

The Curse of Natural Resources

Katharina Wick¹ and Erwin Bulte²

¹Department of Economics, Tilburg University, 5000 LE Tilburg, The Netherlands

²Development Economics Group, Wageningen University, 6700 EW Wageningen, Netherlands; Oxford Center for the Analysis of Resource-Rich Economies (OxCarre), Oxford, OX1 3UQ, United Kingdom; email: erwin.bulte@wur.nl

Annu. Rev. Resour. Econ. 2009. 1:139–55

First published online as a Review in Advance on
May 12, 2009

The *Annual Review of Resource Economics* is
online at resource.annualreviews.org

This article's doi:
10.1146/annurev.resource.050708.144219

Copyright © 2009 by Annual Reviews.
All rights reserved

1941-1340/09/1010-0139\$20.00

Key Words

institutions, resources and conflict, resources and economic
performance

Abstract

A large literature has developed that documents a negative association between the presence of natural resources and economic development. In this paper we explore the empirics and theories of the so-called resource curse and try to assess its robustness. We conclude that there are many open questions and that the case of the curse needs revision and nuance.

1. INTRODUCTION

One of the controversial topics in the field of resource economics during the past decade is the so-called resource curse hypothesis. The resource curse refers to the apparently paradoxical result that to have more of a good thing can be bad. In terms of the curse, economists and political scientists have amassed a body of evidence that suggests an abundance of resources is associated with (a) slow growth, (b) an enhanced risk of civil war, and (c) autocratic political regimes. Arguably these three dimensions are interdependent.

In this article we review the emerging literature on the resource curse, focusing on the linkage between resources and slow growth, as this is the domain where economists have contributed most. We present the evidence and set out to discuss the most prominent explanations for the curse. We pay special attention to the pivotal role of institutional quality as a conditional factor. After this, we discuss some of the policy responses to the curse. Finally, we review some of the most recent evidence that challenges the robustness or even existence of the curse. Turning the curse paradigm on its head, these new findings suggest that resources may be a blessing. We conclude that resources do not necessarily spell doom for development and argue that more care must be taken to identify conditions under which the resource curse materializes. As in other fields, simple blanket recommendations are counterproductive.

2. THE PARADOX IS BORN

Concerns about the potential adverse consequences of resource-based development may be traced back to the 1950s. Since then, Gelb (1988) and Auty (1990) have been credited as early analysts of the curse. However, the most influential contribution, and the one that firmly placed the resource curse concept on the academic map, is a paper by Sachs & Warner (1997). They collected data for a large number of countries and estimated a multivariate regression equation to explain average economic growth over the period 1970–1990. One of their reduced-form growth regression equations is as follows:

$$\ln(Y_t/Y_0)/T = \alpha_0 + \alpha_1 \ln Y_0 + \alpha_2 SXP + \alpha_3 Z + \varepsilon,$$

where Y_t is income at time t (thus, Y_0 is initial income), SXP is the resource measure advanced by Sachs and Warner (the ratio of primary exports to GDP in 1970), and Z is a vector of the usual control variables in cross country growth regressions (e.g., openness of the economy, investment proxies, bureaucratic quality) [in a follow-up paper, Z also included a series of geographical variables (see Sachs & Warner 2001)]. When estimating the above equation, or variants thereof, the coefficient for the resource measure entered significantly and with a negative sign. Specifically, Sachs & Warner (1997) found that a one standard deviation increase in their resource measure is associated with a reduction in the annual per capita growth rate of approximately 1%. Similar results are found when trying alternative specifications, including ones where outliers are removed or when correcting for scale effects. It is easy to imagine why such a paradoxical result appealed to both empiricists and theoretical model builders—they were invited to consider the curse’s robustness and explore potential mechanisms to explain its existence.

In the years that followed, a flurry of research results became available—mostly confirming the earlier negative association between resources and growth. Among the key

insights obtained was the result that curse-like outcomes are more likely to emerge for so-called point resources than for diffuse resources. Point resources are natural resources that are clustered in space and can be controlled or defended by one party (perhaps promoting inequality due to highly skewed access to enduing resource rents). Examples include oil fields and diamond mines. In contrast, diffuse resources are spread out thinly—think of fertile land.

In addition to the cross-country growth regressions, there have been several careful case studies of individual countries that support the view that resources may be a hindrance to development. For example, using case studies from Southeast Asia, Ross (2001b) analyzed the destructive effect of timber booms on the quality of the institutions that are supposed to manage timber harvesting. Karl (1997) observed that a large flow of “petrodollars” may weaken the state and undermine the government’s ability to manage the economy, resulting in poor economic performance.

Does the curse spill over to domains other than economic growth? Some of the early evidence suggests that it does—the curse has different faces. For example, Bulte et al. (2005) estimated a basic development equation, where several development indicators are explained rather than income growth—think of the share of the population that is undernourished or lacks access to safe water, life expectancy, and the overall human development indicator. Distinguishing between point and diffuse resources, the results are generally consistent with the findings of the growth literature: Negative associations exist between point resources and the various proxies of development, but there are no significant results for diffuse resources.

Another dimension of the resource curse concerns the connection between certain natural resources and regime type. Ross (2001a) and Jensen & Wantchekon (2004) provide empirical evidence that links oil to autocratic regimes. Other evidence also implicates nonoil minerals as impeding the emergence of democratic structures. Resource proceeds give an authoritarian leader an incumbency advantage and may hinder transition to democracy. Resource wealth often induces a rentier effect (an issue we return to in more depth below), associated with buying political power through “white elephant” projects (Robinson & Torvik 2005), clientism (Robinson et al. 2006), and military repression (Azam 2001). Recently, Ross (2008b) suggested that the effect of oil wealth stretches even further and can also partially explain the underrepresentation of women in public service as well as the slow progress toward gender equality in the Middle East.

In parallel with the literature on resources and economic outcomes, Collier & Hoeffler (1998, 2004) pioneered the literature examining the impact of resources on the onset of conflict. Using the same resource measure as used by Sachs and Warner, i.e., the ratio of resource exports over GDP, they presented evidence suggesting resources fuel civil war. The Collier-Hoeffler results provide support for the view that, in addition to grievance-based reasons for engaging in a rebellion, greed may also play a role. According to this perspective, civil war is a special form of noncooperative behavior, reflecting opportunities for rebels (or rebel leaders) to enrich themselves, for example by seizing resource rents. Rebels are viewed as rational predators or, using terms with a less negative connotation, as entrepreneurs following up on a profitable opportunity. Grievance, in contrast, is rooted in a behavioral paradigm and emphasizes relative deprivation, social exclusion, and inequality (e.g., that due to ethnic or religious divides). In the context of resource-rich societies, grievance may be exacerbated by insufficiently compensated land expropriation, environmental degradation, inadequate job opportunities, and labor migration

(e.g., Rosser 2006). Relevant for both the greed and grievance motive is that resource rents provide a potential source of funding for the start-up costs associated with initiating a rebel organization.

