

## ECONOMICS

# Linking Natural Resources to Slow Growth and More Conflict

C. N. Brunnenschweiler<sup>1</sup>\* and E. H. Bulte<sup>2</sup>

The appreciation for natural resources as a driver of economic development has undergone a dramatic change in the past decades. Although an abundance of resources was generally perceived as advantageous until the 1980s, an influential literature emerged in the 1990s that reached seemingly opposite conclusions. The phrase “natural resource curse” was coined and, perhaps because of its paradoxical connotation, caught on in both academic and policy circles. Two prominent “dimensions” of the resource curse include the association of resources with slow economic growth [a literature inspired by Sachs and Warner (1)] and with armed civil conflict [a literature mainly inspired by Collier and Hoeffler (2)].

The causal mechanisms linking resources to slow growth and more conflict are ill understood. It is often argued that resource-rich economies suffer from weak leadership, rent seeking, and failing institutions (3). This may be either because resource profits (rents) trigger “rentier state” dynamics and the associated disconnect between the rulers and the people, or because resource rents enable autocratic and unaccountable rulers to oppress opposition (4). Resources may also invite conflict if greedy rebels seek profitable looting opportunities. Finally, dependency theories of development predict that the strategic and commercial value of resources may affect politics

and economic outcomes in developing countries, as they are of interest to powerful nations and corporations. The stories associated with the curse are compelling, and

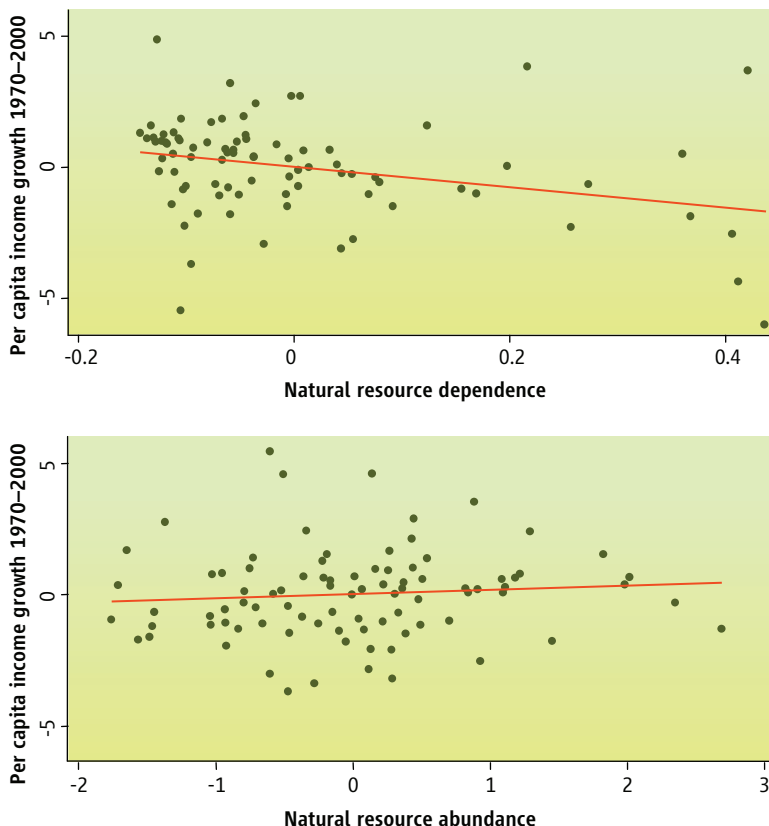
Natural resources do not necessarily spell doom for development.

one suggesting to first distribute resource profits to the people and then to tax them back (6). Increasingly, there are calls to regulate international trade to face certain manifestations of the curse head-on (e.g., the Kimberlite initiative dealing with “blood diamonds”).

But how robust is the evidence for the curse? We believe it is actually weaker than generally perceived. A key problem of most existing analyses is that the common resource variable used in cross-country regression models is endogenously determined, and itself not invariant with respect to changes in institutional quality or conflict (the variables it is supposed to adversely affect). If so, existing empirical results would be biased.

The standard resource variable used by Sachs and Warner, as well as by Collier and Hoeffler, is primary exports divided by a measure of national income. It thus captures the resource dependence of economies, rather than abundance. A negative correlation between this variable and growth could mean that resources lead to slower economic growth, as sug-

gested by the curse proponents. Alternatively, it could mean that poor economic development policies—leading an economy to become dependent on its primary exports—dampen growth. Similarly, although a negative correlation between the resource variable and institutional quality may imply that resources undermine institutions, it might also capture that the resource sector is the “default sector” in the absence of decent institutions when nobody is willing to invest in alternative forms of capital. Finally, a positive correlation between the resource variable and conflict may indeed mean that



**Natural resource dependence, abundance, and economic growth.** Regression fits of natural resources and economic growth 1970–2000. (**Top**) Natural resource dependence in 1970; (**bottom**) World Bank total natural wealth data (log values) measured in USD per capita in 1994.

ample anecdotal evidence exists to lend credibility to the key ideas.

The curse is now an immensely popular research topic and receives serious attention from multilateral agencies and nongovernmental organizations (NGOs) (5). Its increasing status within the development community is reflected by the fact that international organizations are providing advice to resource-rich developing countries on how to manage their resource base (reducing reliance on the primary products sector) and revenue streams to exorcise the curse. Some of the proposals are quite radical, such as the

<sup>1</sup>CER-ETH (Center of Economic Research at the Swiss Federal Institute of Technology), Zurich, Switzerland. <sup>2</sup>Development Economics Group, Wageningen University, Netherlands, and research fellow of the Oxford Center for the Study of Resource-Rich Economies (Oxcarre), Oxford, UK.

