World Development Vol. 36, No. 3, pp. 399–419, 2008

0305-750X/$ - see front matter
ELSEVIER
www.elsevier.com/locate/worlddev
doi:10.1016/j.worlddev.2007.03.004

Cursing the Blessings? Natural Resource Abundance, Institutions, and Economic Growth

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Summary. — Since Sachs and Warner's [Sachs, J. D., & Warner, A. M. (1995a). Natural resource abundance and economic growth. *NBER working paper*, no. 5398] 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.

Key words — natural resources, resource curse, economic growth, institutional quality

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 have 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 (1999, 2001), Jensen and Wantchekon (2004), Collier and Hoeffler (2005), and Hodler (2006) 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), Bravo-Ortega and De Gregorio (2005), and Stijns (2006) concentrate on different links with 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 second finds 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. And the third concludes that *per capita* rents from natural resources are positively correlated with human capital accumulation. Baland and Francois (2000) and Torvik (2002) focus on the effects of natural resource abundance on rent-seeking behavior and 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

* I thank three anonymous referees, Erwin Bulte, Geoffrey Heal, Eric Neumayer, David Popp, Ragnar Torvik, Simone Valente, Roger Wehrli, and numerous conference participants for their valuable comments. All remaining errors are of course mine. I gratefully acknowledge the financial support of the Center for Corporate Responsibility and Sustainability (CCRS) of the University of Zurich. Final revision accepted: March 21, 2007.

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 nontraded 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.

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 two alternative indicators—developed by the World Bank (1997, 2005) and measuring *per capita* mineral and total natural resource wealth, respectively—which in our view better capture a country's natural resource abundance. 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., Acemoglu, Johnson, & Robinson, 2001; Knack & Keefer, 1995; La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1999), the role of institutional quality has received limited attention in work on growth with resource abundance. [2] A 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 the 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.

It is not within the scope of this paper to offer policy recommendations to resource-rich countries, but the results do question development advice based on the idea that there is a general "natural resource curse." The findings strongly suggest that a more cautious approach is called for when evaluating the development effects of natural resource abundance: the "resource curse" should be re-assessed before incurring a policy error made trying to avoid it.

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 the results of OLS and 2SLS regressions of the 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

(a) *Measuring natural resource abundance*

Most resource-and-growth research has focused on the "curse" effect of absolute natural resource abundance, both empirically and theoretically (e.g., Hodler, 2006; Leite & Weidmann, 1999; Torvik, 2002). However, following Sachs and Warner (1995a, 1997), primary exports divided by a measure of national income have constituted the preferred indicator of natural resource abundance in empirical analysis. [3] 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. But if the aim is to quantify natural resource abundance, then primary exports seem an unsatisfactory measure for two main reasons. [4]

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 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 specialized economy. Slow growth in countries with a large share of primary exports may therefore be due more to economic policy leading to a high economic dependence on the natural resource sector, rather than a direct natural resource "curse." [5] 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 & Maloney, 2003). [6]

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 labor 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 nonfuel 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, that is GDP minus depreciation of produced and natural 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, Atkinson and Hamilton (2003) use the ratio of resource rents to GDP to show both positive and negative economic effects, and Stijns (2006) also argues in favor of using resource rent data, although he prefers *per capita* measures. 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—that is minerals and plantation crops characterized by localized, intensive production—often show evidence of worse economic performance and institutions than economies dependent on more "diffuse" resources, that is characterized by more extensive production (Isham, Pritchett, Woolcock, & Busby, 2005). Mineral production over GDP however delivers less clear-cut 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 nonfuel 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 nonfuel 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 indication 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