A government wishing to avoid conflict can choose between two distinct strategies: suppressing the people by force or bribing them into production by providing productivity-enhancing public goods (e.g., Wick 2008). Such choices have implications for economic outcomes, cementing a link between different dimensions of the curse. Moreover, in line with observations in the literature dealing with resources and slow growth, point resources are more likely to invite conflict than are diffuse resources [e.g., see Wick & Bulte (2006) for a theoretical analysis and Ross (2008a) for recent evidence on the relation between oil and conflict].

3. LINKING RESOURCES TO SLOW GROWTH

Why are natural resources associated with slow economic growth? A number of possible explanations have been advanced. Long before the curse concept became “en vogue,” a group of economists pointed to the dangers of resource-based development strategies. Taken together, the theories developed in the 1950s may be classified as structuralist explanations. They focus on long-run declining terms of trade for primary commodities (Prebisch 1950, Deaton 1999), fluctuations in the prices of such commodities, or the lack of linkages between resource extraction enclaves and the rest of the economy (Hirschman 1958). However, none of these early explanations have stood the test of closer empirical scrutiny (Ross 1999). There are many exceptions to the structuralist’s dismal predictions, despite their relevance for certain resources during specific episodes (e.g., Tan 1983, Moran 1983, Behrman 1987, Cuddington 1992, Lutz 1994, Dawe 1996, Fosu 1996).

So the hunt for alternative explanations has been on. The list of candidate stories includes work by Manzano & Rigobon (2001), who focus on the pivotal role of debt overhang. They argued that resource-abundant countries, using their stocks as collateral, incurred large debts in the 1970s (when resource prices were high) that adversely affected their growth potential in the 1980s (after resource prices fell). This is consistent with an earlier observation by Davis (1983), who demonstrated that windfall gains triggered large-scale imports in a number of coffee-exporting countries. Imports rose as much as exports when coffee prices increased because countries wanted to use their sudden wealth to promote development. As a result, spending exceeded levels that could sustainably be afforded, and after the boom, contractionary measures, with detrimental effects on growth, were necessary to balance the current account.

Manzano & Rigobon (2001) also demonstrated that introducing credit constraints (the value of a country’s debt over its GDP) into a growth regression renders the coefficient on the resource measure insignificant. This suggests that curse-type outcomes were caused by credit constraints faced by resource-rich countries after the commodity booms of the 1970s. However, two interesting questions arise: Why did resource-abundant countries accumulate larger debts than they could reasonably service, and why did they fail to invest their loans in sufficiently productive projects? Consistent with earlier suggestions by Auty (1990), these questions point to some form of policy failure—perhaps akin to institutional failure—to which we return below.

Another class of explanations comprises so-called Dutch disease theories. Traditionally, Dutch disease refers to outcomes in which the manufacturing sector in resource exporting

countries shrinks during a boom as domestic prices increase (making investment goods more expensive) and the domestic currency is appreciated (undermining the international competitiveness of the sector) (see van Wijnbergen 1984, Krugman 1987). The term Dutch disease was coined by *The Economist* (1977) to describe the fate of the Netherlands following the discovery of sizable natural gas reserves. Capital and labor were drawn away from the manufacturing sector, which became less competitive. If one believes that the manufacturing (tradables) sector is the long-term engine of growth for economies—for example because of external effects, technology spillovers, or learning by doing effects, which result in increasing returns to scale at the sector level—then it is possible to explain curse-like outcomes (see Matsuyama 1992).

In its simplest form, Dutch disease models have a rather blunt prediction: Resource-rich countries should suffer from the curse. The evidence suggests a more mixed picture, with some countries benefiting from their resource endowments. Think of the diverging experiences of Botswana and Malaysia versus those of Nigeria and Venezuela. In light of this observation, it may come as no surprise that existing empirical work suggests that Dutch disease plays, at best, a minor role in explaining the curse (e.g., Leite & Weidmann 2002, Sala-i-Martin & Subramanian 2003). According to Matsen & Torvik (2005), traditional Dutch disease models fail to account for public savings and incorrectly assume that resource revenues must be spent immediately. In reality, (public) savings decisions may play an important role in some resource-rich states—think of the Norwegian pension fund, which is projected to grow until a size more than double the Norwegian GDP. Allowing for optimal savings implies trading off consumption today with tomorrow (the usual user cost) as well as decreased future productivity growth (due to Dutch disease effects). As a result, optimal consumption growth is higher in resource-rich countries than it is in resource-poor ones, and a greater share of income should be saved today. One explanation for diverging economic fates of resource-rich countries may lie in the inability of some countries to save optimally.

But there are other candidate explanations. In resource-rich countries the primary sector tends to be large. This has several counteracting effects on the (incentives for) human capital accumulation in the economy, which in turn impact long-term growth if there are positive externalities associated with schooling. Indeed, a negative correlation appears between resources and various proxies of educational attainment in countries (e.g., Gylfason 2001, Papyrakis & Gerlagh 2004). Schooling may be hampered by Dutch disease effects—a real exchange-rate appreciation impairs the development of human capital intensive sectors (Gylfason et al. 1999). Moreover, if the primary sector requires low-skill levels, then incentives to invest in human capital are reduced further—both for individual workers and for the government. Resource wealth may also act as a “sugar daddy” by inviting sloth and reducing incentives to work or study. To the extent that such responses are “irrational,” that is, not explained by enhanced demand for leisure due to an income effect, these extraeconomic explanations are usually frowned upon by economists.

Papyrakis & Gerlagh (2004) explored several potential channels via which the curse may work, including reduced investment, schooling, or openness to trade as well as worsening terms of trade or corruption levels. When controlling for all these mechanisms, the curse disappears, suggesting that the curse works indirectly—via one of these channels. Their results implicate the investment channel as the most significant one. Thus, a steady stream of resource revenues may attenuate incentives to put aside capital now and undertake productive investments.

