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Natural Capital and the Resource Curse

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An abundance of natural resources is intuitively expected to be a blessing. Nonetheless, it has been argued for some decades that large endowments of natural resources–oil, gas, and minerals in particular–may actually become more of a curse, often leading to slow economic growth and redistributive struggles (including armed conflict). Over the years, vast empirical literature has addressed this "paradox." The literature has had to rely on proxies for natural resource abundance because of the lack of appropriate data, generating doubt on whether results would be similar if direct measures of natural wealth were available. This gap is now starting to be filled with the data series released by the World Bank (1997, 2006, 2011) on natural capital and other forms of countries' wealth. This note presents an analysis of these data to revisit some of the conclusions reached in the literature on the relationship between natural resource abundance and economic growth. The findings are in alignment with the view that there is no clear deterministic evidence of natural resource abundance as a curse or a blessing; therefore, the effect on a country depends on other determinants.

Natural Capital and Income Levels

How to measure development progress? "While precise definitions may vary, development is, at heart, a process of building wealth—the produced, natural, human, and institutional capital which is the source of income and wellbeing" (Andersen and Canuto 2011, xi). However one defines development, it supposes rising income levels and an underlying process of building and managing a portfolio of assets. At least in an accounting sense, such wealth accumulation spans the wide range of capital types mentioned above.

The World Bank (1997, 2006, 2011) has started a breakthrough in national accounts toward capturing the span of assets. A set of wealth accounts covering a 10-year period, 1995 to 2005, for more than 120 countries is now available. This includes produced capital (machinery, structures, and equipment); natural capital (agricultural land, protected areas, forests, minerals, and energy); and intangible capital. The latter is clearly a wealth component requiring much further work. Intangible capital is still measured as a residual, the difference between estimates of total wealth and the sum of natural and produced capitals:[1] "It implicitly includes measures of human, social, and institutional capital, which includes factors such as the rule of law and governance that contribute to an efficient economy" (World Bank 2011, 4–5).[2]

Table 1 reproduces the aggregate figures of wealth and per capita wealth by type of capital and income group in 1995 and 2005 (World Bank 2011, 7). From an accountant's perspective, there are some striking features regarding an archetype of progress up the income-wealth ladder. First, the share of produced capital in wealth moves upward from low levels in low-income countries, but remains reasonably modest thereon. Figures for lower-middle-income countries are heavily influenced by the weight of China and by its extraordinarily fast pace of produced

capital accumulation, with the ex-China subgroup displaying numbers closer to a smoother evolution. It appears that cumulative savings used for investments in physical assets accompany and support the rise in income levels, but typically at a proportionate speed.

Secondly, intangible wealth is the largest single component of total wealth at all levels of income, but increasingly so as it moves to the upper-middle- and high-income levels. Increased educational attainments, as well as improvements in institutions, governance, and other intangible forms of wealth are imperative if a country is to overcome "middle-income traps" (Canuto 2011). The nexus with savings and investments is not as straightforward as in the case of produced capital, because the dynamics of intangible wealth accumulation—or depletion—depend to a large extent on factors of another nature (quality of education; institutional evolution; collective knowledge tacitly embedded in routines of firms, the public sector, organizations, and other social groups; and non-research- and development-derived technical progress).[3]

It follows that natural assets comprise a substantial portion of total wealth at low-income levels, decreasing in relevance—particularly compared to intangible wealth—if the economy succeeds in moving up the income ladder. However, no matter how large or small that natural capital is, it combines with unskilled labor and existing intangible wealth to generate income, and the subsequent corresponding savings and investments create new produced capital and intangible wealth.

As one might expect, levels and compositions of natural capital vary widely between countries (World Bank 2011, appendix C). In all cases, however, if the use of nonrenewable natural capital—extractive resources such as oil, gas, and minerals—does not lead to the accumulation of other forms of productive wealth, but instead is used to support consumption, there will be no income-generating assets to replace it when it is exhausted. As for the renewable part of natural capital, such as forest land, inappropriate management regimes and property rights may also lead to wealth depletion.[4]

Natural capital also varies over time for reasons other than its use. The fact that it diminishes in relative terms as a wealth component when the economy moves up the income ladder does not preclude it to rise in absolute terms as a result of technological changes or new discoveries. As Collier (2009, 2) has highlighted, this partially explains why paradoxically:

> As of 2000, the typical square kilometer of the OECD had $125,000 of known subsoil assets waiting to be exploited. In contrast, the average kilometer of Africa had only $25,000 of known subsoil assets. Most likely, this reflects a massive failure in the discovery process in Africa: the scope for resource extraction may be five times what it currently appears to be.

