Natural resources and economic growth: a curse or a blessing?

Vittorio Daniele

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1. Introduction

The relationship between natural resources and economic growth is one of the most controversial issues in the empirical research on development. While historically natural resources constituted an important development factor for many countries (Wright and Czelusta 2002; De Ferranti et al. 2002), since the 1990s some influential studies have found that resource-rich countries growth has been lower in comparison to resource-poor ones (Sachs and Warner 1995, 1999, 2001). This evidence, known as the 'curse of natural resources', has been confirmed by a large literature using different econometric specifications (Leite and Weidmann 1999; Gylfason et al. 1999; Gylfason, 2001). The main evidence on the curse has been summarized by R. Auty in the subsequent terms:

> "In recent decades the resource-abundant developing countries have underperformed when compared with the resource-deficient developing countries. [...] between 1960 and 1990 the per capita incomes of the resource-*poor* countries grew at rates two to three times faster than those of the resource-abundant countries and the gap in the growth rates has widened significantly since the 1970s." (Auty 2001, p. 3).

Despite the curse concerning, primarily, the detrimental effect on growth rates, there is also evidence that indicates how countries rich in resources tend to perform comparatively worse in the main development indicators, such as life expectancy, education, child mortality or in the human development index (Ross 2001; Bulte et al. 2005).

Recently, some studies have critically re-examined the literature on the resource curse, particularly from a methodological point of view (Lederman and Maloney 2007). It has been observed, for example, how some economic explanations of the curse — such as the Dutch disease — tend to be too deterministic, neglecting the role of national policies (Auty 2001; Davis and Tilton 2005), while, from an empirical point of view, the terms of trade result as a insignificant variable in cross-country regressions on growth (Sala-i-Martin and Subramanian 2003; Iimi 2006). An important critique regards the variables used to measure natural resource *wealth* or *abundance*. A large number of studies have, in fact, used trade proxies, such as the share of primary commodities exports on GDP or on total exports but, as some scholars have observed, without measuring abundance or wealth of resources and correctly focusing, rather, on economic *dependence* on these resources (Brunnschweiler and Bulte 2008a, 2008b).

The objective of this paper is to examine the relationship between natural resources and economic growth. Starting from the results of the literature, a distinction is made between *dependence on* resources and *abundance* of the same. With respect to previous studies, that re-examined the curse hypothesis focusing on the impact of resources on institutions and conflicts, this paper analyses the effects of different types (and measures) of natural resources on growth rates in a cross-section of countries.

The work is structured in four sections. Section two reviews the literature and the criticisms on the resource curse hypothesis. Section three contains the empirical analysis. Some conclusive remarks follow. Results show the existence of a strong and negative relationship between resource dependence — measured by the share of metals and ores on exports — and economic growth. When natural resources abundance indicators are considered there is no evidence of the curse. These results corroborate the literature that critically reviews the notion of the resource curse, suggesting that the effects of natural resources on economic growth can be diverse, and strictly related to the institutional and social capability to manage them.

2. The resource curse

In the 1990s, the existence of a strong and negative relationship between natural resources exports and the rate of growth was shown in the influential studies of Sachs and Warner (1995, 1999). Using data for a large number of countries (varying from 40 to 95 depending on the specific regression), these studies indicated that, after controlling for a number of factors, natural resources — measured by primary-product exports as a percentage of GDP — have a negative impact on economic growth. This finding, confirmed by further research, using different variables and econometric specifications, has become one of the most popular results of the literature on development (Auty 2001; Gylfason et al. 1999; Gylfason 2001; Sala-i-Martin and Subramanian 2003)

The literature offers different explanations of the resource curse. Broadly speaking, these explanations can be comprised in two large groups. The first includes those strictly economic, such as the "Dutch disease", the volatility of primary commodities revenues or the misallocation of production factors as in the "staples trap" thesis (Mikesell 1997; Sachs and Warner 2001; Auty 2001; van der Ploeg and Poelhekke 2009). The second group comprises, rather, those explanations that focus on institutional and political factors (Rosser 2006). The principal argument of this strand of literature is that windfall gains generated by natural resources tend to increase voracious and rent-seeking behaviour, corruption (Leite and Weidmann 1999; Dalgaard and Olsson 2008), or, more generally, cause a deterioration in the quality of institutions and governance (Sala-i-Martin and Subramanian 2003; Isham et al. 2005). Furthermore, there is evidence of a close relationship between natural resource abundance and armed conflicts, in particular in Africa (Collier and Hoeffler 1998, 2004). Negatively affecting the quality of institutional systems, natural resources therefore hamper long -term growth.

