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Natural Resource Production, Corruption, and Expropriation

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Abstract

We develop a formal model that looks at the mutually endogenous determination of foreign direct investments in natural resource-rich countries, the decision of host governments to expropriate these investments, and the level of corruption. Higher resource production makes expropriation more attractive from the perspective of national governments. A low expropriation risk is in turn an important determinant of international investments and is therefore associated with high levels of production. Moreover, resource production leads to high levels of corruption. Our theoretical results are confirmed by estimations of a simultaneous equation model for 50 resource-rich countries in which we endogenize expropriation risk, corruption, and resource production.

JEL classification: F21, D73, Q38.

Keywords: Natural resources, hold-up problem, foreign direct investment, corruption.

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1 Introduction

Conflicts between foreign investors and domestic governments seem to be particularly frequent and acrimonious in the natural resources sector. Prominent examples of conflicts about revenue sharing and outright expropriation of foreign investments include Repsol in Argentina, Rio Tinto in Guinea, and First Quantum Minerals in the Democratic Republic of Congo, which alone are estimated to have cost some 13bn US-$ (Stevens et al. 2013). These are only recent visible cases illustrating bad relations between investors and source country governments. According to the World Bank (2009), 30 countries have revised oil contracts and taxation systems between 1999 and 2010, and Stevens et al. (2013) mention 25 cases in which increases in taxes and royalties were announced and implemented. These events demonstrate an increasing wave of conflicts before arbitration panels and outright expropriations that are highly correlated with higher prices for natural resources.

One explanation for expropriations in the resource sector is that exploitation of non-renewable natural resources like minerals, oil, and gas typically involves large investments, uncertainty and a considerable time-span before production can begin and returns are realized. Given a high capital demand and a lack of own technical expertise, resource rich countries often need to rely on foreign investors in the resource extraction sector. Since investments are sunk, foreigners are vulnerable to renegotiation, which then often leads to struggles about sharing investment costs and revenues. If prices for natural resources rise, so do rents and conflicts about their distribution.[1] Apart from outright expropriations, conflicts also arise about taxation and how returns are to be shared, since production agreements and contracts are usually not renegotiation-proof (Joffé et al. 2009).[2]

A second factor is that natural resource-rich countries are often characterized by deficient institutions, meaning high levels of corruption, a lack of rule of law, and non-inclusive political institutions. This is connected with insufficient protection of property rights, and reinforces the risk of expropriation and renegotiation of revenue-sharing agreements (Collier 2010, Deacon 2011, van der Ploeg 2011). Again, these problems are often increasing in the price of natural resources as incentives for rent-seeking and distributional conflicts increase in the size of rents.

In this paper, we look at the interaction between expropriation risk, quality of institutions (in particular corruption), and the incentive for foreign firms to invest in resource-rich countries. While the literature often treats at least one of these dimensions as exogenous, we explicitly model the interaction between all three factors. We develop a formal model that endogenizes foreign investment, the incentive to expropriate, and the degree of corruption. Our model shows that the incentive to expropriate is a positive function of resource revenues and thereby is related to foreign investment as more investments lead to more resource output. Higher prices are also an incentive to expropriate.

Foreign investment in turn is a negative function of the risk of expropriation and depends on the expected price level of resources. While higher expected prices make

[1]Historically, resource-rich countries participated very little in the gains from their resources (Venn 1986, Yergin 1991). It is not surprising that this led to often fierce conflicts about revenue sharing, waves of expropriation, and to the creation of state-owned companies especially after de-colonization (see Bremmer and Johnston 2011, Hogan et al. 2010, Maurer 2013, Tomz and Wright 2010).

[2]Notorious cases in which the terms of contracts and agreements have been changed repeatedly by the host countries' governments are Venezuela (Manzano and Monaldi 2000) or Russia (Gustafson 2012). For an overview of cases, see the papers collected in Hogan and Sturzenegger (2010).

investments more attractive, because they promise higher revenues, they also raise the risk of expropriation. Foreign investment is declining in the level of corruption and bribes firms have to pay. We model corruption as an additional tax on firms' investments that is determined by an independent bureaucracy. The corruption rate is increasing in resource output and declining in the costs of corruption.

We also test the theoretical predictions of our model empirically. Using averaged data on natural resource production and institutional quality from 2000-2010 for a sample of 50 resource-rich countries, we are able to support our theoretical results. In particular, we estimate a system of equations that endogenizes the risk of expropriation, resource production and corruption by employing instruments which are derived from our theoretical model. We apply two estimation techniques – firstly, an instrumental variable estimator based on the Generalized Method of Moments (GMM); and secondly, the Three-Stage Least Square method (3-SLS) – to estimate the structural equations of our model simultaneously. With both methods, we show that the risk of expropriation negatively affects resource production whereas higher resource production in turn leads to a higher risk of expropriation. Our findings also support (although less robustly) the theoretical hypothesis that resource production raises the extent of corruption.

Our paper is related to three different strands of literature. Firstly, we build on the huge literature on the relation between foreign direct investment and the risk of expropriation (Cole and English 1991, Eaton and Gersovitz 1983, Thomas and Worrall 1994). Like most of this earlier literature, we find that FDI is a negative function of the risk of expropriation and "bad" institutions such as corruption (Busse and Hefeker 2007, Hajzler 2012). In particular, in countries in which the rule of law is absent, governments are not able to commit credibly on not renegotiating terms of contracts and not expropriating. The absence of a binding commitment mechanism leads to less foreign investment and sub-optimally low levels of output.[3] A sizable theoretic literature has looked at optimal contracts trading off the risk of expropriation and risk sharing with respect to fluctuations in the price of the underlying resource (e.g., Stroebel and van Benthem 2013). In our paper, expropriation occurs in equilibrium due to insufficient institutional quality. Since the government cannot commit to large compensation payments, the risk of expropriation cannot be eliminated completely.

Secondly, our results confirm earlier studies showing that the risk of expropriation depends positively on the price of the underlying resource and on the rents it generates (Bohn and Deacon 2000, Guriev et al. 2011, Hajzler 2012). This is particularly obvious if governments receive a fixed compensation for the depletion of the resource, and if this compensation does not increase with resource revenues. But even if host government and foreign investors alike benefit from higher resource prices and higher tax revenues, too high profits for foreign firms lead to public and political resistance in host countries and calls for "fairer" shares of national resources.

