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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 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. In both OLS and 2SLS regressions, the positive resource effects are particularly strong 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
JEL classification: O11, O13, Q0

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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,[1] 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 lead 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.[2]

In this paper, we re-examine two main aspects of the resource curse literature and find new cross-country evidence contradicting previous findings of detrimental growth effects of natural resource wealth. 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.,

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

[2] See Ross (1999) and Stijns (2005) for more extensive literature overviews.

1999; Acemoglu et al., 2001), the role of institutional quality has received only limited attention in work on growth with resource abundance.[3] A brief review of the literature shows that institutions may however play a critical role in determining the economic performance 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 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, 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 proposes some alternatives, and then 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 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", *sxp*, 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, one should expect any conclusion on a "curse" of natural resource *wealth* or *abundance* to be based on the closest possible approximation of such wealth—in other words: some measure corresponding to the widely used indicator of economic wealth, income (GDP) per capita. Assuming a strong positive

[3]A notable recent exception by Robinson et al. (2006) offers a rare theoretical explanation of the resource curse based on a country's political institutions.

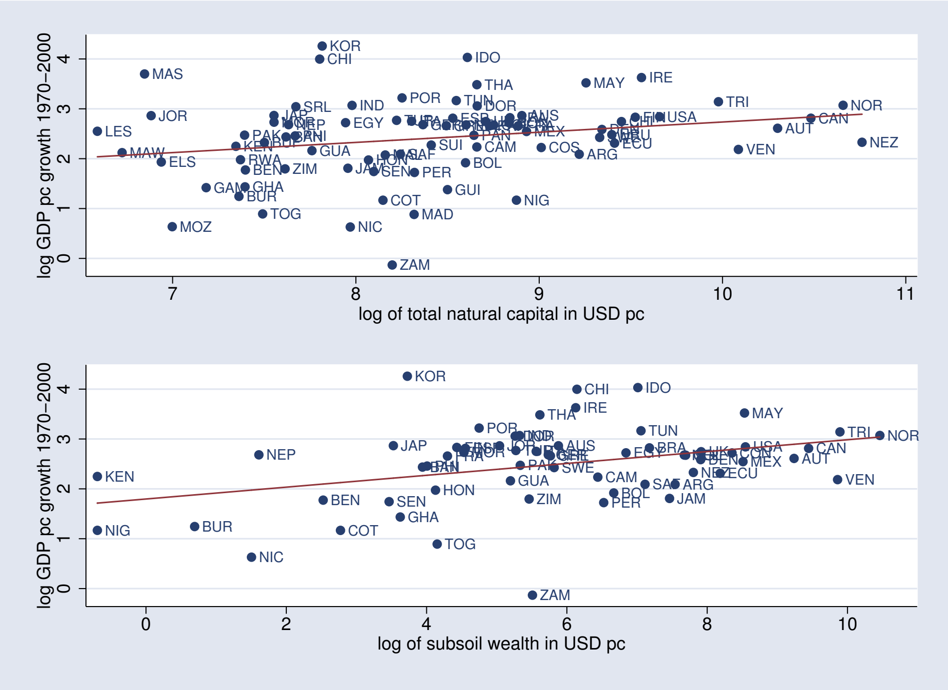

Figure 1. Natural resource wealth and growth (1970-2000)

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

correlation between natural resource abundance and natural resource exports is by no means obvious given counter-examples of resource-rich countries with relatively low primary exports such as Australia and Germany. Moreover, we could also plausibly argue that a dominant share of primary resource exports in GDP is a strong indication for an overly specialised economy. Slow growth in countries with a large share of primary exports may therefore be due more to a high economic dependence on the natural resource sector 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).[4]

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

[4] *sxp* is calculated for 1971, although the observation period in SW is 1970-1989.

resource exports variable, he takes growth in *genuine* income, i.e. GDP minus depreciation of produced capital, as the dependent variable to find a negative, albeit weakened, resource effect.