The detrimental effects on institutions particularly regard those resources concentrated in some circumscribed areas (point-source resources), and characterised by ready appropriation and easy tradability - such as diamonds or some minerals – which generate easy, exploitable rents (Boschini et al. 2007; Olsson 2007). The competition for the appropriation of rents can, in fact, exacerbate existing tensions between ethnic groups, or factions with political power, leading to armed conflicts (Le Billon 2001, 2008; Reynal-Querol 2002; Ross 2004; Olsson 2007). In his analysis on the world's poorest countries, Collier (2007) has indicated how low income, stagnating or declining economic growth and a dependence on natural resources — and other characteristics, such as the absence of coastal areas — notably increase the probability that an economy falls into a poverty trap. In Collier's approach, conflict reflects elite competition over valuable natural resource rents, while poverty makes soldiering more attractive, lowering the social costs of war between poor nations. In turn, resource rents finance conflict, and conflict serves to perpetuate poverty because of its destructiveness: a vicious cycle of poverty-conflict-poverty ensues. In this approach, the motive of conflicts and violence is found in the *greed* of elites or groups wanting to seize power in order to access resource rents (Collier and Hoeffler 2004; Murshed and Tadjoeddin 2007). This has been the case of conflicts in Angola, Sierra Leone and in the Kiwu region of the Democratic Republic of Congo, where revenues from diamonds provided funds to sustain military and rebel groups (Lalji 2007). In a different interpretation, conflicts are based on *grievance*, that is the perceived or actual deprivation of a population that does not receive any benefits from the exploitation of natural resources: such is the case of the conflicts in the oil-rich regions of Cabinda in Angola and in the Niger Delta (Basedau 2005).

The effect of natural resource wealth on different types of regime has also been widely recognised in the literature. For example, Wantchekon (2002), using data for 141 countries for the period 1950-90, found that an increase of one per cent in natural resource dependence (measured by the ratio of primary export on GDP) increases the probability of an authoritarian government by about 8 per cent. An inverse link between oil and mineral export and democracy was also found by Ross (2001) and Collier and Hoeffler (2009), who investigated the effect of resource rents on the economic performances of democracies. Measuring performance by medium-term economic growth, Collier and Hoeffler found that, in the absence of resource rents, democracies significantly outperform autocracies, whereas if rents are large, relative to GDP, autocracies outperform democracies. The critical threshold at which the two have equivalent effects is when resource rents are around 8 percent of GDP: many resource-rich economies have a share well above this level. Hence, in one sense resource rents appear to undermine the normal functioning of democracies.

Numerous studies suggest how the effects of natural resources can be heterogeneous and strictly related to national institutional contexts (Papyrakis and Gerlagh 2004; Costantini and Monni 2008). In countries with diffuse corruption, weak rule of law or "grabbing institutions", a natural resource boom tends to depress growth, while in the opposite situation it produces positive effects (Mehlum et al. 2006; Stijns 2005). From a political economy perspective, Robinson et al. (2006) provide a model of clientelism that shows how political incentives are the key to understanding whether resources are a curse or, instead, a blessing. These authors demonstrate how, in presence of a permanent resource boom, political elites have the incentives to appropriate the rents to their advantage and to engage in inefficient redistribution, to influence elections. The extent of this phenomenon is crucially related to the quality of institutions: in nations where institutions limit the possibilities for politicians to use clientelism to corrupt elections, resource boom tends to increase national income; when these institutions are absent, perverse incentives prevail and natural resources become a curse (Robinson et al. 2006).

The influence of natural resources on conflicts has been critically re-examined by Fearon (2005) and Fearon and Laitin (2006) who, by using the same approach as Collier and Hoeffler (2002), found that the relationship between primary commodities exports (in particular oil) and civil war is neither strong nor robust. Their main results suggest that oil predicts wars not because it provides a source of finance for rebel groups but, more likely, high oil exports indicate a weaker state given the level of per capita income. In this sense, a state is weak or fragile if its military and institutional structures are not capable of effectively repressing an outbreak of armed insurrection as has happened, for example, in various Sub-Saharan nations. The link between oil and civil war has been analysed by Di John (2007), who shows how the correlation between civil war and the presence of oil is weak. In oil rich nations where violent conflicts occur oil is not necessarily the cause, but other factors, such as a weak government, recent conflict, poor economic performance or war in a neighbouring state tend to play an important role.

Case-studies reinforce the idea according to which resource abundance can produce diverse effects on growth, depending on specific national institutional and political factors (Dunning, 2008). For instance, in Botswana the discovery of diamonds in the 1970s has sustained an impressive economic growth (Acemoglu et al. 2003), while in Angola and Liberia diamonds have fuelled conflicts (Olsson 2007; Le Billon 2008). Oil had totally different effects in Norway, Nigeria and Equatorial Guinea (Larsen 2004; Sala-i-Martin and Subramanian 2003; Toto Same 2008). In the Democratic Republic of Congo, the exploitation of valuable natural resources – such as coltan, alluvial diamonds and gold – fostered conflicts, financed rebels groups and increased corruption, producing detrimental effects on growth and in living standard of population (Lalji 2007).

The overall picture that emerges from studies is that natural resources do not have a *direct* effect on growth but, rather, can have an *indirect* effect, dependent on the quality of the national institutions that represent the channel for the resource curse.

