

Cursing the blessings?  
Natural resource abundance, institutions, and  
economic development

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**Abstract**

Since Sachs and Warner's (1995a) contribution, there has been a lively debate on the so-called natural resource curse. This paper re-examines the effects of natural resource abundance on economic growth and development using new measures of resource endowment and considering the role of institutional quality. We find a positive direct empirical relationship between natural resource abundance and economic growth and income levels. In both OLS and 2SLS regressions, the positive resource effects are particularly significant for subsoil wealth. Our results also show no evidence of negative indirect effects of natural resources through the institutional channel.

*Keywords: Natural resources, resource curse, economic growth, institutional quality*

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# 1 Introduction

Natural resources seem to have been more of a curse than a blessing for many countries. Numerous researchers have supported the view that resource-poor countries often outperform resource-rich countries in economic growth. Sachs and Warner (1995a)—hereafter referred to as SW—made a major contribution when they found a negative association between natural resource abundance and growth in a large cross-country study,<sup>1</sup> and a substantial number of papers has since considered the natural resource curse hypothesis from different points of view. For example, Auty (1997, 2001) tries to explain the curse historically, while Ross (2001) and Collier and Hoeffler (2005) focus on the negative associations between resource abundance and the stability and quality of the political system.

The explicit consideration of various transmission channels of the effects of natural resource abundance on economic growth has led to more differentiated—and ambiguous—results. For example, Gylfason (2001) and Bravo-Ortega and De Gregorio (2005) concentrate on human capital. The first shows that the negative growth effects of natural resources stem from lower education spending and less schooling in resource-rich countries. The latter find that the negative resource effects can in fact be *offset* by higher education levels, making natural resource abundance a boon for countries with high human capital levels. Torvik (2001) shows that natural resource abundance increases rent-seeking behaviour and lowers income; while Manzano and Rigobon (2001) believe that the real problem for growth is the debt overhang in resource-rich countries. The Dutch disease hypothesis is examined by Stijns (2003), who confirms the typical sectoral change pattern but finds little evidence for overall negative resource effects on growth; and by Matsen and Torvik (2005), who propose that long-term growth can be positive provided the savings path is adjusted to take into account the relative importance of the traded and non-traded goods sectors. Hausmann and Rigobon (2002) consider the trade structure and show that (export) diversified economies are less likely to suffer negative effects of natural resource wealth.<sup>2</sup>

In this paper, we re-examine two main aspects of the resource curse literature and find new cross-country evidence, comparing the growth results with more rarely considered income level effects. The first aspect regards the measurement of natural resource abundance. Most empirical studies confirming the resource curse published over the past decade have used the SW (or a similar) measure, which estimates resource abundance based on the share of primary exports in GDP at the beginning of the observation period. We evaluate the validity of this indicator and propose some alternatives, which in our view better capture a country's natural resource wealth. The second aspect concentrates on the importance of institutional quality in the economic growth and development process. Despite several recent studies showing that "institutions matter" for development (e.g. Knack and Keefer, 1995; La Porta et al., 1999; Acemoglu et

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<sup>1</sup>The same authors contributed several more studies on the resource curse, see Sachs and Warner (1999, 2001), as well as Rodriguez and Sachs (1999).

<sup>2</sup>See Ross (1999) and Stijns (2005) for more extensive literature overviews.

al., 2001), the role of institutional quality has not received very much attention in work on growth with resource abundance. A brief review of the literature shows that institutions may however play a critical role in determining the economic growth and development of resource-rich economies, and should therefore be awarded a more prominent place in the analysis.

The results of our cross-country estimations show no evidence of a negative growth or income level effect of natural resource abundance. Using new measures of natural resource wealth, we instead find a positive direct association with economic growth over the period 1970-2000 as well as recent income levels, which is confirmed when we consider the role of institutional quality. The findings are consistently highly significant when we concentrate on mineral resources, which runs contrary to most of the resource-and-growth literature. Also, our estimations do not confirm the negative effects of resource abundance through institutional quality found in several other studies. Interestingly, adding an interaction term suggests that the beneficial resource effects diminish as institutional quality increases, although the overall effects remain strongly positive. The positive results hold both in ordinary least squares (OLS) and two-stage least squares (2SLS) estimations which consider the endogeneity of institutions, and they are robust to the inclusion of a wide range of additional control variables from the growth literature.

The next section takes a closer look at various measures of natural resource abundance used in the literature and discusses the importance of considering institutional quality. Section 3 presents results of OLS and 2SLS regressions of the levels and growth rates of GDP per capita on our measures of natural resource endowment and institutional quality, and section 4 concludes.

## 2 A fresh look at the natural resource curse hypothesis

### 2.1 Measuring natural resource abundance

Following Sachs and Warner (1995a), primary exports over GDP have constituted the preferred indicator of natural resource abundance in the natural-resource-and-growth literature. SW's measure of "resource intensity",  $exp$ , is easily available and has been employed by numerous researchers who confirmed the negative growth effects of natural resource wealth. However, primary exports seem an unsatisfactory indicator of natural resource abundance for two main reasons.

First, even if we were to assume a strong positive correlation between natural resource *abundance* and natural resource *exports*—which is by no means obvious given counter-examples of resource-rich countries with relatively low primary exports such as Australia and Germany—we could also plausibly argue that a dominant share of primary resource exports in GDP is a strong indication for

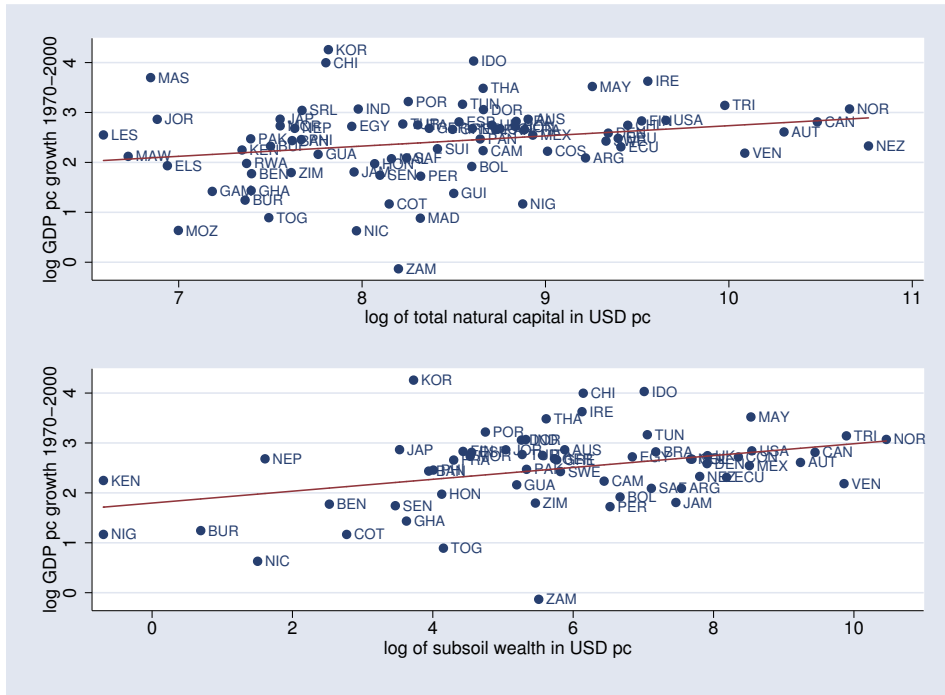


FIGURE 1. NATURAL RESOURCE WEALTH AND GROWTH (1970-2000)

Notes: Regression fit using World Bank natural wealth data measured in USD per capita (pc). See appendix for data and regression details.

an unbalanced economy. Slow growth in countries with a large share of primary exports may therefore be due more to general macroeconomic distortions—i.e. a high economic dependence on natural resources—rather than a direct natural resource "curse". Second, it is worth noting that the resource export variable is quite volatile, suggesting that the period average would in any case be a better measure than the beginning-of-period value employed in the literature (Ledermann and Maloney, 2003).<sup>3</sup>

Empirically, variations in the setup of the resource exports variable have cast substantial doubt on the resource curse hypothesis. For example, Ledermann and Maloney (2003) find *positive* growth effects using the share of primary exports in total exports and primary exports over total labour force. Davis (1995) used the share of mineral exports in total merchandise exports as one of his natural resource proxies, showing a positive relationship with economic development. Leite and Weidmann (1999) and Sala-i-Martin and Subramanian (2003) find ambiguous growth effects when disaggregating resource exports into agricultural, and fuel and non-fuel mineral products. Neumayer (2004) introduces another variation on the resource curse theme: although still using SW's resource exports variable, he takes growth in *genuine* income as the dependent variable to find a negative, albeit weakened, resource effect.

