The Curse of Natural Resources:

The Role of Economic Institutions

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Abstract:

This study examines the evidence for the existence and the possible causes of the "curse of natural resources", a robust negative relation between natural resource wealth and economic growth observed across countries during the second half of the 20th century. In a cross-country growth framework covering 114 countries over the period 1970-2000, two main channels of transmission from resource abundance to low growth are isolated – Dutch disease effects and the quality of economic institutions. In addition, it is shown that the institutions channel can be attributed to the negative impact of "point-source" resource types such as oil and minerals, which generate substantial economic rents, on institutions. Two-stage least-squares estimation is used to account for the endogeneity of institutional quality in the growth equation.

Contents

I call petroleum the devil's excrement. It brings trouble… Look at this locura – waste, corruption, consumption, our public services falling apart. And debt, debt we shall have for years.

Juan Pablo Pérez Alfonso, a founder of OPEC, 1975

[The Economist, May 24th 2003]

In one generation to the next, we went from riding camels to riding Cadillacs. The way we are wasting money, I fear the next generation will be riding camels again.

King Faisal of Saudi Arabia (1964-1975)

[Cited in Gylfason (2001, p. 848)]

We are in part to blame, but this is the curse of being born with a copper spoon in our mouths.

Kenneth Kaunda, President of Zambia (1964-1991)

[Cited in Ross (1999, p. 297)]

1. Introduction

The "curse of natural resources" refers to the observation that many resource-rich countries have experienced lower rates of economic growth than their resource-poor counterparts during the second half of the 20th century. Although recent empirical research provides evidence for a negative relationship between resource wealth and growth, there is no generally accepted explanation for the causes of this phenomenon.

Understanding the curse is important especially for developing countries, many of which rely on exports of primary commodities. The lessons to be learned for policy-making are particularly valuable where resource reserves are currently developed, as in the Caspian region.

First, this study investigates whether there is evidence of the resource curse, i.e. of a significant negative relation between resource wealth and growth, in a pure cross-section of 114 countries over the period 1970 to 2000, and if yes, what channel of transmission may be at work. Second, we explore the hypothesis that the part of the curse that works through institutions can be explained by the detrimental effects of resources generating rents on institutional quality.

Towards the first aim, a simple growth model is estimated, with variables for resource dependence and several possible channels of causation added one at a time. A system of two equations, estimated with two-stage least-squares to control for the endogeneity of institutions, is used to study the indirect effect of resources on growth via institutions.

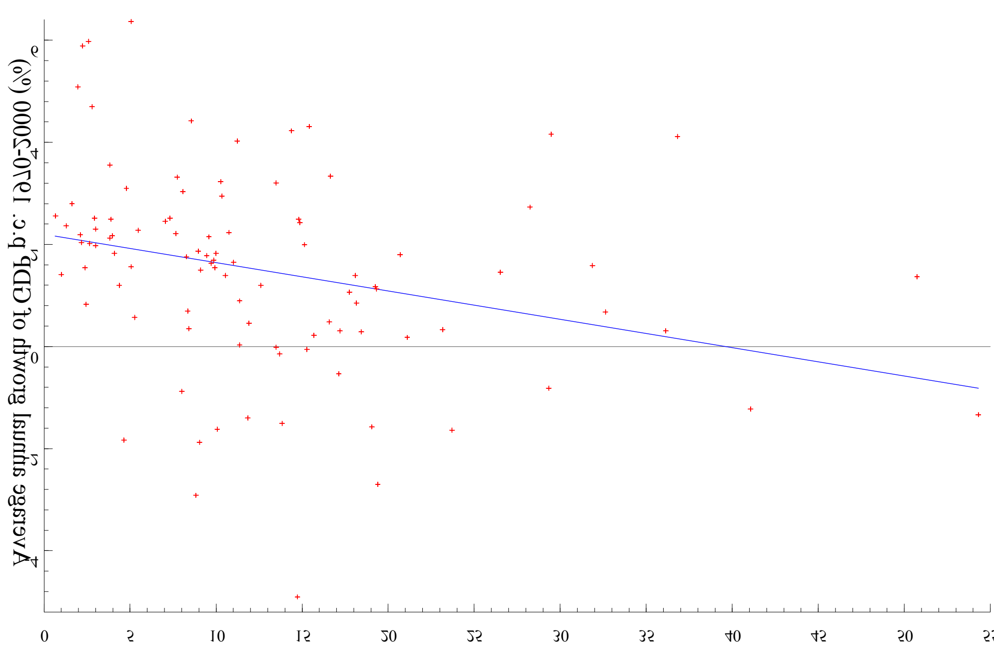
2. The Curse of Natural Resources

The Basic Hypothesis

The thesis that possessing abundant natural resources may be more of a curse than a blessing is based on observations like the following: Between 1960 and 1990, countries with scarce natural resources grew two to three times faster than countries with abundant resources, in particular since the 1970s (Auty 2001, p. 3). Some of the fastest-growing countries of the post-World War II-period are resource-poor, while many countries endowed with enormous resources have suffered economic collapse. For example, the East Asian tigers, countries with little natural wealth, averaged growth rates of 4 to 5% per annum over the period 1970 to 2000. By contrast, GDP per capita in Venezuela, Zambia, and Sierra Leone, which own large reserves of oil, copper, and diamonds, respectively, shrank by between 1.3 and 1.9% per year over the same period.

Figure 1 provides an illustration of the resource curse thesis – a negative correlation between per capita output growth from 1970 to 2000 and resource abundance, measured by the share of total natural resource exports in GNP in 1970, for a cross-section of 114 countries.

Figure 1: Economic growth and resource abundance



Differences in Growth Effects by Types of Resources

In addition to the apparent obstacle that resource wealth poses to development, there is also evidence that certain types of natural resources have a particularly negative effect on growth. Table 1 shows that countries which mainly exported fuels and minerals over the period 1970 to 2000 fared worse than those specialising in agricultural raw materials and foodstuffs, with the average growth rate of the former about 0.7% below that of the latter group.