Debts, Dutch disease effects, and reduced schooling or investment may be viewed as proximate causes. One may probe deeper and consider ultimate causes: Why do some countries fail to respond optimally to windfall gains? This suggests a pivotal role for policy making or institutions. Indeed, it appears as if a consensus is now growing that points to institutional quality—or the lack thereof—as a driver or the curse. Including the institutional dimension allows analysts to account for the mixed experiences of resource-rich countries whereby some, but not others, escape the curse.

4. A FOCUS ON INSTITUTIONS

Institutional quality is now recognized as a key driver of development. Indeed, the emphasis on institutions in current development thinking has reached such levels that Rodrik argued we are now in the midst of a phase of “institutions fundamentalism” (which follows the “market fundamentalism” of getting prices right associated with the Washington Consensus of the 1980s and early 1990s). The popularity of institutions has been triggered in part by the seminal work of Sokoloff & Engerman (2000) and Acemoglu et al. (2001).

Sokoloff & Engerman (2000) found that extractive colonies based on plantation crops (sugar and coffee) were established in places where physical conditions were suitable for plantation agriculture (benefiting from returns to scale) and where cheap labor was locally available or could be imported. Once in place, institutions based on unequal distribution of power and income are beneficial for (domestic) elites and are therefore perpetuated and reproduced over time. In contrast, development in North America was based on different factor endowments, favoring household farms and triggering a relatively equal distribution of wealth and power. These egalitarian beginnings affected the way American society is currently organized. One hypothesis, therefore, is that colonies with diffuse resources (arable land) developed favorable institutions, conducive to long-term growth, whereas colonies endowed with pointy resources or conditions enabling plantation agriculture moved in other directions. Inspired by this approach, Acemoglu and coworkers (2001) used settler mortality as an instrumental variable for institutional quality and addressed the endogeneity concerns that hampered earlier work on the role of institutions in explaining income differentials. Follow up work by Rodrik et al. (2004) and Easterly & Levine (2003) confirmed the pivotal role of institutions, firmly placing this issue at the heart of modern development economics. The resource-curse literature has naturally absorbed some of this mainstream thinking.

Why would institutions matter for growth? Governance proxies such as property rights security (one key component of the institutional framework) matter because they determine to what extent potential investors expect to be able to reap the benefits from their investments. However, additional—perhaps more indirect—avenues via which institutions matter may also exist. For example, institutional quality codetermines a country’s ability to react to external shocks. As Rodrik (1998) noted, “When social divisions run deep and the institutions of conflict management are weak, the economic costs of exogenous shocks—such as deteriorations in the terms of trade—are magnified by the distributional conflicts triggered.” Dealing with shocks may require unpopular and painful measures to be borne by (parts of) the population, and if civil peace is unstable as a result of smoldering conflicts between factions in the country, implementing appropriate policies may be quite a challenge.

Broadly speaking, two streams of literature can be distinguished. The first analyzes the growth (or conflict) effects of resources, conditional on the quality of institutions. The second endogenizes institutional quality and explicitly considers the impact of natural resources on the institutional framework. Within the latter stream, papers focus on the adverse effect of natural resources on the nature of political regimes (e.g. less democracy) and governance quality (e.g. more corruption).

First consider the case where the institutional context is taken as given. Mehlum et al. (2006) provide a successful attempt to analyze why the curse occurs in some economies and not in others. They developed a model where some entrepreneurs have to divide themselves across two sectors: the rent-seeking sector and a modern manufacturing sector. When rent seeking, entrepreneurs are unproductive and live off resource rents. In contrast, the modern manufacturing sector is productive and even subject to increasing returns to scale at the sector level (such that entry of one new modern manufacturer raises the income of all others in that sector). Entrepreneurs in manufacturing may also, to some extent, share in the available resource rents, depending on the quality of institutions. Movement of talent occurs to equate the return to entrepreneurial skills—in equilibrium, income differentials between the sectors have been arbitrated away.

When institutions are bad (“grabber-friendly economies”), the rent seekers are able to grab a large share of the national resource pie for their private benefit. Instead, when institutions are good (“producer-friendly economies”), rents are shared more equally, and the returns to rent seeking are low. Mehlum and coworkers solved for the equilibrium allocation of talent across sectors as well as the ensuing income levels. Next, they considered what happens during resource booms—when the resource pie suddenly increases in size. The model predicts that resource booms tend to reduce total income in grabber-friendly economies and raise income in producer-friendly economies. The latter effect follows because extra income is poured into the economy. The former effect is more counterintuitive and follows from the reallocation of talent from the manufacturing to the rent-seeking sector after a boom. The structure of the economy, with increasing returns to scale in manufacturing, implies that everybody’s income will fall as a result of such a reallocation. These theoretical predictions are confirmed in an empirical analysis, where the resource measure is interacted with a measure of institutional quality.

Additional papers have taken rent seeking as a starting point. Resource rents accrue to resource owners, so in practice they often fall in the hands of the government who can then allocate them to certain uses. It has been argued that such rents are easily appropriable by elites, leading to bribes and distortions in public policies (Karl 1997, Tornell & Lane 1999, Torvik 2002). Rent seeking may also affect economic production in the formal economy through crowding out of talent, and it may shift entrepreneurial activity from manufacturing to the resource sector. Atkinson & Hamilton (2003) captured the adverse effects of rent seeking on an economy using the concept of the genuine savings rate. The term refers to the net national savings adjusted for natural resource depletion (i.e., extracting a resource is equivalent to de-saving). In an empirical analysis they found that resource-rich countries with low or negative genuine saving rates (i.e., that use resource money for government consumption rather than investment) fall prey to the resource curse.

Several papers have analyzed the potentially adverse effects of resources, conditional on the institutional setting. For example, Robinson et al. (2006) focused on the political foundations of the curse and highlighted perverse incentives for incumbent policy makers.

Because resource booms raise the value of staying in power, unaccountable policy makers are tempted to create unproductive public sector employment (e.g., nepotism, clientalism). If incumbents want to prolong their reign by appointing friends to positions of power, thereby redistributing income to influence elections, resource curse-type outcomes may eventuate. However, it is important to note that the degree to which this is feasible depends on the institutional setting within which policy makers operate.