Other empirical research does not rely on export data at all, but has instead employed completely different measures of natural resource abundance. For example, 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. 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). Finally, Ding and Field (2005) use World Bank data on natural resource wealth to re-estimate SW's basic regression, as well as a three-equation model to consider the effects of resources on human capital. They find negative growth effects of natural resources as a share of total produced capital, and positive growth effects of natural resources per capita; but both indicators become insignificant in the three-equation model. However, their simple approach leaves many open questions on the robustness of the results.

Hence, as a first step in re-examining the hypothesis of a curse of natural resource *abundance*—as opposed to the curse of a *dependence* on natural resource *exports* actually found by much of the literature—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) to give a better indicator of their relative importance. 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 on the basis of the net present value of rents and are available for 1994 and 2000. We use the average measure over the two years available to minimise possible measurement errors and price fluctuations in the calculations.[5]

[5]Ding and Field (2005) made use of the total natural capital data for 1994. Natural resources valued by the World Bank in both its 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 statistically 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									
	(−0.11)										
fuelmin	−0.05	0.85*	1.00								
	(−0.23)	(0.47)									
min	−0.05	0.88*	0.99*	1.00							
	(−0.17)	(0.78)	(0.96)								
nonfuelminpc	−0.11	0.13	0.06	−0.00	1.00						
	(0.03)	(0.82)	(0.15)	(0.53)							
fuelminpc	−0.15	−0.04	0.06	0.05	−0.04	1.00					
	(−0.28)	(0.23)	(0.71)	(0.62)	(0.28)						
minpc	−0.14	0.02	0.07	0.08	0.12	0.99*	1.00				
	(−0.19)	(0.67)	(0.60)	(0.8)	(0.75)	(0.93)					
subsoil	0.14	0.19	0.07	0.12	0.37*	0.54*	0.58*	1.00			
	(0.12)	(0.41)	(0.21)	(0.45)	(0.4)	(0.44)	(0.60)				
natcap	0.02	0.28*	0.1	0.16	0.30*	0.42*	0.49*	0.74*	1.00		
	(0.05)	(0.27)	(0.08)	(0.25)	(0.3)	(0.36)	(0.37)	(0.73)			
nonfuelmin/gdp	−0.1	0.03	0.00	−0.03	0.61*	0.52*	0.38*	0.12	−0.01	1.00	
	(−0.02)	(0.72)	(0.23)	(0.51)	(0.9)	(0.3)	(0.7)	(0.25)	(0.09)		
fuelmin/gdp	0.19	0.07	0.17	0.16	0.17	0.88*	0.79*	0.50*	0.28*	0.41*	1.00
	(−0.13)	(0.34)	(0.79)	(0.68)	(0.19)	(0.87)	(0.69)	(0.39)	(0.14)	(0.35)	
min/gdp	0.04	0.13	0.16	0.14	0.45*	0.89*	0.75*	0.49*	0.20*	0.70*	0.99*
	(−0.12)	(0.75)	(0.69)	(0.8)	(0.73)	(0.77)	(0.89)	(0.49)	(0.16)	(0.79)	(0.91)

Notes: * Pearson's correlation statistically significant at 10 percent level or less. Spearman's rho rank correlation in parentheses. *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.

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 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)). Put differently, the amounts of primary exports are clearly not a reliable indicator of a country's relative natural resource wealth.

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 significant.[6] There are several reasons why the World Bank data would deliver the most reliable measures of relative natural resource abundance, and hence the best measures for testing the resource curse hypothesis. For one, data quality on mineral production for the early 1970s is not uniform, and unweighted production data are unsatisfactory proxies for natural resource wealth as they make no distinction between the value of different minerals.[7] Moreover, mineral production is more likely to be affected by the levels of technology in a country. This endogeneity is assumed less of a problem for the World Bank data, as they rely more on the own Bank's estimates as opposed to countries' sometimes questionable published statistics.[8] And finally, these measures of natural resource wealth are deemed the best parallel to the economic wealth indicator of income per capita.

In our estimations, we will use the World Bank's per capita natural resource data to test their effect on economic growth over the period 1970-2000. We will also compare the results with those reached using *sxp*.

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

[6]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).