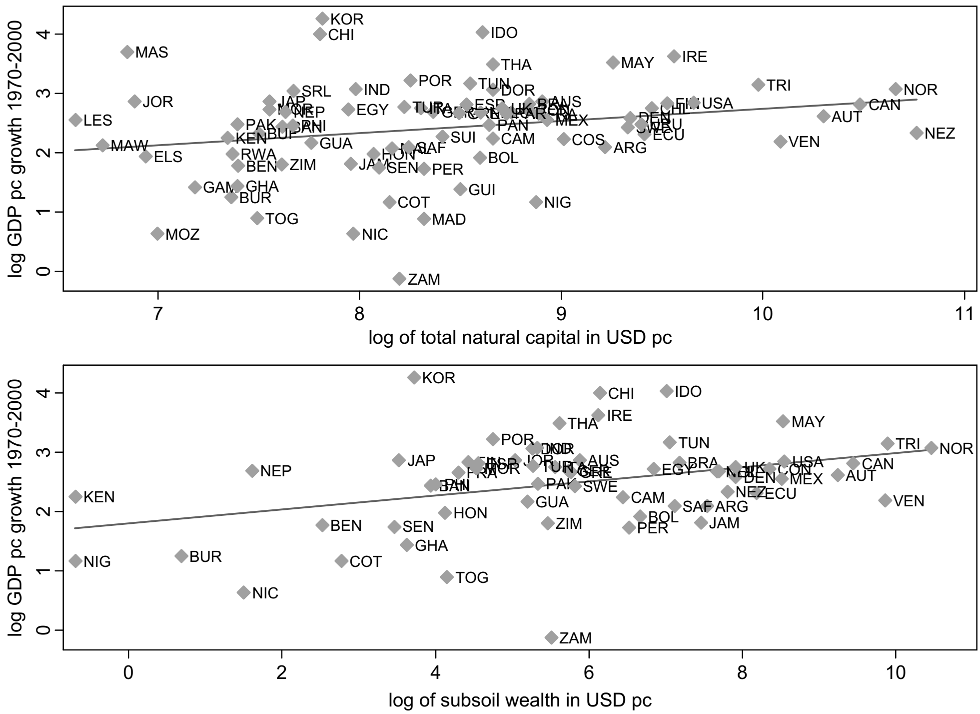

Figure 1. *Natural resource wealth and growth (1970–2000). Notes: regression fit using World Bank natural wealth data measured in USD per capita (pc). See Appendices A–D for data and regression details.*

measure over the two years available to minimize possible measurement errors and price fluctuations in the calculations. [7]

Figure 1 shows the ordinary least squares (OLS) regression fits of the World Bank resource abundance measures on economic growth during 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.

As a further illustration of 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*. We can see from the results in Table 1 that *sxp* is positively correlated with mineral production *per capita* and weighed by GDP (column (1)), though correlations with absolute production amounts are consistently negative. However, primary export shares are clearly not correlated with the other measures of resource abundance, *natcap* and *subsoil*. 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. [8]

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, and then compare the results with those reached using *sxp*. There are several reasons to choose the World Bank estimates over the production data as the most reliable measures of relative natural resource abundance currently available, and hence the best measures for testing the resource curse hypothesis. For one, data quality on mineral production

Table 1. *Correlations between natural resource wealth estimates*

	sxp	*nonfuelmin*	*fuelmin*	*min*	*nonfuel-minpc*	*fuel-minpc*	*minpc*	*subsoil*	*natcap*	*nonfuel-min/gdp*	*fuel-min/gdp*
nonfuelmin	−0.20*	1.00									
	(−0.34*)										
fuelmin	−0.06	0.85*	1.00								
	(−0.13)	(0.47)									
min	−0.08	0.88*	0.99*	1.00							
	(−0.14)	(0.78)	(0.96)								
nonfuelminpc	0.28*	0.13	0.06	−0.00	1.00						
	(−0.01)	(0.82)	(0.15)	(0.53)							
fuelminpc	0.60*	−0.04	0.06	0.05	−0.04	1.00					
	(0.34*)	(0.23)	(0.71)	(0.62)	(0.28)						
minpc	0.54*	0.02	0.07	0.08	0.12	0.99*	1.00				
	(0.18*)	(0.67)	(0.60)	(0.8)	(0.75)	(0.93)					
subsoil	0.05	0.19	0.07	0.12	0.37*	0.54*	0.58*	1.00			
	(0.02)	(0.41)	(0.21)	(0.45)	(0.4)	(0.44)	(0.60)				
natcap	−0.01	0.28*	0.1	0.16	0.30*	0.42*	0.49*	0.74*	1.00		
	(−0.12)	(0.27)	(0.08)	(0.25)	(0.3)	(0.36)	(0.37)	(0.73)			
nonfuelmin/gdp	0.4*	0.03	0.00	−0.03	0.61*	0.52*	0.38*	0.12	−0.01	1.00	
	(0.08)	(0.72)	(0.23)	(0.51)	(0.9)	(0.3)	(0.7)	(0.25)	(0.09)		
fuelmin/gdp	0.29*	0.07	0.17	0.16	0.17	0.88*	0.79*	0.50*	0.28*	0.41*	1.00
	(0.09)	(0.34)	(0.79)	(0.68)	(0.19)	(0.87)	(0.69)	(0.39)	(0.14)	(0.35)	
min/gdp	0.34*	0.13	0.16	0.14	0.45*	0.89*	0.75*	0.49*	0.20*	0.70*	0.99*
	(0.02)	(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% level or less. Spearman's ρ in parentheses. *sxp* measures primary exports over GDP in 1970 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, 2005). Mineral production data for 1970 are measured in tons and taken from IGS (1978) and British Petroleum database. For detailed variable descriptions and sources see Appendices A–D.