Thirdly, our paper is related to the discussion on corruption.[4] Like in Acemoglu and Verdier (1998) and Shleifer and Vishny (1993), we ask how a government's control and

[3]Of course, it could also be that firms are not able to commit to their part of the contract and renege on their investment or tax obligations (Guriev et al. 2011). In fact, charging firms with not fulfilling their obligations is often used as an argument for expropriation (Hefeker and Kessing 2014). We abstract from this complication here and assume that firms always fulfill their part of the contract.

[4]For general surveys, see Aidt (2003) or Banerjee et al. (2012).

punishment of corruption feeds back into corruption and the incentives to invest in a given country. Moreover, like in Ades and Di Tella (1999) we look at the incentives to become more corrupt when rents are high, and thus replicate earlier results that show how high resource revenues and rents lead to more rent seeking, corruption and weaker institutions in general (Bhattacharyya and Hodler 2010, Bulte and Damania 2008, Busse and Groning 2013, Karl 1997, Leite and Weidmann 1999, Mehlum et al. 2006, Ross 2012, Vicente 2010), thus suggesting a vicious circle between resources and bad institutions when institutions are weak in the first place.

The paper is structured as follows: Section 2 develops our theoretical model and endogenizes expropriation risk, corruption and foreign investment and output. Section 3 presents our empirical implementation and section 4 concludes.

2 The model

Consider a small open country, endowed with a tradable natural resource. Extraction of the resource requires a capital investment K provided by a representative international firm. For simplicity, we assume that the extracted quantity Q of the resource increases one to one with the invested capital stock, i.e., $Q = K$. The firm can sell the resource on the world market for a given price p, and this price is unknown to the firm *ex ante* at the time of the investment decision. Corrupt bureaucrats in the host country appropriate a part of the firm's assets, and thereby impose an iceberg cost on the investment of the firm.[5] That is, the firm has to raise $\tau > 1$ units of capital to produce one unit of resources in the South, whereas $\tau - 1$ units of the investment are appropriated by local bureaucrats. The level of τ therefore stands for the extent of corruption in this country.

After the investment decision has been made by the international firm, the resource price realizes, and the firm obtains a gross revenue of pQ. The government in the host country receives βpQ as a predetermined tax payment (or revenue participation). We assume that the tax rate β is given and can not be changed *ex post*. The government, however, may decide to expropriate the international firm completely.[6] In this case, the government retains the entire revenue pQ but bears fixed expropriation costs f, which may be interpreted as political and economic costs resulting from a loss of reputation, costs of economic sanctions, or of curtailed access to international capital markets in subsequent periods.[7]

The following sequence summarizes the timing of events:

(1) The international firm decides on capital investment K

[5]Alternatively one may assume that bureaucrats appropriate a share of expected revenues, e.g. $(\tau - 1)E[p]Q$ with $E[p]$ denoting the *ex ante* expected value of the resource price. However, our theoretical results would not change qualitatively using this formulation. Since we match the quantities of extracted resources with the quality of institutions in our empirical analysis, we prefer the formulation here.

[6]Of course, as some of the examples mentioned in the introduction show, expropriation in the real world is not that clear-cut and may also occur via renegotiation of revenue sharing agreements or through tax hikes. In such a situation, governments expropriate firms only partially, and no clear-cut line can be drawn between expropriation and taxation. In this paper, we abstract from this complication and focus on full expropriation only.

[7]Alternatively, and without changing the central findings of our model, one can assume a fixed compensation payment f from the expropriating government to the international firm.

(2) Bureaucrats decide on τ

(3) Nature determines the price p according to a distribution function $G(p)$ with density $g(p)$

(4) The host government decides on expropriation and payoffs are realized

To determine the equilibrium, we proceed by backward induction. In stage 4, the government decides to expropriate if $pQ - f > \beta pQ$. This inequality determines the following threshold price $\tilde{p}$, above which expropriation occurs:

$$\tilde{p} \equiv \frac{f}{(1-\beta)Q} \ . \tag{1}$$

The *ex ante* probability for the firm of being expropriated is $1 - G(\tilde{p})$. This probability declines in the cut-off $\tilde{p}$. According to (1), the cut-off price $\tilde{p}$ declines in the output level, increases in the expropriation costs f and in the tax rate β, i.e.,

$$\frac{\partial \tilde{p}}{\partial Q} < 0 \ , \qquad \frac{\partial \tilde{p}}{\partial f} > 0 \ , \qquad \text{and} \qquad \frac{\partial \tilde{p}}{\partial \beta} > 0 \ . \tag{2}$$

Before the price p is drawn, bureaucrats decide about τ by maximizing their payoff:

$$\max_{\tau} \Pi^B \ = (\tau - 1)Q - \frac{1}{2} v \tau^2 \ . \tag{3}$$

In this equation, $v > 0$ stands for the marginal costs of being corrupt. These can be moral costs (people do not want to be corrupt) or also costs of being detected and punished, as in Acemoglu and Verdier (1998) or Shleifer and Vishy (1993). The first order condition for the bureaucrats determines the equilibrium corruption rate τ^* as

$$\tau^* = \frac{Q}{v} \ . \tag{4}$$

According to (4), the higher is output the higher is corruption in the host country. In the first stage of the model, the firm maximizes its expected payoff which is given by

$$E[\Pi^F] = (1-\beta)Q \int_0^{\tilde{p}} pg(p)dp - \tau c Q \ . \tag{5}$$

The variable c denotes the constant unit cost of resource extraction. Maximizing (5), a representative competitive firm does not take into account the effect of Q on $\tilde{p}$ and τ^*, which are given by (1) and (3). Its optimal investment can then be written as

$$Q = \frac{v(1-\beta)}{c} \int_0^{\tilde{p}} pg(p)dp \ . \tag{6}$$

According to (6), the equilibrium level of resource production increases in the cut-off price, in the costs of corruption, and declines in the tax rate β and production costs c, i.e.,[8]