The “policies for sale” approach, pioneered by Bernheim & Whinston (1986) and Grossman & Helpman (1994), provides another avenue to link resource abundance to policy making. According to this model, politicians trade with interest groups (industries), exchanging policies for support (bribes). In equilibrium, bribing is truthful—firms pay more money in return for greater benefits from the policies. Bulte & Damania (2008) developed a simple general equilibrium model in which the manufacturing sector (characterized by increasing returns to scale at the sector level) and the resource sector purchase “supporting policies” from a selfish government (such as investments in education for the manufacturing sector, and physical infrastructure for the resource sector). In this model, resource booms and discoveries tilt the balance in favor of the resource sector, yielding a reorientation of support to this sector. As policy support for manufacturing falls, entrepreneurs exit from that sector. In spite of the windfall gain, aggregate income in the economy falls. There exist, however, conditions under which the dismal outcome described above need not materialize—again an example where the institutional structure matters and determines whether the curse materializes. When there is a political challenger waiting in the wings to oust the incumbent government, the story changes. In particular, the threat of a political transition “disciplines” incumbents, so that they are forced to care about aggregate income as well as the bribes they can pocket for themselves. A Sachs-Warner-style growth regression, but including an interaction term for political competition multiplied by resource abundance, supports the central idea that abundant point resources can lead to bad policies and bad economic performance, but only in the absence of political competition.

As a final example of how the resource curse can materialize in some settings, and not in others, consider the work of Andersen & Aslaksen (2006), which hones in on constitutional design. Their work is based on insights by Persson & Tabellini (2004), who pioneered the notion that constitutional design has consequences for economic policies. Key concepts in their analysis are accountability and representativeness of a country’s executive body. Andersen & Aslaksen (2006) found that both presidential regimes and majoritarian electoral rules (as opposed to parliamentary systems and proportional representation) tend to be associated with more spending for special interests, at the expense of public goods that benefit a wider swathe of voters (and that could enhance economic growth). The reason is that presidential regimes and majoritarian rules imply that the incumbent decision maker is not dependent on a stable majority among the legislators and is therefore more likely to cater to the interests of powerful minorities. In this light, it is no surprise that sectoral lobbying for preferential treatment is more successful in presidential than in parliamentary systems.

As mentioned above, a growing literature goes one step further and attempts to endogenize institutional quality in the analysis. A prominent and motivating contribution in this vein is provided by Ross (2001a), who demonstrated a negative correlation between resource measures—especially the presence of oil—and the level of democracy in a large sample of countries. This analysis has developed into one of the dimensions of the resource

curse described in the Introduction—a negative association between resources and political regimes [see also Aslaksen & Torvik (2006), who analytically showed how resource wealth may decrease the probability of sustained democracy].

Leite & Weidmann (2002) provide another early attempt to capture this phenomenon and deal with a different “level” of institutional quality. They distinguished between point and diffuse resources and argued that abundant point resources tend to stimulate corruption and that corruption, in turn, retards economic growth. After controlling for the level of corruption, resource abundance is no longer significant in growth regressions. Corruption lowers the incentive to invest and innovate, as it tends to raise uncertainty and decreases returns (by effectively imposing an investment tax). This evidence suggests that the main effect of resources on economic performance is indirect—through the level of corruption. Researchers often use the level of corruption in countries as a governance measure, providing one specific type of institutional quality (see Williamson 2000).

Isham et al. (2005) confirmed the findings by Leite and Weidmann and placed them in a more general context. In addition to corruption, they considered the governance proxies Voice and Accountability and Government Effectiveness made available by the World Bank. They analyzed the association between (point) resources and economic growth, examining direct and indirect links. Given a certain level of institutional quality, natural resources have no separate effect on growth. However, point resources tend to result in worse institutions (whereas diffuse resources do not).

How may resources affect institutional quality? It is easy to imagine that resource rents have a direct income effect. To the extent that rents translate into government income, one may expect they could be used to improve the provision of public goods (including the quality of the institutional system). Various indirect mechanisms could also play a role—some of which have negative consequences that could easily dominate any positive income effect. For example, Hodler (2006) presented a model in which a certain dimension of institutional quality, namely property rights, is endogenously determined. According to his model a resource boom triggers an increase in fighting activities in an economy. The increase in appropriating activities leads to a general worsening of the property rights in the economy. This contribution thus ties together the slow growth and conflict dimension of the resource curse.

Yet other mechanisms, perhaps more subtle ones, may also be at play. In political science the concept of rentier states is well known and often used to explain why resource-rich countries may suffer from bad institutions and policies (e.g., Karl 1997, Ross 1999). This concept identifies a “disconnection” between the state and its citizens as one of the main causes for weak institutional capacity. As Moore (2001) pointed out, when the state can control resource rents associated with extraction, then it does not rely on taxation of citizens for revenues. Several things happen when the state does not have to “earn its income” but lives off rents. First, citizens may care less about how the government spends its income (as they do not have to pay for it directly) and are less inclined to scrutinize public expenditures and hold the government accountable—possibly giving rise to exorbitant private consumption of the government or hopelessly inefficient bureaucracies. Second, because the government does not need to generate its income from the people, the interests of the state and the people do not necessarily run parallel. The state has a weaker incentive to provide the public goods needed by the people to enhance production (such as the rule of law). Furthermore, the state may have less knowledge about what the people desire. Third, the state has ample means to quell potential opposi-

tion—either by wasteful public spending programs and patronage or by investments in repression. The latter may also be induced by the fact that resource wealth could trigger ethnic or regional conflict. One response would be to invest in a larger military apparatus, so as to “keep the peace” in the region. As mentioned above, this means that income from resource rents may support authoritarian, rather than democratic, regimes.

Another difference between rentier states and states relying on taxing citizens is that the former are more attractive to take over by force. Whereas tax revenues flow only if the whole complex revenue mechanism is kept going, the immediate rewards for obtaining access to point resources are far greater. In rentier states, therefore, the danger of violent strife is greater—a prediction consistent with stylized facts.

5. EXORCISING THE CURSE?

Some of the poorest countries in the world, for example in Sub-Saharan Africa, appear to be suffering from the natural resource curse. A better understanding of the phenomenon and its driving mechanisms—whether or not the result of institutional erosion—enables formulation of appropriate policy recommendations. Not surprisingly, this has become a priority for both the academic and policy-making world in recent years.

Sala-i-Martin & Subramanian (2003) provide an innovative perspective. They suggested distributing rents to the people as a means around the rentier state problem. Distributing resource rents to the population in a lump-sum fashion and subsequently requiring the government to tax part of it back to finance any state activity would reintroduce a stronger linkage between the state and its people. If so, perhaps the government would be held more accountable for the way the money is spent. Sandbu (2006) argued that such a strategy would trigger two effects, each one helping to alleviate resource curse-type problems. First, an “endowment effect” would be created—people care more about the usage of money, which they have formerly possessed and had to give up through taxation, than about the spending of resource rents they never owned in the first place. Second, owing to an “information effect,” citizens of countries where the government relies on taxation are more aware about the amount of money the government has at its disposal.

