in office without the people's support. If this difference is small, a bad incumbent engages in corrupt activities. The level of corruption that he chooses in this case

* Corresponding author at: Department of Economics, University of Melbourne, VIC 3010, Australia. Tel.: +61 3 8344 5292; fax: +61 3 8344 6899.
E-mail addresses: sambit.bhattacharyya@anu.edu.au (S. Bhattacharyya), rhodler@unimelb.edu.au (R. Hodler).

[1] This finding goes back to Corden and Neary (1982) and has been popularized by Sachs and Warner (1995). For an overview of this literature, see, e.g., Gylfason (2001) and Sachs and Warner (2001), or van der Ploeg (2008).

[2] As discussed below, there is a closely related hypothesis that natural resources lead to various forms of rent-seeking, which then lower economic performance.

0014-2921/$ - see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.euroecorev.2009.10.004

increases in the abundance of natural resources because resource rents are less sensitive to corruption than domestic production. Our model thus predicts that resource abundance increases corruption in countries with poor democratic institutions, but not in countries with comparatively better democratic institutions.

In the empirical part, we test this prediction using a reduced form model and panel data covering the period 1980–2004 and 124 countries. Our estimates confirm that the relationship between resource rents and corruption depends on the quality of the democratic institutions. We find that resource rents are positively associated with corruption in countries for which the net democracy score POLITY2 is 8.5 or less.[3] Our basic results hold when we control for the effects of log income, time varying common shocks, regional fixed effects and various additional covariates. It is also robust to various alternative measures of corruption, resource abundance and the quality of democratic institutions, as well as to the instrumental variable method of estimation and across different samples.

Our contribution in this paper is twofold. First, we present a theoretical model that clearly demonstrates why we should expect the effect of resource rents on corruption to depend on the quality of the democratic institutions. We thereby also introduce a novel way of modeling the quality of democratic institutions. Second, using a reduced form econometric model we show that the effect of resource rents on corruption indeed depends on the level of democracy.

The literature that studies the effect of natural resources on corruption is rather small. Ades and Di Tella (1999) present a theoretical model which predicts that resource rents and rents induced by a lack of product market competition foster bureaucratic corruption, as well as evidence that corruption increases in the proportion of total exports accounted by fuel, minerals and metals. In his broad cross-country study, Treisman (2000) shows that this proportion is a robust determinant of corruption. Leite and Weidmann (2002) find that natural resource exports (as shares of GNP) tend to increase corruption, and that this in turn lowers growth. Isham et al. (2005) show that this effect is most pronounced for "point source" natural resources such as oil, minerals, and plantation crops. Aslaksen (2007) also finds that oil and minerals increase corruption. She further divides her sample into countries with low, medium and high POLITY2 scores in the year 1982. Using this cardinal approach, she finds that minerals increase corruption only in the first sub-sample whereas oil increases corruption in the first two of these sub-samples. In our empirical part, we choose a different approach to investigate how the level of democracy influences the effect of natural resources on corruption. Consistent with our theoretical model, we use an ordinal measure of democracy.[4] We introduce an interaction term between natural resources and democracy and also control for the direct effect of democracy on corruption. Finally, Vicente (2009) presents evidence that the oil discoveries in the late 1990s increased perceived corruption in Sao Tome and Principe.[5]

Corruption can be seen as one of many forms of rent-seeking. Our paper therefore is related to the literature which argues that natural resources may lower the economic performance because they foster rent-seeking activities (e.g., Lane and Tornell, 1996; Tornell and Lane, 1999; Baland and Francois, 2000; Torvik, 2002). In particular, our paper is related to the recent contributions to this literature which emphasize that whether natural resources are a curse or a blessing depends on country-specific circumstances. Mehlum et al. (2006) show that natural resources boost economic performance if institutions are producer-friendly, but dampen economic performance if institutions are grabber-friendly. Hodler (2006) shows that natural resources lead to intensive rent-seeking, poor institutions and lower incomes in ethnically fractionalized societies, but to little or no rent-seeking and higher incomes in homogeneous societies. Robinson et al. (2006) argue that natural resources can lead to inefficiently high public sector employment unless strong political institutions prevent such patronage. Bulte and Damania (2008) present a model in which entrepreneurs from the natural resource sector lobby for sector-specific public goods when there is no political competition. Collier and Hoeffler (2009) investigate whether the effect of democracy on growth is distinctive in resource-rich societies. They find that strong checks and balances, which are often missing in newly established democracies, would be of particular importance in these societies.

The remainder of the paper is structured as follows: Section 2 presents the theoretical model, and Section 3 derives the equilibrium and some comparative static results. Section 4 discusses our empirical strategy and the data. Section 5 presents the empirical evidence and various robustness tests. Section 6 concludes.

2. The model

There is an economy inhabited by an incumbent president, who is in office for exogenous reasons, a challenger and the people. The incumbent and the challenger are each a good type $\overline{\theta}$ with probability $\alpha \in (0,1)$ and a bad type $\underline{\theta}$ with probability $1-\alpha$. Each politician's type is his private information, but α is common knowledge.[6]

[3] See Section 4 for information on the POLITY2 score and its source, the Polity IV database.

[4] Collier and Hoeffler (2009, pp. 298–299) argue that "[s]ince the democracy score is ordinal, all uses that treat it as cardinal are at best approximations."

[5] Sao Tome and Principe is not covered in the Polity IV database. The coup d'etat in 2003, however, suggests that its democratic institutions are relatively poor. The increase in corruption is therefore consistent with the predictions of our model.

[6] None of our results depends on the value of α as long as $\alpha \in (0,1)$. Hence, they hold even if good politicians are very rare.

There are two periods $t \in \{1,2\}$.[7] In period one, the incumbent chooses the level of corruption $c_1 \in [0,1]$. At the end of period one, the people observe c_1 and support either the incumbent or the challenger. The people's decision determines the probability of the incumbent staying in office and, hence, the probability of the challenger getting into office. In period two, the politician in office again chooses the level of corruption $c_2 \in [0,1]$.

The economy consists of a production and a natural resource sector. Total income is thus given by the sum of domestic production A_t and the resource rent Ω_t. Domestic production A_t is primarily determined by the individuals' labor-leisure choices and their decisions to accumulate physical and human capital and to invest in better technologies. Corruption lowers the private returns on productive activities and, consequently, the incentives to work hard and to invest in physical and human capital and better technologies. As a result, domestic production decreases in corruption. For simplicity, we directly assume $A_t = A(c_t)$ with $A'(c_t) \leq 0$ and $A''(c_t) < 0$.[8] Further, we assume that $A(c_t)$ is continuous, $A'(0) = 0$ and $A'(1) = -\infty$.

The resource rent Ω_t, on the other hand, depends to a large extent on a country's resource endowment, which is exogenous and hence independent of the level of corruption. Corruption should thus have smaller disincentive effects on the revenues from natural resources than on domestic production. For simplicity, we assume that $\Omega_t = \Omega \geq 0$ in each period t. This assumption is. however, overly restrictive; all we need is that the resource rent is less sensitive to corruption than domestic production.

The people's welfare is $W_t = W(c_t) \equiv (1 - c_t)[A(c_t) + \Omega]$ in period t. Welfare unambiguously decreases in corruption c_t. When deciding which politician to support, the people maximize their expected welfare, and we assume that they support the incumbent if they are indifferent between him and his challenger.[9]

In each period t, the politician in office derives utility from different sources. On the one hand, he gets the corruption revenues $\Pi_t = \Pi(c_t) \equiv c_t[A(c_t) + \Omega]$. Similar to a Laffer curve, $\Pi(c_t)$ is a hump-shaped function of c_t.[10] On the other hand, the politician in office may benefit for several reasons from high social welfare W_t. First, his salary may depend on the performance of the official economy. Second, his status and influence in the international community may depend on the people's welfare and the economy's performance. Third, he may genuinely care about the people's well-being. We therefore assume that a politician of type θ gets the utility θW_t from social welfare W_t when in office, and that $0 < \underline{\theta} < \overline{\theta}$. The reason for the first inequality is that any politician cares about his salary and his status; and the reason for the second inequality is that good politicians care more about the people's well-being than bad politicians. Consequently, the total instantaneous utility of a politician of type θ in office is

$$u_t = u(c_t;\theta) \equiv \Pi(c_t) + \theta W(c_t) = [c_t + \theta(1 - c_t)][A(c_t) + \Omega]. \tag{1}$$

We further assume $\underline{\theta} < 1 \leq \overline{\theta}$, such that good politicians in office care for all the various reasons more about social welfare than about corruption revenues while bad politicians care more about corruption revenues. For simplicity, we abstract from discounting and assume that politicians get zero utility when not in office.