for the early 1970s is not uniform; furthermore, unweighted production data are unsatisfactory proxies for natural resource wealth as they make no distinction between the value of different minerals. [9]

Mineral production is also more likely to be affected by the levels of technology (and economic development) in a country. This endogeneity is assumed to be less of a problem with the World Bank data, as they rely more on the Bank's own estimates as opposed to countries' sometimes questionable published statistics. Nevertheless, we cannot completely rule out endogeneity a priori, as simple correlation tests reveal that both natural resource measures correlate moderately but positively with income and schooling levels. [10] Much lower correlation coefficients for the mineral assets measure—which is of particular interest due to the previous literature—seem to suggest that mineral deposits have attracted substantial research effort regardless of their location, and consequently suffer less from endogeneity. However, we keep this issue in mind when performing the robustness tests in Section 3 to check for a bias in the estimations. As a final point, the World Bank measures of natural resource wealth are deemed the best parallel to the economic wealth indicator of income *per capita*.

(b) *Natural resources and institutional quality*

Several recent contributions have stressed the importance of institutional quality for economic development (e.g., Acemoglu *et al.*, 2001; Hall & Jones, 1999; Knack & Keefer, 1995; La Porta *et al.*, 1999; Mauro, 1995). 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., Papyrakis & Gerlagh, 2004; Sachs & Warner, 1995a). There are some notable exceptions: Bulte, Damania, and Deacon (2005) find that natural resource abundance, and especially mineral resources, has an ambiguous direct effect on several measures of human development, and a slightly negative indirect effect *via* two measures of institutional quality. Mehlum *et al.* (2006) 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*. [11]

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 behavior and corruption, thereby decreasing the quality of government, which in turn negatively affects economic performance (e.g., Auty, 2001; Isham *et al.*, 2005; Leite & Weidmann, 1999; Norman, 2006). [12] Robinson *et al.* (2006) develop a political economy model which shows that the impact of a "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 & Hoeffler, 2005). Empirically, rent-seeking due to natural resources has been shown to be nonlinear, 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, p.10) 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 clear-cut. He concludes that "learning processes" are the crucial element in determining the direction of influence of resource wealth on growth, that is, how countries exploit and develop their resources. Finally, Acemoglu *et al.* (2001) test the effects on current income levels of their instrumented indicator for institutions against those of natural resource abundance, measured by the country shares of world nonfuel mineral reserves and *per capita* oil resources. They find no significant influence 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, and implicitly questioning the natural resource curse hypothesis even further.

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. The most important institutional aspects in this context appear to be the rule of law and corruption, and the competence of the state and particularly the bureaucracy—aspects which are in fact connected. We show results for two different institutional quality indicators that cover these aspects, namely measures of 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

(a) *Data and descriptive statistics*

Table 2 presents descriptive statistics for the key variables. Average growth of *per capita* income during 1970–2000 is PPP adjusted (detailed variable descriptions and sources are provided in Appendices A–D). 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, which are taken from a World Bank dataset covering different dimensions of governance from 1996 onwards (Kaufmann, Kraay, & Mastruzzi, 2005; also included in the *World Development Indicators*). The dataset comprises six "clustered" indicators, which are all positively correlated among each other, as well as with measures of institutional quality used in the growth literature (e.g., Acemoglu & Johnson, 2005; Knack & Keefer, 1995; La Porta *et al.*, 1999). [13] The main advantages of the World Bank measures 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.

The six indicators are roughly divided into three groups: the first looks at the selection and replacement process of those in authority (*voice and accountability* and *political stability and violence*); the second examines the state's ability to implement sound policies (*government effectiveness* and *regulatory burden*); and the final two indicators measure the respect of citizens and the state for rules and regulations (*rule of law* and *control of corruption*). We present results for one indicator each from the second and third group—the more relevant groups for our purposes—which closely resemble those used in other studies, and averaged them over 1996–2000. For space reasons, we do not present the findings for *control of corruption*; however, all regressions were also performed with this, as well as the other World Bank indicators, with analogous results (available upon request). *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 0 to 5, with institutional quality increasing with the value of the indicator.

(b) *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.

Table 2. *Descriptive statistics*

Variable	Observed	Mean	SD	Minimum	Maximum
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 1970 (*sxp*)	111	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 Appendices A–D.

