SHOULD DEVELOPING COUNTRIES RENOUNCE MINING? A PERSPECTIVE ON THE DEBATE

by

Graham A. Davis and John E. Tilton*

Executive Summary

According to conventional or traditional wisdom, countries that possess rich mineral deposits are fortunate. Such deposits are assets, and so are part of a country's natural capital. Like an individual or family, the more capital and wealth a nation possesses, the richer and better off it is. In this view of the world, mining is the key that converts dormant mineral wealth into schools, homes, ports, and other forms of capital that directly contribute to economic development.

Despite the intuitive appeal of the traditional wisdom, a new view of mining has emerged over the past two decades that questions the positive relationship between mineral extraction and economic development. Empirical studies suggesting that countries where mining is important have not progressed as rapidly as other countries provided the initial impetus for the new view. More recent studies have explored the reasons behind the disappointing performance of some mineral producing countries, and have identified the following possible explanations as to why mining may hinder economic development.

1. The prices of primary products may have fallen relative to those for manufactured goods. If true, countries producing and exporting primary goods have over time had to export more and more for a given basket of imported manufactured goods.

* Graham A. Davis is Associate Professor of Economics and Business at the Colorado School of Mines (gdavis@mines.edu). John E. Tilton is the William J. Coulter Professor of Mineral Economics at the Colorado School of Mines (jtilton@mines.edu), and while this study was conducted the 2002 Haydn Williams Fellow at the Western Australian School of Mines at Curtin University in Perth, Australia. We are grateful to Ian Emsley, Holly R. Lindsay, and Philip Maxwell for their helpful comments, to Tyler Hodge for his research assistance, and to the International Council on Mining & Metals (ICMM) for its financial support.

2. The volatility of primary commodity markets causes considerable fluctuations in government revenues and foreign exchange earnings for mineral dependent developing countries. These fluctuations make planning more difficult, and may as a result hinder economic development programs.

3. Mineral booms cause labor and other resources to flow out of agriculture and manufacturing and into the mining sector. Once their mineral resources are exhausted, countries may find it difficult to regain their competitiveness in these traditional export sectors.

4. Mining in some instances is an enclave industry providing few benefits to mineral producing countries other than the share of the economic profits or rents they capture through taxation.

5. The rents from mining may be misused and wasted. They may also promote rent seeking (efforts by groups to increase their share of the available profits) at the expense of rent creation (efforts that increase the total profits or wealth available for distribution). Even worse, rents may promote corruption, civil strife, and wars.

The new view of mining has precipitated a lively debate over the role of mining in the development of mineral producing countries. Adherents to the traditional view have challenged not only the empirical evidence suggesting that mining is associated with poor development but also all the causal links noted above tying mining to poor performance.

Though the debate is far from over, a few advocacy groups have nevertheless concluded that governments and international organizations should be discouraging rather than encouraging mining in the developing world. This policy conclusion, however, is appropriate only if (1) the new view is correct, and (2) the same policy has to apply to all countries and all situations. The first of these necessary conditions may or may not hold (which is why the debate continues); the second clearly does not hold.

While the central point of contention between the two views—namely, whether or not mining *usually* promotes economic development—remains unresolved, there is widespread agreement that rich mineral deposits provide developing countries with opportunities, which in some instances have been used wisely to promote development, and in other instances have been misused, hurting development. The consensus on this issue is important, for it means that one uniform policy toward all mining in the developing world is not desirable. The appropriate public policy question is not should we or should we not promote mining in the developing countries, but rather where should we encourage it and how can we ensure that it contributes as much as possible to economic development and poverty alleviation.

Introduction

Where the extraction costs for a mineral commodity are less than its market price, mining generates profits or economic rents.[1] For this reason, most economists and policy makers have presumed that mining creates wealth and in the process contributes to economic development in rich and poor countries alike.

The past couple of decades, however, have witnessed the emergence of a new and far less benevolent view of mining's contribution to economic development, particularly in the developing world. Based at first on case studies of individual mining countries and then later on more comprehensive comparisons among countries, a growing number of scholars have reported a negative association between mining on the one hand and a host of different indicators of economic development on the other (see Box 1).

These studies have led some to conclude that the governments of developing countries, along with international organizations such as the World Bank, should critically review their policies.[2] They contend that we should be discouraging, rather than encouraging, mining activities in developing countries. Though the new view of mining, as we will see, does have its critics, it is raising serious doubts about the benefits of mining for developing countries.

[1] This study uses the term mining broadly to include the extraction of all mineral and energy deposits. Similarly, it uses the terms profit and economic rent more or less interchangeably. While these two concepts are similar, they do in fact differ. Profit is an accounting concept, which reflects the conventions of that discipline. Economic rent or simply rent is an economic concept. Rent arises when an economic activity, such as mining, produces a surplus or wealth, in the sense that the revenues generated exceed the true economic costs of all inputs into the production process.

[2] See, for example, Ross (2001) and Friends of the Earth (no date).

Box 1. Economic Development

This study uses the term economic development somewhat loosely to reflect all the measures of social welfare found in the relevant literature. These include the level of per capita income along with its growth over time, the incidence of poverty as well as the alleviation of poverty over time, the distribution of income and changes in its distribution over time, as well as host of other welfare indicators—literacy, infant mortality, life expectancy—and their changes over time. While this simplifies the discussion, it is important to note that mining in particular situations may be positively associated with some of these measures while simultaneously negatively associated with others. For example, if rich countries grow more slowly than poor countries, mining in poor countries is likely to be correlated with low levels of per capita income but with rapid economic growth.

In the pages that follow, we provide an overview of the issues surrounding this important topic, highlighting where one still finds widespread agreement and where the debate between the two views is focused. We begin by describing separately the traditional and new views, then examine in some detail the outstanding and unresolved issues between the two, and finish the main part of the study by summarizing the findings and exploring their policy implications for mining in the developing world.

There are two appendices, which are somewhat more technical in nature. The first examines the works of Jeffrey Sachs and Andrew Warner, economists who have made particularly important contributions to the new view of mining. The second explores the widely read report by Oxfam America, *Extractive Sectors and the Poor*, which Michael Ross, a political scientist at the University of California, Los Angeles has prepared.

It is important to note that the use of the terms “traditional view” and “new view” is a convenient simplification. The traditional view has always had its critics, of

whom Prebisch (1950) and Singer (1950) are perhaps the best known, and as a result has never been universally accepted. Indeed, following World War II many developing countries, believing that specializing in primary product production led to low levels of economic development and slow growth, resorted to autarkic policies that protected inefficient domestic manufacturers and had what are now widely considered as disastrous consequences.

The Traditional View

The positive relationship between mining and economic development advanced by the traditional view rests on neo-classical economics and in particular the concept of the production function. The latter reflects the technical relationships that govern how much output a country can produce from any given amounts of labor, capital, energy, materials, and other inputs. Everything else being equal, the more capital a country has, the greater its output and the greater its per capita income.

According to the traditional view, mineral wealth in the form of deposits that can be profitably mined is part of a country's stock of capital. In particular it, along with agricultural land, forest resources, and other natural resources, comprises a country's natural capital.

There are, of course, other types of capital. Physical structures, including houses, roads, factories, hospitals, and railways, constitute man-made or physical capital. Education, safe public water and sanitary systems, as well as other investments in people, create human capital. Investments in scientific research and new technologies create knowledge capital. Finally, investments in the legal system and other forms of governance create institutional capital. (See Box 2)

Box 2. The Importance of Mineral Wealth

The World Bank (Kunte, et al., 1998) has estimated on a per capita basis the natural, physical, and human capital for nearly 100 countries for the year 1994. It has also estimated the contribution of subsoil assets (oil, natural gas, metals and minerals, and coal) to natural capital, and so the contribution of mineral wealth to a country's total natural, physical, and human capital can easily be calculated. While many questions can be raised about the reliability of the findings given the intrinsic difficulties involved in such an effort, the results are interesting. As Table 1 shows, for a number of countries mineral wealth is important, and represents a significant portion of the natural capital and total capital that they can mobilize in their efforts to develop.

Table 1. Subsoil Assets for a Selected Group of Countries, in U.S. Dollars Per Capita and as a Percentage of the Natural Capital and Total Capital, 1994

Country	Value in U.S. Dollars per person	Percent of Natural Capital[a]	Percent of Total Capital[b]
Saudi Arabia	67910	94	39.5
Venezuela	14960	72	13.7
Papua New Guinea	2980	40	7.6
Mauritania	1640	32	7.0
Trinidad & Tobago	9310	77	6.9
Norway	20090	66	6.6
Jamaica	2630	85	6.0
Chile	5580	39	3.9
Mexico	3860	58	3.5
Australia	9080	26	3.1
Congo	960	22	3.1
Ecuador	1970	17	2.9
Malaysia	3230	27	2.6
Namibia	1860	26	2.6
Canada	6750	18	2.0
Bolivia	640	11	1.9
Colombia	1380	23	1.6
South Africa	1340	32	1.6
China	420	16	1.1
Indonesia	670	9	1.1
Netherlands	2250	54	1.1
Brazil	910	13	1.0
United States	3180	19	0.8
Peru	430	9	0.7
Botswana	570	10	0.6

Notes: [a]Natural capital includes the value of pasture land, crop land, timber resources, non-timber forest resources, protected areas, and subsoil (mineral) assets.
[b]Total capital is the sum of physical, human, and natural capital.

Generally, the more capital a country possesses, the greater its output and the higher its per capita income. This is not necessarily the case, however, for natural capital in the form of mineral deposits. As long as such deposits lie dormant in the ground, they remain unproductive. For their potential to be realized, mineral deposits have to be extracted.[3] So, according to the traditional view, mining plays an important role in the development process by converting mineral resources into a form of capital that contributes to a nation's output.

The traditional view recognizes that under special circumstances a country may want to postpone the development of its mineral wealth. Such behavior makes sense if the value of its mineral wealth in the ground is appreciating faster than other assets with similar risks.[4] The available empirical evidence, however, suggests this rarely if ever occurs in practice.[5] Indeed, countries that deliberately delay the mining of currently profitable deposits in the hope that these deposits will be even more valuable in the future run the risk that new technology or other developments may make them completely uneconomic.[6] So normally, it is assumed, a country is better off mining its economic mineral resources now.

The output associated with extracting mineral resources can be consumed or invested in other forms of capital. Consumption tends to raise current welfare, while

[3] A country could, instead of extracting its mineral deposits, sell them to foreigners. If the new foreign owners did not then develop the deposits, the country might benefit from these resources without their extraction. However, foreign interests are unlikely to purchase mineral deposits unless they also intended to mine them.

[4] Hotelling (1931) examines the optimal rate over time at which a mine should extract its reserves. Many scholars have since attempted to relax the assumptions and extend the analysis of this seminal article to countries and the world as a whole. See Bohi and Toman (1984) and Krautkraemer (1998) for reviews of this literature.

[5] See Krautkraemer (1998) and Chapter 4 of Tilton (2002b).