Collier remarks that the discovery process depends upon "good governance," a missing component of intangible wealth in many low-income countries.

Values of natural capital may also change as a result of heterogeneity among natural resources. The value of existing assets may rise if increases of global production have to be based on less efficient sources at the margin. Such "rents" tend to be reflected in the value of natural capital in countries well endowed with high-quality resources.

One may then guess that abundance of natural capital—as measured by per capita natural wealth—is in principle favorable to raising per capita income levels. Furthermore, the average archetype of wealth-cum-income progression depicted in table 1 may take place with different shares of natural wealth in different countries. This is illustrated by the different wealth compositions as of 2005 among high-income countries (the United States, Japan, Norway, Canada, and Australia), as well as among middle- and low-income countries (table 2).

Differences in the quality of natural resources may also explain why countries with different levels of technological achievement can have similar income levels. The World Bank (2007) developed country indexes of technological achievements and showed their (nonlinear) relationship with income

Table 1. Wealth and Per Capita Wealth by Type of Capital and Income Group, 1995 and 2005

Income group	Total wealth (US$ billions)	Per capita wealth (US$)	Intangible capital (%)	Produced capital (%)	Natural capital (%)
	1995				
Low income	2,447	5,290	48	12	41
Lower-middle income	33,950	11,330	45	21	34
Upper-middle income	36,794	73,540	68	17	15
High-income OECD	421,641	478,445	80	18	2
World	504,548	103,311	76	18	6
	2005				
Low income	3,597	6,138	57	13	30
Lower-middle-income	58,023	16,903	51	24	25
Upper-middle income	47,183	81,354	69	16	15
High-income OECD	551,964	588,315	81	17	2
World	673,593	120,475	77	18	5

Source: World Bank 2011, 7.
Note: Figures are based on the set of countries for which wealth accounts are available from 1995 to 2005. Data in this table do not include high-income oil exporters. OECD = Organisation for Economic Co-operation and Development.

Table 2. Shares of Natural Capital in Total Wealth Per Capita (Selected Countries)

Country	Total wealth per capita (2005 US$)	Natural capital per capita (2005 US$)	Share of natural capital (%)
Norway	861,797	110,162	12.8
United States	734,195	13,822	1.9
Japan	548,751	2,094	0.4
Canada	538,697	36,924	6.9
Australia	518,805	39,979	7.7
Brazil	79,142	14,978	18.9
Argentina	71,252	10,267	14.4
Malaysia	64,767	12,750	19.7
Botswana	58,895	5,420	9.20
Jordan	51,454	2,690	5.2
Nigeria	10,982	6,042	55.0
India	10,539	2,704	25.7
Malawi	3,471	1,170	33.7

Source: Authors' calculation, from World Bank (2011, appendix C).

levels. On the other hand, many countries in Latin America and the Caribbean managed to reach middle-income levels with much less technological effort than others (figure 1). Produced capital does not seem to explain such a discrepancy and, apart from non-technology-related intangible wealth, the high quality of known natural resources in the region—large swaths of arable land and mapped sources of oil and minerals—may well be among the explaining factors.

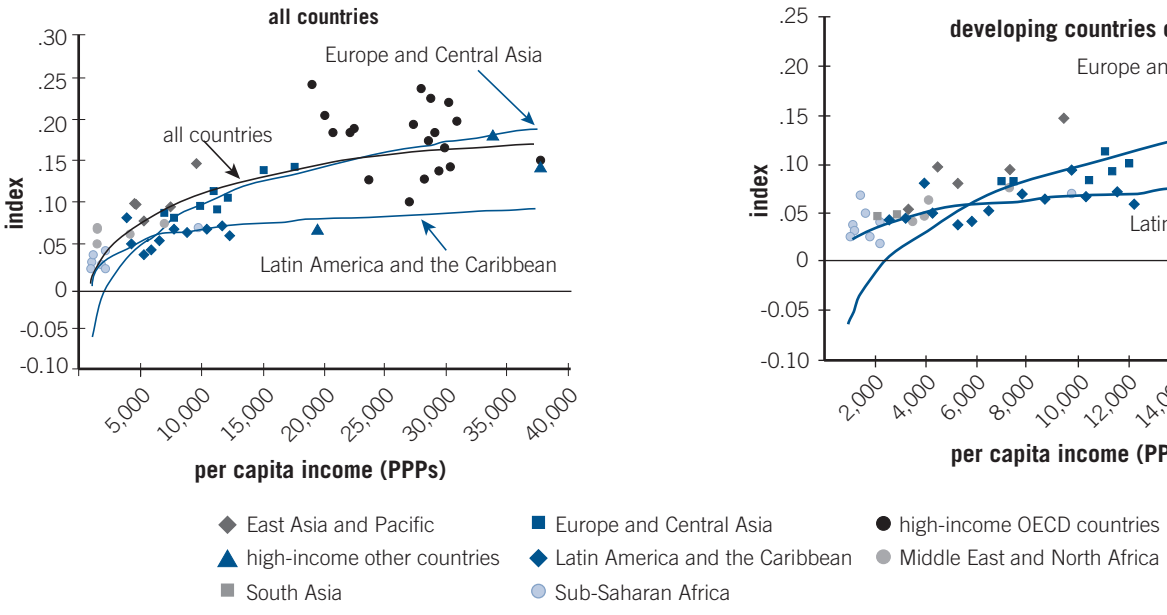
So, where can one locate a possible "natural resource curse"? Since country rankings by per capita income display several natural resource–rich countries at the top, there appears to be no inevitable impediment to income growth associated with abundance of natural resources. As one can see in figure 2, there is no clear pattern regarding gross domestic product (GDP) per capita and shares of natural capital. One can find 14 countries with GDP per capita higher than US$35,000 and natural wealth ratios ranging from almost zero up to 79 percent.

