Natural Resource Curse

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The natural resource curse originally estimated using cross-sectional data from the 1970s and 1980s has disappeared when applying the same econometric model to the same sample of countries but using more recent data. In fact, the most recent data find that natural resources improve economic growth. Explaining the reasons for this gradual reversal of the role natural resources play in economic growth (from curse to asset) is largely understudied in the economics literature. Perhaps the natural resource sector within countries has been decreasing relative to the size of a country's overall economy. Or perhaps global prices of natural resources have increased over the past several decades. Third, perhaps the increasing capital-to-labor ratio associated with natural resource extraction has allowed workers involved in resource extraction to gain transferable skills.

natural resources economic growth economic development

1. Introduction

The role that natural resources play in economic growth has been debated in the economics literature for decades. One argument suggests that economies that specialize in natural resource extraction and export experience comparatively low rates of economic growth. Several reasons are provided to support what has been frequently called a curse associated with natural resource production and export. First, natural resource extraction processes consume economic resources that could otherwise be allocated to industries thought to better promote long-term economic growth, such as manufacturing or professional services [1]. Second, natural resource prices vary over time, which can destabilize exporting economies [2]. Third, the concentrated locations of many natural resource supplies facilitate rent capture by governments interested more in retaining political power than facilitating economic growth [3].

A second argument, often relying on basic neoclassical economic theory, suggests that natural resources increase economic growth. In the short run, the revenue earned from the domestic or international sale of natural resources contributes directly to gross domestic product (GDP). Over time, the rents gained from natural resource production can be invested in human or physical capital and thus help promote long-term economic growth. In the very long run, if the rents from natural resources enrich a broad group of diverse resource owners rather than a single regime, then this diverse group can exert pressure on governments to adopt institutions favorable to economic growth such as democracy, respect for and protection of private property, and the establishment of an impartial system of justice [4].

Perhaps because both of these arguments can be persuasive, the debate over whether natural resource production helps or hinders economic growth turned to the empirical data. The anecdotal evidence by itself is unconvincing. Comparing resource-rich growth losers such as Nigeria, Zambia, Sierra Leone, Angola, and Venezuela with resource-poor growth winners such as Japan, Korea, Taiwan, Hong Kong, and Singapore seems to support the notion of a natural resource curse. But resource-rich growth winners such as the United States, Canada, and Australia can also be compared to dozens of resource-poor growth losers across Africa and Asia to draw a different conclusion. Resource-rich Norway was one of Europe's poorest countries in 1900 but is now one of its richest and may have relied on its natural resources to facilitate this transition. However, resource-rich Nigeria's economy has been hampered by its reliance on oil exports. Thus, anecdotal referencing brings us no closer to understanding the core relationship between natural resources and economic prosperity.

Reliable gross domestic product (GDP) data for a large cross-section of countries became available starting in about 1970. In a series of papers, Sachs and Warner [5][6][7] make use of this data to estimate the empirical relationship between natural resource exports and subsequent economic growth. The results suggest a negative relationship—natural resource exports dampen economic growth. Or, as S&W suggest, "one of the surprising features of modern economic growth is that economies abundant in natural resources have tended to grow slower than economies without substantial natural resources". S&W estimate that, controlling for other variables, a one standard deviation change in the ratio of primary exports to GDP leads to a 1% annual decrease in the subsequent averaged 20-year GDP growth rate. Instead of growing at, say, 3% over the subsequent 20-year period, an identical country with those natural resource exports will grow at a rate of only 2%. These seminal papers were collectively cited over 6000 times by 2012 [8].

2. Resource Curse

The first paper to make use of a cross-section sample of countries to estimate the effect of natural resources on economic growth was Sachs and Warner [5][6][7]. The data were used to estimate the following model, which deserves some attention.

$$ln\left[\frac{GDP_{it+20}}{GDP_{it}}\right] = \alpha + \beta_1\left[\frac{Resource\ Exports_{it}}{GDP_{it}}\right] + \beta_2 ln[GDP_{it}] + \beta_K \overline{X}_{ikt} + \mu_{it} \quad (1)$$

GDP_{it} denotes country *i*'s gross domestic product in period t. Thus, the dependent variable is the natural log of country *i*'s ratio of GDP in year *t* + 20 to its GDP in year *t*. This ratio represents the total growth rate between year *t* and *t* + 20. The important independent variable in the model is the ratio of country *i*'s exports of primary resources to its GDP in year *t* and only in year *t*. This specification is essentially allowing for 20 separate lagged effects on GDP from a single year's natural resource exports. The coefficient $\beta 1$ represents the total of these 20 lagged effects. A negative $\beta 1$ implies that the export of these natural resources reduces 20-year GDP growth.