[7]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 however equivalent to estimating their monetary value.

[8]Nevertheless, the correlation between technology levels and natural resource abundance estimates is considered in the robustness tests in section 3.3 below.

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 *exports 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 performance (e.g. Auty, 2001; Leite and Weidmann, 1999; Isham et al., 2005).[9] Robinson et al. (2006) develop a political economy model which shows that the impact of "resource boom" crucially depends on the quality of the political institutions, and in particular the degree of clientelism in the public sector. Countries with worse-quality institutions are more likely to suffer from a resource curse. 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 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

[9] For formal models of rent-seeking behaviour, see Tornell and Lane (1999) and Torvik (2001).

Table 2. Descriptive statistics

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

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

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 growth: 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 dependent variable for the subsequent estimations. It is evident from the data 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. Rows 2-3 describe the logs of the natural resource abundance indicators introduced above, namely total natural capital and subsoil wealth per capita, 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 natural resource indicator *sxp* is described in row 4.

The last two rows show the main variables used to measure institutional quality. The World Bank recently compiled a list of six governance indicators measuring different dimensions of governance from 1996 onwards (Kaufmann et al., 2005; also included in the *World Development Indicators*). These indicators are all positively correlated amongst each other, as well as with measures of institutional quality used in the growth literature (e.g. Knack and Keefer, 1995; La Porta et al., 1999; Acemoglu and Johnson, 2005).[10] The main advantages of the World Bank indicators lie in their objectivity—provided by a very broad survey sample which includes and adds to the sources for earlier indicators—and the excellent country coverage. From the six indicators, we chose two which closely resemble those used in other studies and averaged them over 1996-2000.[11] *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. 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.

3.2 Ordinary least squares regressions

To better compare the growth effects of different natural resource measures, we begin with standard cross-country OLS 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 $G^i = \big(1/(T-t)\big)ln(Y_T^i/Y_t^i)$, is a function of a vector of explanatory variables, including the natural logarithm of natural resource abundance R^i, and institutional quality $INST^i$.

Table 3 presents results of the linear regressions for[12]

$$G^i = \alpha_0 + \alpha_1 Y_{70}^i + \alpha_2 R^i + \alpha_3 INST^i + \alpha_4 Z^i + \epsilon^i \qquad (1)$$

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

[10] Correlations with several other measures of institutional quality, including indicators for the beginning of the sample period are shown in Appendix B. They confirm 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. Results for the remaining World Bank indicators were very similar for all regressions and are available upon request.

[11] For example, Acemoglu and Johnson (2005) recently found that institutions affecting the relations between the government and individuals (firms) had a more significant effect on economic development than those affecting relations between individuals (firms). Their favored "top-down" measure *property rights* closely corresponds to our *rule of law* measure.

[12] The results of simple OLS regressions using only our natural resource variables *lnnatcap* and *lnsubsoil* and the SW variable *sxp* are presented in Appendix A.

Table 3. OLS regressions: natural resources, institutions, and growth

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

Notes: Dependent variable is log income growth 1970-2000. 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.

the natural resource abundance and institutional quality variables, respectively, Z is a vector of other covariates, and ϵ is a random error term. Throughout the paper, we are particularly interested in the coefficient α_2. Since we use logs, the effect of natural resource abundance on income growth 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 *sxp*. 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