Table 1: Economic growth by types of resources (developing countries)[1]

	Average annual growth rate 1970-2000 (%)	Number of countries
Resource exporters	0.955	56
Oil, Minerals	0.758	40
Agricultural raw materials, Food	1.448	16
Non-resource exporters (Manufactures)	3.738	8

These empirical relationships are not easily explained, given that historical experience and some strands of economic theory suggest that resources contribute to growth instead of hindering it: First, the revenues earned from a resource boom (such as a resource discovery or an increase in its world price) can be reinvested in other sectors of the economy to promote growth. In the spirit of "big push" models, the stimulus to aggregate demand following a surge in revenues can help poor countries push themselves out of a poverty trap towards economic development.

Second, natural resource revenues also help relieve constraints on development that arise if the demands of accelerating growth exceed the capacity of the domestic economy, as described by the gap models: In the two-gap model, growth is limited by insufficient domestic savings to finance investment (savings gap), as well as by insufficient export earnings to finance imports (foreign exchange gap). The three-gap model introduces an additional constraint, arising from a shortage of fiscal revenues (fiscal gap). Resource revenues can fill these gaps by providing an additional source of savings, foreign exchange, and fiscal revenue.

[1] For 64 developing countries of the total sample; classification by export structure from Isham, Woolcock, Pritchett, Busby (2003), according to leading export good using UNCTAD data; the present author was unable to find data on export classification for all countries in the sample.

Finally, natural resources provide an input for domestic industry that other countries may lack, and throughout history, resources have contributed to successful industrialisation and development in Western Europe, the U.S. and Australia. There are also examples of resource-rich countries experiencing sustained growth over the last decades, including Botswana (diamonds), Chile (copper), Norway and Malaysia (oil). The resource curse thesis is therefore not uncontroversial.

Definition of Resource Abundance

The measures of resource intensity used in this study are the shares of total and component exports of natural resources in GNP and in total merchandise exports. Natural resource exports are exports of four categories of primary products, as defined in the World Bank World Development Indicators 2003: Agricultural raw materials, food, fuels, and ores and metals. Total merchandise exports comprise exports of natural resources as well as manufactured goods. Further details can be found in Appendix B.

3. Four Channels of Transmission

This section introduces four theoretical approaches to unravelling the mechanisms through which resource intensity impedes growth. In general, these models explain the resource curse with the negative effect of resource wealth on another variable that is important for growth.

Decline and Volatility in the Terms of Trade

This line of argument attributes the curse to the characteristics of primary commodity prices relative to those of other goods such as manufactures. Prebisch (1950) and Singer (1950) predicted a secular decline in the prices of primary commodities, as falling costs of primary production, increasing use of synthetics instead of raw materials as inputs in production, and low income elasticity of demand for primary products would raise supply and lower demand. As a result, resource exporters would suffer falling revenues and a reduced ability to buy capital goods in exchange for their exports, thus hindering investment and growth.

In addition, world prices for raw material are typically highly volatile. Demand for many primary commodities is relatively price-inelastic, so that supply shocks cause large price swings (e.g. agricultural goods). Industrial primary goods such as minerals are also price-inelastic in supply, so that cyclical changes in demand in importing countries result in price fluctuations. The consequences are considerable instability in export revenues and thus heightened uncertainty for producers and the government. This makes private investment more risky, and the planning of public investment expenditures and effective macroeconomic management in general become more difficult.

The Dutch disease

"Dutch disease" refers to a decline of economic activity in non-resource sectors triggered by a booming resource sector. In the basic model, as in Corden and Neary (1982), there are three sectors: a tradable resource sector, a sector of non-resource tradable goods (often associated with manufacturing), and a sector of non-tradable goods (services).

A boom in the resource sector has two separate effects – a spending effect and a resource movement effect. First, the additional domestic income earned from the resource boom raises aggregate demand, and hence demand for both manufactures and services. As a result, the price of services increases relative to the price of imports and the price of manufactured goods (determined on world markets), so that the real exchange rate appreciates. Manufacturing output contracts because the price increase in services draws factors of production from manufacturing into services and because the currency appreciation reduces international competitiveness. Second, there is an additional shift of productive factors out of manufacturing into the resource sector, as higher returns in the latter increase marginal products and factor demand.

If manufacturing is characterised by external effects that are conducive to growth but that the resource sector lacks, a contraction of manufacturing leads to a resource curse. It has been argued that manufacturing creates more backward and forward linkages with the local economy by stimulating productive activity in the supply of inputs and in the further processing of output. Because of the highly specialised nature of capital-intensive industries like mining or oil production, the primary sector creates few such linkages and remains an enclave, limiting diversification of the economy and thus reinforcing its dependence on resource exports. Furthermore, it is often assumed that manufacturing contributes to productivity growth more than other sectors such as resource extraction because it generates learning-by-doing, which occurs if knowledge accumulates as a by-product of production. This is sometimes attributed to greater high-skill labour intensity in manufacturing in comparison with agriculture in developing countries or mining.[2]

Institutions

A third approach relates the curse to the detrimental effect of particular types of resources on the quality of economic institutions. Institutional quality refers to the degree of protection afforded to property rights and the independence of the judiciary (rule of law), the absence of corruption, and the effectiveness of government.

In particular, it has been suggested that countries specialising in the extraction of "point-source" resources like fuels and minerals, which is geographically and economically concentrated and thus easily controlled, are more likely to develop weaker institutions than countries endowed with "diffuse" resources like agricultural and food products. Hence the type of resource a country is endowed with shapes its institutional structure, so that there is an indirect effect of resources on growth via institutions. The following explains:

In contrast to agricultural production, the exploitation of fuels and minerals generates substantial economic rents which are relatively concentrated and hence easily appropriable. The rents often accrue directly to the government as the owner of these industries. This provides incentives for unproductive rent-seeking behaviour, i.e. the emergence of powerful lobby groups that compete to secure a share of the resource revenues for themselves, entailing corruption and, overall, weaker institutions.

Rent-seeking and corruption directly hamper growth. As rent-seeking becomes more attractive than commodity production during a resource boom, entrepreneurial talent moves away from production into rent-seeking, reducing profit and output in production. Corruption by e.g. government officials stifles incentives to invest and innovate by private firms. In addition, government policies are diverted away from the goal of long-term growth towards the interests of rent-seeking factions. The dominance of powerful interest groups also hinders the capacity of the economy to respond effectively to shocks, with adverse effects on growth.