A key feature of the model is the democratic institutions. They determine the extent to which the people can choose their government, i.e., whether or not the incumbent is replaced by the challenger. We assume that the incumbent can remain in office with probability p if the people support him, and with probability q if the people support the challenger, where $0 \leq q \leq p \leq 1$. We measure the quality of the democratic institutions by $D \equiv p - q$. This measure suggests that the democratic institutions are of high quality when the incumbent is likely to stay in office if and only if the people want him to stay. The quality of the democratic institutions D is low if the people's vote has little impact on the chances that the incumbent can stay in office. This measure allows for different types of poor democratic institutions or democratic failures, respectively: The high q-failure that an authoritarian incumbent is likely to stay in office even without the people's support, and the low p-failure that an incumbent in an anarchic environment is likely to be overthrown even when supported by the majority.[11]

The appropriate solution concept for our dynamic game of incomplete information is perfect Bayesian equilibria (PBE).

[7] This assumption is made for simplicity only. Results would remain qualitatively unchanged if there were more than two periods, e.g., an infinite number of periods.

[8] The reason for directly assuming that production decreases in corruption rather than explicitly modeling labor-leisure choices or investment decisions is that these richer models would require more notation and additional steps of analysis without yielding additional interesting insights on the interrelations between natural resources, democracy and corruption.

[9] To motivate this tie-breaking rule, we could, e.g., assume that there is a very small probability $\varepsilon \to 0$ that the challenger is a complete maniac who would set $c_2 = 1$ such that $W_2 = 0$.

[10] This similarity is not surprising given that we follow common practice and model grand corruption as a tax for which no public good is provided.

[11] We consider this novel approach of modeling democratic institutions to be intuitively appealing and sufficiently general to allow for various reasons why incumbents are sometimes overthrown even when supported by the people, and why they can sometimes stay in office without the people's support. In the real world, autocrats who manage to stay in power despite being disliked by the people often bribe the military or other powerful groups. In Appendix A.2, we therefore study an extended version of our model in which the incumbent can bribe the military to increase the probability that he can stay in office even if the people do not support him. This extended version yields predictions that are qualitatively similar to those from our baseline model.

3. The equilibrium

We use backward induction and start by solving the period two subgame. The politician who is in office in period two has no strategic incentives and simply chooses the level of corruption c_2 that maximizes his instantaneous utility $u_2 = u(c_2;\theta)$. A good politician in office benefits more from high welfare W_t than from high corruption revenues Π_t since $\overline{\theta}>1$. He therefore chooses $c_2(\overline{\theta})=0$. A bad politician in office, who cares more about Π_t since $\underline{\theta}<1$, chooses $c_2(\underline{\theta})=\hat{c}\equiv \text{argmax}_{c_t} u(c_t;\underline{\theta})$. It follows:

Lemma 1. *In period two, a good politician in office chooses $c_2(\overline{\theta})=0$ and a bad politician in office chooses $c_2(\underline{\theta})=\hat{c}$, where $\hat{c}$ satisfies $\hat{c}\in(0,1)$, increases in Ω and decreases in $\underline{\theta}$.*

Proof. It follows from Eq. (1), $\overline{\theta}>1$ and $A'(c_t)\leq 0$ that $c_2(\overline{\theta})=0$. The first-order condition $(1-\underline{\theta})[A(c_t)+\Omega]+[c_t+\underline{\theta}(1-c_t)]A'(c_t)=0$ determines $\hat{c}$. Note that $A'(0)=0$ and $A'(1)=-\infty$ guarantee an interior solution $\hat{c}\in(0,1)$; and that the second-order condition $\Gamma(c_t)\equiv 2(1-\underline{\theta})A'(c_t)+[c_t+\underline{\theta}(1-c_t)]A''(c_t)<0$ is satisfied since $\underline{\theta}\in(0,1)$, $A'(c_t)\leq 0$ and $A''(c_t)<0$. The implicit function theorem implies $d\hat{c}/d\Omega=-(1-\underline{\theta})/\Gamma(\hat{c})$ and $d\hat{c}/d\underline{\theta}=-((1-\hat{c})A'(\hat{c})-[A(\hat{c})+\Omega])/\Gamma(\hat{c})$. It follows from $\underline{\theta}<1$, $A'(\hat{c})\leq 0$ and $\Gamma(\hat{c})<0$ that $d\hat{c}/d\Omega>0$ and $d\hat{c}/d\underline{\theta}<0$. □

Lemma 1 shows that a bad politician in office chooses a higher level of corruption in period two, the less he benefits from social welfare. Moreover, the level of corruption that he chooses increases in the resource rent Ω. To understand why, note that a higher level of corruption benefits a bad politician by allowing him to grab a higher share of the total income $A_t+\Omega$, but harms him by decreasing domestic production A_t and thereby the total income. The larger the corruption-independent resource rent Ω is, the less he cares about this decrease in A_t. The level of corruption $\hat{c}$ that maximizes his instantaneous utility thus increases in Ω.

When deciding whom to support at the end of period one, the people know that their welfare W_2 in period two will be higher with a good politician in office than with a bad politician in office. Hence they support the incumbent if and only if they believe that he is good with a higher probability than the challenger. That is, they support the incumbent if and only if their belief that he is good is $\mu(\overline{\theta}|c_1)\geq\alpha$.

In period one, a good incumbent has two objectives when choosing the level of corruption c_1. First, he would like his instantaneous utility $u(c_1;\overline{\theta})$ to be high. Second, he would like to ensure the people's support. Notice that $u(c_1;\overline{\theta})$ is maximized by $c_1(\overline{\theta})=0$; and that in any PBE a good incumbent gets reelected whatever his equilibrium choice $c_1(\overline{\theta})$ is, because Bayes' rule implies that the people's beliefs must satisfy $\mu(\overline{\theta}|c_1(\overline{\theta}))\geq\alpha$ for all possible $c_1(\overline{\theta})$ and $c_1(\underline{\theta})$. Therefore, in equilibrium a good incumbent also receives the people's support when choosing his most preferred corruption level $c_1(\overline{\theta})=0$. It seems thus reasonable to focus on PBE in which he plays $c_1(\overline{\theta})=0$.[12]

Given that a good incumbent plays $c_1(\overline{\theta})=0$, a bad incumbent is supported by the people whenever he plays $c_1(\underline{\theta})=0$, as the people then believe $\mu(\overline{\theta}|0)\geq\alpha$. However, in equilibrium a bad incumbent does not get the people's support when he plays some $c_1(\underline{\theta})>0$, as the people then know that he must be a bad incumbent, i.e., $\mu(\overline{\theta}|c_1(\underline{\theta}))=0$. But when he is not supported by the people anyway, it is best for him to choose the level of corruption that maximizes his instantaneous utility $u(c_1;\underline{\theta})$. This level is $c_1(\underline{\theta})=\hat{c}$. His expected lifetime utility from choosing $c_1(\underline{\theta})=\hat{c}$ and not being supported is $V(\hat{c};\underline{\theta})=(1+q)u(\hat{c};\underline{\theta})$,while his expected lifetime utility from choosing $c_1(\underline{\theta})=0$ and getting the people's support is $V(0;\underline{\theta})=u(0;\underline{\theta})+pu(\hat{c};\underline{\theta})$. He is better off choosing $c_1(\underline{\theta})=0$ if and only if

$$\Delta V(\underline{\theta})\equiv V(\hat{c};\underline{\theta})-V(0;\underline{\theta})=(1-D)u(\hat{c};\underline{\theta})-u(0;\underline{\theta})\leq 0, \tag{2}$$

or, equivalently, if and only if $D\geq D'\equiv(u(\hat{c};\underline{\theta})-u(0;\underline{\theta}))/u(\hat{c};\underline{\theta})$, where $0<D'<1$.[13] To summarize:

Proposition 1. *There exists a PBE in which a good incumbent chooses $c_1(\overline{\theta})=0$, a bad incumbent chooses $c_1(\underline{\theta})=0$ if $D\geq D'$ and $c_1(\underline{\theta})=\hat{c}$ otherwise, and the people support the incumbent if and only if $c_1=0$. There exists no other PBE with $c_1(\overline{\theta})=0$.*

Appendix A.1 shows that this is the unique PBE satisfying a plausible refinement on the people's off-equilibrium beliefs. We thus focus on this PBE in the remainder of this section.