[8] Of course, one may doubt that foreign firms are small such that they do not take the effect of their investment on the decision to expropriate and on corruption into account. If we replace the representative firm by a large firm, the optimal production level becomes $Q = \frac{v(1-\beta)}{2c}\left[\int_0^{\tilde{p}} pg(p)dp - \tilde{p}^2 g(\tilde{p})\right]$. To obtain the same comparative static results as in (7), we need to assume that expression $\int_0^{\tilde{p}} pg(p)dp - \tilde{p}^2 g(\tilde{p})$ increases in $\tilde{p}$ in this setting.

$$\frac{\partial Q}{\partial \tilde{p}} > 0 \,, \qquad \frac{\partial Q}{\partial v} > 0 \,, \qquad \frac{\partial Q}{\partial \beta} < 0 \,, \qquad \text{and} \qquad \frac{\partial Q}{\partial c} < 0 \,. \tag{7}$$

Equations (1) and (6) jointly determine the equilibrium cut-off price $\tilde{p}^*$ and resource production Q^*. Figure 1 depicts this equilibrium. The upward sloping curve (Q) is the first order condition for the firm (6) determining the optimal extraction level as a function of the reservation price. The downward sloping line ($\tilde{p}$) is the reservation price as determined in (1) as a function of the extraction level. A change in the exogenous variables f, v, β, and c shifts the Q and/or $\tilde{p}$ lines and thereby changes the equilibrium investment values and the expropriation cut-off.

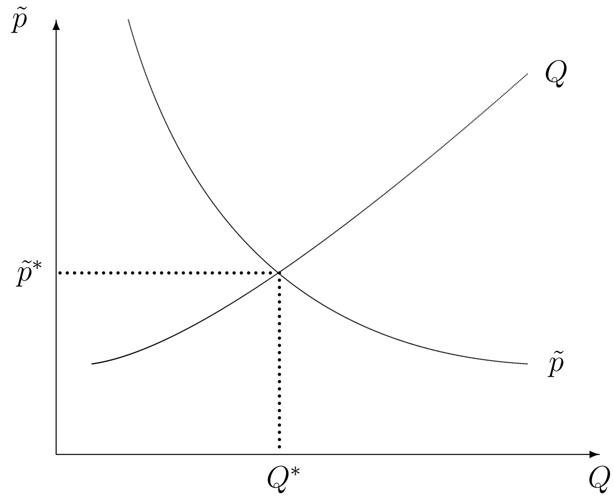

Figure 1: Equilibrium Cut-off Price and Resource Production

After inserting (1), we may write (6) as a function of $\tilde{p}^*$ only:

$$\tilde{p}^* \int_0^{\tilde{p}^*} pg(p)dp = \frac{cf}{(1-\beta)^2 v} \,. \tag{8}$$

Differentiating (8) and (6) yields

$$\frac{d\tilde{p}^*}{df} = \frac{c}{(1-\beta)^2 v \left[\int_0^{\tilde{p}^*} pg(p)dp + [\tilde{p}^*]^2 g(\tilde{p}^*)\right]} > 0 \quad \text{and}$$

$$\frac{dQ^*}{df} = \frac{(1-\beta)v\tilde{p}^* g(\tilde{p}^*)}{c}\frac{d\tilde{p}^*}{df} > 0 \,. \tag{9}$$

Thus, an exogenous increase in the compensation payment raises the equilibrium cut-off price thereby making expropriation less probable. The equilibrium level of resource production increases. For the influence of the tax rate β, we obtain

$$\frac{d\tilde{p}^*}{d(1-\beta)} = -\frac{2f}{1-\beta}\frac{d\tilde{p}^*}{df} < 0 \quad \text{and} \tag{10}$$

$$\frac{dQ^*}{d(1-\beta)} = \frac{v}{c}\left[\int_0^{\tilde{p}^*} pg(p)dp + (1-\beta)\tilde{p}^* g(\tilde{p}^*)\frac{d\tilde{p}^*}{d(1-\beta)}\right] \lesseqgtr 0 \,. \tag{11}$$

That is, the critical price above which expropriation becomes attractive increases in the tax rate. The effect of taxation on equilibrium investment (and extraction of natural resources) is not clear. This is because an increase in the tax rate has an ambiguous influence. On the one hand, it lowers net of tax profits and the incentive to invest and extract. On the other hand, it reduces the risk of expropriation and thereby raises the incentive to invest.

An increase in the corruption costs v lowers $\tilde{p}^*$ and raises Q^*:

$$\frac{d\tilde{p}^*}{dv} = \frac{-f}{v}\frac{d\tilde{p}^*}{df} < 0 \quad \text{and} \tag{12}$$

$$\frac{dQ^*}{dv} = -\frac{f}{(1-\beta)[\tilde{p}^*]^2}\frac{d\tilde{p}^*}{dv} > 0 \; . \tag{13}$$

Obviously, higher costs of corruption limit corruption activities and thus make investments in resource extraction more attractive. By raising investments, however, they also increase the incentive to expropriate and thus lower the critical resource price at which expropriation occurs.

Analogously, an increase in the costs of resource extraction c raises $\tilde{p}^*$ and lowers Q^*:

$$\frac{d\tilde{p}^*}{dc} = \frac{f}{c}\frac{d\tilde{p}^*}{df} > 0 \quad \text{and} \tag{14}$$

$$\frac{dQ^*}{dc} = -\frac{f}{(1-\beta)[\tilde{p}^*]^2}\frac{d\tilde{p}^*}{dc} < 0 \; . \tag{15}$$

Higher extraction costs clearly lower equilibrium investment and production and thereby also the incentive to expropriate.

3 Empirical Implementation

Equations (1), (4), and (6) of the theoretical model establish a joint relationship between resource production and institutional quality in resource-rich countries: Note that each of these three equations has a ceteris paribus causal interpretation thereby explaining the behavior of three different agents of our model: Eq. (1) describes the optimal behavior of the local ruler, and implies that the *ex ante* expropriation risk increases in resource production whereas it declines in expropriation costs as well as in taxation of resource revenues. According to eq. (6), which results from profit maximization of the representative international resource producer, higher expropriation risk lowers investments and thereby resource production. Furthermore, as shown in (7), this equation postulates a negative influence of production costs and taxation and a positive one of the costs of being corrupt on the production volume. Finally, eq. (4) explains the behavior of the corrupt bureaucrats, according to which the extent of corruption rises with the level of resource production and declines in the costs of being corrupt.