[2] For example, Echevarria (1997) finds that productivity growth is greatest in manufacturing. Matsuyama (1992) and Sachs and Warner (1995) assume learning-by-doing in manufacturing. Wood and Berge (1997), Gylfason et al (1999) and Gylfason (2001) point to sectoral differences in workers' skills.

Education and Economic Policies

If primary industries like agriculture and mining require, on average, a less skilled workforce than others, a dominant resource sector reduces incentives to invest in human capital accumulation at the public and private levels. Given both the important role of education in generating technological progress predicted by endogenous growth theory, as well as the supportive results of Barro-style growth regressions, lower levels of schooling adversely affect growth. This channel has been suggested by Gylfason (2001) and Gylfason, Herbertsson and Zoega (1999). The issue is linked to the more general question of how revenue inflows influence policy-making. For instance, resource revenues were often spent too quickly on inadequately planned projects, and many countries chose to use the revenues to foster domestic industry while pursuing protectionist trade policies. Lal and Myint (1996) identify policy failure as the main cause of the resource curse.

4. Literature Review

Before the 1990s, research on the resource curse appeared mainly in the form of case studies, while over the last decade, a large number of econometric cross-country studies have emerged. The literature provides general support for the existence of the curse, but there is little agreement on its underlying causes.

The case studies in Auty (1990, 1993) and Gelb (1988) investigate the impact of windfall gains from resource booms on mineral exporters (fuels, ores), focusing on the oil shocks of the 1970s. The overall picture emerging is that most economies were left severely destabilised by their unanticipated riches both at the macro- and the micro-levels. Pure economics aside, the importance of effective public sector management in the face of large rent streams, and of political economy and the nature of the state in general, is emphasised.

These studies established the main hypotheses that subsequent econometric work built on. Sachs and Warner (1995, 1997) were the first to use regression analysis on a broad set of countries, examining 97 countries over the nineteen-year period 1970-1989. They find significant evidence for the resource curse, with average annual growth rates in resource-rich countries as much as 1 percent below those of other countries. This relationship is robust to the inclusion of several potential channel variables (institutions, terms of trade, investment and trade policy), i.e. the coefficient on the variable for resource abundance remains significant even after their introduction into the growth equation. Further scrutiny of indirect links between resources and growth does not produce clear results as to which transmission mechanism is at work. Overall, Sachs and Warner attribute the curse to the effects of the Dutch disease. To support their empirical conclusions, the authors present a theoretical model of the Dutch disease in an endogenous growth framework, with learning-by-doing externalities in manufacturing.

More recently, much research has been directed at political-economy explanations. Leite and Weidmann (1999), Isham, Woolcock, Pritchett and Busby (2003), and Sala-i-Martin and Subramanian (2003) explore the hypothesis that possessing abundant resources, and in particular those of the point-source type, impedes growth via their detrimental effect on institutional quality. To test for this indirect effect, the papers postulate a system of two equations, a growth equation and an equation for institutional quality, using instrumental variables for institutions. This strategy makes it possible to determine on the one hand, whether resources significantly affect institutional quality in the institutions equation, and on the other, to what extent this channel can explain the resource curse in the growth equation.

Leite and Weidmann find that none of the channel variables can eliminate the significant negative relationship between resources and growth. By contrast, in Sala-i-Martin and Subramanian as well as Isham, Woolcock, Pritchett and Busby, resources have no additional direct effect on growth once institutions are included in the growth equation – the resource curse disappears.[3] All three studies agree that dependence on fuels and ores has a negative impact on institutional quality, while there is no strong relation of this kind for agricultural raw materials and foods.

Finally, Gylfason, Herbertsson and Zoega (1999) and Gylfason (2001) investigate the connection between resource abundance and incentives for human capital accumulation. Gylfason (2001) notes that different measures for education, such as public expenditure on education, expected years of schooling, and secondary-school enrolment rates, are inversely related to resource wealth. Estimating a two-equation system for growth and education similar to that described above, he concludes that about half of the total effect of resources on growth can be explained by the education channel. In a model of endogenous growth with learning-by-doing, Gylfason et al (1999) link the resource curse to the dominance of a low-skill-intensive primary sector. Observing that the inclusion of variables for resource abundance reduces size and significance of education variables in the growth equation, their results also lend support to the human capital channel.

The present paper resembles previous studies in that it also adopts a two-equation estimation procedure. However, in addition to examining three of the more widely cited channels (Dutch disease, institutions, terms of trade), this study also explicitly includes the education channel, which has so far received less attention in the empirical literature.

[3] On this point, it is important to note that the studies use different variables to capture Dutch disease effects: Sala-i-Martin and Subramanian use a measure of exchange rate overvaluation, while in Leite and Weidmann and also in Sachs and Warner, the Dutch disease works through variables for trade openness, the relative price level of investment goods, and the natural resource variable directly. These different terms are intended to capture policy response to the contraction of manufacturing, higher prices of non-tradables, and sectoral shifts of factors of production, respectively.

5. A Model of Endogenous Growth with Convergence

The empirical analysis of the resource curse hypothesis in the next sections is based on a model in the AK tradition introduced by Jones and Manuelli (1990).[4] The simple AK model, building on a production function of the form $Y = F(K, L) = AK$, belongs to the class of endogenous growth models since it explains growth from within the system in that the growth rate of per capita output depends on the behavioural parameters of the model. By contrast, in the neoclassical Solow-Swan model, the only source of per capita growth is exogenously given technological progress. The Solow-Swan model also implies conditional convergence – holding constant other growth determinants, an economy converges to its steady-state income level, with growth faster the further it is away from the steady state – a property that is consistent with empirical evidence but that the AK model lacks.