Other empirical research does not rely on export data, but has instead employed altogether different measures of natural resource abundance. For exam-

<sup>3</sup>  $sxp$  is calculated for 1971, although the observation period in SW is 1970-1989.

ple, resource rent data have revealed both positive and negative growth effects (Stijns, 2001; Atkinson and Hamilton, 2003). In this group of empirical work as well, differentiating between various types of resources has delivered interesting results. When classified by indices, economies dependent on "point-source" resource extraction—i.e. minerals and plantation crops characterised by localised, intensive production—often show evidence of worse economic performance and institutions than economies dependent on more "diffuse" resources, i.e. characterised by more extensive production (Isham et al., 2005). Mineral production over GDP however delivers less clearcut results: using this measure, Davis (1995) finds a positive relationship with economic growth, while Papyrakis and Gerlagh (2004) find both positive and negative growth effects, with the negative ones prevailing. Finally, fuel and non-fuel mineral reserve and production data, as well as land endowment—all measured per 1'000 inhabitants—again show ambiguous effects on economic growth (Stijns, 2005).

Hence, as a first step in re-examining the hypothesis of a curse of natural resource *abundance* as opposed to *dependence*, we compare SW's primary exports indicator *sxp* with several alternative measures of natural resource endowment. We collected data on fuel and non-fuel mineral production in 1970 from the *World Mineral Statistics* (IGS, 1978) and British Petroleum (for natural gas), and used them both separately and as an aggregate, denoted by *fuelmin*, *nonfuelmin*, and *min*, respectively. Additionally, these indicators were calculated as per capita (*pc*) measures and as shares of 1970 GDP (*gdp*). We also employ natural resource wealth data recently published by the World Bank (1997, 2005). The World Bank natural resource indicators value different components of natural wealth in USD per capita and are available for 1994 and 2000.<sup>4</sup>

Figure 1 illustrates the ordinary least squares (OLS) regression fits of two of these new measures on economic growth between 1970-2000 (detailed basic estimation results for income growth and levels can be found in Appendix A). Clearly, there is no longer a negative association suggesting a curse of natural resource abundance: on the contrary, we now observe a significant *positive* relationship, especially when we consider the evidence for per capita subsoil wealth.

To better understand how different measures of resource endowment can deliver radically different estimation results, we calculate the correlations between SW's measure of natural resource wealth at the beginning of the observation period, beginning-of-period mineral production data, and the World Bank indicators for total natural wealth and subsoil assets per capita. It is obvious from the results in table 1 that *sxp* is not correlated with other measures of natural resource wealth at conventional levels of significance (column (1)). On the other hand, the correlations between the World Bank indicators—per capita subsoil assets *subsoil* and total natural capital *natcap*—and per capita mineral production and mineral production over GDP are consistently positive and highly

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<sup>4</sup>Natural resources valued by the World Bank in both studies include subsoil assets (fuel and non-fuel minerals), timber resources, non-timber forest resources, protected areas, cropland, pastureland, and total natural capital. The partial indicators of forest and agricultural wealth gave no significant results in the estimations and are therefore not shown.

TABLE 1. CORRELATIONS BETWEEN NATURAL RESOURCE WEALTH ESTIMATES

	sxp	nonfuelmin	fuelmin	min	nonfuelminpc	fuelminpc	minpc	subsoil	natcap	nonfuelmin/gdp	fuelmin/gdp
nonfuelmin	-0.02	1.00									
fuelmin	-0.05	0.85*	1.00								
min	-0.05	0.88*	0.99*	1.00							
nonfuelminpc	-0.11	0.13	0.06	-0.00	1.00						
fuelminpc	-0.15	-0.04	0.06	0.05	-0.04	1.00					
minpc	-0.14	0.02	0.07	0.08	0.12	0.99*	1.00				
subsoil	0.14	0.19	0.07	0.12	0.37*	0.54*	0.58*	1.00			
natcap	0.02	0.28*	0.1	0.16	0.30*	0.42*	0.49*	0.74*	1.00		
nonfuelmin/gdp	-0.1	0.03	0.00	-0.03	0.61*	0.52*	0.38*	0.12	-0.01	1.00	
fuelmin/gdp	0.19	0.07	0.17	0.16	0.17	0.88*	0.79*	0.50*	0.28*	0.41*	1.00
min/gdp	0.04	0.13	0.16	0.14	0.45*	0.89*	0.75*	0.49*	0.20*	0.70*	0.99*

Notes: \* statistically significant at 10 percent level or less. *sxp* measures primary exports over GDP in 1971 and is taken from SW. *subsoil* and *natcap* are averaged estimates for subsoil assets and total natural capital (in 1994 and 2000), respectively, and are taken from World Bank (1997, 2000). Mineral production data for 1970 is measured in tonnes and taken from IGS (1978) and British Petroleum database. For detailed variable descriptions and sources see the appendix.

significant.<sup>5</sup>

Below, we will use the World Bank's per capita natural resource data—averaged to minimise possible measurement errors and price fluctuations in the calculations—and estimate their effect on economic growth over the period 1970-2000 and recent income levels.<sup>6</sup> We will also compare the results with those reached using *exp*.

## 2.2 Natural resources and institutional quality

Several recent contributions have stressed the importance of institutional quality for economic development (e.g. Knack and Keefer, 1995; Mauro, 1995; Hall and Jones, 1999; La Porta et al., 1999; Acemoglu et al., 2001). But in quantitative work on the resource curse hypothesis, the institutional channel has seldom been verified with much success, although it has frequently been mentioned as an important potential cause of the curse. Institutional quality is often simply controlled for by using a measure of corruption (e.g. Sachs and Warner, 1995a; Papyrakis and Gerlagh, 2004). Notable exceptions are given by Bulte et al. (2005) and Mehlum et al. (2006). The first find that natural resource abundance, and especially mineral resources, have an ambiguous direct effect on several measures of human development, and a slightly negative indirect effect via two measures of institutional quality. The latter show that the interaction of natural resource abundance with high-quality institutions—measured by an aggregate indicator—has a positive growth effect, while the direct negative growth effect of resource wealth seems to persist. However, these results are based on resource exports data, which pose the problems already discussed above: we contend that they more accurately depict the effects of natural resource *dependence*.

From a more qualitative angle, historians, political scientists, and economists generally agree that the presence of abundant natural resources (especially minerals) leads to rent-seeking behaviour and corruption, thereby decreasing the quality of government, which in turn negatively affects economic development (e.g. Auty, 2001; Leite and Weidmann, 1999; Isham et al., 2005).<sup>7</sup> There is also evidence that natural resource abundance considerably increases the potential of violent civil conflict (Collier and Hoeffler, 2005). Empirically, rent-seeking due to natural resources has been shown to be non-linear, both with respect to income and the total amount of resources in a country. In his cross-country

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<sup>5</sup>This also suggests that the countries' natural resource wealth, measured by their mineral abundance (subsoil assets) and total natural capital, has changed relatively little over the past three decades, confirming the hypothesis of Gylfason (2001).

<sup>6</sup>The World Bank measures are deemed to offer the most reliable measures of relative natural resource abundance. Data quality on mineral production for the early 1970s is not uniform; moreover, unweighted production data are unsatisfactory proxies for natural resource wealth, as they make no distinction between the value of different minerals. For example, one additional tonne of sulphur has the same production effect as one additional tonne of gold. Assigning weights to the minerals extracted is equivalent to estimating their monetary value.