\*Author for correspondence. E-mail: cbrunnenschweiler@ethz.ch.

resources trigger conflict. But it may also be the case that conflict makes countries dependent on resource extraction—the default activity that still takes place after other economic sectors (more mobile or, perhaps, better linked to the rest of the economy) have come to a stop. If so, resources are not a curse to development, but rather a safety net to support people and economies even under adverse circumstances. The nature of the causality is, therefore, a concern.

The importance of finding an appropriate proxy for resource endowments, as well as the consequences of this proxy for econometric results, is illustrated by the simple example in the figure on page 616. At the top, a regression fit of the conventional resource variable—primary exports divided by GDP at the start of the period—on economic growth between 1970 and 2000 results in the usual negative “curse” relation. At the bottom, however, a new resource wealth variable is used, and the result is reversed, showing a positive correlation between resource abundance and growth—the curse disappears!

The resource variable used in the bottom figure is one of several made available by the World Bank (7). They capture the discounted value of expected resource rents for a future period of 20 to 25 years, calculated in U.S. dollars (USD) per capita for 1994. Contrary to the standard resource variable (which captures flows), these wealth variables estimate resource stocks—both aggregate and divided by type, such as mineral or cropland assets. They therefore offer more intuitive variables to measure abundance.

In more extensive tests, we used standard econometric techniques to shed light on the causation issue. We used a so-called instrumental variable approach to isolate effects of income and resource dependence on conflict, rather than the reverse effect (8). We do the same to isolate the effect of dependence and institutions on economic growth. We also consider the effect of resource abundance on growth and conflict, using the World Bank resource variables. A summary of representative results, including technical details about the estimation approach, is available on *Science* online (9). Our main results are as follows. If we adopt the conventional methodology—that is, simply assume that resource dependence is an exogenous explanatory variable in growth and conflict regressions—then our data reproduce the conventional curse results. In other words, there appears to be a significant negative relation between resources and growth, and a positive rela-

tion between resources and the probability of conflict. However, inspection of these results suggests that the conventional methodology is flawed and can produce biased results. Specifically, as discussed above, resource dependence is endogenous in the regressions (9).

After addressing the endogeneity problem, the correlation between resource dependence on the one hand, and conflict and slow growth on the other, vanishes. The correlation between resource dependence and slow growth and conflict, therefore, does not imply causation from the former to the latter. Instead, causality appears to be running from weak institutions and conflict to resource extraction as the default sector, which produces resource dependence as the final outcome. Resource dependence appears as a symptom, rather than a cause of underdevelopment. These results are robust to alternative model specifications (9).

However, as already suggested by the simple results at the bottom of the figure, our findings present the possibility of even better news on natural resources. When using the new World Bank variable to proxy for resource abundance, we find that the direct effect of resource wealth (particularly the subset of mineral resource wealth) on income growth is positive and significant. All things considered, an increase in subsoil wealth by one standard deviation—roughly the difference between Senegal and Sweden—would have brought Senegal’s growth performance on a par with that of Mozambique or Kenya; not a huge improvement, but certainly not a growth curse.

Similarly, resource wealth also attenuated the risk of conflict. This is due to a positive indirect effect: Resource wealth raises income, and higher incomes, in turn, reduce the risk of conflict. Again, although the aggregate impact of resource abundance is slight—amounting to less than a 5% reduction in the risk of war in case of a standard-deviation increase in resources—it is still statistically significant. These findings are robust to using alternative measures of resource abundance, such as fuel and nonfuel mineral reserves per capita (9).

Three important caveats are relevant here. First, the number of countries in our regressions is modest (limited by the resource abundance variables). Second, consistent with most of the existing literature, our resource data do not include diamond deposits and trade flows. A focus on highly disaggregated resource measures (diamonds, but also oil) in subsequent work seems worthwhile. Third, although we believe our

resource variables represent improvements over the conventional proxy, they are not perfect. Even though differences in resource stock values are driven by differences in stocks, and not by differences in local institutions (7), they are functions of historic exploration and exploitation. Therefore, they are probably not fully exogenous. The hunt for the perfect resource variable is on, but unlikely to be settled anytime soon.

Nevertheless, our cross-country estimations cast serious doubt on the paradigm of a general resource curse. It appears as if, across the board, resource riches may be associated with higher incomes and a lower risk of civil war. Although there are undoubtedly specific countries where specific resources have eroded institutions or torn countries apart in civil strife, we find this is not the general pattern. This is consistent with several case studies that fail to show a robust link between the onset of war and resource extraction (10), and with evidence that the sector involved in turning natural resources into primary products has many more positive spillovers to the rest of the economy than often are argued (11). Finally, it is consistent with the main message sent by the World Bank in its most recent *World Development Report*, which, after years of intellectual neglect, finally looks favorably at the primary sector.

The last word in the resource curse debate is far from having been spoken; but economic advisors should be aware that natural resources do not necessarily spell doom for development. Instead, their exploitation can be a valuable part of a sustainable development strategy.

## References and Notes

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## Supporting Online Material

[www.sciencemag.org/cgi/content/full/320/5876/616/DC1](http://www.sciencemag.org/cgi/content/full/320/5876/616/DC1)