Another avenue to exorcize the curse is provided by proponents of Dutch disease explanations who point to the Norwegian pension fund fueled by petro-rents. When only the interest of this fund is spent, oil wealth is converted into a key asset for future as well as current generations. By investing rents abroad, appreciation of the currency and associated adverse Dutch disease effects for local manufacturers are avoided. Many resource-rich countries have expressed an interest in following the Norwegian example, but this approach requires high-quality (political) institutions as well as strong political commitment. It is not evident that this approach can be easily mimicked by a large set of developing countries.

Yet another avenue to mitigate the curse may be through regulation of trade in resources. The issue of so-called blood diamonds (the sales of which allegedly finance rebel movements, prolonging civil wars in several African countries) was tackled by the establishment of the Kimberley Process Certification Scheme in 2003. The 48 participants (representing 74 countries) commit to trading only rough diamonds among each other. Each exporting country has to certify its traded diamonds, ensuring buying companies and customers that their money is not fueling conflicts (Bannon & Collier 2003, Kimberley

Process Certification Scheme Working Group 2006). So far, this approach seems promising. A large part of traded diamonds are considered conflict free (United Nations General Assembly 2006, Kimberley Process Certification Scheme Working Group 2006). However, the scheme has been criticized for being based on the voluntary cooperation of participants. Peer review by participating countries is one way to ensure compliance, but some argue that the scheme does not go far enough in its requirements (see, for example, Amnesty International 2006).

Finally, to address the concern that resource spoils trigger institutional deterioration via rent seeking and corruption the Extractive Industries Transparency Initiative (EITI) was launched. The EITI is supported by many institutions, including the World Bank, the International Monetary Fund, the African Development Bank, and the European Bank for Reconstruction and Development as well as many nongovernmental organizations. The aim of the initiative is to strengthen and improve governance in resource-rich countries so that many of the problems discussed above (resulting from bad institutional quality) can be avoided. This goal will be achieved by improving transparency and accountability in relation to natural resources. As discussed, one of the major problems identified is that the population lacks detailed information about the magnitude of resource rents and thus cannot hold the government accountable. The EITI aims to publicize company payments in exchange for usage of natural resources and to provide full accounts of government revenue. So far, 21 countries have joined the initiative, among them Congo, Nigeria, and Peru. However, the EITI is still in the preparation phase, and currently the success of the project is unclear. Yet, several problems have been encountered, including a large discrepancy between rhetoric and concrete actions of government leaders. There is also evidence that some governments fail to recognize the important role of civil society organizations in the process, resulting in marginalization and intimidation of civil society activists (see, for example, Revenue Watch Institute 2006).

6. CHALLENGING THE RESOURCE CURSE EVIDENCE

Slowly but steadily, a consensus perspective on the curse is emerging: (a) An abundance of resources is bad for development, peace, and political freedoms; (b) the ultimate and proximate causes of the curse are debatable, but likely involve institutional quality as a pivotal variable; and (c) through careful policy response, it is possible to exorcize the curse or at least attenuate its implications. This consensus caught root beyond the realm of academia and was shared by nongovernmental organizations, multilateral organizations (the International Monetary Fund and World Bank), as well as some corporations. Trade measures have been implemented, transparency initiatives have been started, and British Petroleum funded a research unit at Oxford University aimed at analyzing resource-rich economies.

At the same time, new evidence has started to trickle down casting doubts on the foundations of the curse. Several questions arise: Does the phenomenon exist at all? If so, how widespread is it? The resource curse literature is, to a very large extent, driven by empirical results—with theoretical analyses added later. It now appears as if the empirical roots of the curse may not stand to close scrutiny.

First, and at a conceptual level, one may argue that empirical work on the curse has been mis-specified. Indeed, the evidence presented may not allow the inference that resources are somehow bad, even if there exists a negative correlation between resources

and economic growth. Referring back to traditional Hotelling-style extraction models, Boyce & Emery (2008) make clear that one should not expect that resource discoveries raise economic growth rates. Instead, such a discovery should instantaneously raise income levels, but theory predicts that resource rents will fall during the extraction phase as the stock gets exhausted. Hence, economic growth is lower (or even negative), but during the extraction phase, income will be higher than in the counterfactual case without resources (and if resource rents are invested wisely income levels will remain higher). As a result, the standard economic model is hard to reconcile with the resource curse perspective—why would countries be “cursed” if their income levels are (temporarily) raised? Evidence provided by Boyce & Emery (2008) and by Bravo-Ortega & de Gregorio (2005) supports the idea that a positive correlation exists between income levels and resource measures.

Second, doubts are rising about the robustness of the claimed results. Manzano & Rigobon (2001) not only used cross-section analysis to analyze the relation between resources and economic growth (as is commonly done in the literature inspired by Sachs and Warner), but also estimated the growth model using panel data. When controlling for fixed effects, the negative effect of resource abundance disappears. The authors thus inferred that the conventional resource curse result is due to an omitted variable bias. They suggested that the omitted variable is “credit constraints.” Once one introduces a measure for credit constraints into the (cross-country) regression, the negative effect of resources disappears. Mackay (2008) went one step further. His panel analyses, which allows for the impact of resources on growth to vary over time, suggested that the curse has been transformed into a blessing in the most recent decades.

Similar findings have been obtained in the literature that focuses on resources and political regimes. Focusing on the most contentious resource of all (oil!), a recent study by Horiuchi & Waglé (2008) found that the negative correlation between resource rents and autocracy measures disappears when a panel model with fixed effects is used. They concluded that current undemocratic and oil-abundant countries were not democratic states before oil began to be discovered and exploited commercially. There is no evidence that the already democratic countries became less democratic under the influence of oil wealth. This study thus points to another omitted variable in most regressions—the overhang of history.

A third concern has arisen about the way resources are measured in the typical growth, conflict, or democracy regression. Sachs & Warner (1997, 2001) and most others used the ratio of primary exports to GDP. However, scaling resource output by the size of the economy implies that this measure captures dependence, rather than resource wealth or abundance. These concepts may be correlated—countries with large resource stocks may derive high incomes from extraction and, because of Dutch disease arguments, may specialize in primary exports and become dependent on resources. Yet, some resource-abundant countries are not dependent on resources, and some relatively resource-scarce countries are.