TABLE 4. OLS REGRESSIONS WITH INTERACTION TERMS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
lgdp70	-0.24^{*}	-0.78^{***}	-0.84^{***}	-0.88^{***}	-0.95^{***}	-0.08	-0.75^{***}	-0.76^{***}	-0.91^{***}	-0.9^{***}
	(0.13)	(0.14)	(0.15)	(0.15)	(0.17)	(0.13)	(0.15)	(0.15)	(0.14)	(0.16)
sxp	-3.4^{***}					-3.84^{***}				
	(1.01)					(1.29)				
lnnatcap		1.25^{***}	1.00^{***}				1.23^{***}	0.96^{***}		
		(0.26)	(0.23)				(0.29)	(0.26)		
lnsubsoil				0.37^{***}	0.37^{***}				0.36^{***}	0.31^{***}
				(0.08)	(0.07)				(0.08)	(0.07)
ruleoflaw	0.15	3.66^{***}	3.34^{***}	1.26^{***}	1.18^{***}					
	(0.15)	(0.7)	(0.63)	(0.25)	(0.24)					
goveffect						-0.03	3.64^{***}	3.23^{***}	1.34^{***}	1.22^{***}
						(0.15)	(0.79)	(0.72)	(0.25)	(0.25)
interaction	1.08^{**}	-0.33^{***}	-0.3^{***}	-0.08^{***}	-0.07^{***}	1.12^{**}	-0.33^{***}	-0.29^{***}	-0.09^{***}	-0.08^{***}
	(0.41)	(0.08)	(0.07)	(0.03)	(0.03)	(0.50)	(0.09)	(0.08)	(0.03)	(0.03)
latitude		0.55		0.67			0.70		0.75	
		(0.64)		(0.7)			(0.67)		(0.64)	
Africa&ME	-0.68^{***}		-0.71^{***}		-0.85^{***}	-0.68^{**}		-0.65^{**}		-0.74^{***}
	(0.24)		(0.25)		(0.26)	(0.28)		(0.27)		(0.26)
Asia&Ocean.	0.19		0.15		-0.15	0.21		0.28		-0.03
	(0.23)		(0.24)		(0.24)	(0.27)		(0.26)		(0.24)
N.Am.	0.82		0.46		0.14	0.41		0.38		0.09
	(0.62)		(0.34)		(0.34)	(0.73)		(0.36)		(0.34)
C.&S.Am.	-0.26		-0.05		-0.27	-0.41		-0.03		-0.25
	(0.24)		(0.24)		(0.28)	(0.29)		(0.26)		(0.28)
Adj.R^2	0.51	0.45	0.58	0.53	0.63	0.37	0.4	0.54	0.56	0.64
N	67	79	79	61	61	69	79	79	61	61

Notes: Dependent variable is log income growth 1970-2000. 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.

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 *sxp* as the preferred measure of natural resource abundance may have led to a negative bias in the literature.

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.[13] The highly significant negative coefficients for initial income throughout the growth estimations are in accordance with the convergence literature.[14]

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

[14] 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).

OLS estimations with interaction terms A question which naturally arises is how resource abundance and institutional quality interact. Although natural resources may have positive 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 are shown in Table 4. First, we note that the coefficients on our natural resource and institutional quality measures retain their expected signs; their significance in fact seems reinforced. But the interaction terms appear significantly negative throughout the estimations, suggesting that the *positive growth effects diminish as institutional quality improves.* And conversely, from columns (1) and (6) we see that higher institutional quality appears to reinforce the negative growth effects of the GDP share of primary exports, confirming the findings of Mehlum et al. (2006). So have countries with high-quality institutions relied less on the positive growth impulses of natural resource abundance for the development of their economy, generating a sort of "convergence effect" with regard to institutions? Institutional quality and income levels are positively correlated; consequently, to test this "institutional convergence" hypothesis, we re-estimated the regressions allowing initial GDP per capita to interact with our resource abundance measures. The interaction terms again turned up with a negative sign, confirming that more institutionally and economically developed countries have on average experienced weaker positive growth effects of resource wealth.[15]

We can therefore explain the negative interaction coefficients in Table 4; but what of the positive findings on the growth effects of natural resource abundance found so far? In fact, our overall results do not change much with the interaction terms: natural resource abundance still has a significantly positive influence on economic growth. To show this, we can calculate the total 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), we can take the sample mean of the quality of rule of law to obtain the average effect of a one-percent increase in natural resources per capita 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 previously without interaction terms! Similarly, from column (4) a one-percent increase in mineral resources gives us a total growth effect of $0.37 - (0.08 * 2.54) = 0.17$ percent, an effect similar in magnitude to that found in earlier estimations above. On the other hand, *sxp* still has negative overall growth effects, namely around -0.66 (column (1)).