<sup>7</sup>For formal models of rent-seeking behaviour, see Tornell and Lane (1999) and Torvik (2001).

study, Ross (2001) finds that the negative resource effects of mineral abundance on institutions decline with increasing income levels and with greater past mineral exports. And in their case study of Nigeria, Sala-i-Martin and Subramanian (2003) describe how "oil corrupts and excess oil corrupts more than excessively". They stress that the natural resource curse only holds for mineral—and particularly oil—abundance, and not agricultural products and food (all measured by their respective export shares).

In a different vein, Atkinson and Hamilton (2003) show that natural resource abundance may have negative effects on development when weak institutions allow resource profits to be spent in government consumption rather than investment, especially in countries with low levels of genuine saving. Stijns (2005) contends that there are both positive and negative channels through which natural resource abundance affects economic growth; he finds that land abundance tends to have negative effects on all determinants of growth, including different measures of institutional quality, while the effects of mineral abundance are less clearcut. He concludes that "learning processes" are the crucial element in determining the direction of influence of resource wealth on growth, i.e. how countries exploit and develop their resources. Acemoglu et al. (2001) question the resource curse hypothesis even further when they find no significant income effect of natural resource abundance at all, confirming their view that institutional quality alone can explain a great deal of the cross-country differences in economic development.

From the literature, it emerges that the growth and development effects of natural resource abundance are rather ambiguous when institutional quality is included in the analysis: there may in fact only be a curse when natural resource wealth occurs together with low-quality institutions. In this paper, we will explore this possibility by focusing both on natural resource abundance and on institutional quality. We use two different institutional quality indicators, namely measures for the rule of law and government effectiveness (described below), and interact them with our resource abundance measures; in a second step we instrument for them to account for the possible endogeneity of the quality of institutions themselves, including the possibility that natural resource abundance negatively affects institutions.

### **3 Natural resources, institutions, and income: results of cross-country estimations**

#### **3.1 Data and descriptive statistics**

Table 2 presents descriptive statistics for the key variables. Average growth of per capita income between 1970-2000 is PPP adjusted (detailed variable descriptions and sources are provided in the appendix). This will be the main dependent variable for the subsequent estimations. It is evident from the data



TABLE 2. DESCRIPTIVE STATISTICS

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Log growth of income per capita, average 1970-2000 ( <i>g7000</i> )	102	2.44	0.80	-0.13	4.26
Log income per capita in 2000 ( <i>gdp00</i> )	132	8.6	1.13	6.19	10.8
Log total natural capital in US\$ per capita, average 1994-2000 ( <i>lnnatcap</i> )	84	8.36	0.92	6.59	10.76
Log subsoil wealth in US\$ per capita, average 1994-2000 ( <i>lnsubsoil</i> )	63	5.76	2.41	-0.69	10.46
Primary exports / GDP in 1971 ( <i>sxp</i> )	114	0.16	0.16	0.01	0.89
Rule of law, average 1996-2000 ( <i>ruleoflaw</i> )	158	2.54	1.0	0.67	4.74
Government effectiveness, average 1996-2000 ( <i>goveffect</i> )	165	2.52	0.99	0.19	5.01

*Note:* Variable sources and detailed descriptions are given in the appendix.

that the growth differences in the sample of roughly 100 countries are quite large, with a standard deviation in log per capita income growth of 0.8. Row 2 presents the comparison dependent variable, log of real GDP per capita in 2000. The data show a similar picture as those for GDP growth, with wide variations in recent income per capita. Rows 3-4 describe the logs of the natural resource abundance indicators introduced above, namely total natural capital and subsoil wealth, respectively, averaged over 1994-2000. The differences in subsoil wealth between the countries in the sample are particularly remarkable, with a standard deviation of 2.39. SW's main natural resource indicator *sxp* is described in row 5.

The last two rows show the main variables used to measure institutional quality. Both are 1996-2000 average values, taken from the World Bank governance indicators (Kaufmann et al., 2005; also included in the *World Development Indicators*), which estimate different dimensions of governance. *ruleoflaw* measures the quality of contract enforcement, of the police and the courts, as well as the likelihood of crime and violence; *goveffect* measures the quality of the bureaucracy and of public services. These indicators show a high correlation with similar measures of institutional quality used in the growth literature (e.g. Knack and Keefer, 1995; La Porta et al., 1999).<sup>8</sup> The two main advantages of the World Bank indicators lie in their objectivity—provided by a very broad survey sample—and the excellent country coverage. Again, the data report a wide variety in the level of rule of law and government effectiveness between the countries, considering that the estimates range from zero to 5, with institutional quality increasing with the value of the indicator.

TABLE 3. OLS REGRESSIONS: NATURAL RESOURCES, INSTITUTIONS, AND INCOME

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A</i>										
lgdp70	-0.31** (0.13)	-0.62*** (0.15)	-0.63*** (0.15)	-0.75*** (0.16)	-0.85*** (0.16)	-0.86*** (0.16)	-0.93*** (0.18)			
sxp	-0.65 (0.42)							0.09 (0.38)		
lnnatcap		0.20** (0.10)	0.20** (0.10)	0.08 (0.09)					0.30*** (0.07)	
lnsubsoil					0.15*** (0.04)	0.16*** (0.04)	0.13*** (0.03)			0.14*** (0.03)
ruleoflaw	0.48*** (0.14)	0.73*** (0.13)	0.71*** (0.16)	0.69*** (0.14)	0.81*** (0.13)	0.69*** (0.17)	0.67*** (0.16)	0.77*** (0.08)	0.83*** (0.11)	0.73*** (0.11)
latitude	0.53 (0.57)		0.11 (0.70)			0.77 (0.74)		1.43*** (0.39)	0.29 (0.57)	0.65 (0.57)
Africa&ME				-0.85*** (0.28)				-0.99*** (0.27)		
Asia&Ocean.				0.07 (0.27)				-0.21 (0.26)		
N.Am.				0.21 (0.37)				-0.12 (0.35)		
C.&S.Am.				-0.05 (0.27)				-0.37 (0.3)		
Adj. <i>R</i> <sup>2</sup>	0.31	0.32	0.31	0.48	0.46	0.46	0.58	0.71	0.8	0.85
N	67	79	79	79	61	61	61	80	80	61
<i>Panel B</i>										
lgdp70	-0.16 (0.14)	-0.59*** (0.15)	-0.59*** (0.15)	-0.68*** (0.16)	-0.85*** (0.15)	-0.87*** (0.15)	-0.87*** (0.17)			
sxp	-0.98** (0.45)							-0.06 (0.43)		
lnnatcap		0.19* (0.10)	0.2* (0.10)	0.07 (0.1)					0.30*** (0.08)	
lnsubsoil					0.14*** (0.03)	0.15*** (0.04)	0.12*** (0.03)			0.13*** (0.03)
goveffect	0.32** (0.14)	0.72*** (0.13)	0.68*** (0.17)	0.67*** (0.15)	0.86*** (0.13)	0.73*** (0.17)	0.67*** (0.16)	0.66*** (0.09)	0.83*** (0.12)	0.74*** (0.11)
latitude	0.44 (0.63)		0.29 (0.72)			0.80 (0.69)		1.39*** (0.45)	0.45 (0.59)	0.77 (0.53)
Africa&ME				-0.80*** (0.29)				-0.89*** (0.28)		
Asia&Ocean.				0.16 (0.27)				-0.11 (0.25)		
N.Am.				0.1 (0.38)				-0.21 (0.34)		
C.&S.Am.				-0.04 (0.28)				-0.35 (0.29)		
Adj. <i>R</i> <sup>2</sup>	0.20	0.29	0.28	0.45	0.49	0.49	0.59	0.59	0.79	0.85
N	69	79	79	79	61	61	61	84	80	61

*Notes:* Dependent variable in columns (1)-(7) is log income growth 1970-2000, and in columns (8)-(10) log income per capita in 2000. Standard errors in parentheses. \*, \*\*, \*\*\* statistically significant at 10, 5, and 1 percent levels, respectively. Joint significance tests strongly reject hypothesis of no difference between covariates in all estimations. For detailed variable descriptions and sources see appendix.