[6] Radetzki (1992), for example, argues that the falling costs of transporting bulk commodities, which allowed the development of the great iron ore deposits in Brazil and Australia during the second half of the 20th century, would have destroyed much if not all of the wealth associated with the iron ore

investment leaves current welfare unchanged but raises future welfare by leading to economic growth. This assumes, of course, that the funds are invested wisely. If they are invested poorly, mining may provide little or no future benefit to the country.

In such cases, however, the problem is not mining, according to the traditional view. Mining provides the country with an opportunity. If the country fails to take advantage of this opportunity, the fault lies with the government and the other entities that decide how the newly converted mineral wealth is used.[7] Moreover, at times the welfare of society may require that governments use their available mineral wealth for purposes other than economic development. During World War II, for example, Britain, the United States, and their allies devoted much of their wealth and resources to winning the war. Few even now would argue that this was a mistake.

The New View

In the late 1980s, doubts about the traditional view of mining started to arise, largely as a result of a growing number of studies of individual mineral exporting countries that showed little or no economic growth over extended periods.[8] For some of these countries, growth was even negative, causing early regional dominance to be lost over time. This research clearly demonstrated that the exploitation of mineral wealth was far from a sufficient condition for sustained economic development.

In the wake of these country case studies, more comprehensive empirical analyses attempted to identify and measure the effect of mining on economic development using cross-section samples of developing countries. The most

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deposits in northern Sweden had Sweden decided to postpone their development during the first half of that century.

[7] A large literature within the field of political economy has developed around this theme. See Ross (1999) and Davis (1998) for a summary and critique.

[8] See, for example, the works of Gelb (1985a, 1985b, 1988) and Auty (1990, 1993, 1994a, 1994b).

influential of these analyses are the works of Sachs and Warner,[9] which Appendix A reviews in some detail. Many, including those of Sachs and Warner, find that a greater dependence on mining is associated with poorer economic growth, and so directly contradict the traditional view of mining.[10]

Of course, an association between two variables does not necessarily imply cause and effect. One can, for example, easily show that, when the percentage of people leaving home for work with umbrellas rises, the probability of rain later in the day increases. This is because people listen to weather forecasts, not because the decision to carry an umbrella affects the weather. In addition, there is still some dispute over whether the Sachs and Warner results are methodologically sound, and whether slower economic growth necessarily reflects diminished economic welfare (see Appendix A).

Still, the accumulating empirical evidence suggesting that mining is negatively associated with economic development at least raised the possibility of a causal relationship and stimulated the search for reasons as to why this might be the case. The possible explanations, it turns out, are many:

Declining terms of trade. According to the new view, over time the prices of primary commodities tend to fall relative to those for manufactured goods. This is in part because primary commodity markets are competitive and so reductions in costs are passed on immediately to consumers in the form of lower prices. The producers of many manufactured products on the other hand enjoy some market power, which allows them to divert the benefits of falling costs to workers in the form of better

[9] See Sachs and Warner (1995a, 1995b, 1997a, 1997b, 1999a, 1999b, 2000, and 2001).
[10] The two views are contradictory in the sense that they come to different conclusions regarding the benefits of mining for economic development. This difference, however, to some extent simply reflects the fact that they focus largely on different aspects of economic development. The traditional view concentrates primarily on level indicators of economic development, such as per capita income, literacy

salaries and to shareholders in the form of greater dividends. As a result, countries that produce and export mineral commodities will over time have to export more and more for a given basket of manufactured imports.[11] The effect is equivalent to having the purchasing power of one's salary decline; growth in welfare can slow or even be negative.

Volatile markets. The markets for primary products, including mineral commodities, are known for their instability. Prices variations of 30 percent or more within a year or two are not uncommon. In the case of mineral commodities, this volatility arises because demand fluctuates greatly over the business cycle.[12] When the economy is booming, the end-use sectors that consume most mineral commodities—construction, capital equipment, transportation, and consumer durables—are expanding even faster than the economy as a whole. Conversely, when the economy is in a recession, these sectors are usually even more depressed.

Instability in the metal markets arises primarily because of shifts in demand (rather than in supply, as is typically the case for agricultural products). As a result, when demand is down so are prices, and vice versa. This means that profits, and the taxes governments collect on profits, are particularly volatile.

Market instability makes it difficult for developing countries to count on revenues from the mineral sector, and hampers the effective planning needed for economic development. It also means that a country's government revenues and

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rates, and infant mortality. In contrast, the new view focuses mainly on growth indicators, such as the changes in per capita income, literacy rates, and infant mortality over time.

[11] Both Prebisch (1950) and Singer (1950) relied heavily on this argument in their early challenge to the traditional view of mining.

[12] There are two other conditions that contribute to the short-run fluctuations in mineral commodity prices. First, the responsiveness of demand to changes in price is small in the short run. Second, the responsiveness of supply to change in price is also small in the short run once output approaches existing capacity. This means that both the supply and demand curves are quite steep, so a shift in either curve will cause the market clearing price to change greatly. As noted in the text, the shift occurs in the demand curve as a result of fluctuations in the business cycle.

foreign exchange earnings are curtailed exactly when an expansionary monetary policy is needed to help the domestic economy weather the recession in a vital economic sector.

The Dutch Disease. A mineral boom, such as the expansion of the natural gas sector of the Dutch economy during the 1970s in response to the discovery of the Groningen fields, requires adjustments within the economy. Typically, domestic wage rates rise as the booming mineral sector is forced to offer workers higher salaries to attract the labor it needs. In addition, rising mineral exports cause the domestic currency to appreciate. Both of these developments harm those domestic industries, such as agriculture and manufacturing, that have to compete in home or foreign markets with overseas competitors. This, according to the new view, hurts economic diversification and increases a country's dependence on the volatile mineral markets. Moreover, after the mineral boom is over, the country's traditional sources of exports may well be devastated and beyond resuscitation.

Nature of mining. The new view also points to several characteristics of mining itself. First, local communities tend to bear most of the environmental and other social costs associated with mining, while the benefits flow largely to the central government and elsewhere. In addition, it is argued, mining is often an enclave activity. Needed supplies are imported, and little value added is carried out domestically, as ores and concentrates are exported for processing abroad. On top of this, mining employs few workers, and many of those it does employ (particularly the more skilled workers) come from abroad. As a result, the host country gets little from mining besides its share of the profits or economic rents.

Use of rents. Since mining (unlike most agriculture) is geographically concentrated, so are the profits and rents it generates. For this and other reasons, they

tend to accentuate the income disparities that already exist in most developing countries.

The concentration of rents also makes it worthwhile for individuals and organizations to devote considerable effort and resources to capturing a share of the rents. Such rent-seeking activities are unproductive; they are devoted to increasing the share of the existing economic pie that a particular group enjoys, rather than to increasing the size of the pie itself. The size of the pie is increased by rent-creating activities, such as mining itself.

Even worse, the concentration of rents can lead to corruption and in some instances to civil insurrection and war. Moreover, even when the rents are not squandered, but used by the government to promote economic development, the results are often disappointing due to incompetence and poor planning.

For one or more of the above reasons, many who subscribe to the new view of mining believe that the negative association between mining and economic development does in fact reflect a causal relationship. For them, developing countries on balance could well be better off if they left their mineral resources in the ground. Governments and international organizations, instead of supporting mining, should be assisting developing countries in other economic activities and in other ways.

Unresolved Issues

The traditional and new views of mining, despite their differences, actually agree on a number of important issues. In particular, there is widespread consensus that:

1. Mineral deposits that can be extracted profitably are (natural) capital assets. If they are converted into human or physical capital, they can promote economic growth; and if they are consumed, they can lower current poverty. In either case, they can enhance economic development. In short, mineral resources provide developing countries with opportunities that they would not otherwise enjoy.
2. Some countries have taken advantage of these opportunities, and used their mineral wealth to promote economic development. Historically, Britain, the United States, and Germany are often cited as successful examples.[13] In more recent times, it is generally agreed that mineral resources have promoted economic development in Australia, Botswana, Canada, Chile, Malaysia, the Netherlands, and Norway. Botswana, it should be noted, is the only country ever to graduate from the United Nations' least developed country grouping.[14]
3. Similarly, it is widely recognized that in other countries, such as Zambia and Sierra Leone, mining has increased poverty and impeded long-term economic development through many of the avenues described earlier.[15]

[13] As we were finishing this report, Oxfam America issued a new report, entitled "Digging to Development? A Historical Look at Mining and Economic Development," prepared by Thomas Power, an economist at the University of Montana. It contends that mining was never a significant source of national wealth or development in Australia, Canada, and the United States. From the press report that we have seen (we have not yet had the opportunity to see the original study), it is not clear whether the study is simply arguing the mining is one of many factors that contributed to the economic development of these three countries, in which case the findings are neither surprising nor controversial, or whether the report is arguing that mining made no contribution or a negative contribution to the development of these countries, in which case the findings are both surprising and in sharp conflict with the available literature on this topic.

[14] UNCTAD (2002, p. 128), though as Appendix B notes, the devastating impact of the AIDS epidemic has significantly reduced expected longevity in Botswana during the 1990s with adverse effects on the country's development.

[15] A recent study by UNCTAD (2000) asserts that mineral production is responsible for the large and rising levels of poverty in the Central African Republic, the Democratic Republic of Congo (formerly Zaire), Guinea, Liberia, Niger, and Sierra Leone.

So the debate is largely focused on whether mining promotes or impedes economic development *in most developing countries*. The widely read Oxfam report (Ross, 2001), entitled *Extractive Sectors and the Poor*, and a few other recent studies suggest that this issue is now settled. Mining, they contend, on balance hinders economic development and aggravates poverty in the developing world. Yet other scholars come to the opposite conclusion.[16] Moreover, the Oxfam study itself suffers from several shortcomings. In particular, both the reliability of the empirical findings and the conclusions and policy recommendations derived from the findings can be challenged (see Appendix B). So here the consensus found on other issues does not exist.

Debate also continues over the validity and the importance of the arguments that mining actually causes poor economic development. So it is useful to look once again at these arguments.

Declining terms of trade. Numerous studies have both attacked and defended the thesis that the prices of primary products have fallen over time relative to the prices of manufacturing products.[17] The mere fact that studies continue to appear on this topic indicates that the issue is far from settled.