The notion of a resource curse has also been questioned from a methodological and econometric perspective. Criticisms particularly concern the trade-based proxies (such as the share of primary product export) traditionally used to measure natural resource abundance. For example, Leaderman and Maloney (2007), using the net natural resource export per worker in a panel system estimator, found a strong positive relationship between this variable and growth. Furthermore, these authors obtained analogous results using Sachs and Warner's measure of resource export on GDP, concluding that there is no evidence of a resource curse. With particular reference to mineral production, Davis (1995) demonstrated how mineral dependent economies, that is those with a high share of minerals in export and GDP, performed well in 1970s and 1980s, while Stijns (2005) did not find a correlation between fuel and mineral reserves on growth during the period 1970-1989. In their analysis on the robustness of the variables used to explain growth, Doppelhofer et al. (2000) included the fraction of mining in GDP among the most robust determinants of growth but with a positive sign. Recently, Brunnschweiler and Bulte (2008a, 2008b) have argued how trade measures, commonly used in literature, represent properly a *dependence* on resources not an *abundance* of the same. Conceptually, in fact, the notion of abundance refers to a stock variable, that can be measured by the natural capital estimates. In their papers, Brunnschweiler and Bulte (2008a, 2008b), treating resource dependence as endogenous, show how there is not a negative relationship between resources, growth and institutional quality. Using an index of the natural capital (proxy of the abundance) they found, instead, a positive correlation with growth and institutional quality.

The distinction between the notions of resource abundance and dependence is crucial in empirical analysis. For example, the World Bank (2009) has shown that when resource abundance is measured by the value of per capita primary commodities in exports, high income countries are more resource rich than developing countries. On the contrary, when the share of primary commodities in total merchandise exports is considered, rich countries are less resource dependent. In other words, poor countries are more dependent on commodities but relatively resource poorer: the reason is that resource dependence reflects primarily low GDP levels, not a wealth of natural resources (World Bank, 2009, pp. 98-100).

Starting form these findings, in the next section different types and measures are used to examine the relationship between natural resources and economic growth.

3. The empirical analysis

3.1. Data description

The aim of this section is to examine the effect of different kinds and measures of natural resources on economic growth rates, estimating different specifications of the subsequent cross-country growth regression:

$$\mathbf{g}_i = \beta_0 + \beta_1 \mathbf{NR}_i + \beta_2 \mathbf{X}_i + \varepsilon_i . \qquad (1)$$

in this set-up, **g** is the average rate of GDP per capita growth in the period 1980-2006, **NR** is a measure of natural resources and **X** a set of control variables that includes a measure of institutional "quality" and other regressors potentially related to economic growth rates.

Natural resources. Empirically, the effect of natural resources on economic growth could be estimated using different proxies. As previously noted, the most common measure used in the literature has been the value of primary commodity exports as a share of GDP or of total exports; other proxies include sales or stocks of different types of commodities.

In our analysis, different measures of natural resources are considered. The first is the share of exports of metals and ores on total merchandise export for each country. This proxy simply captures the degree of dependence of a nation on a given commodity.

Data on metal and ores exports are taken from the World Bank (2008) and, to reduce the volatility that characterises the export of primary commodities, and which may bias results, averages for the period 1980-90 are considered. Calculated as share of export, this variable reduces the problem of endogeneity that derives when primary exports are calculated as share of GDP. This measure has been used recently in the literature on the theme. For instance, Béland and Tiagi (2009), testing for the resource curse and the role of institutions using the Fraser Institute's Economic Freedom of the World index, conclude that metals and ores bring about a stronger resource curse than natural resources in general. Similar results have also been obtained by Pessoa (2009).

Secondly, the role of natural resources is analysed using data on the production of oil and diamonds. These data are taken from the detailed dataset of Humpreys (2005), where the production of diamonds is measured in billions of metric carats per year per capita, while that of oil in millions of barrels per day per capita. It is important to note that these measures do not concern resource dependence (as a share of GDP or export) but, being calculated in terms of per capita production, are related to actual *abundance* of these resources.

Diamonds and oil are separately introduced into regressions, in order to take into account the effects that each of these resources causes on economic growth. Point-source resources, particularly diamonds (one of the most lootable resources) show a higher correlation with institutional failures like corruption, rent-seeking and armed conflicts, in particular in countries with weak institutions (Collier 2007; Boschini et al. 2007; Olsson 2007). Oil wealth is, instead, considered strongly associated with institutional fallacies and poor economic performances (Karl 1997; Ross 2006), even if recently Sachs (2007) suggested how oil-rich countries tend to have higher per capita income and consumption levels, higher life expectancy, lower child mortality rates, higher electricity use per capita and more paved roads than oil-poor countries.