### 3.2 Ordinary least squares regressions

To better compare the income effects of different natural resource measures, we begin with standard cross-country OLS growth regressions of the type used in the resource curse literature. The idea is that economic growth between  $t=1970$  and  $T=2000$  in country  $i$ , defined as  $G^i = (1/(T-t))\ln(Y_T^i/Y_t^i)$ , is a function of a vector of explanatory variables, including the natural logarithm of natural resource abundance  $R^i$  and institutional quality  $INST^i$ . We further add to the analysis by comparing these results with those using GDP per capita in 2000 as an alternative dependent variable, to see if natural resource abundance has

<sup>8</sup>As shown in Appendix B, the World Bank measures are highly correlated with several other measures of institutional quality, including indicators for the beginning of the sample period. This confirms the view that institutions have remained relatively stable over the last decades, and also diminishes the disadvantage of not having earlier data for our estimations.

differing income growth and level effects.

Table 3 presents results of the linear regressions for<sup>9</sup>

$$G^i = \alpha_0 + \alpha_1 Y_t^i + \alpha_2 R^i + \alpha_3 INST^i + \alpha_4 Z^i + \epsilon^i \quad (1)$$

where  $Y$  is the log of income per capita in 1970 (our basic control for the growth regressions, as in SW and subsequent estimations),  $R$  and  $INST$  are the natural resource abundance and institutional quality variables, respectively,  $Z$  is a vector of other covariates, and  $\epsilon$  is a random error term. Throughout the paper, we are particularly interested in the coefficient  $\alpha_2$ . Since we use logs, the effect of natural resource abundance on income growth and level is expressed as an elasticity.

Panel A in table 3 shows the results of estimations using the rule of law as the main institutional indicator, while panel B reports the results using government effectiveness. Column (1) shows a negative *but not very significant* effect of natural resource abundance on growth when using the SW indicator *exp*. Columns (2)-(4) show a weakly significant positive influence of natural resource abundance on growth when using per capita natural capital, which disappears when we control for regional effects (Europe and Central Asia is the omitted region throughout the estimations). Columns (5)-(7) however show that an abundance of subsoil wealth has a consistent and highly significant *positive* effect on economic growth. All other things equal, the results would imply that an increase in per capita subsoil wealth would have a fairly large positive growth effect if we were to assume a direct causality. On average, a one-percent increase in dollarised per capita subsoil assets would have meant up to 0.16 percent more income growth over the period. The findings suggest that the use of *exp* as the measure of natural resource abundance may have led to a negative bias in the literature.

Columns (8)-(10) show the corresponding results using income level as the dependent variable instead.<sup>10</sup> Interestingly, these closely resemble the growth results: again, both total natural capital and subsoil wealth have positive income effects, although the aggregate measure loses significance when controlling for regions (not shown). This suggests that, all other things equal, countries rich in natural resources—and again especially mineral assets—have a higher per capita income today than resource-poor countries.

In all estimations, the institutional quality indicators are positive and highly significant, confirming the view that "institutions matter". The coefficients for our rule-of-law and government-effectiveness measures suggest that a one-point increase on the institutional quality index would have had a large positive growth effect on average, again assuming a direct causal relationship.<sup>11</sup> The

<sup>9</sup>The results of simple OLS regressions using only our natural resource variables *lnnatcap* and *lnsubsoil* and the SW variable *exp* are presented in Appendix A.

<sup>10</sup>For convenience, only a small selection of income level estimations is shown. Full regression results are available upon request.

<sup>11</sup>For example, the result from column (2) suggests that in case of a one-point improvement on the rule-of-law index, we could have observed a *ceteris paribus* average growth increase of  $100 * [\exp(0.73 * 1) - 1] = 107.5\%$  over the period. Obviously, this effect is extreme even considering that one point on the institutional quality scale corresponds to a very substantial

highly significant negative coefficients for initial income throughout the growth estimations are in accordance with the convergence literature.<sup>12</sup>

**OLS estimations with interaction terms** At this point, we may wonder if and how natural resource abundance and institutional quality interact. For example, although natural resources may have positive income and growth effects in general, the results so far could have been driven by resource-rich countries with high-quality institutions. To investigate this possibility, we insert an interaction term between our natural resource abundance and institutional quality measures in the basic regression equation (1) and again compare them with the SW indicator of primary exports over GDP, *sxp*.

The results for income growth and levels are shown in table 4. First, we note that the coefficients on our natural resource and institutional quality measures retain their expected signs, irrespective of whether we take income growth or levels as the dependent variable; their significance in fact seems reinforced. But the interaction terms appear significantly negative throughout the estimations, suggesting that the *positive income and growth effects diminish as institutional quality improves*. It is unclear how to interpret this result; perhaps countries with high-quality institutions have relied less on natural resources for the development of their economy, generating a sort of "convergence effect". On the other hand, in column (1) we see that higher institutional quality appears to reinforce the growth effects of the GDP share of primary exports.

Should we therefore re-evaluate our previous positive findings on natural resource abundance? In fact, our overall results do not change much with the interaction terms: natural resource abundance still has significantly positive effects on economic growth and income levels. To show this, we can calculate the overall resource effects for interesting values of our institutional quality measures—as the coefficients in table 4 correspond to an effect with zero, i.e. unrealistically bad, quality institutions. For example, using the results from column (2), panel A, we can take the sample mean of the quality of rule of law to obtain the average effect of a 1-percent increase in natural resources on a country's growth as  $1.25 - (0.33 * 2.54) = 0.41$  percent. This is twice as high as the effect we found without interaction terms. Similarly, a 1-percent increase in mineral resources from column (4), panel A, gives us an overall growth effect of  $0.37 - (0.08 * 2.54) = 0.17$  percent, an effect similar in magnitude to that found in previous estimations. Analogously, the overall income level effect of total natural resources now has an elasticity of around 0.44 (from column (7), panel A), and that of mineral resources approximately 0.14 (column (9), panel A). Conversely, *sxp* still has negative overall growth and income level effects, namely around  $-0.66$  (column (1), panel A) and  $-0.42$  (column (6), panel A), respectively.

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institutional improvement. Given this caveat, the coefficients found in subsequent estimations confirm the large positive growth effects of sound institutions.

<sup>12</sup>As an interesting aside, latitude proves insignificant in our estimations, running counter to the hypothesis that geographical and climatic factors, determined by distance from the equator, have an important direct effect on economic growth (see also 2SLS regressions below).