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A							
lgdp70	−0.32**	−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	−2.48***						
	(0.79)						
lnnatcap		0.20**	0.20**	0.08			
		(0.10)	(0.10)	(0.1)			
lnsubsoil					0.15***	0.16***	0.14***
					(0.04)	(0.04)	(0.03)
ruleoflaw	0.59***	0.73***	0.72***	0.71***	0.81***	0.69***	0.68***
	(0.13)	(0.13)	(0.16)	(0.15)	(0.13)	(0.17)	(0.18)
latitude	−0.32		0.11			0.77	
	(0.58)		(0.70)			(0.74)	
Africa & ME				−0.79***			−0.95***
				(0.29)			(0.28)
Asia & Ocean				0.1			−0.19
				(0.27)			(0.26)
N. Am.				0.01			−0.23
				(0.44)			(0.40)
C. & S. Am.				0.02			−0.31
				(0.27)			(0.3)
Adj. R^2	0.34	0.32	0.31	0.47	0.46	0.46	0.58
N	90	79	79	79	61	61	61
Panel B							
lgdp70	−0.32**	−0.59***	−0.59***	−0.69***	−0.85***	−0.87***	−0.87***
	(0.13)	(0.15)	(0.16)	(0.16)	(0.15)	(0.15)	(0.17)
sxp	−2.32***						
	(0.8)						
lnnatcap		0.19*	0.2*	0.08			
		(0.10)	(0.10)	(0.1)			
lnsubsoil					0.14***	0.15***	0.13***
					(0.03)	(0.04)	(0.03)
goveffect	0.56***	0.72***	0.68***	0.68***	0.86***	0.73***	0.68***
	(0.12)	(0.13)	(0.17)	(0.16)	(0.13)	(0.17)	(0.17)
latitude	−0.1		0.29			0.80	
	(0.58)		(0.72)			(0.69)	
Africa & ME				−0.77**			−0.87***
				(0.30)			(0.28)
Asia & Ocean				0.18			−0.10
				(0.28)			(0.26)
N. Am.				−0.01			−0.25
				(0.45)			(0.40)
C. & S. Am.				0.00			−0.32
				(0.28)			(0.30)
Adj. R^2	0.34	0.29	0.28	0.45	0.49	0.49	0.59
N	89	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% levels, respectively. Joint significance tests strongly reject hypothesis of no difference between covariates in all estimations. For detailed variable descriptions and sources see Appendices A–D.

The idea is that (the log of) economic growth G^i between $t = 1970$ and $T = 2000$ in country 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 [14]

$$G^i = \alpha_0 + \alpha_1 Y^i_{70} + \alpha_2 R^i + \alpha_3 \mathrm{INST}^i + \alpha_4 Z_i + \varepsilon^i, \qquad (1)$$

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 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 significant negative effect of natural resource abundance on growth when using the SW indicator *sxp*. Columns (2)–(4) show a significant positive influence of natural resource abundance on growth when using total natural capital *per capita*, 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, an increase by one standard deviation in dollarized *per capita* subsoil assets would have increased income growth over the period by up to 0.39 (2.41 ∗ 0.16). The corresponding beta coefficient of 0.39/0.80 = 0.48 shows that a one-standard-deviation difference in mineral wealth corresponds to an average change in growth of nearly half a standard deviation. 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 an increase on the institutional quality index would have had a sizeable positive growth effect on average, again assuming a direct causal relationship. [15] The highly significant negative coefficients for initial income throughout the growth estimations are in accordance with the convergence literature. [16]

(i) *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 primary exports ratio, *sxp*. Accordingly, the new estimation equation is

$$G^i = \alpha_0 + \alpha_1 Y^i_{70} + \alpha_2 R^i + \alpha_3 \mathrm{INST}^i + \alpha_4 R^i * \mathrm{INST}^i + \alpha_5 Z_i + \varepsilon^i, \qquad (2)$$

where α_4 denotes the coefficient of the interaction term. 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 (columns (2)–(5) and (7)–(10)), 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 share of primary exports, confirming the findings of Mehlum *et al.* (2006). It is possible that natural resource wealth has boosted growth rates more in countries at lower levels of institutional development; the more highly developed the institutions, the weaker the positive growth impulses of natural resource abundance. This explanation is reminiscent of the convergence effect of income levels with respect to growth rates; and in fact institutional quality and income levels are highly positively correlated. Consequently, to test this "convergence effect" of natural resources with regard to institutions, 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 lower positive growth effects of resource wealth (results available upon request).