One troubling problem arises because many manufactured products improve in quality over time. For some products—computers being a particularly good example—the improvements are spectacular. So even assuming the trend in the ratio of prices for primary to manufactured products is indeed downward, this may simply

[16] See Davis (1995), Lederman and Maloney (2002), and Sala-i-martin (1996, 1997), as well as the discussion in Appendices A and B.
[17] See Sapsford (1990) for a survey of this literature. More recent contributions include Powell (1991), Ardeni and Wright (1992), Bleaney and Greenway (1993), Bloch and Sapsford (2000), and de Ferranti et al. (2002).

reflect improvements in the quality of the manufactured goods. Removing this bias, however, is extremely difficult, particularly over many decades.[18]

Perhaps of greater importance, even if the new view is correct and the true terms of trade are declining, the relevance of this decline for developing countries is not clear. We know, for example, that the real price of copper has declined over the past three decades, which presumably has diminished the terms of trade of Chile, the world's largest copper producer. We also know that this decline has come about largely because the costs of producing copper around the world have fallen as a result of new technology and other developments.[19] The wealth or economic rent created by Chile's mining industry depends not only on the price the country receives for its copper but also on the costs of production. If the country's costs have fallen faster than the copper price—which seems quite likely given the many world class copper mines starting operations in that country over the past 15 years—the benefits flowing to the country from mining may actually be rising despite the downward trend in the price of copper.[20,21]

[18] See Svedberg and Tilton (2002). The Boskin Commission (1996) estimates that the U.S. Consumer Price Index overestimates inflation by 1.1 percentage points a year, of which 0.6 percentage points is attributed to two biases—the failure to introduce new goods in a timely manner into the index, and pure quality improvements in goods over time. For the sake of illustration, assume that (1) pure quality improvements account for half of the latter figure, or 0.3 percentage points, (2) this figure represents the annual increase in the price of manufactured products due to quality improvements over the 20th century, and (3) that primary products enjoyed no corresponding improvements in quality. Then, even had the true terms of trade remained unchanged, the pure quality bias would have produced a 30 percent decline in the reported terms of trade between primary and manufactured products over the 20th century. Or alternatively, had the recorded terms of trade for primary product producers fallen by 20 percent, their true terms of trade would actually have risen by 10 percent. While all of the above assumptions can be questioned, the fact remains that the failure to account for quality improvements introduces a significant downward bias in the recorded terms of trade of primary producers.

[19] See Tilton (2002a).

[20] As a result of the opening of new mines and the introduction of new technology at existing mines, labor productivity in the Chilean copper industry more than doubled during the 1990s (Garcia et al., 2001).

[21] Economists have long known that the ratio of export to import prices, or what is called the net barter terms of trade, does not necessarily reflect trends in a country's gains from trade. To deal with this issue, they have developed other concepts of terms of trade. See Meier (1968, ch. 3).

Volatile markets. There is little dispute over the fact that mineral commodity markets are volatile, particularly over the business cycle, for the reasons laid out earlier, and that countries whose economy and exports are dominated by a single mineral commodity are likely to face considerable swings in government revenues and export earnings. Yet advocates of the traditional view of mining tend to discount this concern.

Some argue that volatility is actually not all that bad for economic development. While it does make planning more difficult, and may reduce the efficiency of both public and private investment, downturns in the commodity cycle often force needed changes that would not occur under less stressful conditions. Government spending programs, for example, often take on lives of their own and continue long past the time when they would best be put to rest. When government revenues and export earnings are down, it is clear to all that the budget has to be cut, providing the government with the needed political cover to terminate no longer useful programs.

Similarly, market slumps provide mining companies with strong incentives to improve their productivity and reduce their costs. Between 1980 and 1986, for example, with copper prices in the doldrums, the U.S. copper industry doubled its labor productivity, and managed to survive despite media predictions of its imminent demise.[22] The improvements during these crisis periods, such as new work rule agreements with organized labor, often would not be possible under more normal conditions.

Moreover, even assuming that fluctuations in government revenues and export earnings are a deterrent to economic development, governments can mitigate these

[22] See Tilton and Landsberg (1999)

fluctuations. In particular, when mineral markets are booming, they can put some of their commodity revenues into a stabilization fund. Then, when the markets are depressed, they can withdraw the accumulated revenues to support government programs that otherwise they would be forced to curtail. Indeed, Alaska, Canada, Chile, Ghana, Norway, Papua New Guinea, Venezuela, and other countries have created such funds.

It is true that the results have been mixed. In some countries, money seems to burn a hole in the pockets of government officials, so adequate funds are not available when they are needed. Some conclude that this shows stabilization funds cannot work, but others point to more positive experiences, and argue that better governance and stronger institutional arrangements should correct the problems.

The Dutch Disease. The structural adjustments that occur within a country during a mineral boom, such as the Netherlands during the 1970s, are by themselves not a problem. In fact, the term, the Dutch Disease, is really a misnomer: It is not a disease. Nor is it particularly Dutch. Many other countries have gone through similar experiences. Indeed, the Dutch disease actually allows a country to benefit from its new found mineral wealth by encouraging resources to flow from other sectors of the economy to the booming sector. It basically reflects the mechanism by which this occurs (an appreciating domestic currency and rising wage rates).

For the Dutch disease to be a true disease, in the sense that it hurts economic development in the long run, additional assumptions are necessary. One approach that achieves this end is to assume that the resource boom will eventually peter out and when this happens the country will find it difficult or impossible to shift resources back to its traditional export industries, presumably in agriculture or manufacturing. Since there have been few countries that have made this transition, it is perhaps too

soon to tell whether this hypothesis has any merit. However, there is little evidence to suggest that resources would not flow out of the resource sector and into other sectors once the boom ended.[23]

Another approach is to assume that learning occurs in the production of manufactured goods, but not in the production of mineral commodities. Learning causes production costs to fall as the cumulative output of a firm or country increases, and is reflected in increasing productivity. Countries that take advantage of a resource boom crowd out manufacturing and lose this benefit. If in addition one assumes that the profits or rents countries could earn in the future as a result of this learning by doing exceed the profits or rents from mining, then it can be demonstrated that moving resources out of manufacturing and into mining is a mistake.[24]

Of course, the assumption that no learning takes place in mining can be challenged. Mining is, after all, a form of manufacturing that takes rocks and other resources and transforms them through a highly mechanized means into metals, fuels, and other useful products. The discovery, extraction, and processing of mineral commodities entails highly sophisticated technologies, which have advanced rapidly in recent years. As a result, learning by doing may occur in mining at a pace at or above that found in many manufacturing industries.

So the debate regarding the Dutch disease is not over the macroeconomic structural adjustments that a resource boom precipitates. These by themselves are benign, even beneficial. Rather, it focuses on the plausibility of the additional assumptions required for the structural adjustments to affect economic development

[23] Davis (1995) identifies Tunisia as the only economy that has drastically decreased its oil and mineral intensiveness since 1970, and it seems to be doing fine, with a Human Development Index that has increased remarkably since 1975 (UNDP 2001).

[24] This argument also assumes that the governments of other countries, which presumably are equally aware of the potential benefits from learning by doing, do not encourage through public policies and

adversely. To date, researchers have been unable to verify empirically whether these assumptions are reasonable.[25] And, even if the assumptions do hold, the optimal policy response may be subsidization of the shrinking sectors, rather than a curtailment of mining (van Wijnbergen 1984).

Nature of mining. Few would dispute that most of the environmental and other social costs of mining are inflicted on the local community, while most of the profits or rents realized by the country flow elsewhere.[26] This has led to growing demands that a sufficient portion of the benefits from mining should flow to local communities to ensure they are adequately compensated for the costs of mining that they incur. If this is not possible, or if it is not done, then for many the basic principles of equity suggest that mining should not proceed.

On this point, local communities have increasingly demonstrated an ability to stop mine development and even to shut down existing operations when they believe the costs to them exceed the benefits. As a result, many mining companies are no longer prepared to proceed with new projects without the support of the local community.

Once the full costs are covered, however, there is less agreement on how the rents from mining should be allocated. These rents are in part created by exploration and by research and development, and the mining companies themselves often feel entitled to them. However, they are also a gift of nature reflecting geological processes that occurred hundreds of millions of years ago. To whom does this portion

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subsidies sufficient over-investment in the manufacturing sector to offset the potential external benefits arising from learning by doing.

[25] Sachs and Warner (2001, p. 835) note: "It seems fair to say that some variant of these crowding-out stories are the most likely explanations for the curse of natural resources, although further refinement is necessary."

[26] Other benefits of mining, such as the opportunity to acquire technical skills, may, of course, be more focused on the local community and region than the rents (see McMahon and Remy 2001).

of the rents rightfully belong? To the local community, the country? To the poor and disadvantaged? To the original landowners and indigenous peoples? To the current generation, future generations, or both? Reasonable people can disagree on the answer to this question.

The argument that mining is typically an enclave industry with the host country realizing few benefits aside from its share of the rents, though not new, is also far from settled. Many studies of mining regions show that wages and other domestic expenditures do have a significant multiplier effect on the local economy.[27] Others document that mining in many cases does in fact promote important downstream and upstream linkages.[28] However, for various reasons, these studies concentrate primarily on the developed countries and the more advanced developing countries. More evidence from the poorest developing countries, where mining is most likely to follow the enclave pattern, would be useful.

A more direct challenge, suggested by some, to the enclave argument against mining is that it is irrelevant. So what if the benefits to a country are mostly in the form of money or rents? These are as good as gold; they can support education, public health, infrastructure developments, and other investments that stimulate development. Indeed, it is even argued that host government efforts to replace expatriate employees with nationals, to promote downstream processing, and to require mining firms to acquire supplies from domestic firms are probably counterproductive since these efforts raise the costs of mining and so reduce the monetary rents that could be flowing to the host country. In such situations, the government is in effect subsidizing these linkage activities simply because they are

[27] See Ahammad and Clements 1999, Aroca 2001, Clements and Johnson 2000, Clements and Greig 1994, and Stilwell et al. 2000.
[28] See, for example, de Ferranti, et al. 2002.

associated with the mining industry. While a desire to create domestic employment may be commendable, there are far more labor intensive industries than mining or mineral processing. Moreover, economic development requires the creation of wealth. Subsidizing industries that would otherwise lose money destroys wealth.

More developing countries, it is true, would probably enjoy a comparative advantage in downstream processing if the developed countries did not impose a structure of tariffs and other barriers to mineral trade that discriminates against the more processed mineral commodities. So changes in the trade policies of the importing countries could help mineral producing developing countries (and consumers in the importing countries as well). But this does not change the fact that, as long as the current structure is in place, subsidizing unprofitable industries reduces the wealth of the developing country. This is true even when the industries receiving subsidies would not need them in the absence of discriminatory trade policies.

Use of rents. The use of rents, it is widely recognized, is critical in determining whether or not mining promotes economic development. When they are squandered by corruption, war, and other rent-seeking activities, mining is likely to be a negative rather than positive force for development. The same is true when the rents are wastefully consumed—on shopping trips to Europe by the wealthy, for example—rather than invested in alternative forms of capital. Where the debate on this argument against mining is met today is on the extent to which such misuse is endemic and inevitable.

The traditional view of mining contends that good governance can and does prevent corruption and minimize the internal frictions that breed war and violence. Good governance can also thwart the economic incentives that give rise to rent-

seeking behavior, and ensure that mining rents are re-invested in human capital and other assets that promote economic development.

The new view of mining counters, not so much by claiming that mining rents cannot foster economic development, but instead by arguing that in practice this is rarely the case. In addition and perhaps even more troubling, it points to evidence suggesting that large mining rents may themselves undermine good governance by breeding corruption within government.[29]

Findings and Their Policy Implications

In the 1950s, Charles Kindleberger, a well-known professor of economics at the Massachusetts Institute of Technology, was working on the first edition of his textbook, *Economic Development*. Early in the draft he paused to write "Anyone who claims to understand economic development *in toto*, or to have found the key to the secret of growth, is almost certainly wrong" (Kindleberger, 1958). At that time the field of development economics was in its infancy. Very little data were available, and limited computing power prevented the rigorous analysis of the information that did exist.