In order to put these model predictions to the data, we estimate the following simultaneous equations model (SEM):

$$ER_i = \alpha_0 + \alpha_1 Q_i + \alpha_2 exprcosts_i + \alpha_2 tax_i + \alpha_3 Z_{1i} + u_i, \tag{16}$$

$$Q_i = \beta_0 + \beta_1 ER_i + \beta_2 tax_i + \beta_3 prodcosts_i + \beta_4 corrcosts_i + \beta_5 Z_{2i} + v_i, \tag{17}$$

$$corruption_i = \gamma_0 + \gamma_1 Q_i + \gamma_2 corrcosts_i + \gamma_3 Z_{3i} + w_i, \tag{18}$$

where i is the country index, ER stands for the expropriation risk, *exprcosts*, *prodcosts*, and *corrcosts* denote the different costs of expropriation, production, and corruption. Z_j $j \in (1, 2, 3)$ is a vector of additional equation specific exogenous variables, and u, v, w, are error terms.

To estimate the above system of equations, we follow two general estimation strategies suggested in the econometric literature in related contexts: The first one is an instrumental variable approach in which each equation is estimated *individually.*[9] Here, we apply an estimator based on the generalized method of moments (GMM). The second approach estimates the relationships in the system *simultaneously.* A standard tool applied in this context is the Three-Stage Least Square estimator (3SLS). With both methods, each endogenous variable is first instrumented by all exogenous variables in the system, and then each equation of the system is estimated with the predicted values of the endogenous variables obtained from the first step. The methods differ, however, with respect to the treatment of disturbances. The GMM estimator is based on an optimal weighting matrix, which relaxes the i.i.d. assumptions of the error terms, i.e. u_i, v_i, w_i. As a result the obtained estimates are efficient even under an assumption of heteroscedasticity of the error terms. By contrast, the 3SLS methodology takes into account a possible simultaneous correlation between the error terms of the individual equations but requires the error terms to be homoscedastic.[10] Since the latter appears to be a rather unrealistic assumption for a cross-country sample, we present the GMM estimation results as our benchmark, and report the results obtained from 3SLS as additional robustness checks.[11]

3.1 Data and Indicators

In finding indicators and corresponding data for our model parameters, most difficulties arose with respect to data concerning the governments' share of total resource revenues (the tax rate). The best source with a sufficient cross-country coverage that we could find are two IMF reports on resource-rich countries (IMF 2010, 2012), which contain data on governments' revenues from two types of natural resources, hydrocarbons and minerals, as a share of total fiscal revenues and as a share of GDP. The respective values are averages over 2000 to 2010 and are available for 56 counties, which are classified by IMF (2010, 2012) as being resource-rich.[12]

[9] Note that each of the above equations can be potentially identified since the order condition is satisfied for each of them.

[10] E.g, Wooldridge 2010, Ch. 8, shows that the 3SLS estimator is a GMM estimator that uses a particular weighting matrix.

[11] The usual tests, such as Breusch-Pagan/Cook-Weisberg and White's tests, confirmed the presence of heteroscedasticity for each equation in the above system.

[12] A country is classified as resource-rich if its natural resources contribute to at least 20% of its total fiscal revenues and/or at least 20% of its total exports. Moreover, data in IMF (2012) is averaged from 2006 to 2010 whereas the corresponding data from IMF (2010) is averaged from 2000 to 2007. From both values we calculate a simple unweighted average for the respective indicator.

Data on quantities produced and production costs as well as world market prices for each type of natural resources comes from the World Bank. This data is used to construct the so called *Adjusted Net Saving* dataset, the WB's measure of national wealth, and contains numbers for oil and natural gas production as well as for the production of 10 different types of minerals.[13] All quantities are available in metric tons (mt) except for gas, which is notated in terajoule (TJ), and therefore is converted into metric tons using the formula $1\ TJ = 22.8846\ mt$. The production costs are unit costs in US-$/mt, and they are, naturally, resource specific. For each country, we have first calcuated average values for total resource revenues – by multiplying prices with respective quantities – as a share of current GDP (in US-$) and relate this variable to the IMF's (2010, 2012) date on the government's revenues as a share of GDP to obtain the variable tax.

Constructing country specific data on the volume of resource production (*prodvolume*), production costs (*prodcost*), and total revenues, we rely on the information on the *type* of natural resources provided by IMF (2010, 2012). If, for instance, a country is characterized as a hydrocarbon producer, the produced quantity is the sum of oil and gas production, and the corresponding costs are unit costs of producing one ton of oil (according to WB data, oil and gas unit costs are identical). These costs are still country-specific primarily due to the countries' geographical characteristics. By contrast, if a country's resource revenues stem from, say, copper production (as in the case of Chile), we consider only the cost data for copper production for this country. In cases in which, according to IMF (2010, 2012), a country produces more than one type of resources or in which the type is simply characterized by "minerals", production quantities and revenues are the sum of the respective resources. We build the production costs in these cases as a weighted average of unit costs using the share of the specific resource output in aggregate production as the respective weight. To control for the potential differences between hydrocarbon and minerals producers, a dummy (*hydro*) for oil/gas production is additionally included in equation (17).

Among 56 countries listed in the IMF reports, Sao Tome and Principe as well as Timor-Leste are not listed in the World Bank's data on resource production. Furthermore, for Botswana, Laos, and Suriname we do not have production data for the resources which, according to IMF (2010, 2012), contribute to these countries' resource revenues. Finally, Liberia is excluded from our sample as being only a gold producer with extremely low output. This leaves us with 50 countries for which we have data on resource production and costs as well as on the tax rate. The sample mean for the latter variable is 37%. Table A.3 lists all countries in our sample classifying them according to the income class and specifying also the type of natural resource for each country.