Data show how the most important diamond producer is Botswana, followed by Australia and Namibia. Other Sub-Saharan countries, such as the Democratic Republic of Congo, South Africa and Liberia are also important producers. It is easy to see how this list includes countries with different patterns of economic growth: growth miracles, such as Botswana, growth disasters such as the Democratic Republic of Congo and Liberia, together with rich countries, such as Australia. Similar observations can be made for oil producers. In this case too, in fact, the data show a variety of growth performances.

The third measure used is a proxy of the abundance of natural resources in terms of stocks. This proxy is given by the subsoil assets as estimated by the World Bank (2006) for the year 2000. Subsoil assets were estimated in economic terms, evaluating the net present value of benefits over a time span of 20 years. Dollar values were assigned to the stocks of the main energy resources (oil, gas and coal) and to the stocks of 10 metals and minerals (bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin and zinc) for all the countries with available production figures. To offer comparable international measures of subsoil wealth, in subsequent analysis we calculated data both in per capita terms and per square kilometre, in logs. These two variables permit the analysis of a concept of resource abundance, different to production, that is the potential rents that can be obtained by exploiting subsoil assets. The basic idea is that ore deposits, reservoirs or subsoil assets in general, even if actually unexploited, can produce detrimental effects on growth, because they can stir up conflicts, tensions or voracious behaviour among groups or factions aiming to appropriate resource rents.

Control variables. Economic growth is an elusive phenomenon, potentially influenced by a number of factors. Not surprisingly, in empirical research, literally hundreds of explanatory variables have been used to investigate the growth determinants (Pritchett 2000). Nevertheless, only (relatively) few variables remain robust as alternative choices of estimators, time frames, data structures, treatment of outliers, measurement of key variables, and model specifications. For these reasons, in selecting the control variables to include in the regression, we have followed a criterion of parsimony, supported by the statistics of Schwarz and Akaike, and considered the results obtained in studies that checked the robustness of the explanatory variables used in growth regressions (Doppelhofer et al. 2000; Fernandez et al. 2001).

Since the literature on the resource curse indicates that the transmission channel through which resources affect economic growth is represented by institutions and politics, the regressions control for a proxy of national institutional "quality". This proxy is given by an index (*IQ*) obtained as an average of the six indicators of governance contained in the dataset of Kaufmann et al. (2008). This index has been normalized to obtain values between 0 and 1, with higher values indicating better governance[1]. Since data commence from 1996-98, and it is not possible to exclude the eventuality that institutional indicators are correlated to the rate of growth of the economy, two stages least squares (TSLS) estimations are used to remove possible endogeneity problems.

The other control variables included are: the log of per capita GDP in 1980; the log of the price level of investment (*PriceInv*); an index of ethnic fractionalisation (*EthnicFractio*); an index of human capital level differences, given by primary school enrolment in 1980 (*School*); a dummy for landlocked countries (*Landlock*) and continental dummies for Africa, Asia, Latin America and the Caribbean. These variables are commonly used in cross-country studies on growth. Sensitivity analyses show, in fact, how the initial GDP per capita and the price level of investment are among the most robust determinants of

[1] The governance indicators range between -2.25 to 2.25, with higher scores corresponding to better outcomes. Data have been normalized to obtain a ranking on positive values.

growth (Ciccone and Jarocinski 2008). The absence of coastal areas — an obstruction to international trade — is, furthermore, strongly and negatively correlated to the development levels (Warner 2002). Ethnic fractionalization is negatively and significantly correlated to the level of development (Alesina et al. 2003); in addition there are theoretical and empirical results that prove how the effect of natural resources tends to be related to the degree of fractionalization of countries: in those highly fractionalized, natural resources tend to lower income, while in more homogenous countries they tend to increase income (Hodler 2006). Tab. 9 in the appendix contains a description of the variables and their sources.

Tab. 1. Correlation matrix

	Growth 1980-2006	GDP p.c. 1980	IQ 1996	Metals	Subsoil p.c.	Subsoil km	Oil	Diamonds
Growth 1980-2006	1.00							
GDP p.c. 1980	0.16	1.00						
IQ1996	0.46	0.79	1.00					
Metals	-0.38	-0.19	-0.11	1.00				
Subsoil p.c.	0.08	0.43	0.17	0.01	1.00			
Subsoil km	0.19	0.44	0.20	-0.15	0.91	1.00		
Oil	-0.22	0.35	0.08	-0.06	0.45	0.44	1.00	
Diamonds	0.14	-0.02	0.07	0.20	0.00	-0.09	-0.02	1.00

Tab. 1 reports the correlation matrix among the natural resources measure, the level of per capita GDP, rates of growth and the institutional variable. It is possible to observe how metal and ores exports are negatively correlated to economic growth, income levels and institutional quality; oil production is negatively correlated to growth rates, while diamond production is positively correlated; stock measures are, conversely, positively correlated to levels of per capita income and growth rates, and with the measure of institutional quality. It is important to highlight how less developed countries are, on average, more dependent on mineral exports, while subsoil assets per capita are positively correlated to the level of income.