These differences between the models result from the assumption of diminishing returns to capital in the neoclassical model but of constant returns in the AK model. The latter can be justified if capital is interpreted to include not only physical, but also human capital. The model presented here combines the more realistic predictions of both in that it generates endogenous growth as well as conditional convergence. The production function is a combination of the AK function and the Cobb-Douglas representation of the Solow-Swan model:

$$Y = F(K, L) = AK + BK^{\alpha} L^{1-\alpha}$$

This function exhibits diminishing returns, but as $k \to \infty$, it approaches the AK form with constant returns.[5] In per capita terms:

$$y = f(k) = Ak + Bk^{\alpha}$$

where $y = Y / L$ is output per capita (or per worker), $k = K / L$ is the stock of capital per capita, L is labour input (identified with the total population), A and B are positive constants representing the level of technology, and α is a constant with $0 < \alpha < 1$.

The total stock of capital K available in the economy changes over time according to

$$\dot{K} = \frac{dK}{dt} = I - \delta K =$$
$$= sY - \delta K$$

[4] The discussion here draws on Barro and Sala-i-Martin (2004), pp. 66-68.

[5] It has to be noted that his production function violates one of the characteristics of the neoclassical production function: Since $\lim_{K \to \infty} (\partial F / \partial K) = A > 0$, the Inada condition $\lim_{K \to \infty} (\partial F / \partial K) = 0$ is not satisfied.

where I is gross investment which equals total savings S, $s = S/Y$ is the saving rate, and δ is the fraction of total capital that depreciates each period. Thus the net increase in the capital stock from one period to the next consists of new physical and human capital generated by investment in e.g. machinery and education of the workforce, minus the amount that depreciates. Expressing the equation in per capita terms and using that the growth rate of the population is constant at $\dot{L}/L = n$ yields the fundamental dynamic equation:

$$\begin{aligned}\dot{k} = \frac{dk}{dt} &= sy - (n+\delta)k = \\ &= s \cdot f(k) - (n+\delta)k = \\ &= s \cdot (Ak + Bk^{\alpha}) - (n+\delta)k\end{aligned}$$

Asymptotically, the economy converges to a steady state, in which all variables grow at constant rates. The growth rate of capital per worker during transition to the steady state is

$$\gamma_k = (\dot{k}/k) = s \cdot \left[A + Bk^{-(1-\alpha)} \right] - (n+\delta).$$

As $k \to \infty$, γ_k diminishes and approaches the steady-state growth rate,

$$\gamma_k^* = (\dot{k}/k)^* = sA - (n+\delta),$$

which is positive, assuming $sA > n+\delta$. As in the neoclassical model, there is conditional convergence, since the growth rate is higher the lower the starting value of k, i.e. the further away the economy is from its own steady state. As in the AK model, growth can be explained by the parameters of the model. Changes in the saving rate, the level of technology, the growth rate of the labour force (population) and the depreciation rate permanently affect the growth rate of per capita output.

6. Empirical Specification

The empirical specification is a system of two equations, consisting of a growth equation and an equation for institutional quality. The data is purely cross-sectional, covering 114 countries from 1970 to 2000 (see Section 7). In the growth equation, the growth rate of per capita output depends on those variables implied by the growth model in Section 5 that have been found robust in the recent empirical growth literature[6] and for which data were available. In the first part of the analysis, the variables for natural resources and the four channels of transmission identified in Section 3 are added step by step, to determine whether the resource curse exists for the data used and, if yes, through which channel it works. If the inclusion of a particular channel variable renders the resource term insignificant, then there is no additional effect of resources on growth once this channel is controlled for – we have isolated the transmission mechanism. This yields the following equation:

$$\text{GDP Growth}_i = \alpha + \beta \text{Growth Variables}_i + \gamma \text{Natural Resources}_i + \delta \text{Channel Variables}_i + \varepsilon_i$$

There are endogeneity problems for almost all variables in the growth equation. Endogeneity occurs if causality in the model is not unidirectional, so that not only do the explanatory variables affect growth, but growth may also affect some of the explanatory variables. For instance, this is the case for institutional quality: If low growth is related to bad institutions, it is not clear whether this is because low growth hinders the development of sound institutions, or because bad institutions hinder growth.

While an exogenous variable is determined outside the model, an explanatory variable that is endogenous in the growth equation is determined within the model, jointly with the dependent variable. It is generally correlated with the error term, so estimating the growth equation by OLS yields biased and inconsistent estimators (simultaneity bias). To ensure the exogeneity of all explanatory variables, initial period values are used for all endogenous variables[7] except institutional quality, which is estimated with instrumental variables (IV) in a two-stage least-squares (2SLS) procedure.

The first stage of 2SLS estimation of the growth equation consists of an OLS regression of institutional quality on all exogenous variables in the model plus additional exogenous, "instrumental", variables (here two are used) which should be correlated with

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[6] For example, Doppelhofer, Miller, Sala-i-Martin (2003), Sala-i-Martin (1997), Levine and Renelt (1992)

[7] Although e.g. dependence on resource exports in 1970 may affect growth over the subsequent period 1970 to 2000, the reverse cannot be the case.

institutions but uncorrelated with the error in the growth equation. If these two conditions are satisfied, the 2SLS estimates are consistent. In the second stage, the growth equation is estimated by OLS, with the fitted values for institutions from the first stage replacing the sample values. The instruments provide a source of exogenous variation in institutions and essentially break the correlation between institutions and the error in the growth equation.[8]

This two-equation model provides a useful setup for the second part of the analysis, which examines whether the institutions channel, i.e. the part of the resource curse that works indirectly through institutions, can be attributed to the influence of those types of resources that give rise to rent-seeking:

Stage 1:

$$\begin{aligned}\text{Institutional Quality}_i = \alpha_2 + \theta\text{Growth Variables}_i + \lambda\text{Natural Resources}_i + \\ + \tau\text{Channel Variables}_i + \phi\text{Instruments for Institutional Quality}_i + \eta_i\end{aligned}$$

Stage 2:

$$\text{GDP Growth}_i = \alpha_1 + \beta\text{Growth Variables}_i + \gamma\text{Natural Resources}_i + \delta\text{Channel Variables}_i + \varepsilon_i$$

The fitted values for Institutional Quality enter Stage 2 in the term "Channel Variables". Since the first-stage equation includes only exogenous variables (it is a reduced-form equation and the system is recursive rather than simultaneous), it can be interpreted and used to determine whether the variables for fuels and ores have a more significantly negative impact on institutions than those for agricultural products and food.