Table 4. *OLS regressions with interaction terms*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
lgdp70	−0.30**	−0.79***	−0.83***	−0.88***	−0.94***	−0.24*	−0.75***	−0.76***	−0.91***	−0.9***
	(0.14)	(0.14)	(0.15)	(0.15)	(0.17)	(0.14)	(0.15)	(0.15)	(0.14)	(0.16)
sxp	−5.95**					−5.59**				
	(2.39)					(2.29)				
lnnatcap		1.25***	1.00***				1.23***	0.98***		
		(0.26)	(0.23)				(0.29)	(0.26)		
lnsubsoil				0.37***	0.32***				0.36***	0.31***
				(0.08)	(0.07)				(0.08)	(0.07)
ruleoflaw	0.33*	3.66***	3.34***	1.26***	1.17***					
	(0.18)	(0.7)	(0.64)	(0.25)	(0.24)					
goveffect						0.29*	3.64***	3.33***	1.34***	1.22***
						(0.17)	(0.79)	(0.73)	(0.25)	(0.25)
interaction	1.53*	−0.33***	−0.3***	−0.08***	−0.07***	1.43*	−0.33***	−0.3***	−0.09***	−0.08***
	(0.85)	(0.08)	(0.07)	(0.03)	(0.03)	(0.83)	(0.09)	(0.08)	(0.03)	(0.03)
latitude		0.55		0.67			0.70		0.75	
		(0.64)		(0.69)			(0.67)		(0.64)	
Africa & ME	−0.22		−0.70***		−0.85***	−0.2		−0.65**		−0.75***
	(0.28)		(0.26)		(0.27)	(0.29)		(0.27)		(0.27)
Asia & Ocean	0.48*		0.16		−0.15	0.48		0.27		−0.04
	(0.26)		(0.24)		(0.24)	(0.26)		(0.26)		(0.24)
N. Am.	0.04		0.44		0.15	0.04		0.46		0.16
	(0.45)		(0.41)		(0.40)	(0.45)		(0.44)		(0.44)
C. & S. Am.	0.14		−0.03		−0.26	0.14		−0.03		−0.25
	(0.26)		(0.24)		(0.29)	(0.26)		(0.26)		(0.28)
Adj. R^2	0.44	0.45	0.58	0.53	0.62	0.43	0.4	0.53	0.56	0.64
N	90	79	79	61	61	89	79	79	61	61

Notes: Dependent variable is log income growth 1970–2000. Standard errors in parentheses. *,**,*** statistically significant at 10%, 5%, and 1% levels, respectively. Joint significance tests strongly reject hypothesis of no difference between covariates in all estimations. For detailed variable descriptions and sources see Appendices A–D.

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 net 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, that is 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-standard-deviation increase in natural resources *per capita* on a country's growth as $0.92 * (1.25 - (0.33 * 2.54)) = 0.38$. In other words, a one-standard-deviation change in natural resource wealth would increase economic growth by 0.38 from the mean. Similarly, from column (4) a one-standard-deviation increase in mineral resources gives us a positive total growth effect of $2.41 * (0.37 - (0.08 * 2.54)) = 0.40$. On the other hand, *sxp* still has negative overall growth effects, namely around −0.33 for a one-standard-deviation change in the share of resource exports (from column (1)).

However, it is possible that the institutional indicators in our OLS estimations suffer from endogeneity due to omitted variable effects. Indeed, if there is resource-induced rent-seeking behavior leading to corruption among government officials and less respect for the rule of law, as well as worse bureaucratic quality, 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 use an appropriate instrument for institutional variation and also take into account the possible influence of resource wealth, and then perform two-stage least squares (2SLS) estimations.

(c) *Two-stage least squares regressions*

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

$$\mathrm{INST}^i = \beta_0 + \beta_1 R^i + \beta_2 L^i + \beta_3 Z_i + \upsilon^i, \qquad (3)$$

where INST denotes the measure of institutional quality, now the dependent variable, R is again the natural resource abundance measure, Z is the vector of covariates affecting all variables, υ is the random error term, and L is latitude (distance from equator calculated on a scale from 0 to 1), our main instrument for institutional quality. [17]

There have been several studies on the link between latitude and economic development, but there is no widely accepted explanation for the observed correlation. [18] 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 and 4).

Table 5 presents OLS regressions for Eqn. (3). Columns (1) and (6) show 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) and (7)–(10) 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. Nevertheless, we believe that these findings cast some doubt on the rent-seeking explanation for the resource curse: we find that natural resource abundance does not *necessarily* lead to worse institutions, and may even have a positive influence. [19]

Eqns. (1) and (3) form the basis for the two-stage least squares regressions presented in Table 6. Eqn. (3) is our first stage for the institutional quality measures, shown in Panel B; Eqn. (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. The results show that resource-rich African and Middle Eastern economies in particular have performed much worse than European and Central Asian ones. 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. But our results consistently show that on average a one-standard-deviation increase in *per capita* subsoil wealth in a country would have directly