However, there is now enormous evidence, both systematic and anecdotal, of cases in which natural resource discoveries or appreciations, instead of being followed by a transformation of natural capital into other forms of productive wealth through some virtuous process of savings and investment, were accompanied by stagnation or even income regression, generally in combination with political disruption.[5]

Brahmbhatt, Canuto, and Vostroknutova (2010) explain how certain conditions could result in situations where natural resource booms become a curse. Weak governance and corresponding poor economic policies underlie the misallocation and mismanagement of resources. Resources shift out of productive activities into unproductive rent-seeking activity when, for example, patronage networks are strengthened with their appropriation of fallen-from-heaven rents. It is not by chance that resource curse cases can be primarily associated with extractive industries (oil, gas, and minerals) because these are "concentrated 'point source' resources that can easily become the object of rent-seeking and redistributive struggles" (ibid, 107), a point originally made by Collier and Goderis (2007).

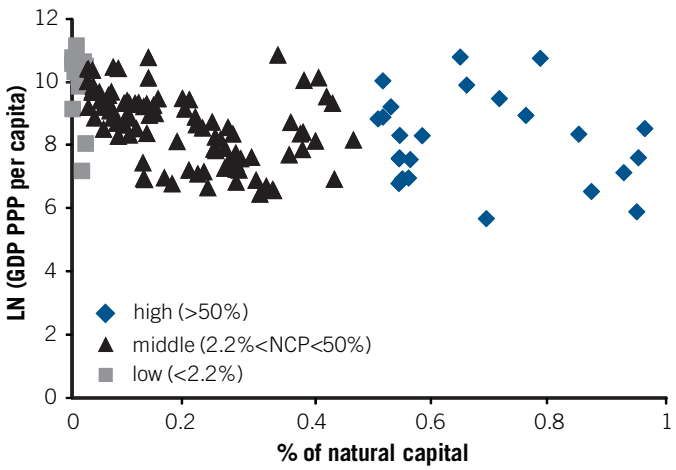
Consumption use of tax revenues derived from natural resource extraction through public spending is also a typical

Figure 1. Technological Achievements Rise with Income Levels



Source: World Bank 2007, 84.

Figure 2. Natural Capital and GDP Per Capita



Source: Authors' calculation, from World Bank (2011).

manifestation of poor governance. In fact, the handling (whether good or bad) of macromanagement challenges that typically accompany natural resource booms in natural resource–rich countries (volatility, risks of overborrowing, and crowding out of intangible wealth-intensive manufacturing) can in most cases be traced back to governance quality.[6] Natural resource curses may thus be associated with governance traits that either precede the boom or emerge with it (the "voracity effect" [Tornell and Lane 1999]).[7]

The next section uses the data on wealth stocks presented by the World Bank (2006, 2011) to empirically revisit whether natural resource abundance is a curse or blessing.

Natural Wealth and the Resource Curse: An Empirical Examination

Due to the lack of more precise data, empirical literature on the natural resource curse is based on a few proxies of natural resource abundance. The ratio of natural resource exports to GDP is the most common proxy—as, for example, in Sachs and Warner (1995, 2001) or Lederman and Maloney (2007). Alternatively, data on production flows in some sectors—notably oil and mineral extraction—are also used, because these data are more frequently available. Patterns of exports or production in some sectors are supposed to reflect an underlying structure of factor—including capital—endowments.