Moreover, the traditional Sachs and Warner “flow” variable may be subject to serious endogeneity concerns. The typical curse story, as discussed above, views a negative correlation between resource dependence and institutional quality as evidence that resources undermine institutions. However, and alternatively, such a correlation may capture that the resource sector is the default sector in the absence of decent institutions, as nobody is willing to invest in alternative forms of capital. If so, GDP will be low, and the

conventional curse variable takes on high values. Similarly, a positive correlation between resource dependence and the onset of conflict may mean that resources trigger conflict. However, it may also mean that conflict makes countries dependent on resource extraction—the default activity that still takes place after other economic sectors (which may be more mobile or perhaps better linked to the rest of the economy) have ceased. So, which story is true? Do resources undermine institutions, cause slow growth, and trigger conflict, or is the causality running in the opposite direction? Are resources a curse to development and peace, or do they provide a safety net so that people, communities, and economies are able to eke out an existence even under the most adverse circumstances?

Evidence is mounting suggesting that the resource curse claim is not very robust to alternative (arguably more exogenous) resource measures. For example, Stijns (2002) used a physical measure of energy and mining reserves and found that the curse does not spill over to this measure. Ding & Field (2005) distinguished between measures of resource dependence and abundance. After including a physical measure of resource abundance in the traditional model, they found a positive effect of resource abundance on economic growth. Brunnschweiler & Bulte (2008c) confirmed this finding. They instrumented for resource dependence (to identify exogenous variation of this variable) and found that the Sachs and Warner resource measure no longer enters significantly in growth regressions. In contrast, a resource-abundance measure (based on the discounted value of resource rents) is positively correlated with growth and income levels. In a follow-up paper they demonstrated that similar results are obtained in the resource-conflict model (Brunnschweiler & Bulte 2008b). Conflict makes countries dependent on resource extraction, not vice versa, and resource abundance attenuates the risk of civil war via a positive effect on income (which in turn is negatively correlated with the risk of war). Brunnschweiler & Bulte (2008a) summarized these results.

7. DISCUSSION AND CONCLUSIONS

A long-standing tradition in economics and political science argues against development strategies based on exports of primary products. These so-called structuralist theories point to declining long-term price trends, deteriorating terms of trade, volatile prices, enclave production, and the absence of economies of scale. Nevertheless, standard comparative advantage arguments imply a strong case for exports of primary commodities, and in light of the favorable experiences in countries like Australia, the United States, and Canada, the dominant view until the mid-1990s was that an abundance of natural resources is a blessing for development. This perspective changed in the 1990s after seminal work by Sachs & Warner (1997, 2001) (in the growth domain) and Collier & Hoeffler (1998, 2004) (in the conflict domain). In the words of Rosser (2006), “the conventional wisdom is now arguably the exact opposite of what it was prior to the late 1980s.” The resource curse was born and widely embraced by the scientific community.

After a decade of empirical and analytical research, the resource curse literature now appears to be at a crossroad. Whereas some analysts have tried to carefully build a structure that accommodates the stylized facts, sorting out proximate and ultimate effects and identifying causal mechanisms via which the curse may work, others have undermined the foundations of such a structure by casting doubts on the empirical validity of the curse results. The evidence presented in the previous section of this article seems to seal the fate of the resource curse. After the intellectual “buzz” that surrounded the curse, it now

appears as though the profession has been beating a dead horse. However, such a conclusion is premature—the empirical picture remains mixed, and it is too early to dismiss the curse concept altogether.

For example, Norman (2005) found evidence of a resource curse when physical reserves as opposed to export intensity are used as the key explanatory variable. Atkinson & Hamilton (2003) employed a proxy for resource abundance different from the one used by Sachs & Warner (1997, 2001) and found that the curse emerges for a subset of countries. In addition, Bravo-Ortega & de Gregorio (2005) reported specifications where the resource curse “survives” fixed effects panel estimates.

Most interesting, perhaps, are recent attempts to move beyond aggregate models that yield blanketed recommendations and more carefully embrace the diversity of both the resources as well as the economies that are trading them. As discussed above, resources may generate both level and growth effects, and economies vary in their level of institutional quality. Moreover, resources differ in terms of their value, the ease with which they can be grabbed and smuggled, and the capital intensity of production. For example, Lujala et al. (2005) demonstrated that, although no relation exists between an aggregate measure of diamonds and conflict onset, lootable (alluvial) and nonlootable (i.e., underground) diamonds have opposite effects on the incidence of conflict.

The temporal dimension may also matter. Collier & Goderis (2007) distinguished between short-term and long-term effects of resource extraction and found that long-term effects on development are generally worse. It is also overly simplistic to lump all domestic conflict together under the single header of civil war—the magnitude of the conflict varies, the intentions and motives may be different (e.g., secessionist wars versus nonsecessionist wars), and the international context is also too easily overlooked. To embrace the diversity of resources and economies, more careful econometric evidence is needed. This should involve “new” approaches like Bayesian model averaging, which allow greater flexibility.

In sum, the resource curse hypothesis remains controversial. Although great progress has been made, it is fair to conclude that crucial elements are still unknown or ill understood. It is also fair to say that the curse offers ample scope for future research and will remain a lively research field in the years to come.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

LITERATURE CITED

- Acemoglu D, Johnson A, Robinson JA. 2001. The colonial origins of comparative development: an empirical investigation. *Am. Econ. Rev.* 91:1369–401
- Amnesty International. 2006. External document POL 30/024/2006. *News Serv. No. 158, Amnesty Int.*
- Andersen JJ, Aslaksen S. 2006. *Constitutions and the resource curse*. Work. Pap. Ser. 7506, Dep. Econ., Norwegian Univ. Sci. Tech.
- Aslaksen S, Torvik R. 2006. A theory of civil conflict and democracy in rentier states. *Scand. J. Econ.* 108(4):571–85