To capture our model parameters on expropriation risk and corruption, we use two different data sources. Both sources provide perceived measures on different institutional dimensions. The first are the widely used *World Governance Indicators (WGI)* provided by the World Bank (2013a) and extensively described by Kaufmann et al. (2010). Here we use the indicator on "regulatory quality" (*regqua*), which measures "the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development" (Kaufmann et al., 2010, p. 4), as a proxy for the expropriation risk; and the indicator "control of corruption" (*corrupt*), which mea-

[13] Data is available on http://data.worldbank.org/data-catalog/wealth-of-nations. The minerals included are bauxite, copper, lead, nickel, phosphate, tin, zinc, iron, gold, and silver.

sures "the extent to which public power is exercised for private gain, including both petty and grand forms of corruption" (Kaufmann et al., 2010, p. 4). For both institutional indicators, a higher value means a quality improvement (i.e., lower expropriation risk or lower corruption activities). Arguably, *regqua* may not be a best possible measure to assess the ex ante risk of expropriation. However, the WGI data is available for all of our 50 countries. The second source, *International Country Risk Guide (ICRG)* by the PRS (2012), contains a more appropriate measure on the expropriation risk, namely "investment profile" (*iprof*), by assessing the investment risks resulting from direct or indirect forms of expropriation. This source also contains a measure on corruption (*corrupt(icrg)*), which captures not only financial corruption in form of demands for hidden payments and bribes in business activities but also immaterial forms of corruption, such as patronage, nepotism etc. Yet the ICRG data covers only 44 countries from our sample.[14] Again, a higher value for each institutional indicator implies a better respective institutional dimension, i.e., a higher corruption index implies a lower corruption level.

To account for expropriation costs, we consider two variables: First, a dummy $ICSID$ that takes a value of 1 if a country has signed the Convention on the Settlement of Investment Disputes between States and Nationals of Other States and if this convention entered into force before 2000. This Convention has been established to remove major impediments to the free international flows of private investment posed by non-commercial risks.[15] Second, the "executive constraint" (*exconst*) indicator from the Polity IV data, which is supposed to capture the extent of institutionalized constraints on national governments (Marshall et al. 2013).[16]

To account for the costs of corruption from the perspective of bureaucrats, remember that, in the theoretical model, these costs can result from being detected and punished if agents behave corruptly. In this context, it seems reasonable to use an indicator that captures the degree of transparency in a society. As other studies in the literature (see, e.g., Brunetti and Weder 2003), we therefore use the "freedom of the press" status indicator ($fotp$) provided by Freedom House (2013), which classifies a country's freedom of mass media as not free, partly free, and free.[17] In equations (16) and (18), we additionally include the value of real per capita GDP ($gdppc(t-1)$) using the data from World Development Indicators by the World Bank (2013b) to control for the impact of economic development on institutional quality. We use its averaged value from the previous decade (1990-2000) to avoid the obvious problem of reverse causality.

We take the natural logarithm of all variables – except the institutional indicators – to smooth variation among them. Table A.1 presents summary statistics of all variables used in this paper, and Table A.4 gives a detailed variable description with the respective sources.

A first glance at the data makes clear why a simple analysis of the relationship between

[14]Note that the correlation between $iprof$ and $regqua$ in our sample is quite high at 0.84.

[15]Detailed information about the Conventions as well as about the Member States can be obtained from: https://icsid.worldbank.org/ICSID/Index.jsp

[16]Guriev et al. (2011) use this indicator as a proxy for expropriation costs as well. Since this indicator is not available for Brunei, our sample reduces to 49 countries, and to 43 countries when using the ICRG data. We also used the WGI indicator on democracy "voice and accountability" as an alternative measure for political constraints and could confirm our qualitative results.

[17]Alternatively, we also used a more detailed "freedom of the press" score indicator from the same source, which takes values between 1 and 100.

expropriation risk, measured by the index on “regulatory quality”, and (the logarithm of the) natural resource production may be misleading. As shown by Figure 2, the unconditional relationship between both variables suggests no systematic correlation between them in our sample. However, as our results below show, controlling for other factors, which potentially may influence this relationship, and especially taking into account the endogeneity of *both* variables, help to establish a significant *mutual* relationship between expropriation risk and resource production that has been derived in the theoretical part and is illustrated in Figure 1.

Figure 2 additionally shows that there are two “outliers” in our sample with relative low resource production: Mali and Kyrgyz Republic, the only two remaining gold producers. In the following, we therefore also re-estimate each specification without these two countries.

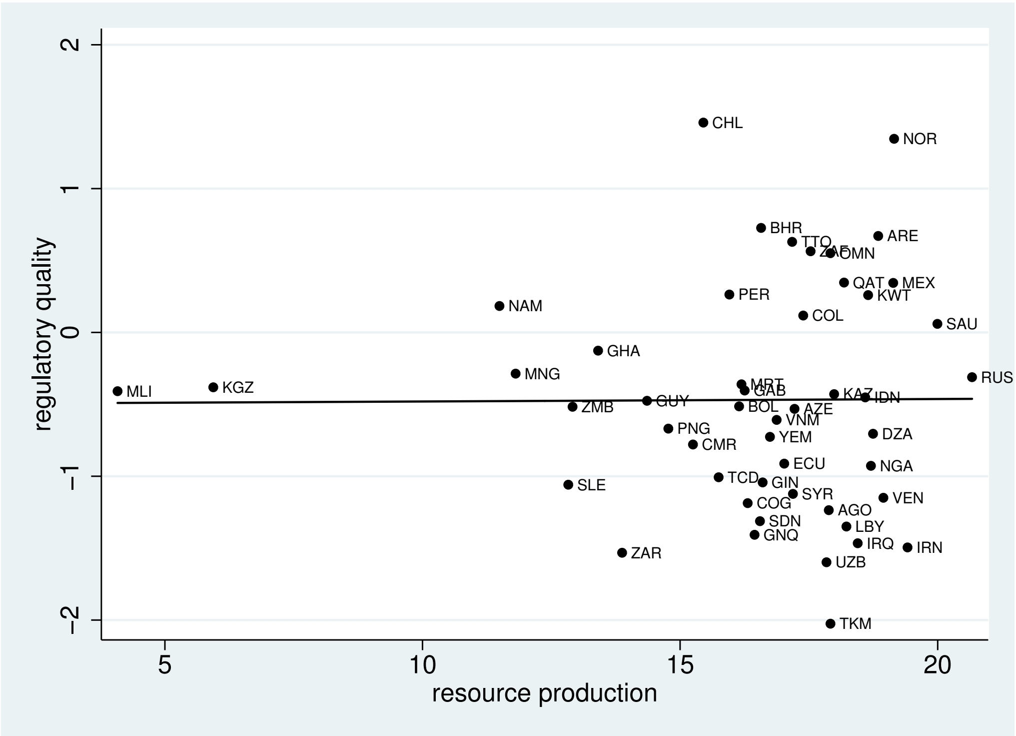

Figure 2: Expropriation Risk and Resource Production

3.2 Results

Table 1 presents the estimation results of the GMM instrumental variable approach using the WGI data for expropriation risk and corruption. Column (1) presents the results obtained by estimating the final stage of equation (16); accordingly, the next columns correspond to equations (17) and (18), and columns (4)-(6) repeat the same estimations excluding Mali and the Kyrgyz Republic.[18] The results show that a higher volume of

[18]The results obtained from the first stage of regressions are presented in Table A.2, and show the statistical relevance of our instruments in explaining “regulatory quality” and the volume of resource production.

resource production leads, on average, to a lower degree of “regulatory quality” (i.e. to a higher expropriation risk) thereby verifying the prediction of eq. (1). A higher degree of “regulatory quality” in turn causes a higher production volume as predicted by eq. (6). The results in this column also verify the main predictions of eq. (4): the extent of corruption increases as resource production rises.