Control variables include each country's capital investment expenditures (as a portion of GDP), each country's reliance on international trade (imports plus exports as a portion of GDP), and an index of each country's institutional quality. Instead of a single value from year *t*, each of these three variables is defined as the 20-year average commencing in period *t*, $\overline{X}_{ikt} = \frac{\sum_{t}^{t+20} X_{ik}}{20}$, for *k* = 3, 4, and 5. The model's final control variable is the level of GDP in year *t*, a control variable included in many long-run growth models. Including the initial level of GDP controls for the possibility that low-GDP countries may grow at different rates than high-GDP countries. The expected sign on $\beta 2$ is negative, suggesting that low-GDP countries grow faster than high-GDP countries—growth rates converge over time. Controlling for initial GDP also holds constant the denominator of other control variables and especially the natural resource exports. Holding GDP constant is important. Otherwise, if high-GDP countries consume rather than export their own natural resources, then the estimate of $\beta 1$ would be biased.

To summarize, the model is designed to estimate the difference in 20-year GDP growth rates among countries with the same initial GDP, the same 20-year average of physical capital investment, the same 20-year average level of trade openness, and the same 20-year average of institutional quality but with different initial ratios of natural resource exports to GDP. Sachs and Warner estimate that, controlling for these variables, a one standard deviation change in the ratio of primary exports to GDP leads to a 1% annual decrease in the averaged 20-year GDP growth rate. Instead of growing at, say, a rate of 3% over a 20-year period, an identical country with those extra natural resources will grow at a rate of only 2%.

This econometric specification raised several questions in the subsequent literature. Some papers argued that the level of some future value of GDP should replace the average growth rate as the dependent variable [9]. Others questioned how to best measure natural resource dependency. Natural resource exports have been replaced by natural resource abundance [10] and the stock of natural resources [11][12][13][14]. Papers have also questioned dividing any measure of natural resources by GDP when GDP is the dependent variable in the model. Dividing instead by the population is used as a substitute [15]. The literature has also questioned the assumption that institutional quality and GDP are exogenous and used various methods to control for possible endogeneity. Finally, the papers vary with respect to the scope of the data set. Whereas many use data from all nations, others use data from just Africa [16], just the Middle East [17], or just China [18]. A number of papers focus on the role of natural resources on economic outcomes in just developing countries, including [19][20][21][22][23].

One group of papers uses the S&W data to better understand the reason for the curse, a question left unanswered by S&W. Ref. [24] replaces S&W's "Rule of Law" with a corruption index and then disaggregates the natural resource variable into four categories and finds that only food exports generate a resource curse. Commodity price variation is found to reduce GDP but only for Africa. Ref. [11] redefines resources as share of natural capital in national wealth and adds several human capital variables. Ref. [11] finds that a 10% increase in natural capital share reduces GDP growth by 1%—partly due to its effect on how resources affect the availability of public education. The model does not control for institutional quality. Ref. [25] uses the S&W data and redefine resources as a share of natural capital in national wealth (World Bank) to find that the curse disappears for all resources except land area.

Another set of papers focuses on the role of political and economic institutions in determining economic growth. Institutions that promote shared governance and respect for individual property rights and equality under the law are considered important to long-run growth. The political science literature [26] suggests that natural resources may compromise political institutions through rent seeking. Ref. [4] suggests that institutions are the only significant predictor of growth. Other variables, including natural resources, are insignificant once institutions, which may be endogenous, are controlled for. Ref. [27] also finds that only institutions, and not natural resources, matter to economic growth. Ref. [12] redefines resources as the share of resource rents in GDP. The natural resource curse exists only if resource rents are consumed by governments rather than invested. Ref. [28] considers forms of human welfare other than GDP and finds that the resource curse operates via its negative impact on institutional quality. Once institutional quality and initial GDP are controlled for, the natural curse disappears. Ref. [14] finds that natural resources increase GDP unless the population of the country is ethnically fractionalized.