Table 5. *Determinants of institutions*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
latitude	2.53***	4.09***	2.67***	4.30***	2.91***	2.61***	3.91***	2.59***	4.06***	2.72***
	(0.37)	(0.36)	(0.40)	(0.35)	(0.42)	(0.35)	(0.34)	(0.38)	(0.35)	(0.42)
lnnatcap		0.26***	0.04				0.27***	0.06		
		(0.07)	(0.07)				(0.07)	(0.07)		
lnsubsoil				0.07**	0.01				0.08***	0.03
				(0.03)	(0.03)				(0.028)	(0.03)
lgdp70			0.51***		0.47***			0.47***		0.45***
			(0.09)		(0.10)			(0.09)		(0.10)
Adj. R^2	0.22	0.71	0.79	0.74	0.81	0.25	0.71	0.79	0.73	0.79
N	158	84	84	63	63	165	84	84	63	63

Notes: All regressions are OLS. The dependent variable in columns (1)–(5) is *ruleoflaw*, and in columns (6)–(10) it is *goveffect*. Standard errors in parentheses. *,**,*** statistically significant at 10%, 5%, and 1% levels, respectively. For detailed variable descriptions and sources see Appendices A–D.

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*	0.07		
	(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***	0.78**	0.96***	0.80*				
	(0.21)	(0.32)	(0.19)	(0.34)				
goveffect					0.79***	0.86**	1.04***	0.97**
					(0.22)	(0.42)	(0.21)	(0.49)
lgdp70	−0.65***	−0.80***	−0.99***	−1.02***	−0.65***	−0.81**	−1.02***	−1.07***
	(0.21)	(0.31)	(0.20)	(0.34)	(0.22)	(0.32)	(0.21)	(0.34)
Africa & ME		−0.76**		−0.88***		−0.67*		
		(0.34)		(0.34)		(0.38)		(0.42)
Asia & Ocean		0.10		−0.19		0.22		−0.06
		(0.27)		(0.26)		(0.29)		(0.27)
N. Am.		0.01		−0.22		−0.01		−0.24
		(0.44)		(0.40)		(0.46)		(0.41)
C. & S. Am.		0.1		−0.16		0.19		0.02
		(0.44)		(0.52)		(0.49)		(0.61)
Panel B								
1st stage								
latitude	2.68***	1.77***	2.85***	1.67***	2.57***	1.60***	2.62***	1.37***
	(0.4)	(0.48)	(0.42)	(0.47)	(0.38)	(0.47)	(0.42)	(0.51)
lnnatcap	0.02	0.03			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***	0.63***	0.50***	0.66***	0.49***	0.59***	0.49***	0.6***
	(0.09)	(0.09)	(0.1)	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)
Africa & ME		−0.12		−0.15		−0.21		−0.34
		(0.23)		(0.22)		(0.23)		(0.23)
Asia & Ocean		0.24		0.25		0.08		0.07
		(0.22)		(0.2)		(0.21)		(0.21)
N. Am.		0.01		0.01		0.04		−0.02
		(0.33)		(0.28)		(0.32)		(0.31)
C. & S. Am.		−0.50**		−0.66***		−0.56***		−0.72***
		(0.22)		(0.22)		(0.22)		(0.24)
Adj. R^2	0.8	0.83	0.82	0.88	0.8	0.83	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% levels, respectively. For detailed variable descriptions and sources see Appendices A–D.

increased average economic growth by up to $0.16 * 2.41 = 0.39$ over the period, all other things equal (beta coefficient 0.48). This closely corresponds to the previous findings in the simple OLS regressions. [20]

These results challenge the resource curse hypothesis: neither a broadly constructed measure of natural resource wealth, nor a narrower measure of mineral wealth shows 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 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.

(i) *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. [21] The variables include ethnic fractionalization on a scale from 0 to 1 (from Alesina, Devleeschauwer, Easterly, Kurlat, & Wacziarg, 2003); the log of initial population; the average years of schooling of adults aged 15 and over during 1970–2000 (Barro & 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) during 1970–2000, yielded statistically significant coefficients but had no effect on the natural resource indicators.