Comparing the influence of the exogenous variables with the model predictions, we obtain the following evidence: Both our indicators for expropriation costs, $ICSID$ and $exconst$, have a positive and significant effect on “regulatory quality” , while the influence of the governments' share in resource revenues (tax) on it is not significant. However, the negative influence of tax on the production volume, as predicted by eq. (6), can in turn be verified. As expected, we also find a negative effect of production costs on production volume. In contrast to our model predictions, a higher freedom of the press – our indicator for low “corruption costs” – dampens the volume of resource production, but it has the predicted positive effect on the corruption index. Additionally, the results confirm the view that a higher level of economic development is associated with better institutional quality.

Table 1 also reports the results of the Hansen's J-test on over-identifying restrictions for each equation. Note that we employ more instruments than we actually need to estimate our endogenous variables. In particular, the expropriation risk is instrumented with $ICSID$, $exconst$, and $gdppc(t-1)$, which do not enter equation (17). This might explain why in columns (2) and (5) the p-values for Hansen's-J estimator are below the critical level of 5% indicating that the joint validity of the instruments has to be rejected. In Table 2, we therefore re-estimate the equations (16)-(18) dropping out the $ICSID$ indicator from our list of exogenous variables. A reciprocal relationship between resource production and expropriation risk can again be established. Moreover, the validity of the over-identification restrictions is not confirmed for any of the equations ensuring us that our equations are correctly identified and our set of instruments is appropriate. (See also Table A.2 for the statistical relevance of the instruments.) Production volume, however, loses its significance in affecting corruption.

3.3 Sensitivity of the Results

In this section, we present two results concerning the robustness of our previous findings. We first reproduce the estimations from Table 1 using a 3SLS estimator, i.e., estimating equations (16)-(18) simultaneously. Table 3 shows that the previous results remain qualitatively unchanged. Most importantly, resource production negatively affects “regulatory quality” and is in turn positively influenced by this variable. Furthermore, corruption is significanty influenced by the resource production in the specification without outliers.

Second, we employ an alternative source for institutional data, the $ICRG$ indicators for expropriation risk (“investment profile”) and corruption. Table 4 reports the corresponding results obtained from our preferred estimation method GMM.[19] Most notably, the effect of resource production on “investment profile” is negative and significant whereas “investment profile” positively influences production quantity. A negative rela-

[19]The results do not change qualitatively with 3SLS. Note also that here as well as in Table 3 we excluded the dummy $ICSID$ from our set of instruments. Again, in both cases the results are not sensitive to this exclusion.

Table 1: WGI Institutions and Resource Production

	All Countries			Without Outliers		
	regqua	prodvolume	corrupt	regqua	prodvolume	corrupt
prodvolume	-0.062***		-0.042*	-0.067*		-0.131***
	(0.001)		(0.055)	(0.057)		(0.010)
tax	0.045	-0.480**		0.067	-0.394	
	(0.490)	(0.045)		(0.314)	(0.127)	
ICSID	0.337***			0.370***		
	(0.009)			(0.006)		
exconst	0.168***			0.169***		
	(0.000)			(0.000)		
gpdpc(t-1)	0.423***		0.457***	0.423***		0.525***
	(0.000)		(0.000)	(0.000)		(0.000)
regqua		1.537***			1.452***	
		(0.000)			(0.000)	
fotp		-0.661*	0.219***		-0.638*	0.107
		(0.069)	(0.009)		(0.085)	(0.223)
prodcost		-0.891***			-0.771***	
		(0.000)			(0.003)	
hydro		1.977***			2.214***	
		(0.003)			(0.003)	
N	49	49	49	47	47	47
Adj.R-squared	0.72	0.77	0.66	0.72	0.48	0.66
p-value Hansen's J	0.067	0.017	0.025	0.098	0.022	0.089

Final stage results of GMM estimations with averaged data over 2000-2010.
p-values in parentheses $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Heteroskedasticity consistent standard errors are used.

tionship between resource production and the corruption indicator cannot be established in this specification. Regarding the influence of the exogenous variables, the significance is also weaker compared to Table 1. We no longer obtain a significant influence of the indicator for expropriation costs on "investment profile". This might also explain the very low p-value of the Hansen's J-test in column (2), implying that "investment profile" is weakly instrumented in the first stage. The influence of the tax rate on the resource extraction is only significant at the 88%-level. The negative effect of production costs on extraction volume remains stable. Furthermore, the negative influence of "freedom of the press" on resource production, which has been established before in contradiction to our model prediction, vanishes now while its positive effect on the corruption indicator

Table 2: WGI Institutions and Resource Production: Alternative Specification

	All Countries			Without Outliers		
	regqua	prodvolume	corrupt	regqua	prodvolume	corrupt
prodvolume	-0.054***		-0.019	-0.083**		-0.084
	(0.000)		(0.398)	(0.029)		(0.127)
tax	0.041	-0.594**		0.032	-0.567**	
	(0.489)	(0.017)		(0.616)	(0.036)	
exconst	0.168***			0.168***		
	(0.000)			(0.000)		
gpdpc(t-1)	0.399***		0.451***	0.433***		0.498***
	(0.000)		(0.000)	(0.000)		(0.000)
regqua		2.013***			1.987***	
		(0.000)			(0.000)	
fotp		-0.926**	0.325***		-0.949**	0.222**
		(0.021)	(0.001)		(0.022)	(0.041)
prodcost		-0.886***			-0.780***	
		(0.000)			(0.001)	
hydro		2.041***			2.178***	
		(0.001)			(0.003)	
N	49	49	49	47	47	47
Adj.R-squared	0.68	0.73	0.66	0.69	0.38	0.68
p-value Hansen's J	0.13	0.21	0.10	0.22	0.24	0.16