A number of papers in the literature redefine natural resources as a stock variable rather than a flow variable. Ref. [13] utilizes S&W data but replaces the export share of GDP with the share of natural capital in national wealth and add human capital. Resource exports become insignificant and natural capital is estimated to be positive and significant. Ref. [15] also redefines resources as the share of natural capital in national wealth to find that small non-resource sectors of the economy are responsible for slow growth. Once the size of the non-resource sector is controlled for, the natural resource curse dissipates. Ref. [15] also finds that replacing exports per USD of GDP with exports per person causes the coefficient on natural resources to become insignificant (both for exports and for natural capital endowment). Ref. [10] distinguishes natural resource abundance (stock) and natural resource dependence (export flow). Both are considered endogenous to the model. Resource dependence is found to be insignificant and resource abundance is estimated to be positive and significant. Ref. [29] responds directly to [10] and finds that natural resources have no impact (positive or negative) on GDP. Ref. [30] estimates that stocks of natural resources reduce institutional quality but not economic growth. Export flows do not affect institutions (when controlling for stocks) but do impact growth. Ref. [9] develops instruments for 1970 GDP to find that oil and minerals enhance economic growth and are neutral towards institutional quality. Ref. [31] utilizes a heterogeneous panel data approach and find that oil production and oil rents improve GDP, whereas oil reserves are neutral. A simple OLS model with cross-section data estimates a resource curse when not controlling for institutional quality. Ref. [32] redefines resources as the share of natural capital in national wealth (using World Bank data) and use instruments for institutional quality and openness to estimate that both resource stocks and resource exports reduce GDP growth. Finally, [33] estimates that major resource discoveries increase GDP by 40% in the long run. This increase is greater for non-OECD countries than for OECD countries. To summarize, only [32] finds evidence of a natural resource curse for broad categories of natural resources. Ref. [34] distinguishes between GDP growth and GDP levels. Using panel data from just the United States, natural resource abundance is estimated to decrease growth rates but increase income levels.

3. The Data and Model

Any single econometric model can be applied to data panels over time to isolate the passage of time on the estimated coefficient on natural resource exports. The original S&W model is chosen for this task for a few reasons. First, the S&W model is widely cited, making it widely known to researchers in the field. Second, the data demands of the S&W model are modest, which allows for the estimation to take place in the early years, when data were less available. The S&W model is once again given here, with all variables defined above.

$$ln\left[\frac{GDP_{it+20}}{GDP_{it}}\right] = \alpha + \beta_1\left[\frac{Resource\ Exports_{it}}{GDP_{it}}\right] + \beta_2 ln[GDP_{it}] + \beta_K \overline{X}_{ikt} + \mu_{it} \quad (2)$$

Regarding the original S&W sample, there were 182 sovereign countries in 1970. The S&W data set initially includes 95 of these countries, but that number falls to 59 countries when all variables are included in the model. One question never posed by the literature devoted to advancing the S&W results is whether or not these 59 countries represented a random sample of all 182 countries in 1970. Countries not included in the original sample of 59 countries include Bahrain, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates—countries that are known to export large quantities of natural resources. Many African countries are also excluded. One concern is that although all wealthy countries may have had the administrative resources necessary to collect and provide data on primary exports in 1970, resource-rich income-poor countries may have been more likely than resource-poor income-poor countries to report resource export quantities to data agencies. Resource-poor income-poor countries may therefore be systematically underrepresented in the sample.

One way to expand the sample is to rely on a different data source. S&W obtain primary export data from the World Bank, which gathers data from exporting countries. A second data source reporting exports of primary natural resources is available from the Center for International Data (CID) and housed by the economics department at the University of California, Davis. This data set includes the same SITC categories as those in the World Bank data. However, instead of relying on countries to report their exports, the CID relies on data submitted by importing countries, who report the origination of each import. Thus, total exports from a non-reporting country are identified by the culmination of all countries that import from that country. The number of countries in the 1970 sample increases from 59 to 87 using the CID data. Iran, Iraq, the United Arab Emirates, and several African countries are included.