[8] Note that the growth equation is overidentified since it excludes the two additional instruments used in the institutions equation. The exclusion restrictions imposed on the model are thus that the instruments in the institutions equation do not appear in the growth equation and are uncorrelated with its error term. Overidentification potentially yields more precise estimates.

7. Data Description

This study takes a purely cross-sectional approach, using data on 114 countries over the period 1970 to 2000. The data set is limited in that some variables were not available for this period exactly, and there are missing values for certain countries. The data were gathered mainly from the Penn World Tables 6.1 and the World Development Indicators 2003. All variables are measured in percent unless indicated otherwise.[9]

Growth Variables

The growth rate of output ($GDPGrowth7000_i$) is measured as the average annual growth rate of real per capita GDP 1970-2000. The variables included as growth determinants are: Firstly, a parameter capturing conditional convergence, namely the natural log of real per capita GDP in 1970 ($LGDP70_i$), measured in 1996 international dollars; this variable enters in log form to facilitate coefficient interpretation. Secondly, the saving rate, proxied by the average share of gross domestic investment in GDP 1970-2000 ($I/GDP7000_i$) and the gross primary school enrolment rate in 1970 ($Prim70_i$). The latter is mainly interpreted as a channel variable for the resource curse (see below). To counter endogeneity, the author attempted to instrument the investment ratio with the initial period value of the price level of investment goods following the empirical growth literature, but without success. For simplicity, the variable is therefore assumed exogenous and enters as the period average. The growth model in Section 5 predicts a negative relation between GDP growth and initial GDP and a positive relation for investment and primary education.

Natural Resource Variables

The measure for resource abundance in the aggregate is the share of total exports of natural resources in GNP in 1970 ($NatResGNP70_i$). The sub-groups of resources are measured as a share in total merchandise exports, due to lack of data for their share in GNP. This yields the variables $AgriEXP70_i$, $FoodEXP70_i$, $FuelEXP70_i$, $OresEXP70_i$, $AgriFoodEXP70_i$ and $FuelOresEXP70_i$. According to the resource curse hypothesis, the expected sign of these variables in both growth and institutions equation is negative, with a stronger negative impact for fuels and ores than for agricultural materials and foods in the institutions equation.

[9] The countries in the sample are listed in Appendix A, while full variable definitions and sources are listed in Appendix B. A table of means, standard deviations, minima and maxima for each variable can be found in Appendix C.

Institutions Variables

Institutional quality is proxied by an index for average rule of law over 1996-2000, measured from -2.5 to 2.5 (*RoL9600*$_i$). Higher index values indicate better institutional quality. Rule of law is defined as the protection of persons and property against violence or theft, independent and effective judges and contract enforcement. Ceteris paribus, better institutions are beneficial for growth, as outlined in Section 3.

The instruments used for institutions are the fraction of the native population in each country speaking English (*EngFrac*$_i$) and the major languages of Western Europe (*EurFrac*$_i$) as a native language today. These variables measure the extent of Western European influence through history. According to Hall and Jones (1998), countries where European influence was strong were more likely to develop sound institutions, hence these variables are correlated with institutions. They can also be taken as exogenous in the growth equation since those countries that are rich today were not primarily those targeted by European colonisers.[10]

Other Channel Variables

Dutch disease effects are captured by an index for average exchange rate overvaluation over 1970-1999, ranging from 59.95 to 193.2 (*ExchOver7099*$_i$). An increase in the index indicates more overvaluation. Long-term changes in the terms of trade are measured by the average annual growth rate of terms of trade over 1970-2000 (*ToTGrowth7000*$_i$). Higher currency overvaluation and falling terms of trade are expected to reduce growth. The education channel is captured by *Prim70*$_i$.

Of all explanatory variables, only *ExchOver*$_i$ and *ToTGrowth*$_i$ are treated as truly exogenous, since the correlation between overvaluation and income level was found insignificant, and since most countries can be assumed price-takers on world markets. Therefore, they are measured over the full sample period.

[10] These variables are used as instruments for institutions in several other studies on the curse, including Sala-i-Martin and Subramanian (2003) and Isham, Woolcock, Pritchett, Busby (2003)

8. Estimation Results and Analysis

Table 2 presents the results of the stepwise inclusion of the resource and channel variables into the growth equation. Both 2SLS and OLS results are shown for comparison. As a rule, the IV estimator is less efficient than OLS, so the estimates have larger standard errors and are less precise. This is because using the fitted values for institutional quality from the first stage increases the variance of the growth equation. As can be seen from the tables, many variables are indeed less significant when estimated with IV. $\overline{R}^2$ has little meaning in IV estimation and is thus not reported.

Table 2: The resource curse in the growth equation
(Dependent variable: $GDPGrowth7000_i$)

Two-stage least-squares

	I (OLS)	II (OLS)	III (2SLS)	IV (2SLS)	V (2SLS)	VI (2SLS)
$LGDP70_i$	-0.453*	-0.517*	-1.133	-1.298	-1.694*	-1.299*
	(-2.49)	(-2.53)	(-1.82)	(-1.77)	(-2.02)	(-2.03)
$I/GDP7000_i$	0.185**	0.173**	0.117*	0.086	0.071	0.091
	(8.04)	(6.71)	(2.0)	(1.5)	(1.23)	(1.9)
$NatResGNP70_i$		**-0.031***	**-0.024**	**-0.0008**	**-0.015**	**-0.021**
		(-2.04)	(-1.59)	(-0.038)	(-0.832)	(-0.99)
$RoL9600_i$			1.097	1.326	1.417	1.012
			(1.04)	(1.19)	(1.35)	(1.23)
$ExchOver7099_i$				-0.017**	-0.012	-0.014*
				(-2.94)	(-1.89)	(-2.36)
$Prim70_i$					0.023	0.017
					(1.93)	(1.66)
$ToTGrowth7000_i$						0.066
						(0.75)
Constant	2.11	3.269	8.803	12.226	13.308	10.754
	(1.64)	(2.21)	(1.6)	(2.0)	(2.2)	(2.25)
$\overline{R}^2$	0.381	0.378				
Sample size	114	99	99	83	80	72

t-ratios in parentheses; ** Significant at 1%-level; * Significant at 5%-level
The instruments used for $RoL9600_i$ are $EngFrac_i$ and $EurFrac_i$.