The PBE described in Proposition 1 is pooling if $D\geq D'$, and separating otherwise. The reason for the former is that a bad incumbent mimics a good incumbent to ensure the people's support if democratic institutions are sound and the people's support therefore important for staying in office. He has, however, little disadvantage from revealing his bad type if the people have little impact on whether or not he can stay in office. He thus chooses the high corruption level $\hat{c}$ if democratic institutions are poor.

We now analyze how an increase in the resource rent Ω affects corruption $c_1(\theta)$ in the PBE described above, and how this effect depends on the democratic institutions D. Since a good incumbent always chooses $c_1(\overline{\theta})=0$, we focus on the level of corruption $c_1(\underline{\theta})$ that a bad incumbent chooses. When democratic institutions are relatively sound, i.e., when $D\geq D'$, a bad incumbent chooses $c_1(\underline{\theta})=0$ and a marginal increase in Ω has therefore no effect on corruption. But when $D<D'$, a bad incumbent chooses $c_1(\underline{\theta})=\hat{c}$, which increases in Ω as we know from Lemma 1. Hence:

[12] As we show in Appendix A.1, a good incumbent plays $c_1(\overline{\theta})=0$ in any PBE that satisfies a plausible refinement on the people's off-equilibrium beliefs. Also a good incumbent would always choose zero corruption if we assumed that he receives a sufficiently high disutility from acting corruptly.

[13] In the special case in which $D=D'$, a bad incumbent is indifferent between 0 and $\hat{c}$.

Proposition 2. *A marginal increase in the resource rent Ω raises corruption $c_1(\underline{\theta})$ if and only if $D<D'$*, i.e., *if and only if the democratic institutions are relatively poor.*

It holds even more generally that the effect of the resource rent Ω on corruption depends on the democratic institutions D. In particular, the effect of Ω on the relative attractiveness of high corruption, as measured by $\Delta V(\underline{\theta})$, is decreasing in D and positive if and only if D is sufficiently low.[14] The reason is that the positive effect of Ω on $V(0;\underline{\theta})$ increases in p, while the positive effect of Ω on $V(\hat{c};\underline{\theta})$ increases in q.

Therefore, our model predicts that when looking at a sample of countries differing in various aspects including the quality of their democratic institutions, we should expect the effect of resource rents on corruption to be negative in countries with poor democratic institutions, but neutral or even positive in countries with strong democratic institutions.

4. Empirical strategy and data

We use panel data which covers 124 countries over the period 1980–2004.[15] Our basic specification uses five year averages of our measures of corruption, natural resources, democracy and income. To estimate whether the relationship between natural resources and corruption varies systematically with the quality of the democratic institutions, we use the following model:

$$CI_{srt} = \alpha_r + \beta_t + \gamma_1 RR_{srt} + \gamma_2 D_{srt-5} + \gamma_3 (D_{srt-5} \times RR_{srt}) + \phi Y_{srt} + X'_{srt}\,\Lambda + \varepsilon_{srt}, \tag{3}$$

where CI_{srt} is the corruption index in country s in region r averaged over the years $t-4$ to t, α_r is a region dummy variable covering seven regions of the world which controls for regional fixed effects,[16] β_t is a year dummy variable which controls for time varying common shocks, RR_{srt} is a measure of resource rents in country s in region r averaged over the years $t-4$ to t, D_{srt-5} is a measure of democracy in country s in region r averaged over the years $t-9$ to $t-5$, Y_{srt} is log per capita income in country s in region r averaged over years $t-4$ to t, and X_{srt} is a vector of other control variables.

The point estimate of the effect of a change in RR_{srt} on CI_{srt} is $\gamma_1 + \gamma_3 D_{srt-5}$. Therefore we focus on the coefficients γ_1 and γ_3. Given that high values of the corruption index CI_{srt} correspond to low levels of corruption, and that we scale our democracy measure D_{srt-5} such that it is zero for the least democratic countries, we expect γ_1 to be significantly negative and γ_3 to be significantly positive. This would imply that there is a threshold level of D_{srt-5} below which the effect of RR_{srt} on CI_{srt} is negative (implying more corruption), and above which this effect is positive (implying less corruption).

We use the corruption index (CI_{srt}) from the Political Risk Services (PRS). This measure is predominantly an assessment of corruption within the political system, and it covers most common forms of corruption.[17] The advantages of using this measure are threefold. First, it suits our purpose as it best captures our notion of corruption in the theoretical model in which corruption is part of the political process. Second, it covers the time period 1980–2004 and has the largest number of observations.[18] This allows us to use panel data and minimizes the sample selection bias both across countries and over time. Third, it is also widely used in the literature (e.g., Knack and Keefer, 1995; Alesina and Weder, 2002). The PRS corruption index varies between 0 and 6, with higher values indicating lower levels of corruption. Averaged over the sample period, the Democratic Republic of Congo was the most corrupt country with an average value of CI_{srt} of 0.6, and Finland was the least corrupt country with an average value of CI_{srt} of 6.0.

Our main natural resource measure RR_{srt} is the log per capita rent from energy, minerals and forestry taken from the World Bank's adjusted net savings dataset, which is described by Hamilton and Clemens (1999).[19] The rent from a particular commodity is defined as the difference between its world price and the average extraction costs both expressed in current US dollars. The world price of a particular commodity is global and it only varies over time. The extraction costs, however, are variable over time and across countries. We calculate total rents accruing from all natural resources covered in the dataset by following a three step procedure. First, we multiply the natural resource rent per unit of output of a particular commodity by the total volume of that commodity extracted. Second, we aggregate them across commodities for a country and a particular year and we divide the aggregate resource rent by population size. Third, we average the per capita rents for five year periods and take the natural logarithm to smooth out any noise in the data. Averaged over the sample period, Madagascar has the lowest per capita resource rent with an average value of RR_{srt} of 1.6, and the United Arab Emirates the highest with an average value of RR_{srt} of 16.0.

We choose RR_{srt} as our preferred measure of natural resources for the following reasons. First, it is consistent with our theoretical model in which Ω_t is a resource rent. Second, it is best able to bypass the endogeneity related concerns

[14] To see this, notice that $du(\hat{c};\underline{\theta})/d\Omega = \hat{c} + \underline{\theta}(1-\hat{c})$ and $du(0;\underline{\theta})/d\Omega = \underline{\theta}$. Eq. (2) thus implies $d\Delta V(\underline{\theta})/d\Omega = (1-\underline{\theta})\hat{c} - D[\hat{c} + \underline{\theta}(1-\hat{c})]$, such that $d^2\Delta V(\underline{\theta})/d\Omega\, dD < 0$, and that $d\Delta V(\underline{\theta})/d\Omega > 0$ if and only if $D < (1-\underline{\theta})\hat{c}/((1-\underline{\theta})\hat{c} + \underline{\theta})$.

[15] Due to data limitations, not all specifications cover exactly 124 countries and in most specifications, the panel is unbalanced.

[16] The region dummies cover Europe and Central Asia, East Asia and the Pacific, Latin America, Western Europe and North America, the Middle East and North Africa, South Asia, and Sub Saharan Africa.

[17] For example, patronage, nepotism, job reservations, secret party funding, bribes connected with export and import licenses, exchange controls, tax assessments, police protection, loans, etc.

[18] Even though the corruption perception index from Transparency International covers more countries than the PRS, the actual number of observations is much lower. We use the corruption perception index to test the robustness of our findings.

[19] Energy resources are oil, gas, hard coal and soft coal. Minerals are bauxite, copper, lead, nickel, phosphate, tin, zinc, gold, silver and iron ore.

Table 1
Summary statistics.