- Atkinson G, Hamilton K. 2003. Savings, growth and the resource curse hypothesis. *World Dev.* 31:1793–807
- Auty RM. 1990. *Resource Based Industrialization: Sowing the Oil in Eight Less Developed Countries*. Oxford, UK: Clarendon
- Azam JP. 2001. The redistributive state and conflicts in Africa. *J. Peace Res.* 38:429–44
- Bannon I, Collier P. 2003. *Natural Resources and Violent Conflict: Options and Actions*. Washington, DC: World Bank
- Behrman J. 1987. Commodity price instability and economic goal attainment in developing countries. *World Dev.* 15:559–73
- Bernheim BD, Whinston M. 1986. Menu actions, resource allocation and economic influence. *Q. J. Econ.* 101:1–31
- Boyce J, Emery H. 2008. *What can exhaustible resource theory tell us about per capita income levels and growth in resource abundant economies?* Mimeogr., Dep. Econ., Univ. Calgary
- Bravo-Ortega C, de Gregorio J. 2005. *The relative richness of the poor? Natural resources, human capital, and economic growth*. Work. Pap. 3484, World Bank Policy Res.
- Bulte EH, Damania R, Deacon RT. 2005. Resource intensity, institutions and development. *World Dev.* 33:1029–44
- Bulte EH, Damania R. 2008. Resources for sale: corruption, democracy and the natural resource curse. *B.E. J. Econ. Anal. Policy* 8(1): artic. 5
- Brunnschweiler CN, Bulte EH. 2008a. Linking natural resources to slow growth and more conflict. *Science* 320(5876):616–17
- Brunnschweiler CN, Bulte EH. 2008b. *Natural resources and violent conflict: resource abundance, dependence and the onset of civil wars*. Econ. Work. Pap. Ser. 08/78, ETH Zurich
- Brunnschweiler CN, Bulte EH. 2008c. The resource curse revisited and revised: a tale of paradoxes and red herrings. *J. Environ. Econ. Manag.* 55:246–64
- Collier P, Goderis B. 2007. *Commodity priced, growth, and the natural resource curse: reconciling a conundrum*. Work. Pap. 2007-15, CSAE, Oxford Univ.
- Collier P, Hoeffler A. 1998. On economic causes of civil war. *Oxf. Econ. Pap.* 50:563–73
- Collier P, Hoeffler A. 2004. Greed and grievance in civil war. *Oxf. Econ. Pap.* 56(4):563–95
- Cuddington JT. 1992. Long-run trends in 26 primary commodity prices. *J. Dev. Econ.* 39:207–27
- Davis JM. 1983. The economic effects of windfall gains in export earnings. *World Dev.* 2:119–39
- Dawe D. 1996. A new look at the growth in developing countries. *World Dev.* 24:1905–14
- Deaton A. 1999. Commodity prices and growth in Africa. *J. Econ. Perspect.* 13:23–40
- Ding N, Field BC. 2005. Natural resource abundance and economic growth. *Land Econ.* 81(4): 496–502
- Easterly W, Levine R. 2003. Tropics, germs, and crops: the role of endowments in economic development. *J. Monet. Econ.* 50(1):3–39
- The Economist. 1977. The Dutch disease. *Economist*, Nov. 26:82–83
- Fosu A. 1996. Primary exports and economic growth in developing countries. *World Econ.* 19:465–75
- Gelb A. 1988. *Windfall Gains: Blessing or Curse?* Oxford, UK: Oxford Univ. Press
- Grossman G, Helpman E. 1994. Protection for sale. *Am. Econ. Rev.* 84:833–50
- Gylfason T. 2001. Natural resources, education, and economic development. *Eur. Econ. Rev.* 45:847–59
- Gylfason T, Herbertsson TT, Zoega G. 1999. A mixed blessing: natural resources and economic growth. *Macroecon. Dyn.* 3:204–25
- Hirschman AO. 1958. *The Strategy of Economic Development*. New Haven, CT: Yale Univ. Press
- Hodler R. 2006. The curse of natural resources in fractionalized countries. *Eur. Econ. Rev.* 50(6): 1367–86
- Horiuchi Y, Waglé S. 2008. *100 years of oil: Did it depress democracy and sustain autocracy?* Work. Pap., Crawford Sch. Econ. Gov., ANU Coll. Asia Pac., Aust. Natl. Univ.

- Isham J, Woodcock M, Pritchett L, Busby G. 2005. The varieties of resource experience: natural resource export structures and the political economy of economic growth. *World Bank Econ. Rev.* 19(2):141–74
- Jensen N, Wantchekon L. 2004. Resource wealth and political regimes in Africa. *Comp. Polit. Stud.* 37:816–41
- Karl T. 1997. *The Paradox of Plenty: Oil Booms and Petro-States*. Berkeley, CA: Univ. Calif. Press
- The Kimberley Process Certification Scheme Working Group. 2006. *Third Year Review*. Windhoek, Namib.: KPCS
- Krugman P. 1987. The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher: notes on trade in the presence of dynamic scale economies. *J. Dev. Econ.* 37:41–55
- Leite C, Weidmann J. (2002). Does Mother Nature corrupt? Natural resources, corruption and economic growth. In *Governance, Corruption, and Economic Performance*, ed. G Abed, S Gupta, pp. 159–96. Washington, DC: IMF
- Lujala P, Gleditsch NP, Gilmore E. 2005. A diamond curse? Civil war and a lootable resource. *J. Confl. Resolut.* 49:538–62
- Lutz M. 1994. The effects of volatility in the terms of trade on output growth: new evidence. *World Dev.* 22:1959–75
- Mackay SH. 2008. *Natural resources: from curse to blessing?* Work. Pap., Dep. Econ., Univ. Manch.
- Manzano O, Rigobon R. 2001. *Resource curse or debt overhang?* Work. Pap. W8390, NBER
- Matsen E, Torvik R. 2005. Optimal Dutch disease. *J. Dev. Econ.* 78(2):494–515
- Matsuyama K. 1992. Agricultural productivity, comparative advantage and economic growth. *J. Econ. Theory* 58:317–34
- Mehlum H, Moene K, Torvik R. 2006. Institutions and the resource curse. *Econ. J.* 116(508):1–20
- Moore M. 2001. Political underdevelopment: what causes bad governance? *Public Manag. Rev.* 3:1–34
- Moran C. 1983. Export fluctuations and economic growth. *J. Dev. Econ.* 12:195–218
- Norman CS. 2005. *Rule of law and the resource curse: abundance versus intensity*. Discuss. Pap., Dep. Econ., Univ. Calif. Santa Barbara
- Papyrakis E, Gerlagh R. 2004. The resource curse hypothesis and its transmission channels. *J. Comp. Econ.* 32(1):1–196
- Persson T, Tabellini G. 2004. Constitutional rules and fiscal policy outcomes. *Am. Econ. Rev.* 94:25–46
- Prebisch R. 1950. *The economic development of Latin America and its principal problems*. New York: United Nations
- Revenue Watch Institute. 2006. *Eye on EITI: Civil Society Perspectives and Recommendations on the Extractive Industries Transparency Initiative*. New York: Revenue Watch Inst.
- Robinson JA, Torvik R. 2005. White elephants. *J. Public Econ.* 89:197–210
- Robinson JA, Torvik R, Verdier T. 2006. Political foundations of the resource curse. *J. Dev. Econ.* 79(2):447–68
- Rodrik D. 1998. Where did all the growth go? External shocks, social conflict, and growth collapses. *J. Econ. Growth* 4(4):358–412
- Rodrik D, Subramanian A, Trebbi F. 2004. Institutions rule: the primacy of institutions over geography and integration in economic development. *J. Econ. Growth*. 9(2):131–65
- Ross ML. 1999. The political economy of the resource curse. *World Polit.* 51:297–322
- Ross ML. 2001a. Does oil hinder democracy? *World Polit.* 53:325–61
- Ross ML. 2001b. *Timber Booms and Institutional Breakdown in Southeast Asia*. Cambridge, UK: Cambridge Univ. Press
- Ross ML. 2008a. Blood Barrels. *Foreign Aff.* 87:2–9
- Ross ML. 2008b. Oil, Islam and women. *Am. Polit. Sci. Rev.* 102(1):107–23
- Rosser ML. 2006. *The political economy of the resource curse: a literature survey*. Work. Pap. 268, IDS