Sachs and Warner (1995, 2001) estimated a negative growth impact of natural resource intensity between 1970 and 1990. They argue this is the case even controlling for the impact of institutions, trade openness, investment rates, rule of law, and terms of trade. Similarly, Gylfason (2001) used wealth data from 1995 to explain growth figures from 1965 to 1998, and proposed some evidence that natural resource–rich countries seemed not to have invested previously in human capital, which tended to slow the pace of economic growth. In this case, however, one should not lose sight of the fact that the impact of a new discovery is forward looking, that is, it may cause benefits or distortions in the economy only after resources are known. In this sense, it is not recommended to match wealth composition in a certain slice of time with past growth data. If subsoil assets are unknown, no management decisions associated with natural resource richness, either good or bad, can be made.

Lederman's and Maloney's (2007) empirical study is another oft-quoted source for links between natural resources and economic growth. Most of their report is dedicated to showing the difficulties in making any safe statement about the negative impact of natural capital abundance. The study presents statistical, historical, and theoretical arguments in favor of the idea that natural resources are neither curse nor destiny as far as income convergence among countries is concerned.

This note uses *Changing Wealth of Nations* (World Bank 2011) data to estimate in a panel whether absolute levels of natural capital and/or their shares in total wealth, as a direct measure of natural resource abundance, could have a negative impact on future income. The regression estimations were based on the countries for which there are data available for both the GDP in 1970 and the wealth estimations. This group is very similar to one considered in Sachs and Warner (1995). On the other hand, the estimations had to limit the study to the period for which those wealth stock figures are available: 1995, 2000, and 2005. The analysis considered five-year averages of GDP per capita in each country of the sample for periods subsequent to each corresponding point-in-time data on wealth stocks.

As a first task, the analysis checked whether the ratio of natural resource exports to GDP, the most-used proxy for abundance in past literature, is a good predictor of the latter.[8] For that, the analysis estimated a regression for the panel data to explain this ratio by natural capital shares in total wealth, using cross-section fixed dummies for each country to exclude countries' particular specificities.[9] This regression showed a very good fit with significant coefficients. As long as a forward-looking perspective is kept, that proxy seems to be satisfactory, which may be highly convenient given its longer-term availability, at least until more exercises such as in the *Changing Wealth of Nations* (World Bank 2011) are made available.

The next step was to estimate a basic model in a panel data, using an estimated equation where GDP per capita is explained by investment ratio, logarithmic of numbers of years of schooling,[10] logarithmic of GDP per capita in 1970 (as a control variable), logarithmic of natural resource per capita, and natural capital participation. Alexeev and Conrad (2009) used a similar approach to estimate the impact of oil and other mineral resources per capita on GDP per capita, but they used exogenous geographical factors as control variables to find a positive impact of the natural resource richness. Because the literature emphasizes a special case for rent seeking in the oil, natural gas,

coal and mining sectors (that is, subsoil assets), this analysis replicates the estimations for three similar cases: (i) the total natural capital per capita and its share of total wealth, (ii) only the subsoil per capita and its abundance, and finally, (iii) similar measures isolating agriculture assets per capita (for example, crop, land, and timber) from subsoil assets per capita, but also considering their share in total wealth.

Coefficients were significant to all independent variables except for the natural capital share in all the cases! As presented in table 3, the higher the levels of education, gross investment ratios, and natural capital per capita, the higher the GDP per capita. Regardless of whether natural resources are dominant or not, it just seems that in most cases new capital translates into more income. The model accounted for around 85 percent of the GDP per capita differential. In fact, as shown in figure 2, there is no regular pattern between relative abundance of natural wealth and income levels, and thus no kind of natural resource curse can be depicted.

Intuitively, as confirmed by these results, the potential blessing associated with natural resource discoveries exists because they expand the country's stock of total capital. In this sense, nations can take advantage of the additional source of richness from the period of exploration until the complete depletion, lifting the GDP per capita. Clearly, the real challenge is to invest those rents in other productive assets, thereby generating other kinds of abundance for future generations and sustaining income per capita at corresponding higher levels. To meet this challenge, responsible governments need to deal with intertemporal decisions, such as those embedded in fiscal and saving rules, coping with the volatility of this income stream while transitioning between the ex ante scarcity and the ex post abundance (Collier 2010).