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Corruption index (CI_{srt})	759	3.046	1.444	0	6
Natural resources (RR_{srt})	1171	10.12	2.694	−0.911	16.93
Democracy lagged (D_{srt-5})	1573	0.507	0.368	0	1
$D_{srt-5} * RR_{srt}$	1051	5.108	4.146	−0.164	16.28
Income (Y_{srt})	1684	7.669	1.363	4.081	10.87

associated with measures of primary exports as a share of GNP or total exports, such as the popular Sachs and Warner (1995) measure. These measures are likely to be endogenous as corruption negatively affects investment and production (Mauro, 1995) and, consequently, the denominator of these measures.[20] Third, RR_{srt} is fairly wide in terms of country coverage. Therefore we are able to minimize the risk of sample selection bias. It also provides a reasonably long time dimension. Fourth, these data on resource rents are used in a number of recent studies (e.g., Ross, 2006; Collier and Hoeffler, 2009). Nevertheless, we conduct robustness tests using alternative resource measures.

Our democracy measure D_{srt-5} is calculated using the Polity IV database, which is described by Marshall and Jaggers (2002). This database reports democracy and autocracy scores, which both vary between 0 and 10 with 10 being the most democratic or most autocratic, respectively. The democracy score measures competition and openness in the electoral process, and the autocracy score measures suppression of competitiveness over executive recruitment, lack of constraints on the executive, and regulation of participation. Note that the democracy and autocracy scores do not have any categories in common. The POLITY2 score is the difference between the democracy and autocracy scores. We average the POLITY2 scores over the period $t-9$ to $t-5$, and we scale these averages such that our democracy measure D_{srt-5} ranges from 0 to 1, with higher values implying better democratic institutions. Averaged over the sample period, Qatar and Saudia Arabia are the least democratic countries with average values of D_{srt-5} of 0. There are various countries with an average value of 1 including the resource-rich democracies Australia and Norway.

The democracy measure D_{srt-5} suits our purpose for the following reasons. First, it is perhaps able to address the endogeneity related concerns better than other measures of democracy since it is a lagged measure. Even though less corrupt countries are likely to be more democratic, it is less likely that corruption in time t will affect democracy in time $t-5$. Nevertheless, we also employ the instrumental variable method of estimation. Second, as a net measure of democracy, D_{srt-5} is best able to capture our notion of democracy in the theoretical model. There, democracy is defined as the difference between p and q which is an indicator of net democracy. Third, D_{srt-5} is ordinal and therefore allows us to distinguish between different shades of democracy. As there is little consensus in the literature on how the quality of democratic institutions is best measured, we discuss the robustness of our results to the use of alternative measures in the next section.

Further we also use log per capita income, legal origin dummies, and various additional control variables. Appendix B.1 contains definitions and sources of all variables used, and Table 1 reports descriptive statistics of the major variables.

Finally, there are concerns of multi-collinearity and omitted variables that we need to address in our estimation. First, there is a possibility that a high correlation between RR_{srt} and D_{srt-5} could inflate the standard errors of our estimates. Ross (2001) documents that natural resource abundance and oil in particular has antidemocratic properties. This may raise issues of multi-collinearity in our specification. We find that the correlation between RR_{srt} and D_{srt-5} is −0.03, and the correlation between RR_{srt} and $D_{srt-5} \times RR_{srt}$ 0.24. The magnitudes of these correlations are not large enough to cause any serious problem of multi-collinearity. Second, we tackle the issue of omitted variables by controlling for unobserved region specific heterogeneity, time varying common shocks and additional covariates that are expected to influence the level of corruption.

5. Empirical evidence

Table 2 reports the estimate of Eq. (3). In column 1 we start by looking at the effects of natural resources and income on the corruption index CI_{srt}. We notice a statistically significant negative effect of the resource rent RR_{srt}. This suggests that natural resources are associated with higher levels of corruption (as higher values of CI_{srt} imply less corruption). But this association may be driven by omitted factors influencing both natural resources and corruption. To tackle this issue in columns 2 and 3 we add legal origin dummies, regional dummies, year dummies, and the lagged democracy measure D_{srt-5}. We notice that the negative relationship survives but the magnitude of the coefficient falls. In column 4 we present our baseline regression. We add the interaction term $D_{srt-5} \times RR_{srt}$ to estimate how the effect of natural resources on

[20] Another potential source of endogeneity is reverse causality between CI_{srt} and RR_{srt}. The average extraction costs which are a component of RR_{srt} include transportation costs. Corruption in year t could affect transportation costs in year t, which raises concerns of endogeneity. However, corruption in year t may not affect transportation costs in year $t-5$. Therefore, we also used lagged resource rents. Our main results remained highly significant. (Results are available upon request.)

Table 2
Natural resources, democracy and corruption.

	Dependent variable: corruption index (CI_{srt})						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Resource rent (RR_{srt})	−0.158***	−0.092**	−0.063**	−0.168***	0.042	−0.199***	−0.919
	(0.028)	(0.031)	(0.030)	(0.046)	(0.061)	(0.050)	(2.296)
Democracy lagged (D_{srt-5})			1.216***	−0.740	0.532	−1.325*	−17.04
			(0.0124)	(0.681)	(0.804)	(0.792)	(69.21)
$D_{srt-5} * RR_{srt}$				0.181***	−0.004	0.237***	1.648
				(0.059)	(0.072)	(0.064)	(4.475)
Income (Y_{srt})	0.787***	0.591***	0.514***	0.579***	−0.568**	0.593***	0.869
	(0.068)	(0.118)	(0.101)	(0.094)	(0.229)	(0.094)	(1.950)
Controls							
Legal origins	No	Yes	Yes	Yes	No	Yes	Yes
Country dummies	No	No	No	No	Yes	No	No
Region dummies	No	Yes	Yes	Yes	No	Yes	Yes
Year dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Instruments						Democracy twice lagged (D_{srt-10}), and $D_{srt-10} * RR_{srt}$	Settler mortality (SM_{sr}), and $SM_{sr} * RR_{srt}$
Countries	130	127	124	124	126	124	58
Observations	670	658	643	643	650	641	329
Adjusted R^2	0.34	0.94	0.94	0.94	0.83	–	–

***, **, and * indicate significance level at 1%, 5%, and 10%, respectively, against a two sided alternative. Figures in parentheses are clustered standard errors and they are robust to arbitrary heteroskedasticity and arbitrary intra-group correlation. All regressions except column (1) are carried out without an intercept. Sample years are every fifth year from 1980 to 2004. In column (6) D_{srt-10} and $D_{srt-10} * RR_{srt}$ are used as instruments for D_{srt-5} and $D_{srt-5} * RR_{srt}$. In column (7) SM_{sr} and $SM_{sr} * RR_{srt}$ are used as instruments for D_{srt-5} and $D_{srt-5} * RR_{srt}$.

corruption depends on the quality of the democratic institutions. We notice that the coefficient on RR_{srt} is negative and statistically significant, and the coefficient on the interaction term positive and statistically significant. This confirms the predictions of our theoretical model. In an average country, resource rents feed corruption unless the net democracy score D_{srt-5} is above the threshold level of 0.93, which corresponds to an average POLITY2 score of 8.6. In 2004 the resource-rich countries Bolivia and Mexico had a POLITY2 score of 8, and resource-rich Botswana POLITY2 score of 9.

To put the results from our baseline regression into perspective, let us focus on Angola—a resource-rich country ($RR_{AGO2004} = 14.20$) with poor democratic institutions ($D_{AGO2000} = D_{AGO2004} = 0.35$, i.e. a POLITY2 score of −3) and high corruption ($CI_{AGO2004} = 2$). Suppose first that Angola's resource rent dropped to zero (while all other explanatory variables remained unchanged). Our model predicts that Angola's corruption index would then increase by one standard deviation from 2.0 to almost 3.5. Suppose second that the quality of Angola's democratic institutions increased to match the quality of Botswana's democratic institutions (while all other explanatory variables remained unchanged). Our model predicts that Angola's corruption index would then increase to a value even slightly above 3.5.[21] These simple examples illustrate that resource rents tend to raise corruption unless the democratic institutions are sufficiently sound.