However, it is possible that the institutional indicators in our OLS estimations suffer from endogeneity due to omitted variable effects. If indeed there is resource-induced rent-seeking behaviour, leading to corruption among govern-

[15] I thank Geoffrey Heal and David Popp for suggesting this hypothesis test. Results of these additional regressions are available upon request.

Table 5. Determinants of institutions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>Panel A</u> *Dep't var. ruleoflaw*										
latitude	2.53***	4.09***	2.67***	4.30***	2.91***					
	(0.37)	(0.36)	(0.4)	(0.35)	(0.42)					
polity70						0.08***	0.07***	0.04***	0.08***	0.04***
						(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
lnnatcap		0.26***	0.04				0.30***	−0.04		
		(0.07)	(0.07)				(0.1)	(0.09)		
lnsubsoil				0.07**	0.01				0.05	−0.04
				(0.03)	(0.03)				(0.05)	(0.04)
lgdp70			0.51***		0.47***			0.73***		0.80***
			(0.09)		(0.1)			(0.09)		(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
<u>Panel B</u> *Dep't var. goveffect*										
latitude	2.61***	3.91***	2.59***	4.06***	2.71***					
	(0.35)	(0.34)	(0.38)	(0.35)	(0.42)					
polity70						0.08***	0.06***	0.02**	0.07***	0.02*
						(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
lnnatcap		0.26***	0.06				0.34***	−0.01		
		(0.07)	(0.07)				(0.1)	(0.08)		
lnsubsoil				0.08***	0.03				0.08	−0.02
				(0.03)	(0.03)				(0.05)	(0.04)
lgdp70			0.47***		0.45***			0.75***		0.82***
			(0.09)		(0.1)			(0.09)		(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.

ment officials, then natural resource wealth itself may be negatively correlated with institutions and outweigh the positive direct growth influence. 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 on the other. In addition we have

$$INST^i = \beta_0 + \beta_1 R^i + \beta_2 L^i + \beta_3 Z^i + \nu^i, \tag{2}$$

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 ν 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.[16]

Columns (6)-(10) show the results of the regressions using a regime index for a country's political system in 1970 (*polity*70). 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. 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.[17] The indirect effect via the institutional channel is statistically even weaker.

Subsoil wealth, on the other hand, has a highly significant positive direct effect on growth, while the indirect effect is once more very weak. Again, this is especially interesting as much of the resource-and-growth literature has found highly significant *negative* growth effects of mineral resources, in particular.

[16]Nevertheless, we believe that these findings cast doubt on the rent-seeking hypothesis: natural resource abundance does not necessarily lead to worse institutions, especially since we found the same results using a measure of corruption as the institutional quality indicator. Resource wealth 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.

[17]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 growth

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

Notes: Dependent variable in 2SLS is log income growth 1970-2000; dependent variable in first stage is *ruleoflaw* in columns (1)-(4) 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.

But our results consistently show that on average a one-percent increase in per capita subsoil wealth in a country would have directly increased average economic growth by up to 0.16 percent over the period, 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. On 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 growth effect of natural resource abundance via institutional quality, apparently contradicting the rent-seeking hypothesis.

Consistent with the hypothesis that "institutions matter", our institutional quality measures remain positive and significant even when accounting for en-