Ordinary least squares

	I	II	III	IV	V	VI
$LGDP70_i$	-0.453*	-0.517*	-1.186**	-1.163**	-1.718**	-1.689**
	(-2.49)	(-2.53)	(-5.0)	(-4.51)	(-5.75)	(-5.32)
$I/GDP7000_i$	0.185**	0.173**	0.112**	0.096**	0.069*	0.064*
	(8.04)	(6.71)	(4.16)	(3.52)	(2.56)	(2.23)
$\boldsymbol{NatResGNP70_i}$		**-0.031***	**-0.024**	**-0.002**	**-0.015**	**-0.02**
		(-2.04)	(-1.68)	(-0.124)	(-0.832)	(-0.968)
$RoL9600_i$			1.19**	1.115**	1.448**	1.553**
			(4.54)	(4.19)	(5.35)	(5.28)
$ExchOver7099_i$				-0.017**	-0.012*	-0.012*
				(-3.47)	(-2.4)	(-2.34)
$Prim70_i$					0.024**	0.021*
					(3.0)	(2.44)
$ToTGrowth7000_i$						0.097
						(1.3)
Constant	2.11	3.269	9.276	11.101	13.481	13.699
	(1.64)	(2.21)	(4.92)	(5.25)	(6.28)	(5.93)
$\bar{R}^2$	0.381	0.378	0.484	0.528	0.578	0.577
Sample size	114	99	99	83	80	72

t-ratios in parentheses; ** Significant at 1%-level; * Significant at 5%-level

The regressions in Table 2 provide some support for the resource curse hypothesis: The coefficient on $NatResGDP70_i$ is significant at the 5%-level when added to the basic growth model of specification I, and it has the expected negative sign in all regressions. Specification II suggests that a 10% higher share of natural resource exports in GNP from one country to another reduces the average annual growth rate of GDP by a third of a percentage point, holding initial income and investment constant across countries.

The coefficient is not robust to the inclusion of the variables for the institutions and the Dutch disease channels. It drops in both size and significance, in particular after the inclusion of $ExchOver7099_i$. This suggests that these two variables capture all the channels of causation of the resource curse, so that there is no significant direct effect of resource dependence on growth once they are accounted for. Hence there is some evidence for the institutions channel, but more for the Dutch disease channel. Since the significance of the coefficient on $NatResGDP70_i$ is unaffected when adding $ToTGrowth7000_i$ and $Prim70_i$, there is no evidence for the terms of trade or education channels (see also Appendix D, Table 6, where each channel variable is included on its own). These results contrast those of Sachs and Warner (1995), who find a robust coefficient about three times as large as ours. However, our results confirm those of more recent work by e.g. Sala-i-Martin and Subramanian (2003), who find that the curse is not robust to the inclusion of the variable for the institutions channel.

The 2SLS estimates of the coefficients on the growth and channel variables are, as expected, less consistently significant than their OLS counterparts. However, they have the predicted signs everywhere, and their magnitudes are roughly in line with other studies on the resource curse as well as with the empirical growth literature (if somewhat lower).[11] So while they may not always be statistically significant, they are certainly economically significant. The size of the coefficient on the parameter for conditional convergence suggests that, holding the other explanatory variables constant, an economy approaches its steady state at a rate of between 1.1% and 1.7% per year. Ceteris paribus, a higher investment ratio, better institutions, less currency overvaluation, a higher primary enrolment rate and falling terms of trade are all conducive to growth. Except for the terms of trade term, these variables are all significant – often at the 1%-level – when estimated by OLS. Institutions have a particularly pronounced impact on growth: A 1-point increase in the index for rule of law between countries raises the average annual growth rate by around 1.3 percentage points!

[11] For instance, Sala-i-Martin and Subramanian (2003), Sachs and Warner (1995), Barro and Sala-i-Martin (2004)

Table 3 presents the first- and second-stage regressions separately. The variables for natural resources, measured in the aggregate as well as the component shares, are part of the list of exogenous variables that enters the first-stage equation. They can be interpreted to capture the indirect effect of resources on growth via institutional quality. As predicted by theory and in accordance with the evidence on the relation between growth rates and types of resources presented in Section 2, of the different sub-groups of natural resources, those types that generate large economic rents have a significantly negative effect on institutional quality: The coefficient on $FuelEXP70_i$ is significant at the 1%-level. It implies that a 10% higher share of fuel exports in 1970 from one country to another reduces the average quality of economic institutions over 1996-2000 by 0.15 index points. $FuelOresEXP70_i$, a composite of the point-source types, also has a significant negative effect, while the variable for agricultural raw materials is insignificant and even has a positive effect on institutions.

The second-stage regression is the growth equation with institutional quality endogenised. As in Table 2, none of the natural resource terms has a significant effect on growth once all the channel variables are included in the equation, although all are correctly signed. Again, the OLS results are shown in a separate table for comparison of the second-stage regressions.

Overall therefore, the part of the curse that works through institutions can be attributed to the negative impact of an abundance of fuels and ores on institutional quality.

Finally, it is important to examine the validity of the instruments used. For the instruments $EngFrac_i$ and $EurFrac_i$ to be valid in 2SLS, they must be uncorrelated with the error in the growth equation and correlated with the endogenous variable $RoL9600_i$. The second requirement is satisfied for $EngFrac_i$ but not for $EurFrac_i$, since all first-stage regressions in Table 3 show a significant non-zero partial correlation between $RoL9600_i$ and the former but not the latter. Also, the instruments are jointly significant at the 5%-level in all first-stage regressions (Table 4). The results of tests of overidentifying restrictions on all 2SLS regressions show that the null hypothesis of no correlation between the instruments and the error cannot be rejected, so that the first requirement is satisfied and both instruments are exogenous in the growth equation (Table 5). Overall, the instruments appear reasonably useful, although the weak correlation between $RoL9600_i$ and $EurFrac_i$ could have further reduced the efficiency of the IV estimator.