In column 5 we add country fixed effects to our baseline specification. We find the coefficients of interest are close to zero and statistically insignificant (while income enters significantly but with the "wrong" sign). This finding implies that our main results are primarily driven by cross-country variations, while within-country variations play a minor role.[22] This is not surprising given that the explanatory variables D_{srt-5} and RR_{srt} change only slowly over time, and that the time dimension of our data matrix is much smaller (only a few time periods per country) relative to the cross-section dimension (124 countries in our baseline regression). Nevertheless, insignificance in the presence of country fixed effects could also result from omitting country-specific factors that affect the divergent corruption levels across countries. We address this concern in Table 4, where we show that our coefficients of interest remain statistically significant when controlling for many additional covariates of corruption. In addition, we also employ two empirical techniques that have been designed as alternatives to conventional fixed effects for cases in which the focal independent variables are only changing slowly over time. These two techniques are the least squares dummy variables approach that Collier and Hoeffler (2009) use based on

[21] These results follow from $(-0.168 + 0.181 \times D_{AGO2000}) \times RR_{AGO2004} = -1.486$ and $(-0.168 + 0.181 \times D_{BWA2000}) \times RR_{AGO2004} = 0.056$.

[22] It is standard in the resource curse literature (e.g., Sachs and Warner, 1995, 2001; Gylfason, 2001; Leite and Weidmann, 2002; Isham et al., 2005; Hodler, 2006; Mehlum et al., 2006; Brunnschweiler and Bulte, 2008) as well as in the literature on the determinants of corruption and governance (e.g., La Porta et al., 1999; Treisman, 2000) that empirical findings are based on cross-country variations. A notable exception to the resource curse literature is the recent contribution by Collier and Goderis (2008) who employ a panel cointegration approach.

Hendry et al. (2004), and the fixed effects vector decomposition approach of Plümper and Troeger (2007). When using these techniques, we find that our coefficients of interest are statistically significant at least at the 10% level. These coefficients are also significant when we estimate a random effects model.[23]

Another potential concern is that our democracy measure D_{srt-5} could be endogenous. However, the endogeneity problem should not be too serious because D_{srt-5} is a lagged democracy measure and therefore less likely to be endogenous than contemporary measures.[24] Moreover, as we discuss below, our results also hold when we use long-run measures of democracy, which are even less likely to be endogenous. Nevertheless, we address the potential endogeneity of our democracy measure D_{srt-5} and the interaction term $D_{srt-5} \times RR_{srt}$ by employing the instrumental variable approach. The instruments need to be correlated to D_{srt-5} and $D_{srt-5} \times RR_{srt}$, respectively, and also orthogonal to the error term. As it is often the case, finding strong and valid instruments is not an easy task. In column 6 we use the twice lagged democracy measure D_{srt-10} and the interaction term $D_{srt-10} \times RR_{srt}$ as instruments. These instruments are highly correlated to D_{srt-5} and $D_{srt-5} \times RR_{srt}$, and it is plausible that they are orthogonal to the error term. We notice that the coefficients of interest remain highly significant when we use these instruments.

In column 7 we alternatively use settler mortality and its interaction term with RR_{srt} as instruments. Acemoglu et al. (2001) show that settler mortality is a valid instrument for property rights institutions, such as constraints on the executive. In their more recent work they show that better property rights institutions led to expansion of the franchise and better democratic institutions (Acemoglu et al., 2008). Therefore, it is reasonable to follow some recent studies (e.g., Collier and Hoeffler, 2009) and to use settler mortality (and its interaction with RR_{srt}) to instrument for democracy measures such as D_{srt-5} (and its interaction with RR_{srt}). There are, however, some drawbacks associated with the use of settler mortality as an instrument. First, it eliminates all countries that were not subject to European colonization from the sample. This leads to a drastic reduction in the sample size and the exclusion of most established democracies among the resource-rich countries. Furthermore, settler mortality is only available as a cross-section, which magnifies the problem of multi-collinearity at the second stage. It is therefore not surprising that the standard errors become so large that the coefficients of interest are no longer statistically significant, while still showing the predicted signs.[25]

Table 3 asks the question of where this nonlinear effect of natural resources on corruption comes from. In column 1 we test whether the effect is driven by a particular time period. We do this by allowing the interaction term $D_{srt-5} \times RR_{srt}$ to be different across time and we estimate separate year effects. We notice that the effect is uniform in terms of statistical significance over the period 1980–2004, while its magnitude tends to decline over time. In column 2 we test whether the effect is predominant among any particular country group. Again we do this by allowing the effect to vary across different country groups based on income. We notice that the effect is uniform across all country-income groups. In column 3 we show that the same holds true if we allow the interaction term to differ for OECD and non-OECD countries.

In Table 4 we add additional covariates into our specification to address the issue of omitted variables. Treisman (2000) finds that countries with Protestant traditions and histories of British rule tend to be less corrupt (see also Fan et al., 2009). We therefore add the share of the population that is Protestant and a dummy for countries with British colonial origin in columns 1 and 2, respectively. In column 3 we add ethnic fractionalization as an additional control because ethnically fractionalized countries tend to be more corrupt (Mauro, 1995) and because the effects of natural resources may depend on ethnic fractionalization (Hodler, 2006). In columns 4–10 we control for official development assistance (ODA), real exchange rate distortions, black market premium, FDI, the Sachs and Warner trade liberalization index, trade shares, and media freedom to check whether these omitted variables might be driving our results. Our main results survive in all instances except that the positive coefficient on $D_{srt-5} \times RR_{srt}$ becomes insignificant when we control for ODA. This is not surprising as controlling for aid inflows eliminates all the resource-rich developed democracies from the sample and the residual resource-rich countries are mainly non-democracies. In column 11 we control for the statistically significant additional control variables, which are the Sachs and Warner trade liberalization index and media freedom, and our main results survive this test. We also notice that barring column 2, the estimated threshold levels of D_{srt-5} for a positive effect of RR_{srt} on CI_{srt} are not significantly different from our preferred estimate of 0.93. (Formal F-tests are reported in Table 4.)

Table 5 presents robustness results with alternative samples. Columns 1–5 check whether our results are influenced by any particular continent. We take out Africa, Neo-Europe,[26] Asia, the Americas, and Europe one at a time from our base sample. Our results remain highly significant except that the positive coefficient on $D_{srt-5} \times RR_{srt}$ becomes marginally insignificant (with a p-value of 0.11) when European countries are excluded. This may be because omitting European countries from the base sample automatically eliminates some of the major resource-rich democracies. In columns 6–8 we omit former British colonies, former French colonies, and former Spanish colonies one at a time. Our main results remain again unaffected. In columns 9–11 we omit influential observations using Cook's distance, DFITS, and Welsch distance formulas, respectively. Our results survive these tests.

[23] Results are not reported here to save space but are available upon request.

[24] In addition, Harrison (2008) shows that the bias of OLS is reduced when an endogenous variable is interacted with a continuous exogenous variable. The bias of the coefficient on $D_{srt-5} \times RR_{srt}$ should thus be rather small even if D_{srt-5} is endogenous.

[25] The coefficients of interest remain statistically significant if we only use the interaction term of settler mortality and RR_{srt} to instrument for $D_{srt-5} \times RR_{srt}$.

[26] Neo-Europe includes all Anglo-Saxon countries outside Europe: Australia, Canada, New Zealand, and the United States.

Table 3
Natural resources, democracy and corruption across time and income.