Final stage results of GMM estimations with averaged data over 2000-2010.

p-values in parentheses $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Heteroskedasticity consistent standard errors are used.

remains.[20]

Summarizing we can state that the empirical results generally confirm the relationship between *ex ante* expropriation risk and resource production, which has been established by the theoretical model: Higher resource production makes expropriation more attractive from the perspective of national governments, resulting in higher levels of expropriation risks. However, a lower degree of expropriation risks in turn is seen as an important factor for international resource producers and it is therefore associated with high levels of production. With regard to corruption, we also obtain an influence of the level of natural resource production – although our results in the respect are more sensitive to estimation details.

[20]We also estimated our model with both WGI and ICRG data using the values of total resource revenues instead of production volumes and could verify our main findings. However, revenues were not affected by the production costs implying that the latter cannot be used as a proper instrument.

Table 3: WGI Institutions and Resource Production: 3SLS Estimation

	All Countries			Without Outliers		
	regqua	prodvolume	corrupt	regqua	prodvolume	corrupt
prodvolume	-0.061**		-0.029	-0.091**		-0.094*
	(0.012)		(0.291)	(0.037)		(0.087)
tax	0.029	-0.530*		0.046	-0.551*	
	(0.623)	(0.071)		(0.461)	(0.091)	
exconst	0.157***			0.146***		
	(0.000)			(0.000)		
gdppc(t-1)	0.427***		0.450***	0.447***		0.505***
	(0.000)		(0.000)	(0.000)		(0.000)
regqua		2.066***			1.989***	
		(0.000)			(0.000)	
fotp		-1.059***	0.286***		-1.012***	0.205**
		(0.001)	(0.000)		(0.004)	(0.035)
prodcost		-0.905***			-0.776***	
		(0.000)			(0.001)	
hydro		1.588***			1.993***	
		(0.008)			(0.003)	
N	49	49	49	47	47	47
R-squared	0.71	0.75	0.69	0.71	0.45	0.70

Final stage results of 3SLS estimations with averaged data over 2000-2010.

p-values in parentheses $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4 Conclusion

In this paper, we have looked at and endogenized three interrelated variables: the production activities of foreign investors in a country's natural resource sector, the level of corruption in this country, and the government's decision to expropriate foreign investments. Our theoretical analysis has shown that resource production is a negative function of taxation, corruption and the perceived risk of expropriation. The risk of expropriation in turn increases in the output level, and declines in expropriation costs and taxation. The level of corruption is determined by a bureaucracy that is independent from the government and depends on natural resources output and the costs of corruption. One implication of this finding is that by controlling bureaucrats more intensively and thereby making corruption more "expensive", the government of the host country can push back corruption.

Our main contribution to the debate on the relationship between institutional quality and natural resources is to endogenize all relevant variables in one approach, and to test the resulting system of equations for a sample of resource-rich countries. Our theory and evidence support the view that foreign investment, risk of expropriation, and corruption are mutually interdependent and should be considered jointly. This also implies that policy measures to increase attractiveness for foreign investment, improve property rights or reduce corruption should take this interdependency into account.

Table 4: ICRG Institutions and Resource Production

	iprof	prodvolume	corrupt(icrg)
prodvolume	-0.185**		0.025
	(0.010)		(0.317)
tax	0.222	-0.803	
	(0.478)	(0.121)	
exconst	0.023		
	(0.788)		
gpdpc(t-1)	1.193***		0.191**
	(0.000)		(0.015)
iprof		0.606***	
		(0.002)	
fotp		-0.236	0.413***
		(0.541)	(0.002)
prodcost		-0.939***	
		(0.000)	
hydro		2.093**	
		(0.015)	
N	43	43	43
Adj.R-squared	0.50	0.66	0.25
p-value Hansen's J	0.80	0.0066	0.19

Final stage results of GMM estimations with averaged data over 2000-2010.
p-values in parentheses $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Heteroskedasticity consistent standard errors are used.

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5 Appendix

Table A.1: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
regqua	49	-.469	.785	-2.025	1.459
prodvolume	49	16.355	3.135	4.081	20.667
corrupt	49	-.518	.773	-1.531	2.065
tax	49	3.355	.849	.358	4.478
exconst	49	3.744	1.978	1	7
ICSID	49	.673	.474	0	1
fotp	49	1.837	.773	1	3
prodcost	49	4.757	2.63	2.608	16.147
hydro	49	.755	.434	0	1
gdppc(t-1)	49	7.196	1.332	5.146	10.368
iprof	43	8.131	1.946	3.814	11.216
corrupt(icrg)	43	2.172	.706	1	5

Table A.2: Determinants of Institutions and Resource Production

	All Countries				Without Outliers			
	regqua	prodvolume	regqua	prodvolume	regqua	prodvolume	regqua	prodvolume
tax	0.092	-0.404**	0.128	-0.453**	0.102	-0.386*	0.152*	-0.454**
	(0.215)	(0.040)	(0.107)	(0.028)	(0.202)	(0.067)	(0.073)	(0.044)
exconst	0.145***	0.470***	0.175***	0.429***	0.138***	0.455***	0.171***	0.412***
	(0.001)	(0.000)	(0.000)	(0.003)	(0.001)	(0.002)	(0.000)	(0.009)
gpdpc(t-1)	0.407***	0.721***	0.396***	0.737***	0.404***	0.715***	0.387***	0.738***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
fotp	-0.040	-1.279***	-0.129	-1.157***	-0.033	-1.268***	-0.113	-1.161***
	(0.708)	(0.001)	(0.207)	(0.003)	(0.761)	(0.001)	(0.270)	(0.003)
prodcost	0.042***	-0.804***	0.057**	-0.823***	0.072	-0.733**	0.077	-0.740**
	(0.005)	(0.000)	(0.016)	(0.000)	(0.158)	(0.014)	(0.208)	(0.010)
hydro	-0.359**	1.475**	-0.307**	1.405**	-0.326***	1.553*	-0.272*	1.480*
	(0.015)	(0.039)	(0.047)	(0.049)	(0.007)	(0.072)	(0.072)	(0.074)
ICSID			0.384***	-0.524			0.413***	-0.560
			(0.010)	(0.191)			(0.009)	(0.206)
N	49	49	49	49	47	47	47	47
Adj.R-squared	0.67	0.86	0.72	0.86	0.67	0.68	0.72	0.68

OLS estimations with averaged data over 2000-2010.

p-values in parentheses $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Heteroskedasticity consistent standard errors are used.