The model is estimated with both the original 1970 S&W sample and the larger 1970 sample based on the CID data. All variables are defined in **Table 1**, and summary statistics are provided in **Table 2** (for the 1970 sample). Data on GDP, population, capital investments, and total exports and imports are obtained from the United Nations Comtrade Database. Adding total exports to total imports and then dividing by GDP provides a measure of trade openness. Institutional quality is obtained from the Heritage Foundation Freedom index. This index is based on factors such as the protection of private property, freedom from corruption, and equality before the law. Each country's institutions are indexed each year, but unfortunately the number of countries indexed in 1970 is just 98 (see **Table 2**).

Table 1. Definitions of variables.

Variable Name	Definition
GDP_{it}	Output-side real GDP at chained PPPs (in mil. 2011USD) for country *i* in year *t* (United Nations)
lgrowth_i	Ln (GDP_{it+20}/GDP_{it}) for country *i*
UNsxp_{it}	United Nations measure of primary resource exports (SITC Codes 1, 2, 3, 4, and 68) divided by GDP for *country i* in year t
CIDsxp_{it}	Center for International Data measure of primary resource exports (SITC Codes 1, 2, 3, 4, and 68) divided by GDP for country *i* in year *t*
CapInvest_i	Share of gross capital formation at current PPPs or country *i* averaged over years *t* to *t* + 20 (United Nations)
Open_i	Share of merchandise exports + imports at current PPPs four country *i* averaged over years *t* to *t* + 20 (united Nations)
IQ_i	Heritage Foundation overall institutional quality score, comprised of property rights, freedom from corruption, fiscal freedom, government spending, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom, and financial freedom for country *i* averaged over year *t* to year *t* + 20

Table 2. Summary Statistics (1970).

Variable Name	Observations	Mean	Standard Dev.	Min	Max
GDP_{it}	156	114,297	436,613	16.76	4,912,720
(annual) growth_{it}	153	4.18%	1.89%	−5.09%	14.24%
UNsxp_{it}	98	0.08	0.09	0.00	0.54
CIDsxp_{it}	132	0.09	0.14	0.00	1.04
CapInvest_{it}	157	0.22	0.12	0.02	0.68
Open_{it}	157	0.48	0.44	0.01	3.00
IQ_{it}	98	58.50	11.19	27.4	88.6

4. Updating Results through Time

Twenty-year data sets are available to estimate the model for initial periods beginning in 1970 (using data through to 1989) to 1994 (with data extending to 2013). Estimated coefficients for the model with initial data in 1994, are reported in Table 3. Seven countries included in the original 1970 S&W data set did not report export data in 1994,

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and thus the sample size is reduced to 52. The results suggest that for the 1994, the estimated coefficient on natural resource exports for these 52 countries is no longer negative and no longer significant. Using S&W's small sample, the resource curse disappears over time. Column 2 of **Table 2** portrays the results when all 104 countries that reported export data to the UN in 1994 are included. For this sample, the estimated coefficient on natural resources is positive and significant. Exporting natural resources is estimated to improve growth rates when holding other variables constant. Finally, the UNsxp variable is replaced by the CIDsxp variable in column 3, allowing the sample size to increase to 153 countries. The coefficient on natural resource exports with the full sample of 153 countries is once again positive and significant. A one-standard deviation increase (the standard deviation of this variable in 1994 is 0.109) in the ratio of natural resource exports to GDP increases annual GDP by 1.20% when compared to a similar economy without natural resources. These results affirm the notion that sample size is crucial to the estimates.

Table 3. The resource curse in 1994 (dependent variable is lgrowth).

	Sample		
	(1)	**(2)**	**(3)**
Variable	1970 S&W Data Set	All Available Data	All Available Data
UNsxp	1.40	3.18 ***	-
	(0.96)	(0.66)	
CIDsxp	-	-	3.29 ***
			(0.54)
CapInvest	−1.00	0.84	1.85 **
	(1.19)	(0.88)	(0.77)
Open	0.13	−0.21 *	−0.07
	(0.14)	(0.12)	(0.12)
IQ	−0.009	−0.004	−0.019 ***
	(0.008)	(0.006)	(0.005)
pcGDP	−0.032 ***	0.004	−0.05 **
	(0.37)	(0.025)	(0.03)
Constant	1.90 ***	0.78 **	2.02 ***
	(0.52)	(0.38)	(0.32)

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