Table 7. 2SLS growth regressions with additional control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A 2SLS with ruleoflaw										
lnnatcap	0.25**	0.20**	0.13	0.17	0.11					
	(0.1)	(0.09)	(0.10)	(0.12)	(0.12)					
lnsubsoil						0.17***	0.14***	0.15***	0.16***	0.16***
						(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
ruleoflaw	0.46*	0.61***	0.6**	0.88***	0.46	0.71***	0.81***	0.92***	0.83***	0.52*
	(0.24)	(0.2)	(0.25)	(0.31)	(0.41)	(0.23)	(0.19)	(0.27)	(0.22)	(0.28)
lgdp70	−0.56***	−0.54***	−0.85***	−0.75**	−0.77***	−0.89***	−0.85***	−1.02***	−0.87***	−0.65***
	(0.21)	(0.29)	(0.18)	(0.29)	(0.26)	(0.21)	(0.20)	(0.20)	(0.22)	(0.2)
ethnic fract.	−1.07***				−0.28	−0.82**				−0.48
	(0.39)				(0.49)	(0.4)				(0.42)
lpop70		0.17***			0.12**		0.16***			0.13**
		(0.05)			(0.05)		(0.05)			(0.05)
schooling			0.15**		0.15*			0.03		0.00
			(0.07)		(0.08)			(0.08)		(0.08)
openness				−0.02	−0.1				−0.13	-0.19
				(0.23)	(0.23)				(0.19)	(0.17)
N	79	79	75	51	48	61	61	59	40	39
Panel B 2SLS with goveffect										
lnnatcap	0.25**	0.19**	0.2	0.18	0.12					
	(0.1)	(0.1)	(0.10)	(0.13)	(0.12)					
lnsubsoil						0.16***	0.13***	0.13***	0.15***	0.16***
						(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
goveffect	0.45*	0.65***	0.59**	0.90***	0.42	0.75***	0.91***	0.97***	0.94***	0.6*
	(0.23)	(0.22)	(0.25)	(0.33)	(0.38)	(0.24)	(0.21)	(0.27)	(0.24)	(0.29)
lgdp70	−0.55***	−0.56***	−0.88***	−0.78***	−0.74**	−0.90***	−0.9***	−1.02***	−0.92***	−0.67***
	(0.21)	(0.21)	(0.19)	(0.26)	(0.3)	(0.21)	(0.22)	(0.2)	(0.22)	(0.2)
ethnic frac.	−1.02***				−0.48	−0.88**				−0.65*
	(0.35)				(0.40)	(0.37)				(0.36)
lpop70		0.15***			0.1*		0.13**			0.11**
		(0.05)			(0.06)		(0.05)			(0.05)
schooling			0.17**		0.16**			0.03		−0.01
			(0.07)		(0.08)			(0.08)		(0.08)
openness				−0.1	−0.15				−0.18	−0.25
				(0.23)	(0.2)				(0.18)	(0.16)
N	79	79	75	51	48	61	61	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.

dogeneity. 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 growth 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 in the literature.[18] The variables include ethnic fractionalisation on a scale from 0 to 1 (see Alesina et al., 2003); the log of initial population; 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. An alternative measure of openness, defined as the GDP share of total trades (exports plus imports) between 1970-2000, was also used with slightly better results from a

[18]See Easterly and Levine (1997) for an early application of this method of testing robustness.

statistical point of view, but with no effect on the natural resource indicators.

Other economic control variables included government consumption and investment as shares of GDP between 1970-2000; and the period averages of financial depth—i.e. the ratio of liquidity in an economy to its GDP—and foreign direct investment. Further social controls were measures of language and religious fractionalisation; a dummy variable derived from the Polity IV database indicating whether a country experienced a regime transition or violent change between 1970-2000; legal origin dummies; and the average mortality between 1970-2000. Our results proved robust to all these additional variables, as well (for convenience, only a selection of controls is presented; full results are available upon request).

Overall, the estimations, reported in Table 7, show that our results change very little with the inclusion of these variables. 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)). Note in particular that the average level of schooling—as a proxy of the level of technology—does not alter the positive growth effects of mineral wealth. We can reasonably assume therefore that the results are not influenced by the quality and amount of resource exploration in a given country, i.e. that our measures of resource abundance are exogenous. There is also no large-country bias: including initial population size does not change the findings for our resource estimates.

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, not all 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). 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. Population size also positively influences the average growth over the period. The measure for economic openness, however, is 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 abundance 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 contradict most of the resource curse literature so far, showing that natural resources, and in particular mineral resources, have a positive direct association with real GDP growth over the period 1970-2000, 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 growth effects seem to diminish as institutional quality improves, although they remain strongly positive overall. The results are robust to controlling through additional variables.