	Dependent variable: corruption index (CI_{srt})		
	(1)	(2)	(3)
Resource rent (RR_{srt})	−0.192**	−0.162***	−0 144***
	(0.044)	(0.051)	(0.044)
Democracy lagged (D_{srt-5})	−1.180*	−0.695	−0.139
	(0676)	(0.817)	(0.736)
$D_{srt-5} * RR_{srt} *$ Year1980	0.309***		
	(0.065)		
$D_{srt-5} * RR_{srt} *$ Year1985	0. 244***		
	(0.063)		
$D_{srt-5} * RR_{srt} *$ Year1990	0. 194***		
	(0.062)		
$D_{srt-5} * RR_{srt} *$ Year1995	0.195***		
	(0.062)		
$D_{srt-5} * RR_{srt} *$ Year2000	0.201***		
	(0.060)		
$D_{srt-5} * RR_{srt} *$ Year2004	0.147***		
	(0.055)		
$D_{srt-5} * RR_{srt} *$ High Income		0.181***	
		(0.062)	
$D_{srt-5} * RR_{srt} *$ Middle Income		0.172**	
		(0.077)	
$D_{srt-5} * RR_{srt} *$ Low Income		0.163*	
		(0.084)	
$D_{srt-5} * RR_{srt} *$ Very Low Income		0.199**	
		(0.090)	
$D_{srt-5} * RR_{srt} *$ OECD			0.181***
			(0.055)
$D_{srt-5} * RR_{srt} *$ Non − OECD			0.112*
			(0.065)
High Income		0.639	
		(0.419)	
Middle Income		0.364	
		(0.348)	
Low Income		0.292	
		(0.317)	
OECD			0.020
			(0.489)
Controls			
Income (Y_{srt})	Yes	Yes	Yes
Legal origins	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Countries	124	124	124
Observations	643	643	643
Adjusted R^2	0.94	0.94	0.94

***, **, and * indicate significance level at 1%, 5%, and 10%, respectively, against a two sided alternative. Figures in parentheses are clustered standard errors and they are robust to arbitrary heteroskedasticity and arbitrary intra-group correlation. All the regressions reported above are carried out without an intercept. Sample years are every fifth year from 1980 to 2004. High Income is a dummy for per capita GDP in 2000 being 10,000 constant 1996 international dollars or more; Middle Income for between 5,000 and 10,000; Low Income for between 2,500 and 5,000; Very Low Income for less than 2,500.

We also test whether the coefficients of interest remain significant when we use alternative measures of corruption, natural resources and democracy. We use the corruption perception index from Transparency International as an alternative measure of corruption. As an alternative measure of natural resources we use log per capita rents from energy and minerals. That is, we exclude the rents from forestry, which might be endogenous because forestry is a renewable resource and hence involves production. We also use primary exports shares, which have been used by Sachs and Warner (1995) and many others, and log per capita natural capital from the World Bank, which has recently been used by Brunnschweiler and Bulte (2008).[27]

We use many alternative measures of democracy. First, we use the lagged democracy score from the Polity IV dataset (without subtracting the autocracy score), and the lagged democracy index from Freedom House, which are alternative

[27] Natural capital was first used as a proxy measure of natural resources by Gylfason (2001).

Table 4
Natural resources, democracy and corruption: robustness with additional covariates.

	Dependent variable: corruption index (CI_{srt})										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Resource rent (RR_{srt})	−0.182***	−0.168***	−0.173***	−0.139***	−0.162***	−0.173***	−0.179***	−0.184***	−0.177***	−0.177***	−0.195***
	(0.046)	(0.048)	(0.046)	(0.043)	(0.061)	(0.056)	(0.057)	(0.049)	(0.051)	(0.049)	(0.0269)
Democracy lagged (D_{srt-5})	−0.838	−0.555	−0.757	0.359	−0.490	−0.823	−0.820	−1.146	−0.703	−0.615	−0.915
	(0.682)	(0.711)	(0.685)	(0.744)	(0.799)	(0.800)	(0.786)	(0.709)	(0.742)	(0.684)	(0.727)
$D_{srt-5} * RR_{srt}$	0.179***	0.179***	0.181***	0.050	0.163**	0.202***	0.188***	0.199***	0.180***	0.186***	0.202***
	(0.059)	(0.061)	(0.059)	(0.062)	(0.074)	(0.069)	(0.070)	(0.065)	(0.063)	(0.060)	(0.067)
F-test (p-value) of $H_0 : -\gamma_1/\gamma_3 = 0.93$	[0.69]	[0.98]	[0.90]	–	[0.79]	[0.70]	[0.91]	[0.96]	[0.79]	[0.92]	[0.84]
Controls											
Income (Y_{srt})	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Legal origins	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Share protestant	British colonial origin	Ethnic fractional.	Official develop. assistance	Real exchange rate distortion	Black market premium	FDI	S & W trade lib. index (+***)	Trade shares	Media freedom (−*)	All stat. significant additional controls
Countries	120	102	122	103	87	116	116	113	122	124	113
Observations	625	576	633	499	482	448	595	587	615	641	585
Adjusted R^2	0.94	0.94	0.94	0.91	0.94	0.94	0.94	0.94	0.94	0.94	0.94

***, **, and * indicate significance level at 1%, 5%, and 10%, respectively, against a two sided alternative. Figures in parentheses are clustered standard errors and they are robust to arbitrary heteroskedasticity and arbitrary intra-group correlation. All the regressions reported above are carried out without an intercept. Sample years are every fifth year from 1980 to 2004. In column 11, we include all statistically significant additional controls which are the Sachs and Warner trade liberalization index and media freedom. F-test (p-value) is the test of the null hypothesis $H_0 : -\gamma_1/\gamma_3 = 0.93$ against a two sided alternative.

Table 5
Natural resources, democracy and corruption: robustness with alternative samples.

	Dependent variable: corruption index (CI_{srt})										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Resource rent (RR_{srt})	−0.181***	−0.141***	−0.181***	−0.164***	−0.167***	−0.176***	−0.174***	−0.165***	−0.224***	−0.215***	−0.207***
	(0.065)	(0.043)	(0.064)	(0.047)	(0.048)	(0.057)	(0.062)	(0.049)	(0.044)	(0.036)	(0.041)
Democracy lag. (D_{srt-5})	−0.992	−0.190	−0.985	−0.935	0.010	−0.252	−0.754	−0.753	−1.715***	−1.568***	−1.322**
	(1.002)	(0.687)	(0.821)	(0.728)	(0.825)	(0.862)	(0.865)	(0.715)	(0.561)	(0.577)	(0.661)
$D_{srt-5} * RR_{srt}$	0.201**	0.120**	0.167**	0.215***	0.122	0.142**	0.188**	0.218***	0.242***	0.232***	0.227***
	(0.080)	(0.059)	(0.076)	(0.063)	(0.076)	(0.072)	(0.074)	(0.061)	(0.049)	(0.050)	(0.057)
Controls	Income (Y_{srt}), legal origins, region dummies, year dummies										
Omitted observations	Base sample without Africa	Base sample without Neo-Europe	Base sample without Asia	Base sample without the Americas	Base sample without Europe	Base sample without British colonies	Base sample without French colonies	Base sample without Spanish colonies	Obs. omitted using Cook's distance	Obs. omitted using DFITS	Obs. omitted using Welsch distance
Countries	90	120	95	101	89	67	86	88	124	124	124
Observations	460	619	494	508	484	374	487	492	611	614	637
Adjusted R^2	0.95	0.94	0.94	0.94	0.92	0.95	0.94	0.94	0.95	0.95	0.94

***, **, and * indicate significance level at 1%, 5%, and 10%, respectively, against a two sided alternative. Figures in parentheses are clustered standard errors and they are robust to arbitrary heteroskedasticity and arbitrary intra-group correlation. All the regressions reported above are carried out without an intercept. Sample years are every fifth year from 1980 to 2004. In column 10, omit if $|Cooksd_i| > 4/n$; in column 11, omit if $|DFITS_i| > 2(k/n)^{1/2}$; and in column 12, omit if $|Welschd_i| > 3k^{1/2}$ formulas are used (see Belsley et al., 1980). Here n is the number of observation and k is the number of independent variables including the intercept. The influential observations according to the DFITS formula are AUS1980, BGD1980, BGD1985, BGD1990, CYP1985, ESP1980, GAB1995, HTI1980, IRL2000, IRQ2004, JPN1980, JPN2000, KOR1990, LBR1990, MDG2000, MNG1990, MYS1980, NIC1990, NZL1980, NZL2004, PHL1980, PHL1985, SDN1980, SYR1995, TTO1980, TWN1980, TZA1980, ZAF1980 and ZAF1985. The influential observations according to the Cook's Distance formula are all of the above plus NZL1985, SDN1985 and ZAR1990. Influential observations according to the Welsch Distance formula are MDG2000, MYS1980, PHL1980, SDN1980, TWN1980 and TZA1980.

ordinal measures of democracy. As some scholars argue that a simple dichotomy between democracy and non-democracy is the most appropriate empirical definition (e.g., Przeworski et al., 2000), we also use a dummy variable which is equal to 1 if a country was democratic in the year $t-5$, and equal to 0 if it was undemocratic.[28] A related view is that a longer-lived democratic experience is important (e.g., Treisman, 2000; Keefer, 2007). Therefore we further use two long-run measures of democracy based on the fraction of (consecutive) years between 1950 and $t-5$ in which a country has been democratic. We find that the coefficient on RR_{srt} is insignificantly different from zero when we use the lagged Freedom House democracy index instead of D_{srt-5}, but that the coefficients of interest remain statistically significant for any other of these alternatives measures of corruption, natural resources and democracy.[29]

Overall these empirical findings support our theoretical prediction that natural resources foster corruption in countries with poor democratic institutions, and they suggest that natural resources may even tend to reduce corruption in strong democracies.