TABLE 4. OLS REGRESSIONS WITH INTERACTION TERMS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A</i>										
lgdp70	-0.24*	-0.78***	-0.84***	-0.88***	-0.95***					
	(0.13)	(0.14)	(0.15)	(0.15)	(0.17)					
sxp	-3.4***					-0.47				
	(1.01)					(1.03)				
lnnatcap		1.25***	1.00***				1.18***	0.83***		
		(0.26)	(0.23)				(0.19)	(0.17)		
lnsubsoil				0.37***	0.37***				0.29***	0.23***
				(0.08)	(0.07)				(0.06)	(0.05)
ruleofflaw	0.15	3.66***	3.34***	1.26***	1.18***	0.77***	3.36***	2.79***	1.13***	1.07***
	(0.15)	(0.7)	(0.63)	(0.25)	(0.24)	(0.09)	(0.52)	(0.46)	(0.18)	(0.15)
interaction	1.08**	-0.33***	-0.3***	-0.08***	-0.07***	0.02	-0.29***	-0.23***	-0.06***	-0.05***
	(0.41)	(0.08)	(0.07)	(0.03)	(0.03)	(0.42)	(0.06)	(0.05)	(0.02)	(0.02)
latitude		0.55		0.67			0.62		0.57	
		(0.64)		(0.7)			(0.50)		(0.53)	
Africa&ME	-0.68***		-0.71***		-0.85***	-0.86***		-0.70***		-0.68***
	(0.24)		(0.25)		(0.26)	(0.17)		(0.19)		(0.19)
Asia&Ocean.	0.19		0.15		-0.15	-0.51***		-0.17		0.31*
	(0.23)		(0.24)		(0.24)	(0.19)		(0.17)		(0.16)
N.Am.	0.82		0.46		0.14	0.84		0.42		0.19
	(0.62)		(0.34)		(0.34)	(0.64)		(0.26)		(0.25)
C.&S.Am.	-0.26		-0.05		-0.27	-0.11		0.00		-0.08
	(0.24)		(0.24)		(0.28)	(0.19)		(0.18)		(0.20)
Adj. R <sup>2</sup>	0.51	0.45	0.58	0.53	0.63	0.75	0.85	0.89	0.86	0.90
N	67	79	79	61	61	80	80	80	61	61
<i>Panel B</i>										
lgdp70	-0.08	-0.75***	-0.76***	-0.91***	-0.9***					
	(0.13)	(0.15)	(0.15)	(0.14)	(0.16)					
sxp	-3.84***					0.65				
	(1.29)					(1.32)				
lnnatcap		1.23***	0.96***				1.21***	0.83***		
		(0.29)	(0.26)				(0.21)	(0.2)		
lnsubsoil				0.36***	0.31***				0.3***	0.24***
				(0.08)	(0.07)				(0.06)	(0.05)
goveffect	-0.03	3.64***	3.23***	1.34***	1.22***	0.66***	3.48***	2.84***	1.19***	1.14***
	(0.15)	(0.79)	(0.72)	(0.25)	(0.25)	(0.11)	(0.58)	(0.55)	(0.17)	(0.16)
interaction	1.12**	-0.33***	-0.29***	-0.09***	-0.08***	0.04	-0.31***	-0.23***	-0.07***	-0.06***
	(0.50)	(0.09)	(0.08)	(0.03)	(0.03)	(0.52)	(0.07)	(0.06)	(0.02)	(0.02)
latitude		0.70		0.75			0.77		0.72	
		(0.67)		(0.64)			(0.53)		(0.49)	
Africa&ME	-0.68**		-0.65**		-0.74***	-0.85***		-0.68***		-0.61***
	(0.28)		(0.27)		(0.26)	(0.20)		(0.21)		(0.2)
Asia&Ocean.	0.21		0.28		-0.03	0.54**		-0.09		-0.25
	(0.27)		(0.26)		(0.24)	(0.23)		(0.19)		(0.17)
N.Am.	0.41		0.38		0.09	0.53		0.34		0.13
	(0.73)		(0.36)		(0.34)	(0.77)		(0.28)		(0.26)
C.&S.Am.	-0.41		-0.03		-0.25	-0.12		0.04		-0.08
	(0.29)		(0.26)		(0.28)	(0.23)		(0.20)		(0.21)
Adj. R <sup>2</sup>	0.37	0.4	0.54	0.56	0.64	0.63	0.83	0.87	0.87	0.9
N	69	79	79	61	61	84	80	80	61	61

Notes: Dependent variable in columns (1)-(5) is log income growth 1970-2000, and in columns (6)-(10) log income per capita in 2000. Standard errors in parentheses. \*, \*\*, \*\*\* statistically significant at 10, 5, and 1 percent levels, respectively. Joint significance tests strongly reject hypothesis of no difference between covariates in all estimations. For detailed variable descriptions and sources see appendix.

TABLE 5. DETERMINANTS OF INSTITUTIONS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A</i>										
<i>Dep't var. ruleoflaw</i>										
latitude	2.53*** (0.37)	4.09*** (0.36)	2.67*** (0.4)	4.30*** (0.35)	2.91*** (0.42)					
polity70						0.08*** (0.01)	0.07*** (0.01)	0.04*** (0.01)	0.08*** (0.02)	0.04*** (0.01)
lnnatcap		0.26*** (0.07)	0.04 (0.07)				0.30*** (0.1)	-0.04 (0.09)		
lnsubsoil				0.07** (0.03)	0.01 (0.03)				0.05 (0.05)	-0.04 (0.04)
lgdp70			0.51*** (0.09)		0.47*** (0.1)			0.73*** (0.09)		0.80*** (0.10)
Adj. $R^2$	0.22	0.71	0.79	0.74	0.81	0.32	0.49	0.71	0.39	0.7
N	158	84	84	63	63	126	83	83	62	62
<i>Panel B</i>										
<i>Dep't var. goeffect</i>										
latitude	2.61*** (0.35)	3.91*** (0.34)	2.59*** (0.38)	4.06*** (0.35)	2.71*** (0.42)					
polity70						0.08*** (0.01)	0.06*** (0.01)	0.02** (0.01)	0.07*** (0.02)	0.02* (0.01)
lnnatcap		0.26*** (0.07)	0.06 (0.07)				0.34*** (0.1)	-0.01 (0.08)		
lnsubsoil				0.08*** (0.03)	0.03 (0.03)				0.08 (0.05)	-0.02 (0.04)
lgdp70			0.47*** (0.09)		0.45*** (0.1)			0.75*** (0.09)		0.82*** (0.10)
Adj. $R^2$	0.25	0.71	0.79	0.73	0.79	0.30	0.44	0.69	0.33	0.67
N	165	84	84	63	63	128	83	83	62	62

Notes: All regressions are OLS. Standard errors in parentheses. \*, \*\*, \*\*\* statistically significant at 10, 5, and 1 percent levels, respectively. For detailed variable descriptions and sources see appendix.

However, the institutional indicators in our OLS estimations may suffer from endogeneity, as it is plausible to assume that many omitted variables will be correlated with institutions. If there is resource-induced rent-seeking behaviour among government officials, then natural resource wealth itself may be negatively correlated with institutions and outweigh the positive direct growth effects. These factors are not sufficiently accounted for in OLS, which is why in the next subsection we proceed to find an instrument for the institutional variation which has no direct effect on economic growth, and then perform two-stage least squares (2SLS) estimations.

### 3.3 Two-stage least squares regressions

Equation (1) described the relationship between natural resource wealth and institutional quality on one side, and economic growth (or income level) on the other. In addition we have

$$INST^i = \beta_0 + \beta_1 R^i + \beta_2 L^i + \beta_3 Z^i + \nu^i, \quad (2)$$

where  $INST$  is our measure of institutional quality, now the dependent variable,  $R$  is again the natural resource abundance measure,  $L$  is our main instrument for institutional quality,  $Z$  is the vector of covariates affecting all variables, and  $\nu$  is the random error term.

Table 5 presents OLS regressions for equation (2) using two different potential instruments for the rule-of-law (panel A) and government-effectiveness

indicator (panel B). In columns (1)-(5) we regress latitude, calculated on a scale from 0 to 1, against our institutional quality measures. There have been several studies on the link between latitude and economic development, but there is no widely accepted explanation for the observed correlation. We follow Hall and Jones (1999) in assuming that the direct effect of a country’s latitude on its economic performance is zero and that any observed influence appears only via the institutional channel. This assumption is strengthened by the observation that latitude becomes statistically insignificant in our OLS estimations once institutional quality is controlled for (see tables 3-4).

Column (1) shows that latitude alone accounts for up to one quarter of the variation in our institutional quality measures, and it remains highly significant when adding other covariates (columns (2)-(5)). Columns (2)-(5) show that natural resource abundance has a positive effect on institutional quality; the effect is however not robust to controlling for initial income, although the sign remains positive.<sup>13</sup>

Columns (6)-(10) show the results of the regressions using a regime index for a country’s political system in 1970 (*polity70*). The index is taken from the Polity IV Project (Marshall and Jaggers, 2002) and classifies a regime on a scale of  $-10$  (institutionalised autocracy) to  $10$  (institutionalised democracy). The polity measure alone explains nearly one third of our institutional quality variation (column (6)), but is less robust to the inclusion of other variables than latitude. In addition, polity is a complex composite index and could suffer from measurement error as well as lack of objectivity; and it is probably itself endogenous and correlated with income. We will therefore use latitude in the specification for the first stage of our two-stage least squares estimations. Interestingly, natural resource abundance has ambiguous effects on institutional quality in the estimations using the polity index, although the results are not very significant (columns (7)-(10)).