Other economic control variables included government consumption and investment as shares of GDP during 1970–2000; and the period averages of financial depth—that is 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 during 1970–2000; legal origin dummies; and the average mortality during 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 significantly positive, but not robust to all controls, in particular years of schooling (column (3)). However, the results using our measure of *per capita* subsoil wealth are very robust to all 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. In other words, there does not seem to be a serious endogeneity problem with our measures of resource abundance related to the quality and amount of resource exploration in a given country. 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 emphasized in previous research prove significant in our estimations. Ethnic fractionalization has a significant negative effect on growth, confirming the results of Easterly and Levine (1997) and Alesina *et al.* (2003). Schooling has 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 only significantly related to economic growth when controlling for all effects simultaneously. 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

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	0.22**	0.21**					
	(0.1)	(0.09)	(0.10)	(0.10)	(0.09)					
lnsubsoil						0.17***	0.14***	0.15***	0.16***	0.15***
						(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
ruleoflaw	0.46*	0.61***	0.6**	0.61**	0.06	0.71***	0.81***	0.92***	0.87***	0.45
	(0.24)	(0.2)	(0.25)	(0.28)	(0.32)	(0.23)	(0.19)	(0.27)	(0.25)	(0.31)
lgdp70	−0.56***	−0.54***	−0.85***	−0.7***	−0.72***	−0.89***	−0.85***	−1.02***	−1.01***	−0.83***
	(0.21)	(0.29)	(0.18)	(0.20)	(0.17)	(0.21)	(0.20)	(20)	(0.20)	(0.18)
ethnic fract.	−1.07***				−0.88**	−0.82**				−0.68*
	(0.39)				(0.36)	(0.4)				(0.37)
lpop70		0.17***			0.12**		0.16***			0.13***
		(0.05)			(0.05)		(0.05)			(0.05)
schooling			0.15**		0.13*			0.03		0.02
			(0.07)		(0.07)			(0.08)		(0.07)
openness				0.57	0.76**				0.32	0.53*
				(0.36)	(0.32)				(0.32)	(0.29)
N	79	79	75	77	73	61	61	59	61	59
Panel B 2SLS *with goveffect*										
lnnatcap	0.25**	0.19**	0.12	0.21**	0.21**					
	(0.1)	(0.1)	(0.10)	(0.10)	(0.09)					
lnsubsoil						0.16***	0.13***	0.13***	0.14***	0.14***
						(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
goveffect	0.45*	0.65***	0.59**	0.65**	0.06	0.75***	0.91***	0.97***	0.95***	0.47
	(0.23)	(0.22)	(0.25)	(0.30)	(0.32)	(0.24)	(0.21)	(0.27)	(0.27)	(0.32)
lgdp70	−0.55***	−0.56***	−0.88***	−0.71***	−0.73***	−0.90***	−0.9***	−1.02***	−1.03***	−0.84***
	(0.21)	(0.21)	(0.19)	(0.21)	(0.19)	(0.21)	(0.22)	(0.2)	(0.20)	(0.18)
ethnic frac.	−1.02***				−0.89***	−0.88**				−0.74**
	(0.35)				(0.32)	(0.37)				(0.34)
lpop70		0.15***			0.12**		0.13**			0.12**
		(0.05)			(0.05)		(0.05)			(0.05)
schooling			0.17**		0.13**			0.03		0.03
			(0.07)		(0.06)			(0.08)		(0.07)
openness				0.58	0.76**				0.3	0.53*
				(0.36)	(0.31)				(0.32)	(0.28)
N	79	79	75	77	73	61	61	59	61	59

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% levels, respectively. For detailed variable descriptions and sources see Appendices A–D.

of resource abundance which estimate natural capital in USD *per capita*, as well as 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, for example through rent-seeking behavior. 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 generally 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 and is also relevant from a policy-making perspective. While advancing particular policy suggestions is beyond the scope of this paper, more caution should be applied before making gloomy predictions for resource-rich countries and suggesting that resources had better be left untouched to avoid adverse development impacts. Further research is needed to analyze normative aspects, including more case studies of how resource-rich countries have developed their natural wealth to supplement the findings of large cross-country studies. Also, the attempts to model the influence of natural resource abundance on economic growth have so far not proven wholly satisfactory; in addition to the possibility that resources may have positive instead of the usually assumed negative growth effects, a theoretical explanation would surely have to include the role of institutions in the growth process.

NOTES

1. The same authors contributed several more studies on the resource curse, see Sachs and Warner (1997, 1999, 2001), as well as Rodriguez and Sachs (1999).

2. A notable recent contribution by Robinson, Torvik, and Verdier (2006) offers a rare theoretical explanation of the resource curse based on a country's political institutions.

3. Although some studies, such as Mehlum, Moene, and Torvik (2006), actually focus on the impact of resource rents when they speak of the "resource abundance curse," they use the SW measure for empirical estimations.

4. Wright and Czelusta (2004) and Stijns (2005) offer earlier critiques of this indicator.

5. See Brunnschweiler and Bulte (2008) for a closer look at this possibility and its implications for the resource curse.

6. sxp is calculated for 1970, while the observation period in SW is 1970–89.

7. Ding and Field (2005) made use of the total natural capital data for 1994, and Gylfason (2001) and Stijns (2006) employ slightly modified versions of the World Bank (1997) data. Natural resources valued by the World Bank in both its studies include subsoil assets (fuel and nonfuel minerals), timber resources, nontimber 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.