- Sachs JD, Warner AM. 1997. *Natural resource abundance and economic growth*. Work. Pap. 5398, NBER
- Sachs JD, Warner AM. 2001. The curse of natural resources. *Eur. Econ. Rev.* 45:827–38
- Sala-i-Martin X, Subramanian A. 2003. *Addressing the natural resource curse: an illustration from Nigeria*. Work. Pap. 9804, NBER
- Sandbu M. 2006. Natural wealth accounts: a proposal for alleviating the natural resource curse. *World Dev.* 34(7):1153–70
- Sokoloff KL, Engerman SL. 2000. Institutions, factor endowments and paths of development in the New World. *J. Econ. Perspect.* 14:217–32
- Stijns J. 2002. *Natural resource abundance and economic growth revisited*. Mimeogr., Dep. Econ., Univ. Calif. Berkeley
- Tan G. 1983. Export instability, export growth and GDP growth. *J. Dev. Econ.* 12:219–27
- Tornell A, Lane P. 1999. The voracity effect. *Am. Econ. Rev.* 89:22–46
- Torvik R. 2002. Natural resources, rent seeking and welfare. *J. Dev. Econ.* 67:455–70
- United Nations General Assembly. 2006. *The role of diamonds in fuelling conflict: breaking the link between the illicit transaction of rough diamonds and armed conflict as a contribution to prevention and settlement of conflicts*. Work. Pap., United Nations
- van Wijnbergen S. 1984. The “Dutch disease”: a disease after all? *Econ. J.* 94:41–55
- Wick K. 2008. Conflict and production: an application to natural resources. *B.E. J. Econ. Anal. Policy* 8(1): artic. 2
- Wick K, Bulte EH. 2006. Contesting resources—rent seeking, conflict and the natural resource curse. *Public Choice* 128(3):457–76
- Williamson OE. 2000. The new institutional economics: taking stock, looking ahead. *J. Econ. Lit.* 38(3):595–613



Contents

Prefatory Article

An Amateur Among Professionals

Robert M. Solow 1

Policy Analysis and Design

Agriculture for Development: Toward a New Paradigm

Derek Byerlee, Alain de Janvry, and Elisabeth Sadoulet 15

Governance Structures and Resource Policy Reform:

Insights from Agricultural Transition

Johan F.M. Swinnen and Scott Rozelle 33

Distortions to Agricultural Versus Nonagricultural

Producer Incentives

Kym Anderson 55

Public-Private Partnerships: Goods and the Structure of Contracts

Gordon Rausser and Reid Stevens 75

Environmental Regulations and Economic Activity:

Influence on Market Structure

Daniel L. Millimet, Santanu Roy, and Aditi Sengupta 99

The Development of New Catastrophe Risk Markets

Howard C. Kunreuther and Erwann O. Michel-Kerjan 119

The Curse of Natural Resources

Katharina Wick and Erwin Bulte 139

Experiments in Environment and Development

Juan Camilo Cárdenas 157

Behavior, Environment, and Health in Developing Countries:

Evaluation and Valuation

Subhrendu K. Pattanayak and Alexander Pfaff 183

Resource Dynamics

Irreversibility in Economics

Charles Perrings and William Brock 219

Whither Hotelling: Tests of the Theory of Exhaustible Resources

Margaret E. Slade and Henry Thille 239

Recent Developments in the Intertemporal Modeling of Uncertainty

Christian P. Traeger 261

Rent Taxation for Nonrenewable Resources

Diderik Lund 287

Land Use and Climate Change Interactions

Robert Mendelsohn and Ariel Dinar 309

Urban Growth and Climate Change

Matthew E. Kahn 333

Reduced-Form Versus Structural Modeling in Environmental and Resource Economics

Christopher Timmins and Wolfram Schlenker 351

Ecology and Space

Integrated Ecological-Economic Models

John Tschirhart 381

Integrating Ecology and Economics in the Study of Ecosystem Services: Some Lessons Learned

Stephen Polasky and Kathleen Segerson 409

The Economics of Urban-Rural Space

*Elena G. Irwin, Kathleen P. Bell, Nancy E. Bockstael,
David A. Newburn, Mark D. Partridge, and Junjie Wu* 435

Pricing Urban Congestion

Ian W.H. Parry 461

The Economics of Endangered Species

Robert Innes and George Frisvold 485

On the Economics of Water Allocation and Pricing

Yacov Tsur 513

Technology and Innovation

The Economics of Agricultural R&D

*Julian M. Alston, Philip G. Pardey, Jennifer S. James, and
Matthew A. Anderson* 537

Supply and Demand of Electricity in the Developing World <i>Madhu Khanna and Narasimha D. Rao</i>	567
Energy Efficiency Economics and Policy <i>Kenneth Gillingham, Richard G. Newell, and Karen Palmer</i>	597
Recent Developments in Renewable Technologies: R&D Investment in Advanced Biofuels <i>Deepak Rajagopal, Steve Sexton, Gal Hochman, and David Zilberman</i> . . .	621
Fuel Versus Food <i>Ujjayant Chakravorty, Marie-Hélène Hubert, and Linda Nøstbakken</i> . . .	645
The Economics of Genetically Modified Crops <i>Matin Qaim</i>	665

Errata

An online log of corrections to *Annual Review of Resource Economics* articles
may be found at <http://resource.AnnualReviews.org>