In sum, an abundance of natural resources may in fact be much less of a curse and more of a boon for economic performance than often believed. This conclusion suggests a different perspective on the growth effects of natural resources over the last thirty years. So far, the attempts to model the influence of natural resource abundance on economic growth have not proven wholly satisfactory; in addition to the possibility that resources may have positive instead of the usually assumed growth effects, a theoretical explanation would surely have to include the role of institutions in the growth process.

A Appendix

Table A. Basic OLS regressions of natural resource abundance on growth

	SW (1)	(2)	(3)	(4)	(5)	(6)	(7)
lgdp70	0.4^{*}				0.16^{*}	0.04	-0.05
	(0.22)				(0.09)	(0.12)	(0.12)
sxp	-6.92^{***}	-1.24^{***}			-1.20^{**}		
	(2.11)	(0.47)			(0.46)		
lnnatcap			0.20^{**}			0.18	
			(0.09)			(0.12)	
lnsubsoil				0.12^{***}			0.13^{***}
				(0.04)			(0.05)
Adj.R^2	0.13	0.08	0.05	0.12	0.11	0.04	0.11
N	97	70	79	61	70	79	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). 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
Argentina	1886.5	10081.0
Australia	10285.5	29753.5
Austria	357.5	7372.0
Bangladesh	51.5	2035.5
Benin	12.5	1631.5
Bolivia	787.0	5421.5
Botswana	408.0	4401.5
Brazil	1309.0	6906.0
Burkina Faso		1809.5
Burundi	2.0	1575.9
Cameroon	627.0	5766.5
Canada	12658.0	35680.5
Chad		3705.5
Chile		12692.0
China	465.5	2446.5
Colombia	2193.0	6323.5
Congo, Rep. of	4248.0	6875.0
Costa Rica		8193.5
Côte d'Ivoire	16.0	3455.5
Denmark	2716.5	11408.0
Dominican Rep.	193.0	5778.0
Ecuador	3587.5	12223.5
Egypt	937.0	2818.0
El Salvador		1031.0
Finland	84.0	13687.5
France	73.5	7227.5
Gambia, The		1317.0
Germany	309.5	4297.5
Ghana	37.5	1628.0
Greece	319.0	4882.0
Guatemala	180.5	2345.5
Guinea-Bissau		4914.0
Haiti	0.0	816.5
Honduras	62.0	3192.5
India	205.5	2919.0
Indonesia	1109.5	5476.0
Ireland	457.5	14157.0
Italy	260.5	4039.0
Jamaica	1743.0	2853.5
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
Malawi		832.5
Malaysia	5076.0	10461.5
Mali		3498.5
Mauritania	4041.0	
Mauritius		941.0
Mexico	4967.5	7561.5
Morocco	93.0	1907.0
Mozambique	0.00	1094.5
Namibia	953.0	4766.0
Nepal	5.0	2064.5
Netherlands	2151.5	5439.5
New Zealand	2448.0	47158.0
Nicaragua	4.5	2891.0
Niger	0.5	7157.5
Norway	34964.5	42524.0
Pakistan	207.5	1624.0
Panama		5675.5
Paraguay		6181.0
Peru	682.0	4102.5
Philippines	55.0	2139.5
Portugal	115.5	3834.5
Rwanda		1588.0
Senegal	32.0	3286.0
South Africa	1229.0	3800.0
Spain	95.0	5057.0
Sri Lanka	0.0	2148.5
Sweden	336.5	11270.0
Switzerland	0.0	4496.5
Thailand	274.5	5768.0
Togo	63.5	1792.5
Trinidad&Tobago	19794.5	21543.5
Tunisia	1160.0	5154.5
Turkey	195.0	3722.0
United Kingdom	2734.5	6053.5
United States	5143.0	15626.0
Uruguay		12044.5
Venezuela	19131	24023.5
Zambia	247.0	3634.5
Zimbabwe	235.5	2025.5

D Appendix

Variables and sources

Variable	Definition	Source
g7000	Log of growth of real GDP per capita between 1970-2000, defined as $G^i = \big(1/(T-t)\big)ln(Y_T^i/Y_t^i)$.	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 "interruption" 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)
lpop70	Population in 1970 (logs).	Penn World Tables 6.1
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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