Equations (1) and (2) form the basis for the two-stage least squares regressions presented in table 6. Equation (2) is our first stage for the institutional quality measures, shown in panel B; equation (1) is the second stage, shown in panel A. The results confirm those found in the OLS regressions, both regarding the sign and the magnitude of the coefficients of interest. The broad measure of natural resource abundance, natural capital per capita, has a positive direct effect on economic growth in the period observed, as well as income levels. But this effect practically disappears when we control for regions, suggesting that most of the positive growth effect of natural capital is limited to certain areas of the world.<sup>14</sup> The indirect effect via the institutional channel is statistically even weaker for the growth regressions. Curiously, there is a strong positive

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<sup>13</sup>Nevertheless, we believe that these findings cast doubt on the rent-seeking hypothesis: natural resource abundance does not necessarily lead to worse institutions. It may have a corruptive effect in poorer and more autocratic countries, a possibility suggested by the findings using the polity indicator (below); but determining the exact nature of this indirect causal relationship goes beyond the scope of the present paper.

<sup>14</sup>The results show that resource-rich African and Middle Eastern economies in particular have performed much worse than European and central Asian ones (Europe and Central Asia being the omitted region).

TABLE 6. 2SLS REGRESSIONS: NATURAL RESOURCES, INSTITUTIONS, AND INCOME

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A</i>										
<i>2SLS</i>										
lnnatcap	0.20** (0.10)	0.08 (0.09)			0.19* (0.10)	0.06 (0.1)			0.12 (0.08)	
lnsubsoil			0.16*** (0.04)	0.13*** (0.03)			0.14*** (0.03)	0.12*** (0.04)		0.11*** (0.03)
ruleoflaw	0.76*** (0.21)	0.69** (0.32)	0.96*** (0.19)	0.67* (0.34)					0.77*** (0.14)	0.70*** (0.13)
goveffect					0.79*** (0.22)	0.8** (0.38)	1.04*** (0.21)	0.90** (0.43)		
lgdp70	-0.65*** (0.21)	-0.75*** (0.28)	-0.99*** (0.20)	-0.9*** (0.31)	-0.65*** (0.22)	-0.77** (0.3)	-1.02*** (0.21)	-1.04*** (0.34)		
Africa&ME		-0.84*** (0.31)		-0.93*** (0.31)		-0.75** (0.34)		-0.75* (0.37)	-0.85*** (0.28)	-0.78*** (0.26)
Asia&Ocean.		0.07 (0.27)		-0.16 (0.26)		0.17 (0.28)		-0.09 (0.26)	-0.28 (0.23)	-0.37* (0.20)
N.Am.		0.20 (0.40)		-0.11 (0.38)		0.13 (0.4)		-0.12 (0.38)	0.23 (0.3)	0.00 (0.26)
C.&S.Am.		-0.04 (0.39)		-0.27 (0.44)		0.08 (0.45)		-0.09 (0.53)	0.01 (0.29)	-0.15 (0.3)
<i>Panel B</i>										
<i>1st stage</i>										
latitude	2.68*** (0.4)	1.98*** (0.48)	2.85*** (0.42)	1.93*** (0.47)	2.57*** (0.38)	1.72*** (0.47)	2.62*** (0.42)	1.53*** (0.51)	3.23*** (0.55)	3.39*** (0.59)
lnnatcap	0.02 (0.07)	0.04 (0.07)			0.03 (0.07)	0.05 (0.07)			0.23*** (0.08)	
lnsubsoil			0.01 (0.03)	0.02 (0.02)			0.02 (0.03)	0.03 (0.03)		0.08** (0.03)
lgdp70	0.51*** (0.09)	0.64*** (0.1)	0.50*** (0.1)	0.67*** (0.1)	0.49*** (0.09)	0.59*** (0.09)	0.49*** (0.10)	0.61*** (0.10)		
Africa&ME		-0.01 (0.23)		-0.03 (0.22)		-0.15 (0.23)		-0.26 (0.37)	-0.57** (0.27)	-0.49* (0.29)
Asia&Ocean.		0.32 (0.22)		0.34* (0.2)		0.13 (0.21)		0.13 (0.22)	-0.2 (0.26)	-0.19 (0.26)
N.Am.		-0.31 (0.28)		-0.31 (0.25)		-0.18 (0.27)		-0.21 (0.27)	-0.32 (0.35)	-0.3 (0.35)
C.&S.Am.		-0.39* (0.22)		-0.51** (0.23)		-0.51** (0.22)		-0.64*** (0.24)	-0.55** (0.28)	0.66** (0.31)
Adj. $R^2$	0.8	0.83	0.82	0.87	0.8	0.82	0.81	0.85	0.73	0.76
N	79	79	61	61	79	79	61	61	80	61

*Notes:* Dependent variable in 2SLS is log income growth 1970-2000 (columns (1)-(8)) and log of per capita income in 2000 (columns (9)-(10)). Dependent variable in first stage is *ruleoflaw* in columns (1)-(4) and (9)-(10), and *goveffect* in columns (5)-(8). Standard errors in parentheses. \*, \*\*, \*\*\* statistically significant at 10, 5, and 1 percent levels, respectively. For detailed variable descriptions and sources see appendix.

first-stage effect of total natural capital on institutional quality when we take income levels as the dependent variable (column (9)).

Subsoil wealth, on the other hand, has a highly significant positive direct effect on growth and income levels; while the indirect effect is once more very weak for the growth regressions, and relatively strong for the income level estimations (column (10)—additional results not shown to save space). Again, this is especially interesting as much of the resource-and-growth literature has found highly significant *negative* growth effects of mineral wealth, in particular. But our results consistently show that on average a one-percent increase in per capita subsoil wealth in a country would have directly increased economic growth by up to 0.16 percent over the period, and income levels by over 0.1 percent, all other things equal. This closely corresponds to the previous findings in the simple OLS regressions.

These results challenge the resource curse hypothesis: neither a broadly constructed measure of natural resource wealth, nor a narrower measure of mineral wealth show a negative effect on economic growth or income levels. On



TABLE 7. 2SLS GROWTH REGRESSIONS WITH ADDITIONAL CONTROL VARIABLES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A 2SLS</i>										
<i>with ruleoflaw</i>										
lnnatcap	0.25** (0.1)	0.26** (0.11)	0.13 (0.10)	0.17 (0.12)	0.24 (0.16)					
lnsubsoil						0.17*** (0.03)	0.16*** (0.04)	0.15*** (0.04)	0.16*** (0.04)	0.17*** (0.04)
ruleoflaw	0.46* (0.24)	0.65** (0.28)	0.6** (0.25)	0.88*** (0.31)	0.22 (0.68)	0.71*** (0.23)	0.95*** (0.29)	0.92*** (0.27)	0.83*** (0.22)	0.49 (0.30)
lgdp70	-0.56*** (0.21)	-0.67*** (0.21)	-0.85*** (0.18)	-0.75** (0.29)	-0.76** (0.34)	-0.89*** (0.21)	-0.9*** (0.25)	-1.02*** (0.20)	-0.87*** (0.22)	-0.72*** (0.25)
ethnic fract.	-1.07*** (0.39)				-0.41 (0.56)	-0.82** (0.4)				-0.59 (0.41)
fin. depth		0.01 (0.01)			0.01 (0.01)		0.00 (0.01)			0.01 (0.01)
schooling			0.15** (0.07)		0.15* (0.08)			0.03 (0.08)		0.00 (0.08)
openness				-0.02 (0.23)	-0.22 (0.33)				-0.13 (0.19)	-0.25 (0.20)
N	79	78	75	51	48	61	60	59	40	39
<i>Panel B 2SLS</i>										
<i>with goveffect</i>										
lnnatcap	0.25** (0.1)	0.26** (0.11)	0.2 (0.10)	0.18 (0.13)	0.25* (0.14)					
lnsubsoil						0.16*** (0.03)	0.14*** (0.04)	0.13*** (0.04)	0.15*** (0.04)	0.16*** (0.04)
goveffect	0.45* (0.23)	0.66** (0.29)	0.59** (0.25)	0.90*** (0.33)	0.17 (0.52)	0.75*** (0.24)	1.02*** (0.31)	0.97*** (0.27)	0.94*** (0.24)	0.50 (0.37)
lgdp70	-0.55*** (0.21)	-0.67*** (0.21)	-0.88*** (0.19)	-0.74** (0.3)	-0.74** (0.3)	-0.90*** (0.21)	-1.02*** (0.25)	-1.02*** (0.2)	-0.92*** (0.22)	-0.71*** (0.23)
ethnic frac.	-1.02*** (0.35)				-0.51 (0.39)	-0.88** (0.37)				-0.70* (0.36)
fin. depth		0.01 (0.01)			0.01 (0.01)		0.00 (0.01)			0.01 (0.01)
schooling			0.17** (0.07)		0.15** (0.07)			0.03 (0.08)		-0.01 (0.08)
openness				-0.1 (0.23)	-0.26 (0.23)				-0.18 (0.18)	-0.30* (0.17)
N	79	78	75	51	48	61	60	59	40	39