Table 3. Regression Results (1995–2005)

Dependent variable: Ln GDP	(1)	(2)	(3)
GCF/GDP	0.072*	0.071*	0.036*
Ln GDP (1970)	0.797*	0.728*	0.485*
Ln YSC	0.436*	0.846*	0.858*
LNC—agriculture			0.311*
LNC—subsoil		0.039*	0.036*
LNC—total	0.053**		
NCS—share		0.010	
NCT—share	0.167		-0.150
Cross-sections	58	51	51
Total pool observations:	173	150	150
R-squared	0.84	0.81	0.89

Source: Authors' calculations.
Note: Method—pooled least squares. Variables are defined as: gross capital formation (GCF)/GDP, natural logarithmic of GDP per capita (Ln GDP), natural logarithmic of years of schooling (Ln YSC), natural logarithmic of natural capital per capita (LNC) considering the agriculture, the subsoil and the total, subsoil capital as share of the total wealth (NCS) and the same measure considering all natural capital (NCT). Estimations were calculated using ordinary least squares, as well as the generalized least squares, allowing for contemporaneous covariances and for serial correlation. In the first variant, case (1) and case (2) showed results very similar to the basic estimation exhibited in table 3, but in case (3), all the coefficients are significant. This was the only particular subcase of significant negative impact of natural capital share in GDP per capital among all nine subcases. When considering the serial correlation, the coefficients are very similar in cases (1), (2) and (3), but in case (1), the *p*-value for the coefficient of the LNC total was 11.5 percent.
* Significant at 1 percent. ** Significant at 2 percent.

Concluding Remarks

Using the data on the natural wealth of countries recently made available by the World Bank, this analysis could not find significant deterministic evidence of a direct negative relationship between the abundance of natural resources and income per capita levels, or the so-called "natural resource curse." The results here align with others who have stressed that intangible wealth in the form of governance quality is a key determinant to the outcome of natural resource abundance as a blessing or a curse.

Three types of policies have been emphasized in the literature as the safest way to make sure the bang from the natural resource buck is maximized, especially in the case of low-income countries for which the use of natural resources may be crucial for a leap upward in the income per capita ladder (Collier 2010; Brahmbhatt, Canuto, and Vostroknutova 2010). Ensuring high transparency and strengthened checks and balances for all phases of natural resource extraction and use (terms of contracts, monitoring of operations, collection and use of taxes) are critical for a favorable outcome, as well as to minimize risks of rent capture by patronage networks and avoid premiums on rent-seeking behavior. By the same token, adopting fiscal rules to ring-fence investments from proceeds of overtime depletion of natural resources and to mitigate the effects of the usual volatility associated with natural resource prices can reinforce the virtuous dynamics of wealth accumulation toward the upper scales of the income ladder. Reforms to improve public sector capacities in terms of public investment management, monitoring and evaluation, budget processes, and so forth will also help transform natural wealth into produced capital and intangible wealth.

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Notes

1. Total wealth is estimated as the present value of sustainable consumption along a 25-year time horizon, assuming the pure rate of time preference and the future rate of per capita con-

sumption growth to be, respectively, 1.5 percent and 2.5 percent per annum (World Bank 2011, 94–95).

2. Net foreign assets are also treated as part of intangible capital in most of the book.

3. See, for example, Canuto (1995) on tacit and idiosyncratic features of knowledge and technologies. The collective nature of knowledge and skills acquisitions is well captured in the concept of capabilities used by Hausmann et al. (2011) as something that cannot be reduced to single "factors of production."

4. The World Bank (2011, appendix D) provides estimates of national savings adjusted to be net of energy depletion, mineral depletion, forest depletion, and others. See also Hamilton and Ley (2010).

5. See Frankel (2010) for a recent survey.

6. Macroeconomic challenges associated with natural resource booms in natural resource–rich countries are also present at higher income and better governance levels, as in the "Dutch disease" case of the Netherlands (Brahmbhatt, Canuto, and Vostroknutova 2010).

7. There is also the classical argument about a secular trend of deterioration of terms of trade for natural resource sectors in comparison to all others. However, as Brahmbhatt, Canuto, and Vostroknutova (2010, 105) have argued: "On the basis of statistical properties alone, we have little reason to expect commodity prices to trend either up or down in the long term."

8. Data were obtained from the World Bank's World Development Indicators database. The analysis team followed a suggestion first made by Edmar Bacha.

9. The panel data regression was estimated using ordinary least squares and generalized least squares (allowing for serial correlation and contemporaneous covariances); all the coefficients are similar and significant at 1 percent, and average R-squared is close to 92 percent.

10. The database for years of schooling comes from Barro and Lee (2000) for 1995 and 2000, and it was assumed to stay constant after that.

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