Governments, international organizations, and other agencies have since amassed huge amounts of data. Computing power has exploded, allowing researchers to search for data patterns and explanations of the results using advanced computational techniques. Yet, in spite of all this progress, theory after theory of economic development has fallen short, and economists continue to struggle in their efforts to understand the causes of development and underdevelopment. The 4th and

[29] See Gylfason (2001a) and Sachs and Warner (1997a). Sachs and Warner find that higher resource intensiveness is correlated with *perceptions* of increased government repudiation of contracts, risk of expropriation, corruption, and decreased bureaucratic quality.

final edition of Kindleberger's book, published in 1983, contains a modified and even stronger warning: "Anyone who claims to understand economic development completely, or to have found 'the' key to 'the' secret of economic growth, is likely to be a fool or a charlatan or both" (Herrick and Kindleberger, 1983, p. xvi).

Clearly the lack of progress is not for want of effort. Economic development is a main area of economic research. Nobel Prize winners and others have dedicated their lives to unravelling the development mystery. Rather, it is because of the extreme complexity of the problem. Each nation brings its own nuances to the issue, and all nations interact regionally and globally in creating the observed economic outcomes. Since a comprehensive model of development would have to consider thousands of variables, it is perhaps not surprising that models focusing on only one or two variables are disappointing.

Within this conundrum lies the narrow set of questions that we have explored: Can mining promote the development of developing countries possessing mineral wealth? And does it do so in practice? For some time, most experts thought the answer to both questions was yes. There was little debate over these issues. The past two decades, however, have seen a growing number of studies challenging the traditional view of mining, precipitating a lively debate in the process.

In reviewing the literature, we have focused on the differences between the traditional and new views of mining, but have also stressed the fact that significant areas of consensus do exist. No one to our knowledge, for example, contends that mineral wealth in the ground is not an asset.[30] Like other assets or other forms of capital, it provides a country with potential opportunities. In addition, no one to our

[30] By mineral wealth, we mean mineral deposits that can be mined at a profit after taking all costs, including the external costs, into account.

knowledge believes that mining has never actually contributed to economic development. Just as no one to our knowledge goes to the opposite extreme and argues that mining has always promoted economic development.

Rather the debate centers on whether mining usually promotes or retards economic development, the reasons why in some cases mining is a positive force and in others a negative for development, and finally the implications for public policy.

In exploring the policy implications, raising the right questions matters. Some studies have addressed the question, should governments and international organizations encourage or discourage mining in developing countries? Drawing on the new view of mining, they contend that the developing countries would be better off if their mineral wealth were left in the ground.

To question this conclusion on the grounds that the debate over the new view of mining is far from settled, while valid, misses the critical point that this is simply not an appropriate question. It implicitly presumes that the correct policy choice is the same under all conditions and for all developing countries. Yet, as we have seen, there is a widespread consensus that mining can promote economic development, and has actually done so in some countries, including Botswana, Chile, and Malaysia. Even in countries where mining on balance does not promote growth, particular projects may. If we want to help the developing countries and to reduce poverty, to discourage mining where it promotes these goals is clearly counterproductive. It impedes poor countries from mobilizing their mineral wealth—a capital asset that for some countries accounts for a significant portion of their total wealth—in their struggle to develop and to shed poverty.

More appropriate and useful questions for policy are: How can public policy maximize the net benefits a country receives from its mining sector? How can policy

ensure these benefits are effectively used for economic development and the reduction of poverty? How should policy respond when good governance and other conditions necessary to ensure that mining will on balance promote development are not in place? These, of course, are much harder questions to answer, in part because there is no single answer that fits all countries and all situations. In addition, there is, as we have seen, still much we have to learn about why mining promotes development in some situations and impedes it in others.

These questions, however, do recognized that mineral wealth provides some developing countries with opportunities they would not otherwise have, and that mining can be a positive force for development. They also recognize that good policy can foster the conditions needed to ensure mining is on balance a positive force for development. The third question even suggests that mining policy can help promote more broadly those conditions, such as good governance, that promote economic development.

Some may object that this implies interference in the internal affairs of sovereign states. On the other hand, it does not seem unreasonable for the international community, through the World Bank and other international organizations, to tailor the support it provides to developing countries so that it fosters its own stated goals, including the promotion of sustainable development and the alleviation of poverty.

So in the end, the appropriate policy question is not should we promote mining in the developing world, but rather where should we encourage it and how can we ensure that it contributes as much as possible to economic development.

Appendix A
The Sachs and Warner Studies

"All-encompassing hypotheses concerning the sources of economic growth periodically surface, and with the support of adequately chosen cross-country correlations, enjoy their fifteen minutes of fame."[31]

If current growth rates are persistent, they provide an indication of future development. Faster growing economies will develop more quickly, and slower growing economies will develop more slowly. Faster growing developing economies may even overtake slower growing developed economies. Understanding economic growth is therefore a forward-looking piece of the development puzzle.

In 1995, Jeffrey Sachs and Andrew Warner, economists then at Harvard University, published what was to be the first in a series of their papers examining mining's role in economic growth (1995a). However, their purpose was not to unravel the growth mystery with the aim of predicting what is to come in the long run, and perhaps to intervene in the interim. Nor was their purpose to assess the current development health of those economies that were extensively extracting minerals and oil. Rather, their paper proposed to investigate what they variously call "a conceptual puzzle," "a surprising feature of economic life," and an "oddity:" namely, the negative association between a country's natural resource (agriculture, minerals, and fuels) production in 1971 and subsequent economic growth in the 1970s and 1980s. A 1997 version of the paper updates the growth period to 1990, and converts the base year to 1970, with little impact on the results. The two papers, and many follow-on

[31] Wacziarg (2002, p. 907).

pieces, are frequently cited as support for a resource curse. This Appendix explains Sachs and Warner's methodology and results, as well as how the results can be interpreted.

Sachs and Warner (1997a) begin by estimating the intensity of 1970 natural resource production and subsequent economic growth for a sample of 87 developed and developing countries. Resource intensiveness is measured in a variety of ways. However, their econometric results are largely invariant to the indicator used, and so for the majority of their work they define a resource-intensive economy as one that has a relatively high share of agricultural, mineral, and fuel exports in relation to GDP. They measure economic growth as the annual change in real GDP per economically active population, which is in fact a measure of growth in labor productivity.

When their data on labor productivity growth are regressed against resource intensiveness in a cross-country analysis, one finds that countries with a higher level of resource intensiveness in 1970 did indeed grow more slowly over the subsequent two decades, with causality implied due to the lagged growth measurement.[32]

While growth in labor productivity depends on many factors, the presence or absence of primary production is not one typically considered. Two factors that economists do frequently control for in these types of growth regressions are initial level of GDP per capita and trade openness. Countries with higher GDP per capita tend to grow slowly, while countries with open economies tend to grow quickly. Since mineral economies tend to have higher GDP per capita and less trade openness

[32] Sachs and Warner (1997a) show the relationship in a scatter diagram, but do not report the estimated results. The results we obtained using their data for this relationship follow: Labor Productivity Growth, 1970-1990 = 2.33 – 9.10 (Share of Primary Exports in GDP, 1970), $R^2 = 0.22$. The standard errors indicate that the coefficient on the share of primary exports is significant at the 99 percent level.

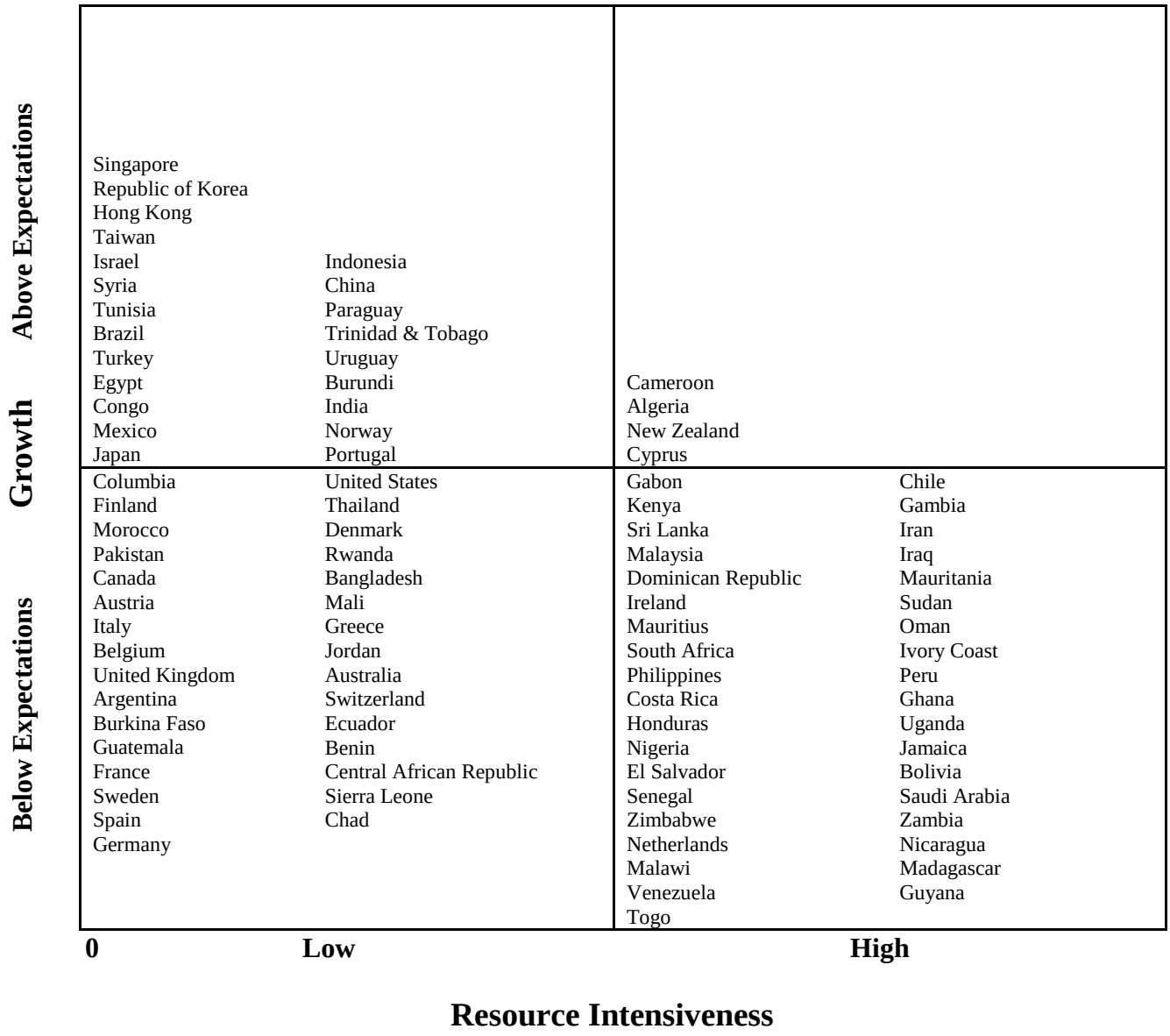
than non-mineral economies, the slower growth may simply be due to unfavorable growth conditions.