Table 4: Test statistics for joint significance of instruments in first stage in Table 3

	I	II	III
$F(m, n-k-1)$	4.919*	4.936*	4.0265*
	(0.0103)	(0.011)	(0.023)

p-values in parentheses; ** Significant at 1%-level; * Significant at 5%-level
$m =$ number of restrictions, $n =$ number of observations, $k+1 =$ number of parameters

Table 5: Test statistics for Sargan's test of overidentifying restrictions

In Table 2:

	III (2SLS)	IV (2SLS)	V (2SLS)	VI (2SLS)
$\chi^2(p-k)$	1.553	0.111	0.026	0.025
	(0.213)	(0.739)	(0.872)	(0.875)

In Table 3 (on second-stage regression in 2SLS):

	I	II	III
$\chi^2(p-k)$	0.025	0.447	0.139
	(0.875)	(0.504)	(0.71)

p-values in parentheses; ** Significant at 1%-level; * Significant at 5%-level
$p =$ number of variables in the list of instruments (all exogenous variables), $k =$ number of regressors

9. Limitations and Extensions

First, the data used is limited in that one of the main variables of interest, the quality of economic institutions, was available only for the late 1990s. The earliest data that exists on this measure goes back until 1982, but it must be purchased. The resulting loss of information could have severely biased the results. In addition, the data set consists of those countries with available data, which leads to further bias since the countries with lack of data are probably the poorer countries with less developed infrastructure. For example, the data set excludes almost all countries of the former Eastern bloc. Also, it would be useful to consider different measures for the Dutch disease, since the various effects of this channel are not easily captured by a single variable. Furthermore, fixed effects panel estimation would be an improvement on the simple cross-sectional method used here, since it accounts for country-specific characteristics that do not change over time.

Second, the result that owning particular types of resources worsens institutional quality raises the question why some countries endowed with point-source resources did not suffer from the resource curse. The best example is the diamond exporter Botswana, with average annual growth rates of around 6% over the last decades. In this context, it is important to bear in mind that the results of large-scale econometric studies like the one undertaken here are extremely generalised and disguise the complexity and diversity of the problem. Therefore, to gain further insight into the curse, statistical conclusions are best complemented with evidence from micro-level case studies.

Third, since the work of this project covers only the latter half of the 20th century, research on whether the curse holds in a historical perspective would be an interesting extension, in particular given the long-run nature of economic growth.

10. Conclusion

Overall, this study finds a significantly negative impact of resource abundance on growth. This relationship can be explained by two of the four channels of transmission considered – the Dutch disease and the institutions channel. While there is more evidence for the Dutch disease channel, the part of the curse that works through institutions can be attributed to the detrimental effects of point-source resource types, which generate large rents, on institutions.

These results imply that appropriate policy responses to Dutch disease effects are of primary importance in countering the resource curse. Also, given the strong impact of institutional quality on growth identified in the empirical section, the results confirm the importance of sound economic institutions in the face of resource revenue streams. Ensuring that the rules governing economic life are clear and enforced removes one obstacle on the road to turning abundant natural resources from a curse into a blessing.

Word Count: 5 537

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Appendix A – Countries in the Sample

Algeria[*]	Gabon	Netherlands
Angola	Gambia, The	New Zealand
Argentina	Germany	Nicaragua
Australia	Ghana	Niger
Austria	Greece	Nigeria
Bangladesh	Guatemala	Norway
Barbados	Guinea	Pakistan
Belgium	Guinea-Bissau	Panama
Benin	Guyana[*]	Papua New Guinea[*]
Bolivia	Haiti[*]	Paraguay
Botswana[*]	Honduras	Peru
Brazil	Hong Kong, China	Philippines
Burkina Faso	Hungary	Portugal
Burundi	Iceland	Romania
Cameroon	India	Rwanda
Canada	Indonesia	Senegal
Cape Verde	Iran, Islamic Rep.	Seychelles
Central African Republic[*]	Ireland	Sierra Leone[*]
Chad	Israel	Singapore[*]
China	Italy	South Africa
Chile	Jamaica	Spain
Colombia	Japan	Sri Lanka
Comoros	Jordan	Sweden
Congo, Dem. Rep.[*]	Kenya	Switzerland
Congo, Rep.	Korea, Rep.	Syrian Arab Republic
Costa Rica	Lesotho	Tanzania
Cote d'Ivoire	Luxembourg	Thailand
Cyprus[*]	Madagascar	Togo
Denmark	Malawi	Trinidad and Tobago
Dominican Republic	Malaysia	Tunisia
Ecuador	Mali	Turkey
Egypt, Arab Rep.	Mauritania[*]	Uganda
El Salvador	Mauritius	United Kingdom
Equatorial Guinea	Mexico	Uruguay
Ethiopia	Morocco	USA
Fiji[*]	Mozambique	Venezuela
Finland	Namibia[*]	Zambia
France	Nepal	Zimbabwe

[*] **Due to data availability, measured over the following time periods:**

1970-1996: Angola, Cyprus, Sierra Leone, Singapore
1970-1997: Congo, Dem. Rep.
1970-1998: Central African Republic, Haiti
1970-1999: Botswana, Fiji, Guyana, Mauritania, Namibia, Papua New Guinea

Total number of countries: 114

Appendix B – Variable Definitions and Data Sources

Growth variables:

GDPGrowth7000 = Average annual growth rate of real per capita GDP over the period 1970-2000, purchasing power parity-adjusted. Measured in %. Calculated as $\left[(\ln GDP_{2000} - \ln GDP_{1970})/30\right]*100$. Source: Penn World Tables 6.1 (using variable *rgdpch*)

LGDP70 = Natural logarithm of real per capita GDP in 1970, purchasing power parity-adjusted. Measured in 1996 international dollars. Source: Penn World Tables 6.1 (*rgdpch*)

I/GDP7000 = Simple average of share of real gross domestic investment in real per capita GDP over 1970-2000, measured in %. Source: Penn World Tables 6.1 (using variable *ki*)

Natural resource variables:

NatResGNP70 = Share of exports of natural resources in GNP in 1970, measured in %. Natural resource exports are the sum of exports of agricultural raw materials, foods, fuels, and ores and metals, as defined in the World Bank World Development Indicators 2003 (WDI). Source: Data set for Sachs and Warner (1997), obtained from Harvard Center for International Development at http://www.cid.harvard.edu/ciddata/ciddata.html (using variable *sxp*)

AgriEXP70 = Share of exports of agricultural raw materials in total merchandise exports in 1970, measured in %. Source: WDI (series code: TX.VAL.AGRI.ZS.UN)

FoodEXP70 = Share of food exports in total merchandise exports in 1970, measured in %. Source: WDI (series code: TX.VAL.FOOD.ZS.UN)

FuelEXP70 = Share of fuel exports in total merchandise exports in 1970, measured in %. Source: WDI (series code: TX.VAL.FUEL.ZS.UN)

OresEXP70 = Share of exports of ores and metals in total merchandise exports in 1970, measured in %. Source: WDI (series code: TX.VAL.MMTL.ZS.UN)

AgriFoodEXP70 = Sum of AgriEXP70 and FoodEXP70, measured in %.

FuelOresEXP70 = Sum of FuelEXP70 and OresEXP70, measured in %.

Institutions variables:

RoL9600 = Rule of law index, averaged over the period 1996-2000. Measured from –2.5 to 2.5, where higher values indicate higher institutional quality. Rule of law is defined as the protection of persons and property against violence or theft, independent and effective judges and contract enforcement. Source: Data set for Kraay, Kaufmann, Mastruzzi (2003), obtained from http://www.worldbank.org/wbi/governance/pdf/2002kkzdata.xls

EngFrac = Fraction of the population speaking English as a native language today, measured in %. Source: Data appendix for Hall and Jones (1998), at http://elsa.berkeley.edu/~chad/HallJones400.asc

EurFrac = Fraction of the population speaking one of the major languages of Western Europe (English, French, German, Portuguese, Spanish) as a native language today, measured in %. Source: see EngFrac

Other channel variables:

ExchOver7099 = Index of average real exchange rate overvaluation over the period 1970-1999. Measured from 59.95 to 193.2, where a value of 100 means no over- or undervaluation. An increase in the index indicates more overvaluation. Calculated as simple average of annual index values for real exchange rate overvaluation over the period 1970-1999. Source: Data for annual real exchange rate overvaluation index at http://www.worldbank.org/research/growth/GDNdata.htm (Macro dataset, CGD)

ToTGrowth7000 = Average annual growth rate of terms of trade (ratio of export to import prices) 1970-2000, measured in %. Long-run change in the terms of trade. Calculated as $\left[(\ln ToT_{2000} - \ln ToT_{1970})/30\right]*100$.

Sources: WDI (series code: TT.PRI.MRCH.XD.WD); data set for Sachs and Warner (1997), obtained from Harvard Center for International Development at http://www.cid.harvard.edu/ciddata/ciddata.html (using variable *dtt7080*)

Prim70 = Gross primary school enrolment in 1970, measured in %. Source: WDI (series code: SE.PRM.ENRR)

Components of total merchandise exports:

Agricultural raw materials: Crude materials except fuels
Food: Food, live animals, beverages, tobacco, animal and vegetable oils and fats, oil seeds, oil nuts, oil kernels
Fuels: Mineral fuels
Ores and metals: Non-ferrous metals; minerals excluding coal, petroleum, precious stones; metalliferous ores and scrap
Manufacturing: Chemicals, basic manufactures, machinery and transport equipment, miscellaneous manufactured goods

Source: World Bank World Development Indicators 2003

Appendix C – Summary Statistics

	No. of Obs.	Mean	Standard deviation	Minimum	Maximum
GDPGrowth7000	114	1.393	1.959	-4.899	6.363
LGDP70	114	8.016	0.977	5.804	9.934
I/GDP7000	114	15.81	7.739	2.269	45.351
NatResGNP70	99	12.87	10.402	0.64	54.311
AgriEXP70	101	11.919	13.805	0.02	71.208
FoodEXP70	101	42.764	29.447	0.596	99.794
FuelEXP70	89	8.028	18.632	0	91.016
OresEXP70	100	12.25	20.428	0	99.068
AgriFoodEXP70	101	54.682	31.314	0.740	99.956
FuelOresEXP70	100	19.396	25.408	0	99.082
RoL9600	114	0.157	1.03	-1.829	2.211
ExchOver7099	89	113.225	30.885	59.945	193.173
Prim70	108	79.822	30.133	12.198	124.793
ToTGrowth7000	99	-0.51	2.249	-5.770	6.509
EngFrac	113	8.335	25.116	0	0
EurFrac	113	27.188	39.941	0	100

Appendix D – Further Econometric Results

Table 6: Individual inclusion of channel variables

	I (OLS)	II (OLS)	III (2SLS)	IV (OLS)	V (OLS)	VI (OLS)
$LGDP70_i$	-0.453*	-0.517*	-1.133	-0.452*	-0.781**	-0.478*
	(-2.49)	(-2.53)	(-1.82)	(-2.11)	(-3.35)	(-2.2)
$I/GDP7000_i$	0.185**	0.173**	0.117*	0.148**	0.156**	0.174**
	(8.04)	(6.71)	(2.0)	(5.54)	(5.93)	(6.46)
$\boldsymbol{NatResGNP70_i}$		**-0.031***	**-0.024**	**-0.01**	**-0.035***	**-0.034***
		(-2.04)	(-1.59)	(-0.51)	(-2.24)	(-2.04)
$RoL9600_i$			1.097			
			(1.04)			
$ExchOver7099_i$				-0.02**		
				(-3.69)		
$Prim70_i$					0.017*	
					(2.34)	
$ToTGrowth7000_i$						0.038
						(0.49)
Constant	2.11	3.269	8.803	5.159	4.284	3.015
	(1.64)	(2.21)	(1.6)	(2.99)	(2.79)	(1.91)
$\overline{R}^2$	0.381	0.378		0.427	0.4	0.375
Sample size	114	99	99	83	96	91

t-ratios in parentheses; ** Significant at 1%-level; * Significant at 5%-level