3.2. Results

Results of OLS estimates for the proxy of resource dependence are reported in Tab. 2. The estimated model is robust, with a high explicative power and all the coefficients have the expected signs. In all specifications, the export of metals and ores is negatively and significantly related to growth, in accordance with the resource curse hypothesis. The initial level of income and the institutional quality proxy are strongly related to growth. The relative price of investments and ethnic fractionalization negatively influence growth, as does the absence of a coastline. The continental dummies (6) partially capture a series of specific effects: as expected, the dummy for Africa is negatively and strongly linked to growth, while that for Asia has a significant and positive coefficient.

Tab. 3 contains the results of estimations for oil production. In this case the variable is negatively related to economic growth, but its marginal effect is substantially inconsistent when other regressors are included. These results can be explained by considering the fact that oil is negatively and strongly related to governance and institutional indicators: consequently, when the regression controls for cross-country institutional/governance differences, the negative influence on growth tends to disappear.

Tab. 2. Metals and ores export and growth

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.017**	0.0079	0.031**	0.087**	0.11**	0.075**
	(8.9)	(0.77)	(2.9)	(4.5)	(5.4)	(3.6)
Metals	-0.00037**	-0.00035**	-0.00034**	-0.00028**	-0.00024**	-0.00020**
	(-3.2)	(-3.0)	(-4.2)	(-3.4)	(-3.0)	(-2.4)
GDPpc 1980		0.0011	-0.0073**	-0.0097**	-0.011**	-0.011**
		(0.89)	(-3.6)	(-4.4)	(-5.0)	(-4.8)
IQ1996			0.071**	0.060**	0.066**	0.066**
			(5.7)	(4.2)	(4.8)	(4.8)
School1980				0.00020*	0.00015	0.00011
				(1.7)	(1.3)	(1.2)
PriceInv				-0.0079**	-0.010**	-0.0034
				(-2.3)	(-3.1)	(-0.92)
EthnicFractio				-0.016**	-0.016**	-0.0079
				(-2.1)	(-2.1)	(-1.1)
Landlock					-0.016**	-0.011**
					(-4.5)	(-2.8)
LAC						-0.0016
						(-0.45)
Africa						-0.012**
						(-2.0)
Asia						0.012**
						(2.1)
n	119	119	118	96	96	96
R^2 Adjusted	0.13	0.13	0.39	0.52	0.58	0.65
lnL	3.1e+002	3.1e+002	3.3e+002	2.8e+002	2.8e+002	2.9e+002

Heteroskedasticity-robust standard errors, variant HC1 - OLS estimates - T-statistics in parentheses; *indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

The effect of diamond production is examined in Tab. 4. In this case, the resource curse hypothesis does not hold up: on average, diamond production is positively related to growth rates. It is important to recall how the top diamond producer is Botswana, a country with one of the highest growth rates in the world, the second is Australia, while other important producers, such as South Africa or Lesotho, had positive growth rates in the analysed period. Finally, Tables 5 and 6 report estimates results for our measure of subsoil resources. In this case, natural resources appear positively linked to economic growth, in particular when other countries' characteristics are considered.

Tab. 3. Oil production and economic growth

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.014**	-0.012	0.017	0.077**	0.10**	0.065**
	(8.2)	(-1.3)	(1.6)	(3.6)	(4.3)	(3.1)
Oil	-0.029**	-0.043**	-0.015	-0.0017	0.0021	-0.0097
	(-4.7)	(-6.4)	(-1.6)	(-0.16)	(0.20)	(-0.87)
GDPpc 1980		-0.0036**	-0.0057**	-0.0091**	-0.011**	-0.0091**
		(3.2)	(-2.5)	(-3.1)	(-3.8)	(-3.2)
IQ1996			0.071**	0.069**	0.073**	0.067**
			(4.7)	(4.6)	(4.9)	(4.1)
School1980				0.00011	0.00011	5.5e-05
				(1.1)	(1.1)	(0.66)
PriceInv				-0.0075**	-0.0094**	-0.0038
				(-3.3)	(-4.3)	(-1.5)
EthnicFractio				-0.018**	-0.020**	-0.013*
				(-2.5)	(-2.8)	(-2.0)
Landlock					-0.015**	-0.0084*
					(-3.5)	(-1.9)
LAC						-0.0019
						(-0.52)
Africa						-0.0081
						(-1.4)
Asia						0.015**
						(3.0)
n	136	136	135	105	105	105
R^2 Adjusted	0.04	0.10	0.32	0.45	0.51	0.58
lnL	3.5e+002	3.5e+002	3.7e+002	3e+002	3e+002	3.1e+002

Heteroskedasticity-robust standard errors, variant HC1 - OLS estimates - T-statistics in parentheses; *indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Tab. 4. Diamond production and economic growth