Notes: Dependent variable in 2SLS is log income growth 1970-2000. First stage regressions for institutional variables are not shown to save space. Standard errors in parentheses. \*, \*\*, \*\*\* statistically significant at 10, 5, and 1 percent levels, respectively. For detailed variable descriptions and sources see Appendix B.

the contrary, the empirical results point to a significant *positive effect of natural resource abundance*, especially for mineral resources, which is confirmed when we consider institutional quality and its possible endogeneity. In other words, natural resources—and particularly mineral resources—seem to have robust direct positive effects even when we explicitly control for institutional quality and possible interactions. We also find no conclusive evidence of a negative indirect income effect of natural resource abundance via institutional quality, apparently contradicting the rent-seeking hypothesis. Interestingly, the positive growth effects of resources hold when we take income levels instead of GDP growth as our dependent variable: not only does natural resource abundance appear to be beneficial for the rates of economic development, but it also seems to positively affect countries' development *levels*.

Consistent with the hypothesis that "institutions matter", our institutional quality measures remain positive and significant even when accounting for endogeneity. In addition, the magnitude of the institutional effect remains largely unchanged with respect to the results of the simple OLS regressions reported in table 3. The robustness of these overall results is investigated below.

**Robustness test** The validity of our results depends on the assumption that natural resource wealth has strong direct income effects which are not due to omitted variable bias. We check the robustness of the findings by adding further control variables which have been found to influence economic growth and development in the literature.<sup>15</sup> The variables include ethnic fractionalisation on a scale from 0 to 1 (see Alesina et al., 2003); the period average financial depth, i.e. the ratio of liquidity in an economy—M2—to its GDP (see e.g. King and Levine, 1993); the average years of schooling of adults age 15 and over between 1970-2000 (Barro and Lee, 2001); and the measure of economic openness developed by Sachs and Warner (1995b), which has been used extensively in the resource curse literature.<sup>16</sup> Overall, the estimations, reported in table 6, show that our results change very little with the inclusion of these variables (results for income levels not shown).

The estimations for the broad natural resource measure, reported in columns (1)-(5), confirm that the influence is positive but not overwhelming: the variable is not robust to the inclusion of several of our controls. However, the results using our measure of per capita subsoil wealth are very robust to additional controls; the positive effect remains highly significant and essentially unchanged in its magnitude even when controlling for all other effects simultaneously (column (10)). Our indicators of institutional quality, on the other hand, are no longer significant when including all control variables together, which is not surprising as there is probably some multicollinearity between the variables.

Interestingly, only two of the variables emphasised in previous research prove significant in our estimations. Ethnic fractionalisation has a significant negative effect on growth (when considered alone, columns (1) and (6)), confirming the results of Easterly and Levine (1997) and Alesina et al. (2003). And the years of schooling have a significant positive growth effect (in the general natural capital estimations in columns (2) and (5)), as found in the human capital and growth literature. The measures for economic openness and financial sector development, however, were not significantly related to economic growth. In the first-stage regressions (not shown), our main instrument for institutional quality—latitude—consistently remained highly significant, while the natural resources measures again had no significant effect on institutions.

## 4 Conclusions

This paper re-examines two main aspects of the resource curse literature, namely the widespread use of Sachs and Warner’s (1995a) measure of resource abun-

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<sup>15</sup>See Easterly and Levine (1997) for an early application of this method of testing robustness.

<sup>16</sup>Other control variables included measures of language and religious fractionalisation; legal origin dummies; the average mortality; and government consumption and the investment share of GDP between 1970-2000. Our results proved robust to these additional variables, as well. For convenience, only a selection of controls is presented; full results are available upon request.

dance based on primary export data, and the limited attention paid to institutional quality in growth with natural resources. Using recently-developed measures of resource abundance which estimate natural capital in USD per capita, as well as two indicators of institutional quality, we find new cross-country evidence which challenges the resource curse hypothesis. Results from both OLS and 2SLS estimations show that natural resources, and in particular mineral resources, have a positive direct association with real GDP growth over the period 1970-2000 and recent income levels, even when controlling for the quality of institutions. In addition, there is no evidence that resource abundance negatively affects institutional quality, contradicting the hypothesis of an indirect natural resource curse, e.g. through rent-seeking behaviour. Interestingly however, the beneficial income level and growth effects seem to diminish as institutional quality improves, although they remain strongly positive overall. The results are robust to controlling through additional variables.

These findings contradict most of the resource curse literature so far, and further add to it by considering the effects of resource abundance on income levels as well as on income growth. In sum, an abundance of natural resources may in fact be much less of a curse and more of a boon than often believed.

## A Appendix

TABLE A. BASIC OLS REGRESSIONS OF NATURAL RESOURCE ABUNDANCE ON INCOME

	SW (1)	g7000 (2)	g7000 (3)	g7000 (4)	g7000 (5)	g7000 (6)	g7000 (7)	gdp00 (8)	gdp00 (9)	gdp00 (10)
lgdp70	0.4* (0.22)			0.16* (0.09)	0.04 (0.12)	-0.05 (0.12)				
sxp	-6.92*** (2.11)	-1.24*** (0.47)			-1.20** (0.46)			-0.92 (0.65)		
lnnatcap			0.20** (0.09)			0.18 (0.12)		0.78*** (0.12)		
lnsubsoil				0.12*** (0.04)			0.13*** (0.05)			0.26*** (0.05)
Adj. $R^2$	0.13	0.08	0.05	0.12	0.11	0.04	0.11	0.01	0.36	0.31
N	97	70	79	61	70	79	61	86	80	61

*Notes:* Column (1) reports the basic result of Sachs and Warner (1995a) with log of per capita GDP growth between 1970-1989 as the dependent variable. In columns (2)-(7) the dependent variable is log of per capita GDP growth from 1970-2000. Results shown using SW's measure *sxp*, as well as logs of World Bank indicators of subsoil and total natural capital (1994-2000 averages). Columns (8)-(10) show the corresponding results using log of per capita GDP in 2000 as the dependent variable. Standard errors in parentheses. \*, \*\*, \*\*\* statistically significant at 10, 5, and 1 percent levels, respectively.