Sachs and Warner control for these factors and find that resource abundant economies still grew more slowly than expected given their income and trade handicaps. We reproduce Sachs and Warner's results in this regard in Figure A-1. Countries in the upper right hand quadrant of this figure had relatively high resource intensiveness in 1970 and grew above expectations over the 1970-1990 period given their initial income and trade openness. Countries in the lower right hand quadrant had relatively high resource intensiveness but grew below expectations. Countries in the lower left hand quadrant had relatively low resources intensiveness and grew below expectations. Finally, countries in the upper left hand quadrant had relatively low resource intensiveness and grew above expectations. The figure clearly shows that the more resource-intensive economies for the most part performed below expectations.[33]

Furthermore, the resource impact was quite pronounced; after allowing for their growth handicaps, the most resource-intensive country still had annual productivity growth rates of between 4 percent and 5 percent lower than expected. For example, the actual difference between annual productivity growth rates in Japan and Zambia over the sample period was 5.5 percent (Japan's productivity grew by 3.3 percent per year, while Zambia's fell by 2.2 percent per year). Of this difference, 1.5

[33] Sachs and Warner exclude several countries from their data estimations. We add seven of them here for visual completeness, although, in keeping with Sachs and Warner, we have not included them in the estimation of expected growth. The lop-sidedness of the country performances in Figure A-1 is a result of the below par performance for any country that had a positive level of resource intensiveness. Of the countries that had zero resource dependence, exactly half had growth that was at or above the expected level, while half had growth that was at or below the expected level. This is not evident in the figure as the left-most column of countries includes those with no resource dependence and those with minor amount of resource dependence, causing the performance in aggregate to be below par (there are more countries in the lower half of the figure than the upper half).

Figure A-1: Growth Performance Over the 1970–1990 Period Versus Resource Intensiveness of Economic Activity in 1970



percent is attributed to differing income levels and trade policies (which on balance make Zambia's anticipated growth lower than that of Japan), and 4.0 percent is attributed to Zambia's resource intensiveness in 1970.[34] Such growth differences are remarkable. If all economies started at the same level of per capita GDP and trade

[34] Zambia should have grown 1.5 percent faster than Japan as a result of its lower initial per capita income, and should have grown 3 percent slower than Japan as a result of its trade policies. Together these two factors explain a net shortfall of 1.5 percent in the growth of Zambia compared to Japan.

openness in 1970, putting them all on an equal footing, the least resource intensive economy would, by 1990, have had a real per capita GDP that was roughly 2.5 times larger than that of the most resource-intensive economy.

Slow growth is traditionally thought to be policy or geographically related, and not related to resource production per se. Since there is no immediately apparent reason as to why resource production itself would cause slower growth, Sachs and Warner go on to look for links between resource production and slower growth via indirect policy effects. But these efforts fail. The resource-abundant economies are still found to grow more slowly from 1970 to 1990 than economies that do not have a large natural resource base, even after controlling for terms of trade changes, investment policy, and political risk. Resource-based economies do tend to have economic, legal, and political policies that are traditionally thought to slow growth. But these indirect effects explain only a small fraction of the total growth effect (Sachs and Warner 1995a, 1997a, 2000). Commodity price trends, geography, and previous growth experiences also do not explain the phenomenon (Sachs and Warner 1997a, 1997b, 2001). Nor do the poorer scores on bureaucratic efficiency and institutional quality of the resource abundant economies (Sachs and Warner 1999b).

In other words, even if all the negative economic, political, and bureaucratic effects associated with resource abundance were corrected, there would remain a negative relationship between resource abundance and economic growth in the 1970s and 1980s. This phenomenon has come to be called the “resource curse”. This is not to say that all developing economies with extensive natural resource production in 1970 experienced worse than expected growth in this period; Cameroon and Algeria are clear exceptions (see Figure A-1). But from these studies there certainly appears to be a tendency in this regard.

If Sachs and Warner had determined that the poorer growth performance was due to, say, bureaucratic inefficiency, one would be able to say something about the persistence of the growth effects of being a resource abundant economy (persistence is likely), and the corrective policy actions (work to provide incentives for good bureaucracy). With no indirect effect identified, the causal relationship remains to be explained. It could even be a "false positive" due to unrepresentative country sampling, inappropriate statistical techniques, or an anomaly related to the 1970s and 1980s. In any event, Sachs and Warner are left to speculate about the cause, and the possible persistence of the cause.

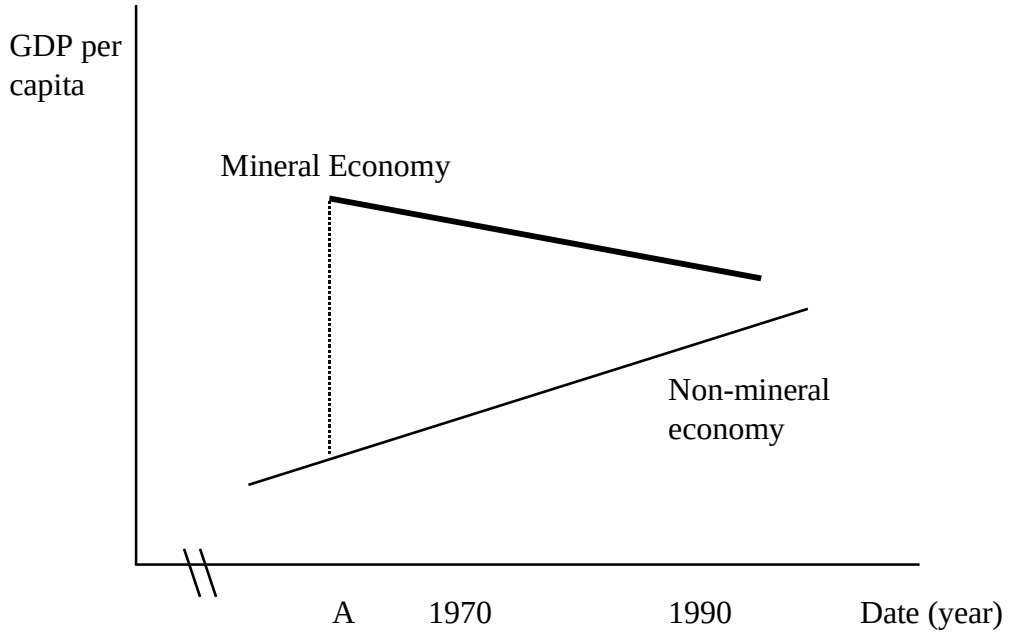
In their 1995 paper, they posit that the problem is a retarded manufacturing sector, with resource-based activities crowding out manufacturing. As they put it in a recent paper: "Natural Resources crowd-out activity *x*. Activity *x* drives growth. Therefore Natural Resources harm growth" (Sachs and Warner 2001, p. 833). Activity *x* may be manufacturing exports, education, entrepreneurial activity, innovation, or pro-growth government activities. A slowing of *manufacturing* activity in resource-based economies is known as the "Dutch Disease," based on the contraction of Dutch manufacturing sectors following the boom in natural gas production from the Groningen fields in the 1970s. Models of Dutch Disease typically show that the resource boom increases welfare in the booming country (e.g., Cordon and Neary 1982), and a simulation of such effects by Bruno and Sachs (1982) determines that a sudden move in the United Kingdom from no energy production to self sufficiency would increase steady-state household welfare by 1.1 percent. Dutch Disease effects are only detrimental to an economy if technological advance is driven mainly by domestic manufacturing experience. To the extent that a resource-based economy does not gain this experience, it will fall behind in its technological know-how. Sachs

and Warner's model has resource-based economies experiencing a boom in economic output upon the extraction and export of their resources, only to have a slower or even negative subsequent growth in GDP as a result of these crowding out effects. The impact is shown in Figure A-2. The mineral boom begins in year A, with a sharp increase in GDP per capita due to the sudden rents from production. Subsequent growth is assumed to slow due to the crowding out of manufacturing, [35] a phenomenon that is picked up in Sachs and Warner's data (1997a, 2001), or education (Gylfason 2001b), or entrepreneurial activity (Torvik 2002). Of note is that in these crowding out models, during the resource boom, mineral economies have higher income levels than non-booming economies. This has been confirmed empirically by Davis (1995) and Rodriguez and Sachs (1999). A particularly good example is Zambia, which rose to be one of Africa's stars in the early years of its minerals boom (Baldwin 1966). Mineral economies will also have a higher rate of growth than non-mineral economies if the period of measurement begins before the resource boom (i.e., prior to year A in Figure A-2). That is, the slow rate of growth is only that subsequent to the boom.

At this point, such crowding out theories need further investigation and refinement (e.g., Torvik 2001). There is no empirical evidence, for example, that a shrinking manufacturing sector will slow growth as posited. If learning by doing effects exist in mining comparable to those in manufacturing, which as suggested earlier is likely, then the crowding out of manufacturing by mining is not cause for concern.[36] Nor is there evidence that the crowding out effects, if real, are large enough to offset the windfall gains from the resource boom in the long run.[37]

[35] Rodriguez and Sachs (1999) develop this model for the case of Venezuela.
[36] Mining, as noted earlier, is a form of manufacturing, that converts mineral resources through highly mechanized means into useful materials. Unfortunately, the Dutch disease model of Sachs and Warner (1995a, 1999b) assumes that there is no labor or capital employed in the extractive sector, making

Figure A-2: Crowding Out of Manufacturing Causes Slower Growth of Resource Economies



Figures A-3 and A-4 show two possible growth paths associated with different levels of crowding out. In Figure A-3, after the resource boom has ended (year B), the resource economy has lost ground as a result of its resource boom. Bolivia, Mexico, Peru and Venezuela are examples of countries where this may be the case according to Sachs and Warner (1999a). In Figure A-4, the resource economy benefits in the long run from its resource boom. Sachs and Warner (1999a) suggest that Ecuador is an example, while other countries (Chile and Columbia) appear to have had no long-run change in per capita GDP in response to their resource booms.

production in that sector more like oil flowing naturally out of the ground and onto a tanker, rather than the processing of rock into metal. As such, the model is inapplicable to mining. De Ferranti et al. (2002, p. 61), in any event, state that the extent of manufacturing crowding out is not as severe as often argued.

[37] In Sachs and Warner's own model of crowding out effects the long-run welfare impacts of the resource boom are not necessarily unfavorable (1999b).