Table A.3: List of Countries

Country	Resource Type	Country	Resource Type
HIC			
Bahrain	hydrocarbons	Oman	hydrocarbons
Brunei	hydrocarbons	Qatar	hydrocarbons
Equatorial Guinea	hydrocarbons	Saudi Arabia	hydrocarbons
Kuwait	hydrocarbons	Trinidad and Tobago	hydrocarbons
Norway	hydrocarbons	United Arab Emirates	hydrocarbons
LIC and MIC			
Algeria	hydrocarbons	Mali	gold
Angola	hydrocarbons	Mauritania	minerals, hydrocarbons
Azerbaijan	hydrocarbons	Mexico	hydrocarbons
Bolivia	gas	Mongolia	copper
Cameroon	hydrocarbons	Namibia	minerals
Chad	hydrocarbons	Nigeria	hydrocarbons
Chile	copper	Papua New Guinea	hydrocarbons, copper, gold
Colombia	hydrocarbons	Peru	minerals
Congo	hydrocarbons	Russia	hydrocarbons
Congo, DR	minerals, hydrocarbons	Sierra Leone	minerals
Ecuador	hydrocarbons	South Africa	minerals
Gabon	hydrocarbons	Sudan	hydrocarbons
Ghana	minerals	Syria	hydrocarbons
Guinea	mining	Turkmenistan	hydrocarbons
Guyana	gold, bauxite	Uzbekistan	hydrocarbons
Indonesia	hydrocarbons	Venezuela	hydrocarbons
Iran	hydrocarbons	Vietnam	hydrocarbons
Iraq	hydrocarbons	Yemen	hydrocarbons
Kazakhstan	hydrocarbons	Zambia	copper
Kyrgyz Rep.	gold		
Libya	hydrocarbons		

Table A.4: Variable Description

Variable	Description & Source
corrupt	Index on "control of corruption" that captures "perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests". The index is constructed by Kaufmann et al. (2010) and ranges between -2.5 (low control) and +2.5 (high control). *Source*: World Bank (2013a).
corrupt(icrg)	"Assessment of corruption within the political system. The measure captures financial corruption in the form of demands for special payments and bribes connected with import and export licenses, exchange controls, tax assessments, police protection. It also takes into account actual or potential corruption in the form of excessive patronage, nepotism, job reservations, and suspiciously close ties between politics and business." The index ranges between 1 and 6 with maximum points indicating low levels of corruption. *Source*: Political Risk Services Group (2012)
exconst	"Extent of institutionalized constraints on the decision making powers of chief executives, whether individual or collective" with a scale ranging from 1 (low constraints) to 7 (high constraints) *Source*: Marshall et al. (2013)
fotp	Index on status of press freedom taking the following values: (1) not free, (2) partly free, (3) free. *Source*: Freedom House (2013)
gpdpc(t-1)	Natural logarithm of GDP per capita at 2005 constant prices, average values over 1990-2000. *Source*: Own calculation; World Bank (2013b) .
ICSID	Dummy that takes a value of 1 if a country has signed the Convention on the Settlement of Investment Disputes between States and Nationals of Other States and if this convention came into force before 2000. This Convention has been established "to remove major impediments to the free international flows of private investment posed by non-commercial risks". *Source*: Own calculation; Information on the Convention and member states is available on: https://icsid.worldbank.org/ICSID and in ICSID (2006).
hydro	Dummy that takes a value of 1 if a country is hydrocarbon (i.e. oil and/or gas) producer. *Source*: Own calculation; information on type of resources stems from IMF(2010, 2012).

continued on the next page

Table A.4: Variable Description

	continued from the previous page
Variable	Description & Source
iprof	Index on"investment profile" which is "an assessment of factors affecting the risk to investment that are not covered by other political, economic and financial risk components. The risk rating assigned is the sum of three equally weighted subcomponents: Contract Viability/Expropriation, Profits Repatriation, Payment Delays.'The index ranges between 1 and 12 with a maximum score indicating low risk. *Source*: Political Risk Services Group (2012)
prodcost	Natural logarithm of unit costs (in \$/mt) of resource production. Production costs depend on the resource type. If the type is hydrocarbon, unit costs of producing one ton of oil are used. In the case in which a country produces more than one type of resources, weighted averaged unit costs are calculated using the share of the specific resource output in aggregate resource production as the respective weights. *Source*: Own calculation. Data for resource production and unit costs is available on http://data.worldbank.org/data-catalog/wealth-of-nations. Information on the type of resources stems from IMF(2010, 2012).
prodvolume	Natural logarithm of resource production quantities in metric ton (mt). Depending on the country-specific type of natural resources, the volume is either the sum of oil and gas production for hydrocarbon producers or the corresponding value for specific minerals. In the case that a country produces more than one type of resources or the type is simply characterized by "minerals", production quantities are the sum of the respective resources. *Source*: Own calculation. The data for resource production is available on http://data.worldbank.org/data-catalog/wealth-of-nations. Information on type of resources stems from IMF(2010, 2012).
regqua	Index on "regulatory quality" that "captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development." The index is constructed by Kaufmann et al. (2010) using different variables from various sources, among others "investment profile" from PRS (see description of the variable $iprof$). The index ranges between -2.5 (low quality) and +2.5 (high quality). This index is used as a proxy for ex ante expropriation risk as alternative for $iprof$. *Source*: World Bank (2013a).
tax	Natural logarithm of the ratio of government's resource revenues to total resource revenues. *Source*: Own calculation. Data on government's resource revenues as share of GDP stems from IMF(2010, 2012). Values for total resource revenues are calculated by multiplying the resource prices with respective quantities. See description of the variable *prodvolume*. Data on GDP on current prices stems from World Bank (2013b).