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.013**	-0.0028	0.021**	0.079**	0.10**	0.079**
	(7.5)	(-0.29)	(2.2)	(4.5)	(5.6)	(4.2)
Diamonds	0.0030**	0.0030**	0.0015**	0.0023**	0.0037**	0.0040**
	(4.5)	(4.6)	(2.1)	(3.7)	(6.3)	(7.1)
GDPpc 1980		0.0020*	-0.0068**	-0.0091**	-0.011**	-0.011**
		(1.7)	(-3.4)	(-4.4)	(-5.3)	(-4.7)
IQ1996			0.076**	0.066**	0.067**	0.064**
			(5.5)	(4.8)	(5.1)	(4.7)
School1980				0.00014	0.00014*	0.00011
				(1.5)	(1.7)	(1.5)
PriceInv				-0.0076**	-0.0099**	-0.0045*
				(-3.4)	(-4.7)	(-1.8)
EthnicFractio				-0.019**	-0.020**	-0.014**
				(-2.8)	(-3.0)	(-2.3)
Landlock					-0.017**	-0.011**
					(-4.8)	(-2.8)
LAC						-0.0019
						(-0.56)
Africa						-0.0095
						(-1.6)
Asia						0.013**
						(2.5)
n	136	136	135	105	105	105
R^2 Adjusted	0.01	0.03	0.31	0.46	0.54	0.61

lnL	3.5e+002	3.5e+002	3.7e+002	3e+002	3.1e+002	3.2e+002

Heteroskedasticity-robust standard errors, variant HC1 - OLS estimates - T-statistics in parentheses; *indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Tab. 5. Subsoil assets per square km. and economic growth

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0027	0.0030	0.032**	0.092**	0.10**	0.077**
	(0.50)	(0.27)	(2.8)	(4.6)	(5.1)	(3.5)
Subsoil Km	0.00098*	0.00099	0.0019**	0.0016**	0.0014**	0.00075*
	(1.7)	(1.6)	(3.5)	(3.0)	(2.7)	(1.8)
GDPpc 1980		-6.5e-05	-0.011**	-0.011**	-0.011**	-0.010**
		(-0.042)	(-4.2)	(-4.5)	(-4.7)	(-4.0)
IQ1996			0.079**	0.058**	0.058**	0.055**
			(6.1)	(4.1)	(3.9)	(3.5)
School1980				0.00013	0.00013	0.00011
				(1.4)	(1.4)	(1.2)
PriceInv				-0.0095**	-0.0097**	-0.0050
				(-2.8)	(-3.1)	(-1.4)
EthnicFractio				-0.020**	-0.021**	-0.013**
				(-2.9)	(-3.1)	(-2.2)
Landlock					-0.012**	-0.0073
					(-2.2)	(-1.4)
LAC						-0.0034
						(-1.0)
Africa						-0.0089
						(-1.4)
Asia						0.012*
						(1.7)
n	99	99	98	83	83	83
R^2 Adjusted	0.03	0.02	0.35	0.46	0.50	0.55
lnL	2.6e+002	2.6e+002	2.8e+002	2.5e+002	2.5e+002	2.6e+002

Heteroskedasticity-robust standard errors, variant HC1 - OLS estimates - T-statistics in parentheses; *indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Tab. 6. Subsoil assets per capita and economic growth – OLS

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0095**	0.0055	0.037**	0.10**	0.11**	0.084**
	(2.8)	(0.48)	(2.8)	(4.7)	(5.2)	(3.8)
Subsoil pc	0.00042	0.00031	0.0013**	0.0014**	0.0013**	0.00087**
	(0.78)	(0.55)	(2.3)	(2.6)	(2.5)	(2.0)
GDPpc 1980		0.00061	-0.0098**	-0.011**	-0.011**	-0.010**
		(0.42)	(-3.7)	(-4.3)	(-4.6)	(-4.1)
IQ1996			0.076**	0.053**	0.054**	0.053**
			(5.8)	(4.0)	(3.8)	(3.5)
School1980				0.00017*	0.00017*	0.00013
				(1.7)	(1.8)	(1.5)
PriceInv				-0.010**	-0.010**	-0.0055
				(-2.8)	(-3.2)	(-1.6)
EthnicFractio				-0.022**	-0.023**	-0.015**
				(-3.0)	(-3.3)	(-2.3)
Landlock					-0.013**	-0.0079
					(-2.4)	(-1.6)
LAC						-0.0036
						(-1.1)
Africa						-0.0082
						(-1.3)
Asia						0.012*

						(1.8)
n	99	99	98	83	83	83
R^2 Adjusted	-0.00	-0.01	0.30	0.44	0.50	0.56
lnL	2.6e+002	2.6e+002	2.8e+002	2.4e+002	2.5e+002	2.6e+002

Heteroskedasticity-robust standard errors, variant HC1 - OLS estimates - T-statistics in parentheses; *indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Since it is not possible to exclude that the institutional measure we use is endogenous to GDP per capita growth[2], TSLS estimations are used to check the previous results. The instruments used for institutions are: the fraction of people speaking English (*Engfrac*); the fraction of people speaking a European language (*Eurfrac*), and the log of absolute latitude. These instruments have been used in diverse studies on growth determinants (Hall and Jones 1999; Sala-i-Martin and Subramanian 2003). Considering the requisite of robustness, the estimated models include the continental dummies and exclude the variable *school* that is barely significant and, being available for a limited number of countries, reduces the number of observations.