6. Conclusions

We study the mechanism through which natural resources feed corruption and the role of democratic institutions in this process. Using a game-theoretic model we show that resource rents increase corruption if and only if the quality of the democratic institutions is below a certain threshold level. To test this prediction, we use a reduced form model and panel data covering the period 1980–2004 and 124 countries. We notice that our theoretical prediction is supported by the data. In particular, resource rents are positively associated with corruption only in countries that have POLITY2 scores of around 8.5 or less. Our main results hold when we control for the effects of income, time varying common shocks, regional fixed effects, legal origin and various additional covariates. It is also robust to various alternative measures of corruption, natural resources and the quality of democratic institutions.

These findings imply that resource-rich countries indeed have a tendency to be corrupt because resource windfalls encourage their governments to engage in rent-seeking. But as in the resource-rich democracies Australia and Norway, this tendency can be checked by sound democratic institutions that keep governments accountable to the people.

Acknowledgments

We gratefully acknowledge comments by and discussions with Aleksander Berentsen, John Braithwaite, Steve Dowrick, Michael Gerfin, Benedikt Goderis, Tim Hatton, Ranjan Ray, Jeffrey Williamson, two anonymous referees, and the editor Thorvaldur Gylfason. We would also like to thank seminar and conference participants at ISI Delhi, Monash University, RSSS (ANU), the Study Center Gerzensee, the University of Basel, the University of Heidelberg, and the University of St. Gallen for their comments. All remaining errors are our own.

Appendix A

A.1. Uniqueness

This appendix introduces a plausible refinement on the people's off equilibrium beliefs and shows that this refinement guarantees the uniqueness of the PBE characterized in Proposition 1.

Definition. The PSE refinement is satisfied when the people's belief after observing some $c_1=\tilde{c}$ which no incumbent $\theta\in\{\overline{\theta},\underline{\theta}\}$ should play in equilibrium is

1. $\mu(\overline{\theta}|\tilde{c})=1$ if playing $\tilde{c}$ is equilibrium-dominated[30] for $\underline{\theta}$, but not for $\overline{\theta}$; and $\mu(\overline{\theta}|\tilde{c})=0$ if playing $\tilde{c}$ is equilibrium-dominated for $\overline{\theta}$,but not for $\underline{\theta}$.
2. $\mu(\overline{\theta}|\tilde{c})=\alpha$ if playing $\tilde{c}$ is not equilibrium-dominated for any $\theta\in\{\overline{\theta},\underline{\theta}\}$.

Part 1 of this refinement is the Intuitive Criterion. Part 2 requires that the people's posterior beliefs about the incumbent's type should be equal to their prior beliefs when both types of incumbents could potentially benefit from a deviation $c_1=\tilde{c}$. This latter requirement relates our refinement to Grossman and Perry's (1986) concept of Perfect Sequential Equilibria.

[28] A country is considered to be democratic if its POLITY2 score is positive, and undemocratic otherwise.

[29] The regression results are reported in the working paper version of this paper (Bhattacharyya and Hodler, 2009).

[30] Playing $\tilde{c}$ is equilibrium-dominated for type θ if his equilibrium payoff strictly exceeds the highest possible payoff that he could possibly get after playing $\tilde{c}$.

Proposition 3. *The PBE characterized in Proposition* 1 *is the unique PBE that satisfies the PSE refinement.*

Proof. The PBE with $c_1(\overline{\theta}) = 0$ satisfies the PSE refinement, because beliefs $\mu(\overline{\theta}|c_1) = 0$ for all $c_1 > 0$ are consistent with this PBE, and because these beliefs satisfy the PSE refinement as deviating and playing some $c_1 > 0$ would be equilibrium-dominated for incumbent $\overline{\theta}$.

We next prove by contradiction that no other PBE satisfies the PSE refinement. Therefore, suppose there exists a PBE with $c_1(\overline{\theta}) > 0$ that satisfies the PSE refinement. To prevent incumbent $\overline{\theta}$ from deviating and playing $c_1 = 0$, it is necessary that the people support the challenger when observing $c_1 = 0$, which requires beliefs $\mu(\overline{\theta}|0) < \alpha$. But playing $c_1 = 0$ is never equilibrium-dominated for incumbent $\overline{\theta}$. The PSE refinement thus requires $\mu(\overline{\theta}|0) \geq \alpha$. This is a contradiction. Hence, there exists no PBE with $c_1(\overline{\theta}) > 0$ that satisfies the PSE refinement. □

A.2. Extended model

This appendix extends our model to allow the incumbent to bribe the military or some other powerful group to increase the probability that he can stay in office even without the people's support. We assume that when the incumbent pays a bribe $b \geq B$, he can stay in office with probability p independently of whether or not the people support him. When not paying $b \geq B$, the probability that he can stay in office is p if the people support him, and q if they do not support him. We still assume $0 \leq q \leq p \leq 1$, but readers may now want to think of q as being close to zero. The new parameter B measures how reluctant the military is to support a corrupt incumbent disliked by the people. Since better institutions generally foster this reluctance, we interpret B as another measure of the quality of the democratic institutions. Countries with sound democratic institutions are thus characterized by high D as well as high B.

In this extended model, a good incumbent still chooses zero corruption and has therefore no incentive to bribe the military. A bad incumbent now considers three strategies $(c_1(\underline{\theta}), b_1(\underline{\theta}))$ in period one: First, $(0,0)$ to imitate an honest incumbent, which leads to an expected lifetime utility of $V(0,0;\underline{\theta}) = u(0;\underline{\theta}) + pu(\hat{c};\underline{\theta})$. Second, $(\hat{c},0)$ to get the corruption revenues $\hat{c}$ in period one, which leads to $V(\hat{c},0;\underline{\theta}) = (1+q)u(\hat{c};\underline{\theta})$. Third, $(\hat{c},B)$ to get the corruption revenues $\hat{c} - B$ in period one without a decrease in the probability of staying in office, which leads to $V(\hat{c},B;\underline{\theta}) = (1+p)u(\hat{c};\underline{\theta}) - B$. It is easy to see that a bad incumbent chooses $(0,0)$ if $D \geq D'$ and $B \geq u(\hat{c};\underline{\theta}) - u(0;\underline{\theta})$; $(\hat{c},0)$ if $D < D'$ and $B \geq Du(\hat{c};\underline{\theta})$; and $(\hat{c},B)$ if $B < \min\{Du(\hat{c};\underline{\theta}), u(\hat{c};\underline{\theta}) - u(0;\underline{\theta})\}$. In equilibrium, a bad incumbent therefore chooses $c_1(\underline{\theta}) = \hat{c}$ if $D < D'$ or $B < u(\hat{c};\underline{\theta}) - u(0;\underline{\theta})$, and $c_1(\underline{\theta}) = 0$ otherwise. We know from Lemma 1 that a marginal increase in the resource rent Ω raises $\hat{c}$. Hence, as our baseline model, this extended model predicts that a higher resource rent raises corruption in countries with poor democratic institutions, but not in countries with sound democratic institutions.

Appendix B

B.1. Data description

Corruption index (CI_{srt}): A 7-point (0-6) index with higher values indicating less corruption. *Source:* ICRG, The PRS Group.

Resource rent (RR_{srt}): Log of the per capita rent from natural resources, which include energy, minerals and forestry, averaged over the period $t-4$ to t. Rents are defined as the world market price minus the average extraction costs. *Source:* Adjusted Net Savings Dataset, World Bank.