Figure A-3: Resource Boom Ultimately Detrimental to Resource Economies

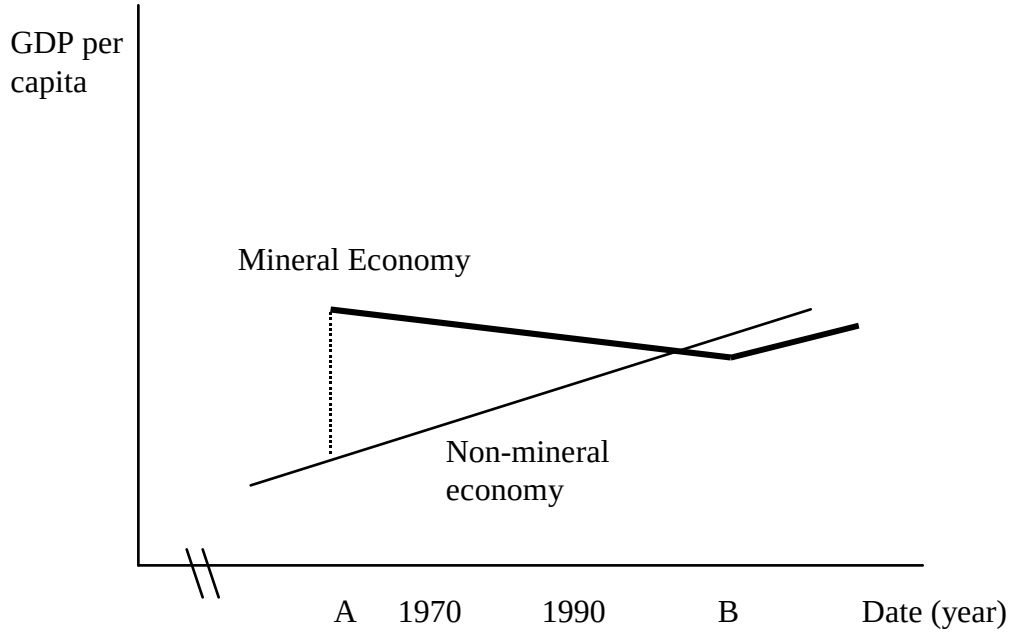
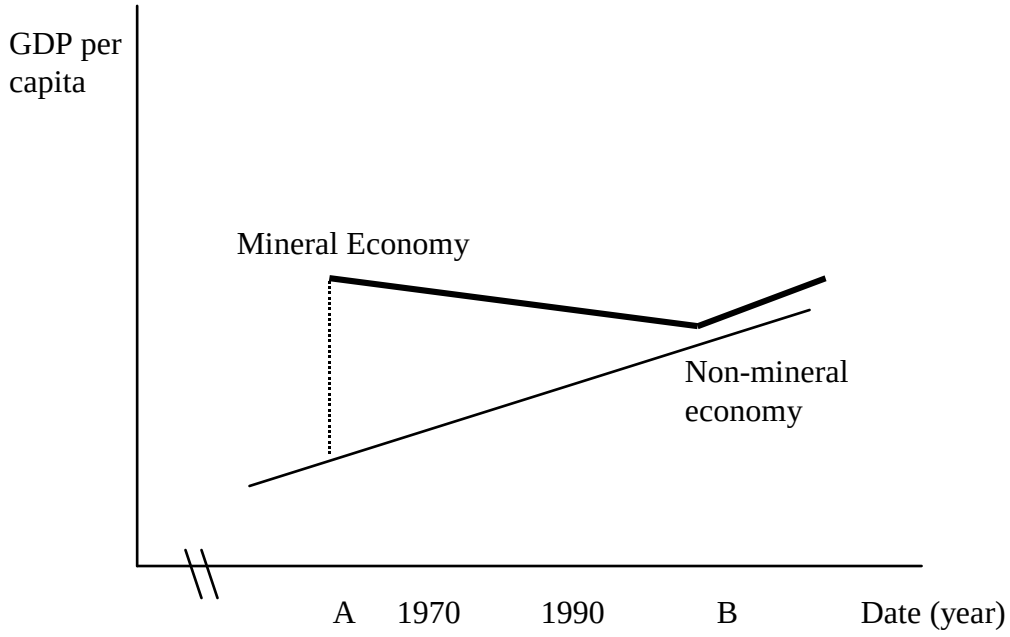


Figure A-4: Resource Boom Ultimately Beneficial to Resource Economies



While work on these crowding out theories continues, other researchers have taken a closer look at the data and methods used by Sachs and Warner. De Ferranti et al. (2002, 42) claim to have found the indirect link between resource production in 1970 and the slow growth in the 1970s and 1980s. High export concentration in and

of itself inhibits growth, and once they control for export concentration, resource abundance no longer has a separate direct effect on growth. Coincidentally, perhaps, mineral economies tend to have a high export concentration. Manufacturing economies tend to have less export concentration.

What the research of de Ferranti et al. suggests is that the negative growth effect is not coming from the impact of resource production on government, investment, and so on, or its crowding out of manufacturing, education, or entrepreneurship, but rather from its impact on the concentration of exports. Another interesting finding is that the export concentration of mineral economies appears not to be solely due to mineral production, but also to the protectionist trade policies that the mineral economies adopted in the 1970s and 1980s (2002, p. 43).[38] If this is the case, then the policy advice is not to diversify away from minerals production via even stronger trade restrictions, but rather through trade liberalization.

However, all of this discussion presumes that the lower growth of the mineral economies in the 1970s and 1980s is truly representative of systematic growth patterns, not only for those mineral economies in Sachs and Warner's sample, but for current and future mineral economies. Yet many issues suggest that this is not the case.

First, in carrying out their tests, Sachs and Warner sample roughly half of the world's economies, those with economic data in 1970. The other half, for which there are insufficient data, are poor economies with little or no capability for data collection. Among the slow growing countries, the mineral economies are likely to be included (because colonial governments set up statistical offices), while the non-

[38] Protectionist trade policies tend to increase the cost of imports, making exports that rely on imported inputs less competitive. The net effect of trade protection is then exactly the opposite of that intended-it reduces export trade and concentrates exports in the few products that do not rely on imports as inputs.

mineral economies are more likely not to be included (since they lack the mineral wealth to induce colonial occupation). If the samples used are not representative of the world as a whole, the results do not represent the world as a whole.

Second, the period of analysis is important. Sachs and Warner's results suggest that, for the countries in their sample, growth in the 1970s and 1980s was slower for those with mineral resources. De Ferranti et al. (2002) look at a different data period and come to the exact opposite conclusion: "Natural resources-based activities can lead growth for long periods of time" (p. 4). The reason for de Ferranti et al.'s different findings: a longer term view, which includes the resource-driven growth success of the early 1900s, and the recognition that much of the negative performance in the 1970s and 1980s was a result of short-term forays into inward looking trade policies in an effort to diversify and the debt crises suffered by many resource-based nations in the 1980s. The 1970s also saw widespread nationalization of mineral assets (e.g., in Zambia, Zaire, Indonesia, and Venezuela). Preliminary work by Lederman and Maloney (2002) confirms that the negative growth effect found in Sachs and Warner disappears if different growth periods are observed.

Third, the selection of 1970 as the year by which to rank countries' resource dependence was arbitrary, but important, as was the selection of labor productivity growth as the growth variable of interest. A similar analysis by Sala-i-martin (1996, 1997) regresses growth in GDP per capita from 1960 to 1992 (versus Sachs and Warner's growth in labor productivity from 1970 to 1990) against mining activity in 1988 (versus 1970 in Sachs and Warner). The results shows that, after controlling for initial level of income, life expectancy, and primary-school enrollment, mineral

economies had *higher* than expected growth.[39] Sala-i-martin also finds that the measure of resource intensiveness matters (Sachs and Warner found that it did not). The differences may be coming from the increased number of countries in the sample (Sala-i-martin samples 130 countries, versus 87 for Sachs and Warner), the different measure of growth, the different growth period, the different reference date for resource abundance, or the different economic and political factors for which Sala-i-martin controls.[40] Whatever the reason, Sala-i-martin's analysis shows just how fragile cross-country regressions are, and how quickly their results can be overturned.

Finally, Sachs and Warner's statistical method of testing growth patterns is liable to give false results. Lederman and Maloney (2002) find that the negative association between resource abundance and labor productivity disappears when a more modern and appropriate statistical test is used.[41]

Whether it is due to the data sample, period of analysis, or statistical method used by Sachs and Warner, the important outcome from this competing work is that the persistence of Sachs and Warner's result is questionable. As mentioned above, if there is no persistence in the growth pattern, there is little in predictive capabilities or sustained policy advice that can be taken away from the research. Sachs and Warner do admit to the preliminary nature of their analysis. But they go further (1997a, pp. 27-28):

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[39] Causality is less clear here, due to the fact that growth may have preceded and thereby caused mineral intensive production, rather than mineral intensive production causing rapid economic growth. More likely, though, is that Sala-i-martin is picking up the spike in GDP that resource booms create (Figure A-2).

[40] Sala-i-martin's approach was to run millions of regressions, controlling for multiple combinations of factors, and to estimate the average impact of mining on growth over these millions of regressions.

[41] The Sachs and Warner regressions include GDP per capita in 1970 on both the left hand side and right hand side of the regression. This leads to a problem called simultaneity, which must be controlled for using a technique called instrumental variables. Lederman and Maloney use Generalized Method of Moments–Instrumental Variables, developed in the early 1990s as a solution to this problem. Referring back to Figure A-1, the impact of simultaneity is that the expected growth of the resource intensive economies may be miss-estimated, meaning that the neat arrangement of over-performers and under-performers is actually more scattered and may show no identifiable pattern.

> Although this paper does find evidence for a negative relation between natural resource intensity and subsequent growth, it would be a mistake to conclude that countries should subsidize or protect non-resource-based [industries] as a basic strategy for growth. First, although the results here using highly aggregated data are suggestive, they are far from definitive. Second, as argued in Sachs and Warner [1995b], the evidence from the recent past suggests that there are simpler and more basic policies that can be followed to raise national growth rates, especially open trade. Third, the welfare implications of resource abundance can be quite different from the growth implications. Resource abundance may be good for consumption even if not good for growth; policies might be good for GDP growth, while reducing real consumption. Put differently, government policies to promote non-resource industries would entail direct welfare costs of their own, and these could easily be larger than the benefits from shifting out of natural resource industries.

An important aspects of this message is that it is welfare that counts, and not GDP or its growth. Another is that even if resource economies have been dealt a bad hand that will cause their welfare ultimately to drop below that of non-resource-based economies (Figure A-3), they can make the best of the situation not by turning their backs on their resource industries, but by promoting growth through good policy, such as trade openness and subsidization of the shrinking manufacturing sector. It is no coincidence that Zambia's fall in economic status since the 1960s was largely a result of its plans, beginning in 1964, to diversify its export base away from copper via trade restrictions. According to Sachs and Warner's results, the closed trade regime that it set up lowered its annual growth in the 1970s and 1980s by between 1 and 3 percent. Moreover, this diversification effort failed. As of 1991, 98 percent of Zambia's exports were still concentrated in minerals (Davis 1995).

Appendix B
The Oxfam America Report

Most of the research on economic development examines the causes of the difference in growth rates between developed and developing countries, and of differences in growth rates between the developing countries themselves. This is an indirect way of understanding the diversity of economic outcomes that we observe today. Countries that are now at the top of the pile must have grown faster than countries that are now at the bottom, and so an understanding of past growth patterns will explain the disparity in current development outcomes. Very few studies have looked directly at the current level of economic development across countries and sought to explain the reasons for the coexistence of wealth and poverty.[42] And aside from the Oxfam America report, the subject of this appendix, only two of these studies have examined the role of mineral extraction in explaining the divergence of current levels of economic development.