Tab. 7. Natural Resources and economic growth – TSLS

	(1)	(3)	(4)	(5)	(6)
const	0.0664*** (3.6)	0.066*** (3.4)	0.066*** (3.9)	0.068*** (3.7)	0.074 (4.1)
GDPpc 1980	-0.0128*** (-4.9)	-0.013*** (-3.9)	-0.013*** (-5.2)	-0.012*** (-3.4)	-0.012 (-3.4)
IQ1996	0.0991*** (5.0)	0.109*** (4.6)	0.107*** (5.4)	0.084*** (3.6)	0.084*** (3.5)
PriceInv	-0.0016 (-0.4)	-0.002 (-0.8)	-0.002 (-0.7)	-0.003 (-1.0)	-0.004 (-1.1)
EthnicFractio	-0.0058 (-0.8)	-0.011* (-1.8)	-0.010* (1-.7)	-0.010* (1.7)	-0.011* (1-8)
Landlock	-0.0102*** (-2.8)	-0.005 (-1.3)	-0.006* (-1.7)	-0.006 (-1.3)	-0.006 (-1.3)
LAC	0.0042 (1.3)	0.005 (1.2)	0.004 (1.2)	-0.001 (-0.2)	-0.001 (-0.3)
Africa	-0.0096* (-1.9)	-0.008 (-1.6)	-0.009* (-1.9)	-0.009* (1.7)	-0.009* (-1.7)
Asia	0.0108* (1.9)	0.013** (2.5)	0.013** (2.4)	0.013* (1.9)	0.014** (2.1)
Metals	-0.0002*** (-3.3)				
Oil		0.002 (0.2)			
Diamonds			0.003*** (4.3)		
Subsoil km				0.001** (2.5)	
Subsoil pc					0.001** (2.2)
Obs.	113	124	124	92	92
P-value (F)	0.00	0.00	0.00	0.00	0.00
Adjusted R-squared	0.57	0.51	0.53	0.54	0.54
Sargan test P(Chi-Square)>	0.37 [0.82]	0.04 [0.97]	0.09 [0.95]	1.29 [0.52]	1.54 [0.46]
First stage F statistic	16.08	15.6	17.4	14.3	12.8

[2] Even if Kaufmann et al. (2002; 2003) show how the institutional changes cause growth and not *vice versa*.

TSLS estimates. Instrumented IQ1996; instruments: all exogenous explanatory variables, plus Engfrac, Eurfrac and Latitude (log). For Sargan over-identification test – under the null hypothesis: all instruments are valid - p-values are reported in square parentheses. Weak instrument test - First-stage F-statistic. z-statistics in parentheses; * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

The results, reported in Tab. 7, show how the sign and statistical significance of natural resource measures do not change. Metal and ore exports are negatively and significantly related to economic growth, diamond production and subsoil assets positively, oil production is not significant. In all specifications, the Sargan test for over-identification restrictions shows how instruments are exogenous, while the first stage F statistic has values higher than 10, that indicate how instruments are relevant (Staiger and Stock 1997). In synthesis, the estimates show how the notion of resource curse can be applied only in the case of dependence on metal and ore exports.

Tab. 8. Natural resources and growth: alternative measure for institutions

	(1)	(3)	(4)	(5)	(6)
const	0.12**	0.11**	0.11**	0.094**	0.10**
	(6.0)	(5.4)	(5.3)	(4.5)	(5.5)
GDPpc 1980	-0.0032**	-0.0039**	-0.0040**	-0.0021	-0.0029**
	(-2.5)	(-2.3)	(-2.2)	(-1.4)	(-2.3)
PoliticalR1980	-0.0029**	-0.0027**	-0.0028**	-0.0030**	-0.0032**
	(-3.3)	(-3.1)	(-3.1)	(-3.5)	(-3.9)
PriceInv	-0.012**	-0.011**	-0.011**	-0.0096**	-0.010**
	(-3.8)	(-3.3)	(-3.4)	(-3.5)	(-3.7)
EthnicFractio	-0.025**	-0.027**	-0.029**	-0.023**	-0.025**
	(-3.1)	(-3.4)	(-3.4)	(-2.9)	(-3.3)
Landlock	-0.011**	-0.0089	-0.0094	-0.0053	-0.0070
	(-2.5)	(-1.5)	(-1.6)	(-1.0)	(-1.4)
Metals	-0.00023**				
	(-2.3)				
Subsoil Km		0.00082*			
		(1.7)			
Subsoil pc			0.00075		
			(1.5)		
Oil				-0.012	
				(-1.3)	
Diamonds					0.0031**
					(4.7)
n	111	92	92	121	121
R^2 Adjusted	0.41	0.38	0.38	0.28	0.30
lnL	3.1e+002	2.7e+002	2.7e+002	3.3e+002	3.3e+002

Heteroskedasticity-robust standard errors, variant HC1 - OLS estimates - T-statistics in parentheses; * indicates significance at the 10 percent level; ** indicates significance at the 5 percent level.