## B Appendix

TABLE B1. CORRELATIONS BETWEEN INSTITUTIONAL QUALITY MEASURES: RULE OF LAW

	ruleoflaw	GLprights70	GLprights7000	Hprights95	Hprights9500
ruleoflaw	1.00 (158)				
GLprights70	0.8 (48)	1.00 (48)			
GLprights7000	0.84 (118)	0.92 (48)	1.00 (118)		
Hprights95	-0.8 (95)	-0.63 (38)	-0.7 (84)	1.00 (96)	
Hprights9500	-0.86 (151)	-0.67 (48)	-0.69 (116)	0.93 (95)	1.00 (153)

*Notes:* Number of observations in parentheses. All results are statistically significant at the 1-percent level. *ruleoflaw* denotes average 1996-2000 World Bank measure of the rule of law. *GLprights70* and *GLprights7000* are measures of the legal system quality and property rights enforcement in 1970 and averaged over 1970-2000, respectively, taken from the dataset compiled by Gwartney and Lawson (2005). They are measured on a scale of 0 (no legal system and property rights in place or enforced) to 10 (very well-developed legal system and fully enforced property rights). *Hprights95* and *Hprights9500* are measures for property right enforcement for 1995 (first available year) and averaged over 1995-2000, respectively. They are measured on a scale from 1 (fully enforced) to 5 (no enforcement) and are taken from the Heritage Foundation dataset (Holmes et al., 2006).

TABLE B2. CORRELATIONS BETWEEN INSTITUTIONAL QUALITY MEASURES: GOVERNMENT EFFECTIVENESS

	goveffect	burdelay	corrupt
goveffect	1.00 (165)		
burdelay	0.85 (58)	1.00 (58)	
corrupt	0.76 (118)	0.85 (54)	1.00 (118)

*Notes:* Number of observations in parentheses. All results are statistically significant at the 1-percent level. *goveffect* denotes average 1996-2000 World Bank measure of government effectiveness. *burdelay* is a measure of bureaucratic delays (average 1972-1995), scaled from 0 to 10 with low ratings indicating higher levels of red tape (less effectiveness). *corrupt* is an indicator of government corruption, scaled from 0 to 10 with low ratings indicating more corrupt government officials. The latter indicators are taken from the dataset compiled by La Porta et al. (1999).

## C Appendix

### Natural resource variables by country

Main World Bank (1997, 2005) natural resource abundance variables used in estimations, measured in USD per capita. 1994-2000 averages shown; variables used and listed only for countries for which data were available in both years.

Country	Subsoil wealth	Tot. natural capital	Country	Subsoil wealth	Tot. natural capital
Argentina	1886.5	10081.0	Malawi		832.5
Australia	10285.5	29753.5	Malaysia	5076.0	10461.5
Austria	357.5	7372.0	Mali		3498.5
Bangladesh	51.5	2035.5	Mauritania	4041.0	
Benin	12.5	1631.5	Mauritius		941.0
Bolivia	787.0	5421.5	Mexico	4967.5	7561.5
Botswana	408.0	4401.5	Morocco	93.0	1907.0
Brazil	1309.0	6906.0	Mozambique	0.00	1094.5
Burkina Faso		1809.5	Namibia	953.0	4766.0
Burundi	2.0	1575.9	Nepal	5.0	2064.5
Cameroon	627.0	5766.5	Netherlands	2151.5	5439.5
Canada	12658.0	35680.5	New Zealand	2448.0	47158.0
Chad		3705.5	Nicaragua	4.5	2891.0
Chile		12692.0	Niger	0.5	7157.5
China	465.5	2446.5	Norway	34964.5	42524.0
Colombia	2193.0	6323.5	Pakistan	207.5	1624.0
Congo, Rep. of	4248.0	6875.0	Panama		5675.5
Costa Rica		8193.5	Paraguay		6181.0
Côte d'Ivoire	16.0	3455.5	Peru	682.0	4102.5
Denmark	2716.5	11408.0	Philippines	55.0	2139.5
Dominican Rep.	193.0	5778.0	Portugal	115.5	3834.5
Ecuador	3587.5	12223.5	Rwanda		1588.0
Egypt	937.0	2818.0	Senegal	32.0	3286.0
El Salvador		1031.0	South Africa	1229.0	3800.0
Finland	84.0	13687.5	Spain	95.0	5057.0
France	73.5	7227.5	Sri Lanka	0.0	2148.5
Gambia, The		1317.0	Sweden	336.5	11270.0
Germany	309.5	4297.5	Switzerland	0.0	4496.5
Ghana	37.5	1628.0	Thailand	274.5	5768.0
Greece	319.0	4882.0	Togo	63.5	1792.5
Guatemala	180.5	2345.5	Trinidad&Tobago	19794.5	21543.5
Guinea-Bissau		4914.0	Tunisia	1160.0	5154.5
Haiti	0.0	816.5	Turkey	195.0	3722.0
Honduras	62.0	3192.5	United Kingdom	2734.5	6053.5
India	205.5	2919.0	United States	5143.0	15626.0
Indonesia	1109.5	5476.0	Uruguay		12044.5
Ireland	457.5	14157.0	Venezuela	19131	24023.5
Italy	260.5	4039.0	Zambia	247.0	3634.5
Jamaica	1743.0	2853.5	Zimbabwe	235.5	2025.5
Japan	34.0	1906.5			
Jordan	154.5	975.5			
Kenya	0.5	1549.00			
Korea, South	41.5	2480.0			
Lesotho		727.5			
Madagascar		4095.5			

## D Appendix

### Variables and sources

Variable	Definition	Source
g7000	Log of growth of real GDP per capita between 1970-2000, defined as $G^i = (1/(T - t)) \ln(Y_T^i/Y_t^i)$ .	Penn World Tables 6.1
gdp00	Log of real GDP per capita in 2000.	Penn World Tables 6.1
natcap	Log of the average total natural capital in 1994 and 2000, estimated in USD per capita. The measure includes subsoil assets, timber resources, non-timber forest resources, protected areas, cropland, and pastureland.	World Bank (1997, 2005)
subsoil	Log of the average subsoil assets in 1994 and 2000, estimated in USD per capita. The measure includes energy resources (oil, natural gas, hard coal, lignite) and other mineral resources (bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, zinc).	World Bank (1997, 2005)
nonfuelmin	Aggregate production in tonnes of 52 non-fuel minerals, ranging from aluminium to zirconium. With the exception of a few countries where series started in 1971-1974, data is for 1970. Variables used in estimations include total tonnes, tonnes per capita, and weighted by real GDP.	IGS
fuelmin	Aggregate production in tonnes of coal, petroleum, and natural gas. With the exception of a few countries where coal and petroleum series started in 1971-1974, data is for 1970. Variables used in estimations include total tonnes, tonnes per capita, and weighted by real GDP.	IGS and BP
min	nonfuelmin+fuelmin	IGS and BP
sxp	Primary exports over GDP in 1971.	SW
ruleoflaw	Measures the average score of the quality of contract enforcement, the police and the courts, as well as the likelihood of crime and violence between 1996-2000. Recalibrated to assume values between zero (worst) and 5 (best).	Kaufmann et al. (2005)
goveffect	Measures the average score of the quality of the bureaucracy and of public services between 1996-200. Recalibrated to assume values between zero (worst) and 5 (best).	Kaufmann et al. (2005)
lgdp70	Log of real GDP per capita in 1970.	Penn World Tables 6.1
latitude	Absolute value of latitude of a country on a scale of 0 to 1.	La Porta et al. (1999)
polity70	Political regime measure ranging from -10 (institutionalised autocracy) to 10 (institutionalised democracy). Transition periods are smoothed, anarchy is assigned score 0, and foreign "intervention" is treated as missing data. Score of 1970.	Marshall and Jaggers (2002)
ethnic fractionalisation	Measure of ethnic fractionalisation ranging from 0 (least fractionalised) to 1 (extremely fractionalised) based on racial or linguistic characteristics, determined country-by-country. Most data for mid-1990s.	Alesina et al. (2003)
findep	Financial depth, a measure of financial sector development defined as liquidity (M2) over GDP. Average 1970-2000.	IFS and WDI
schooling	Average years of schooling of population 15 years and over between 1970-2000.	Barro and Lee (2001)
openness	Measure of openness, defined as the fraction of years during period 1965-1990 in which the country is rated as an open economy according to set criteria.	Sachs and Warner (1995b)

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