In the first, Davis (1995) assesses whether mineral-based developing economies as a group have a higher or lower level of economic development, as measured by a variety of economic and human development indicators, than non-mineral developing countries.[43] He examines a set of 22 developing countries that have had a prolonged period of intensive mineral and energy extraction, and finds that these economies had higher levels of development, based on simple averages, than the non-mineral economies in both 1970 and 1991, the two time periods examined.

[42] The studies also tend to be rhetorical rather than empirical (e.g. Diamond 1997, Landes 1998)
[43] A much earlier study by Nankani (1979) using a single development indicator, school enrollment, found enrollments to be lower in mineral economies. For a critique of Nankani's analysis, see Davis (1995).

More recently, Rodriguez and Sachs (1999) show that, among the countries in Sachs and Warner's (1997a) data set, resource abundant economies had a higher level of GDP per capita in 1970 than would be expected given their trade openness and levels of human and physical capital. GDP per capita and human development levels are highly correlated, and so this is further evidence that mineral economies, all else equal, have a higher level of development than non-mineral economies. Neither of these studies proved causality—that mineral extraction causes higher human development—although theoretically we do expect that the rents from extraction will cause higher GDP per capita, rather than the other way around (see Appendix A).

These findings suggesting that mineral dependency is positively related to the level of economic development, it should be noted, are not necessarily inconsistent with the findings of Sachs and Warner and others suggesting that mineral economies may grow more slowly than other economies. This is because mineral economies may grow relatively slowly while at the same time enjoying what Sachs and Warner (1999b, p. 16) call "euphoric" levels of income while they are extracting their mineral wealth (see Appendix A for more on this).

Oxfam America (Ross 2001) has recently published a report, *Extractive Sectors and the Poor*, which belongs to this second genre of literature focusing on level rather than growth of economic development. The foreward (p. 3) points out, "As an organization dedicated to combating poverty in the developing world, Oxfam America is particularly concerned about the effects of oil, gas, and mining on impoverished communities," and so this study pays special attention to the effects of mineral dependency on poverty.

The foreward (p. 3), in addition, somewhat curiously asserts in summarizing the work to date that resource-dependent countries "simply have not converted their

resource wealth into real improvements in the lives of the majority of their citizens." Economists and activists are pointing out, it claims, that "many countries in the developing world possess tremendous oil and mineral wealth and yet continue to suffer from crushing poverty." Yet the broad evidence to date, as we note above, is that mineral economies tend to enjoy higher levels of economic development than similar economies without a resource base. In addition, one searches the available literature in vain for empirical studies identifying mineral extraction as the cause of the poverty in the developing world.[44]

The Oxfam study, conducted by UCLA political scientist Michael Ross, sets out to examine "how states that rely on oil and mineral exports address the concerns of the poor" (p. 4). Based on empirical evidence across a sample of 123 developed and developing countries in the 1990s, Ross concludes that mineral-dependent states tend to have higher poverty rates than non-mineral dependent states. They also have more corruption, more civil war, more military spending, less effective government, and more authoritarianism. In all, given these results, they are far from ideal places to live.

The Oxfam conclusions are based on a set of 12 cross-country regressions, the results of which are summarized in Table B-1 below. Of the six regressions testing the link between oil dependence and various development indicators and trends, two show oil having a negative linkage (regressions 3 and 7), three show oil dependence having no linkage (regressions 4, 8, and 10), and one (regression 12) shows oil having a positive linkage. Of the six regressions testing the link between mineral dependence

[44] This is not to say that poverty does not exist in many mineral economies, and numerous case studies of such instances exist. Of the least developed economies (LDCs), those that export mainly minerals have some of the highest instances of poverty (UNCTAD 2002, 124). How poverty relates to mineral production in these countries, however, is unclear, and is complicated by among other things the widespread existence of artisanal mining in many of these countries.

Table B-1: Oxfam Regression Results

	Dependent Variable	Independent Variable			Sample Size (# of countries)
		Oil Dependence (1995)	Mineral Dependence (1995)	GDP per Capita (1998)	
1	Human Development Index Rank (1998)	N/a	↑	↓	124
2	Human Development Index Rank (1998)	N/a	↑	N/a	124
3	Human Development Index Rank (1998)	↑	N/a	↓	148
4	Human Development Index Rank (1998)	↔	N/a	N/a	148
5	Human Development Index Score (1998)	N/a	↓	↑	124
6	Human Development Index Score (1998)	N/a	↓	N/a	123
7	Human Development Index Score (1998)	↓	N/a	↑	148
8	Human Development Index Score (1998)	↔	N/a	N/a	148
9	HDI Score Change 1990-1998	N/a	↓	N/a	107
10	HDI Score Change 1990-1998	↔	N/a	N/a	125
11	Income Poverty Rate (c. 1997)	N/a	↑	↓	44
12	Income Poverty Rate (c. 1997)	↓	N/a	↓	52

Notes:

↑ means that the dependent variable has a statistically significant positive correlation with the independent variable.

↓ means that the dependent variable has a statistically significant negative correlation with the independent variable.

↔ means that there is no statistically significant relationship.

N/a indicates that the independent variable was not included in the regression.

Shaded cells represent a correlation that supports Oxfam's conclusions that extraction and the level of poverty are positively linked.

Sample size indicates the number of countries in the sample.[45]

[45] These sample sizes are based on the number of countries for which there were data, based on our replication of the Oxfam results using Ross's data and some additional country sampling. Our sample sizes differ slightly from the sample sizes reported in the Oxfam report because of the countries we added. We thank Michael Ross for sharing his data with us.

and various development indicators and trends, all six show mineral dependence having a negative linkage.

The study is written in a clear, direct style, which the interested non-specialist can easily follow, and it comes to some strong conclusions regarding mining and poverty. It has, as a result, attracted considerable attention, is widely cited, and quite influential. It also suffers from several shortcomings:

Indicators of Poverty

Ross's "preferred" indicator of poverty is the Human Development Index (HDI), an index developed by the United Nations in 1990 to measure the overall progress of a country in human development. The index includes measures of longevity, educational attainment, and standard of living. Ross prefers the index as a measure of poverty because of its availability for almost every developed and developing nation.

HDI, however, is not a measure of poverty (UNDP 1997, pp. 22-23). This is why the United Nations created the Human Poverty Index (HPI) in 1997 for a group of 78 developing countries. In 1998, it created a parallel Human Poverty Index (HPI-2) for selected industrial countries, noting again that there is "no pattern between the HDI and human poverty" (1998, p. 29). Thus, whatever the relationships between minerals or oil dependence and HDI shown in Table B-1, they tell us little about the relationships between mineral dependence and poverty.

Ross's only direct analysis of poverty uses an indicator called income poverty, which is the fraction of a country's headcount with an income below a given level. He finds this indicator less desirable than the Human Development Index because it is

only available for 51 countries (p. 8). However, it is also an unreliable indicator of poverty. As the United Nations points out, "Regression analysis indicates a weak relationship between the headcount index of income poverty and HPI. So, in monitoring progress, the focus should not be on income poverty alone, but on indicators of human poverty as well" (1997, p. 22).[46] In effect, then, the Oxfam report has done little to measure the association between poverty and mineral or oil dependence.

Reliability of Results

While the Oxfam report does suggest a negative association between economic development, measured by HDI, and mineral and oil dependence, Ross's empirical methodology raises questions about the reliability of these findings. In determining the correlation between mineral extraction and various proxies for development and poverty, Ross uses ordinary least squares (OLS). In this technique, the level of poverty (proxied by the Human Development Index score and rank in 1998, and by a measure of poverty) is regressed against the degree of resource intensiveness within an economy (measured by the ratio of value of mineral exports to GDP in 1995). His data set includes up to 144 developed and developing countries.

The simplest set of equations, regressions 2, 4, 6, and 8 in Table B-1 above, shows that countries with greater mineral resource intensiveness tend to have lower levels of human development, whether measured by HDI score or rank. That is, the regression coefficient on mineral dependence is negative and statistically significant when the dependent variable is the HDI score (with this measure a high number

[46] Another problem with the income based poverty measure is that it is based on unreliable survey data, rather than national accounts data (see UNCTAD 2002).

indicates high development) and is positive and statistically significant when the dependent variable is the HDI rank (with this measure a low number indicates high development).[47]

This is a relatively uninformative result. Does it mean that developing countries are developing—and hence not developed—because they have an abundance of mineral extraction and a lack of manufacturing activity? Or is it rather that developing countries competing within a global economy that includes developed economies with established manufacturing sectors tend to possess a comparative advantage in mineral extraction? In short, do developing countries have a low level of development because of their mineral dependence, or is their mineral dependence the result of their low level of development and inability to compete with developed countries in the production of manufactured goods? Thus, there is a problem in asserting causality from such regressions, a subject that we discuss in detail below.

Ross correctly rejects the results of these first regressions as providing little indication of the impact of mining on poverty. The real question, he points out, is "whether countries with similar levels of per capita income, but different levels of oil or mineral dependence, do better or worse in addressing the needs of the poor" (p. 8). Ross adds the natural log of GDP per capita in 1998 as an independent (or right-hand-side) variable, and looks again at the relationship between HDI and mineral dependence. These are regressions 1, 3, 5, and 7 in Table B-1 above. After controlling for per capita income in this way, he again finds a negative and statistically significant relationship between mineral dependence (and now also oil dependence) and HDI performance.

[47] The coefficient on oil dependence is not significantly different from zero, indicating no discernible pattern.

These regressions, however, suffer from two problems that make these results unreliable. The first is heteroskedasticity. Heteroskedasticity arises when the regressions errors are not well behaved, and causes the statistical significance of the regression coefficients to be misrepresented. As a result, a regression that appears to have statistical significance may not be significant at all. Twenty-one of Ross's regressions suffer from heteroskedasticity, including six in Table B-1 above. After correcting for heteroskedasticity using standard procedures, the correlations in four of his regressions become insignificant, including, most importantly, the correlation between mineral dependence and HDI rank (regression 1 in Table B-1 above).[48]

The second technical problem with the regressions is more serious. In regressions 1, 3, 5 and 7 in Table B-1 (above), GDP per capita in 1998 is included as both a right-hand side variable and a left-hand-side variable, since the human development index (HDI) that Ross uses contains GDP per capita in 1998 as one of its components. That is, GDP per capita is an endogenous (dependent) variable, and yet it is being used on the right-hand-side of the regression as an exogenous variable to control for level of income.

This results in a problem called simultaneity or endogeneity. When simultaneity is present, the regression coefficients are biased either upwards or downwards. Researchers go to great effort to avoid such simultaneity problems in their econometric work, and tools exist that allow empirical examination of data that produces unbiased regression coefficients.[49] In any event, the consequence here is that Ross's main finding in regressions 1, 3, 5 and 7, that mineral and oil dependence are

[48] The other regressions that become statistically insignificant are under-five mortality as a function of oil dependence, secondary school enrollment as a function of oil dependence, and government effectiveness as a function of mineral dependence.