Democracy (D_{srt-5}): POLITY2 scores averaged over the period $t-9$ to $t-5$ and scaled such that it ranges from 0 to 1 with higher values indicating better democratic institutions. POLITY2 is defined as the difference between democracy and autocracy scores. *Source:* Polity IV.

Income (Y_{srt}): Log GDP per capita PPP in current international $. *Source:* WDI Online, World Bank.

Legal origins: Legal origin dummies—British, German, Scandinavian, and Socialist with others being the omitted category. *Source:* La Porta et al. (1999).

Share protestant: Percentage of population protestant in 1980. *Source:* La Porta et al. (1999)

British colonial origin: British colonial origin dummy. *Source:* Barro (1999).

Ethnic fractionalization: Probability that two randomly selected individuals from a country's population belong to different ethnic groups. *Source:* Alesina et al. (2003).

Trade share: Total volume of trade as share of GDP. *Source:* WDI Online, World Bank.

FDI: Net inflow of foreign direct investment as share of GDP. *Source:* WDI Online, World Bank.

Official development assistance: Log of official development assistance per capita by all donors. *Source:* WDI Online, World Bank.

Real exchange rate distortions: Real overvaluation. *Source:* WDI Online, World Bank.

Sachs and Warner trade liberalization index: Fraction of years open between $t-4$ and t. *Source:* Wacziarg and Welch (2003).

Black market premium. *Source:* WDI Online, World Bank.

Media freedom: Fraction of years print and electronic media have been free since 1980. *Source:* Freedom House.

Settler mortality (SM_{sr}): Log of estimated mortality of European settlers in colonies before 1850. *Source:* Acemoglu et al. (2001).

B.2. Baseline sample

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Colombia, Dem. Rep. Congo, Rep. Congo, Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Rep., Denmark, Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Gabon, The Gambia, Germany, Ghana, Greece, Guatemala, Guinea, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Rep. Korea, Kuwait, Latvia, Liberia, Lithuania, Madagascar, Malawi, Malaysia, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Papua New Guinea, Peru, The Philippines, Poland, Portugal, Qatar, Romania, Russian Fed., Saudi Arabia, Senegal, Serbia and Montenegro, Sierra Leone, Slovak Rep., Slovenia, Somalia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

References

Acemoglu, D., Johnson, S., Robinson, J., 2001. The colonial origins of comparative development: an empirical investigation. American Economic Review 91, 1369–1401.
Acemoglu, D., Johnson, S., Robinson, J., Yared, P., 2008. Income and democracy. American Economic Review 98, 808–842.
Ades, A., Di Tella, R., 1999. Rents, competition, and corruption. American Economic Review 89, 982–993.
Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., Wacziarg, R., 2003. Fractionalization. Journal of Economic Growth 8, 155–194.
Alesina, A., Weder, B., 2002. Do corrupt governments receive less foreign aid?. American Economic Review 92, 155–194.
Aslaksen, S., 2007. Corruption and oil: evidence from panel data. Unpublished Manuscript.
Baland, J.-M., Francois, P., 2000. Rent-seeking and resource booms. Journal of Development Economics 61, 527–542.
Barro, R., 1999. Determinants of democracy. Journal of Political Economy 107, S158–S183.
Belsley, D., Kuh, E., Welsch, R., 1980. Regressions Diagnostics: Identifying Influential Data and Sources of Collinearity. Wiley, New York.
Bhattacharyya, S., Hodler, R., 2009. Natural resources, democracy and corruption, OxCarre Research Paper 2009-20.
Brunnschweiler, C., Bulte, E., 2008. The resource curse revisited and revised: a tale of paradoxes and red herrings. Journal of Environmental Economics and Management 55, 248–264.
Bulte, E., Damania, R., 2008. Resources for sale: corruption, democracy and the natural resource curse. B.E. Journal of Economic Analysis & Policy 8 (1), Article 5 (Contributions).
Collier, P., Goderis, B., 2008. Commodity prices, growth, and the natural resource curse: reconciling a conundrum. OxCarre Research Paper 2008-14.
Collier, P., Hoeffler, A., 2009. Testing the neocon agenda: democracy in resource-rich societies. European Economic Review 53, 293–308.
Corden, W.M., Neary, P.J., 1982. Booming sector and de-industralization in a small open economy. Economic Journal 92, 825–848.
Fan, C.S., Lin, C., Treisman, D., 2009. Political decentralization and corruption: evidence from around the world. Journal of Public Economics 93, 14–34.
Grossman, S.J., Perry, M., 1986. Perfect sequential equilibrium. Journal of Economic Theory 39, 97–119.
Gylfason, T., 2001. Natural resources, education, and economic development. European Economic Review 45, 847–859.
Hamilton, K., Clemens, M., 1999. Genuine savings rates in developing countries. World Bank Economic Review 13, 333–356.
Harrison, T.D., 2008. On the bias and consistency of OLS for an endogenous interaction coefficient. Unpublished Manuscript.
Hendry, D., Johansen, S., Santos, C., 2004. Selecting a regression saturated by indicators. Unpublished Manuscript.
Hodler, R., 2006. The curse of natural resources in fractionalized countries. European Economic Review 50, 1367–1386.
Isham, J., Pritchett, L., Woolcock, M., Busby, G., 2005. The varieties of resource experience: natural resource export structures and the political economy of economic growth. World Bank Economic Review 19, 141–174.
Keefer, P., 2007. Clientelism credibility and the policy choices of young democracies. American Journal of Political Science 51, 804–821.
Knack, S., Keefer, P., 1995. Institutions and economic performance: cross-country tests using alternative institutional measures. Economics and Politics 7, 207–227.
Lane, P.R., Tornell, A., 1996. Power, growth and the voracity effect. Journal of Economic Growth 1, 213–241.
LaPorta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1999. The quality of government. Journal of Law, Economics and Organization 15, 222–279.
Leite, C., Weidmann, J., 2002. Does mother nature corrupt? Natural resources, corruption, and economic growth. In: Abed, G., Gupta, S. (Eds.), Governance, Corruption, and Economic Performance. IMF, Washington, DC, pp. 159–196.
Marshall, M., Jaggers, K., 2002. Polity IV Project: Political Regime Characteristics and Transitions, 1800–2002. University of Maryland.
Mauro, P., 1995. Corruption and growth. Quarterly Journal of Economics 110, 681–712.
Mehlum, H., Moene, K., Torvik, R., 2006. Institutions and the resource curse. Economic Journal 116, 1–20.
Plümper, T., Troeger, V.E., 2007. Efficient estimation of time-invariant and rarely changing variables in finite sample panel analyses with unit fixed effects. Political Analysis 15, 124–139.
Przeworski, A., Alvarez, M., Cheibub, J., Limongi, F., 2000. Democracy and Development: Political Institutions and Material Well-Being in the World, 1950–1990. Cambridge University Press, New York.
Robinson, J.A., Torvik, R., Verdier, T., 2006. Political foundations of the resource curse. Journal of Development Economics 79, 447–468.
Ross, M., 2001. Does oil hinder democracy?. World Politics 53, 325–361.
Ross, M., 2006. A closer look at oil, diamonds, and civil war. Annual Review of Political Science 9, 263–300.
Sachs, J.D., Warner, A.M., 1995. Natural resource abundance and economic growth. NBER Working Paper 5398.
Sachs, J.D., Warner, A.M., 2001. The curse of natural resources. European Economic Review 45, 827–838.
Sala-i-Martin, X., Subramanian, A., 2003. Addressing the natural resource curse: an illustration from Nigeria. NBER Working Paper 9804.
Treisman, D., 2000. The causes of corruption: a cross-national study. Journal of Public Economics 76, 399–457.
Tornell, A., Lane, P.R., 1999. The voracity effect. American Economic Review 89, 22–46.
Torvik, R., 2002. Natural resources, rent seeking and welfare. Journal of Development Economics 67, 455–470.
van der Ploeg, R., 2008. Challenges and opportunities for resource rich economies. OxCarre Research Paper 2008-05.
Vicente, P.C., 2009. Does oil corrupt? Evidence from a natural experiment in West Africa. Journal of Development Economics, in press.
Wacziarg, R., Welch, K., 2003. Trade liberalization and growth: new evidence. NBER Working Paper 10152.