Finally, to check the robustness of previous results, we use an alternative measure for institutional values: the index of political rights (Freedom House) for the year 1980. The results of the regressions, reported in Tab. 8, substantially confirm the previous ones, first of all the strong negative relationship between the proxy of resource dependence and the positive correlations for diamonds and stocks measures of resources. In synthesis, the results of the empirical analysis suggest the existence of a strong negative correlation between metal and ore dependence and economic growth, while there is no evidence of negative correlation, robust and systematic for the other measures of resources used in the regressions.

4. Conclusive remarks

This paper has examined the effects of different types and measures of natural and economic growth in a cross-section of countries. Firstly, dependence on primary commodities export has been measured by the share of metals and ores on total merchandise exports. As expected, and consistent with the literature on the curse, this measure results as negatively and strongly related to average rates of growth. Secondly, two proxy of resource abundance, namely oil and diamond production, have been considered. In this case, the curse hypothesises is not apt: results show, in fact, that while diamond production is positively linked to income growth, oil is substantially insignificant when other variables are included into the regressions. Finally, the abundance of resources, in terms of stocks, has been proxied by the value of subsoil assets per square km. and per capita. In this case too resources result as positively but weakly linked to economic growth.

These findings add further evidence to the literature that critically re-examined the resource curse hypothesis (Brunnschweiler and Bulte 2008a, 2008b; Kropf 2010), showing that this hypothesis holds for mineral dependence but not for others measures of resource wealth. The conceptual distinction between dependence and abundance should be kept in mind in empirical analysis: resource dependence reflects, in fact, low GDP levels, not necessarily a wealth of resources. Since poorer countries have, on average, weaker institutional systems and policies unable to develop non-primary sectors, they tend to remain heavily dependent on primary commodities. The real question is whether the resource curse is the cause and not, instead, a symptom of institutional and policy failures.

From this point of view, resource dependence appears not so dissimilar to other forms of economic dependence on windfall revenues, for example that on foreign aid. Such a parallel can be extremely useful in order to comprehend this particular dependence: studies indicate, in fact, that countries with high aid receipts on GDP are more likely to be subject to a deterioration of economic and political institutions and, consequently, lower growth (Knack 2000; Djankov et al. 2008). These studies indicate, furthermore, that the “aid curse” damages the economy, operating through the same channels as the resource curse (Harford and Klein 2005). These analogies reinforce the idea according to which a sound institutional system is a fundamental pre-requisite to be able to use economic resources productively. In conclusion, the evidence suggests that a wealth of valuable natural resources can be a blessing for economic growth. The blessing can, however, reverse into a curse, the result depending on the institutional and social capability to manage resources revenues.

Tab. 9. Data and sources

Variables	Description	Source
Growth 1980-2006	Average yearly rates of growth of GDP per capita between 1980 and 2006 at 2000 - constant 2000 US $	World Bank, WDI, 2008
GDP pc1980	GDP per capita in the year 1980 – constant 2000 US $	World Bank, WDI, 2008
Prinv	Price levels of investment as an average for the period 1970-80	PWT 6.2.
EthnicFractio	Index of Ethno-linguistic fractionalization, given by the probability that two randomly selected people in a country will not belong to the same ethnic group.	Alesina et. Al. (2003)
School	School enrolment – primary (% gross)	World Bank, WDI, 2008
Metals	Share of mineral and ore exports on total merchandise exports – 1980-1990 averages	World Bank, WDI, 2008
Oil	Oil production per capita (millions of barrels per day per capita)	Humphreys (2005)
Diamonds	Production of Diamonds (billions of metric carats per year per capita)	Humphreys (2005)
Subsoil pc	Subsoil assets per capita	World Bank (2006)
Subsoil pc	Subsoil assets per square kilometre	Calculations from World Bank data (2006)
IQ	Institutional quality index calculated as an average of the governance indicators (included in the Kaufmann, Kraay e Mastruzzi (2008) dataset) normalised by values between 0 and 1. Data are averages for 1996 and 1998.	Calculations from World Bank data, Aggregate Governance Indicators, 1996-2007.
PoliticalR 1980	Index of political rights year 1980	Freedom House
Landlock	Dummy for landlocked countries.	
LAC	Dummy for Latin America and Caribbean	
Africa	Dummy for Africa	
Asia	Dummy for Africa	
EngFrac	Fraction of population speaking English	Hall and Jones (1999)
EurFrac	Fraction of population speaking one of the four main European Languages	Hall and Jones (1999)

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