8. 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).

9. For example, one additional ton of sulfur has the same production effect as one additional ton of gold. Assigning weights to the minerals extracted is however equivalent to estimating their monetary value.

10. The total natural resource measure has a correlation coefficient of 0.50 with end-of-period income levels and of 0.60 with average schooling, while mineral resources correlated by 0.32 and 0.34 with income and schooling levels, respectively. Results were significantly lower for beginning-of-period values of schooling and income.

11. Partly addressing this shortcoming, Boschini, Pettersson, and Roine (2003) supplement export data with production data and find evidence for a curse of highly "appropriable" resources, for example minerals, in countries with low-quality institutions.

12. For formal models of rent-seeking behavior, see Tornell and Lane (1999) and Torvik (2002).

13. 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.

14. 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.

15. For example, for a one-standard-deviation improvement on the rule-of-law index we could have observed a ceteris paribus average growth increase of up to 0.73 over the period, corresponding to a beta coefficient of 0.91 (0.73/0.80)!

16. 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).

17. We also considered a country's regime type, classified according to the Polity IV index of Marshall and Jaggers (2002), as an instrument for institutional quality, with similar results to those shown using latitude. However, the Polity measure was less robust to the inclusion of other variables, and—being a complex composite index—could suffer from measurement error and endogeneity issues. A further possible instrument for institutional quality is given by the data on settler mortality collected by Acemoglu *et al.* (2001). Using this instrument drastically reduced the sample size and the statistical quality of the estimations, although the coefficients on the resource abundance indicators remained positive. Results are available upon request.

18. See for example Gallup, Sachs, and Mellinger (1999) and the debate on the importance of geography for economic development in Rodrik, Subramanian, and Trebbi (2004) and Sachs (2003).

19. We could also not find signs of rent-seeking using alternative institutional quality measures based on the level of corruption: estimations yielded the same significant positive effect of resource abundance on (the absence of) corruption (results available upon request).

20. Adding the effect of the (statistically insignificant) indirect institutions channel gives us a growth impact of a one-standard-deviation change in mineral resources of up to 0.41.

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

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APPENDIX A

See Table A.1.

Table A.1. *Basic OLS regressions of natural resource abundance on growth*

	SW (1)	(2)	(3)	(4)	(5)	(6)	(7)
lgdp70	0.40*				0.14*	0.04	−0.05
	(0.22)				(0.08)	(0.12)	(0.12)
sxp	−6.92***	−3.39***			−3.16***		
	(2.11)	(0.83)			(0.83)		
lnnatcap			0.20**			0.18	
			(0.09)			(0.12)	
lnsubsoil				0.12***			0.13***
				(0.04)			(0.05)
Adj. R^2	0.13	0.15	0.05	0.12	0.17	0.04	0.11
N	97	90	79	61	90	79	61

Notes: Column (1) reports the basic result of Sachs and Warner (1995a) with log of *per capita* GDP growth during 1970–89 as the dependent variable. In columns (2)–(7) the dependent variable is log of *per capita* GDP growth from 1970 to 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% levels, respectively.

APPENDIX B

See Tables B.1 and B.2.

Table B.1. *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% 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 B.2. *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% level. *goveffect* denotes average 1996–2000 World Bank measure of government effectiveness. *burdelay* is a measure of bureaucratic delays (average 1972–95), 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).

APPENDIX C

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

APPENDIX D

Variables and sources

Variable	Definition	Source
g7000	Log of growth of real (PPP adjusted) GDP *per capita* during 1970–2000	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, nontimber 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, and lignite) and other mineral resources (bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, and zinc)	World Bank (1997, 2005)
nonfuelmin	Aggregate production in tonnes of 52 nonfuel minerals, ranging from aluminium to zirconium. With the exception of a few countries where series started in 1971–74, 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 1971–74, 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 1970	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 during 1996–2000. Recalibrated to assume values between 0 (worst) and 5 (best)	Kaufmann *et al.* (2005)
goveffect	Measures the average score of the quality of the bureaucracy and of public services during 1996–2000. Recalibrated to assume values between 0 (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 (institutionalized autocracy) to 10 (institutionalized 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)

Appendix D—*continued*

Variable	Definition	Source
ethnic fractionalization	Measure of ethnic fractionalization ranging from 0 (least fractionalized) to 1 (extremely fractionalized) 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 during 1970–2000	Barro and Lee (2001)
openness	Measure of openness, defined as the fraction of years during period 1965–90 in which the country is rated as an open economy according to set criteria	Sachs and Warner (1995b)