[49] The usual correction to simultaneity of a right-hand-side variable is to use an "instrumental variable," either within a two-stage least squares or generalized method of moments technique.

statistically related to lower levels of development, is unreliable. As a result, the report contains no reliable empirical evidence of oil or mineral dependence being correlated with a lower human development score after controlling for GDP per capita.

In two equations that do not immediately appear to suffer from heteroskedasticity or simultaneity since they have different right-hand-side and left-hand-side regressors, Ross regresses income poverty on GDP per capita and oil or mineral dependence (regressions 11 and 12 in Table B-1 above). In a sample of only 44 countries, there is a positive and statistically significant relationship between mineral dependence and poverty; higher mineral dependence is associated with a greater level of poverty, after controlling for GDP per capita. In another sample of 51 countries, there is a *negative* and statistically significant relationship between oil dependence and poverty –higher oil dependence is associated with a lower level of poverty, after controlling for GDP per capita. From this, Ross concludes that "mineral dependence is strongly linked to lower standards of living and increased poverty rates" (p. 8).

For several reasons, however, this conclusion is misleading. Mineral economies tend to have higher levels of GDP per capita than developing non-mineral economies at a comparable level of development (Rodriguez and Sachs 1999). This in and of itself most likely results in a lower level of poverty than in the absence of minerals. Ross's regressions are simply telling us that, for his small sample of countries, the level of poverty in mineral economies is higher than we would expect *given their higher level of GDP per capita.* We can say nothing about absolute levels of poverty.

Also, while a regression result may be statistically significant, it is not necessarily important. Of the difference in poverty rate between a mineral-intensive mineral least developed economy, such as Guinea (31.4 percent), and a non-mineral-intensive developing economy, such as Thailand (13.1 percent), only six percentage points can be ascribed to the difference in mineral dependence. The rest is due to difference in GDP per capita.[50]

Finally, simultaneity is in fact a problem here, too, since mining activity likely depends on the level of poverty in a nation. For example, one would expect more artisanal mining—a low skill and highly labor intensive activity that requires little capital investment—in nations where poverty has left a large portion of the populace without the skills needed for jobs in manufacturing and other economic sectors. In other words, poverty can cause an absence of manufacturing and abundance of mining. This simultaneity means that the regression coefficients are biased and therefore unreliable indicators of the relationship between mining and poverty.[51] Table B-2 below represents the Oxfam results after taking into account the impacts of simultaneity, where any unreliable results due to simultaneity are now indicated by a question mark. The table shows that no reliable correlation exists between oil dependence and HDI or poverty scores. Nor is there any reliable correlation between mineral dependence and HDI or poverty scores once one controls for differences in per capita income, which as we have seen is necessary to demonstrate any causal relationship between mineral dependence and development. Indeed, the only

[50] For a clear exposition of the difference between statistical significance and economic importance, see Chapter 2 of McCloskey (1996).

[51] One might argue that, if all of the Oxfam poverty data were measured as of 1997, then the simultaneity problem would disappear, as poverty in 1997 cannot affect the level of mining in 1995. However, data on poverty were taken at the latest date available, from 1987 through 1997. Moreover, a country's poverty level in 1997 is likely to depend on its poverty level in earlier years, in which case simultaneity would still be a problem.

Table B-2: Oxfam Regression Results after Corrections for Simultaneity

	Dependent Variable	Independent Variable			Sample Size (# of countries)
		Oil Dependence (1995)	Mineral Dependence (1995)	GDP per Capita (1998)	
1	Human Development Index Rank (1998)	N/a	?	?	124
2	Human Development Index Rank (1998)	N/a	↑	N/a	124
3	Human Development Index Rank (1998)	?	N/a	?	148
4	Human Development Index Rank (1998)	↔	N/a	N/a	148
5	Human Development Index Score (1998)	N/a	?	?	124
6	Human Development Index Score (1998)	N/a	↓	N/a	123
7	Human Development Index Score (1998)	?	N/a	?	148
8	Human Development Index Score (1998)	↔	N/a	N/a	148
9	HDI Score Change 1990-1998	N/a	↓	N/a	107
10	HDI Score Change 1990-1998	↔	N/a	N/a	125
11	Income Poverty Rate (c. 1997)	N/a	?	?	44
12	Income Poverty Rate (c. 1997)	?	N/a	?	52

Notes:

↑ means that the dependent variable has a statistically significant positive correlation with the independent variable.

↓ means that the dependent variable has a statistically significant negative correlation with the independent variable.

↔ means that there is no statistically significant relationship.

N/a indicates that the independent variable was not included in the regression.

? means that the regression estimate is biased and unreliable due to simultaneity.

Shaded cells represent a correlation that supports Oxfam's conclusions that extraction and the level of poverty are positively linked.

Sample size indicates the number of countries in the sample.

conclusive results reported in Table B-2 are that mineral extraction is linked with a lower HDI score and higher HDI rank (indicating that mineral economies tend to be the developing economies, which is not surprising), and that the HDI score for mineral economies dropped from 1990 to 1998 (a finding we examine next).[52,53]

The final results from Table B-1 that require inspection are regressions 9 and 10, where the change in HDI score is regressed on oil and mineral dependence. On the basis of the results summarized in Table B-1 above, Ross concludes "Moreover, over the course of the 1990s, the mineral-dependent states lost ground: the greater a country's level of mineral dependence, the larger the amount it tended to fall in the HDI rankings between 1990 and 1998" (p. 8).

We interpret the results differently. First, given that mineral economies had a higher level of HDI in 1990 (Davis 1995), the mineral economies are only losing ground to the extent that the non-mineral economies were catching up. They are not necessarily falling behind, which is what one might take away from Ross's conclusion.

Second, the degree of change is not very large, again getting at the difference between statistical significance and economic importance. The regression results suggest that the average HDI score for non-mineral economies increased by 0.031 from 1990 to 1998.[54] The average mineral economy's HDI score declined by 0.016.[55]

[52] Simultaneity is avoided as long as the level of mining activity in 1995 is not a function of the change in development level from 1990 to 1998.
[53] Ross reports the regression results for change in HDI score (p. 21), but discusses change in HDI rank in the text of the report (p. 8).
[54] The data to make this determination was not presented in the Oxfam report, and we have calculated it by replicating Ross's results. The HDI score ranges from zero to one, with a higher number indicating higher development. The highest score among countries for which data exist is about 0.95, while the lowest score is around 0.15. For a detailed account of how the HDI score is calculated, see any UNDP Human Development Report.
[55] The average minerals dependence score from Table 1 is 10.62 (median = 6.30). -.0015 x 10.62 = -0.016.

Third, the drop in score for the mineral economies is a result of two highly mineral dependent economies—Botswana and Zambia—whose HDI scores fell dramatically over the 1990-1998 period. If these two countries are removed from the sample, one finds no statistically significant pattern between changes in HDI scores and mineral dependence. In many cases, where a regression result is driven by only one or two countries out of a sample of a 100 or more, these countries are deemed outliers and are removed from the data (see, for example, Sachs and Warner 1997).

Finally, Ross simply infers that the loss in HDI score must be a result of mineral extraction, since the two are correlated. In fact, the large declines in HDI scores for Zambia and Botswana over the 1990-1998 period, which are driving the regression results, are due to the drop in expected longevity in these countries caused by the AIDS epidemic (United Nations Development Program 1997, pp. 46-47).[56] In contrast, over the two decades prior to 1990, Botswana's HDI grew at the seventh fastest rate among 110 countries, increasing by 0.215.[57] According to the United Nations Development Programme, Botswana "benefited from the sale of minerals and skillfully invested this in human development" during this period (UNDP 1992, pp. 24, 94).[58]

For all these reasons the evidence presented in the Oxfam report is unreliable, and does not in fact support the conclusion that mining was detrimental to the

[56] Botswana's HDI index dropped by 0.058 points from 1990 to 1998. The change in life expectancy caused a 0.076 drop, the change in educational attainment a 0.032 drop, and the change in standard of living a 0.049 increase, producing the net change of 0.058. Without AIDS and the decline in life expectancy, Botswana's HDI would have risen over this period. The same is also true for Zambia, whose HDI fell by 0.031. In this country, the drop in longevity caused a 0.077 decline, the rise in educational attainment a 0.057 increase, and the fall in standard of living a 0.011 decline.

[57] Even though it was one of the worst performers over this period (103 out of 110), Zambia's score fell by only 0.006.

[58] Another mineral economy, Gabon, was also lauded for its development performance from 1970 to 1990, as was Saudi Arabia and Indonesia, two oil-producing nations.

development of mineral economies over the 1990s, or that this pattern had previously persisted for some time.

Cause and Effect

Another major shortcoming of the Oxfam report arises from the way the empirical results are interpreted. Correlations can be spurious, as is the case, just discussed, of mineral extraction and changes in HDI scores. So correlation by itself does not indicate causation.

The Oxfam report recognizes that mineral activity itself is unlikely to directly affect poverty. Rather it asserts that mineral dependence acts on poverty indirectly: if *x* causes poverty, and minerals dependence affects *x*, then mineral dependence causes poverty. Ross posits that the *x* that is causing poverty is institutional effectiveness, a widely accepted view, and indeed finds that minerals extraction and several indicators of institutional effectiveness are negatively correlated.

In parallel work to that of Oxfam, Acemoglu et al. (2001) finds that a large amount of the current difference in developing country income levels can be explained by the effectiveness of the institutions within an economy. In fact, this study concludes that current levels of income are caused mainly by the types of institutions set up by colonial powers, and that natural resource abundance has no separate effect on institutional quality. If the quality of institutions is determined by colonial origins, and not mineral resource abundance, why is Ross picking up a correlation between mineral dependence in 1995 and institutional quality? Poor government institutions create a comparative advantage in minerals production (De Ferranti et al. 2002). In other words, if one takes an economy with civil wars, corruption, and lack of government effectiveness, all due to colonial influences, it is

not unreasonable to expect that country to have an economic structure based on primary production rather than manufacturing. In this case, primary production is the best thing that these economies can do, an argument made by development economists as early as 1967 (Ohlin 1967).

What are the implications for mineral dependence and poverty? High levels of poverty in such badly run countries are quite likely. So mineral dependence may be found to be correlated with poverty, but the correlation is spurious. Both poverty and mineral dependence are caused by poor institutions, and are each, separately, correlated with institutional quality. Ross's regression of poverty on mineral dependence (aside from the reliability issues discussed earlier) may be picking up this effect, and yet minerals production is not causing poverty, and nor in this situation is poverty causing minerals production.

Non-Supported Conclusions and Recommendations

The Oxfam report provides the following summary of the empirical results: "Oil and mineral dependence produce a type of economic growth that offers few direct benefits for the poor; moreover, oil and mineral dependence make pro-poor forms of growth more difficult, due to the Dutch Disease." (p. 16). Not only is the report devoid of any study of growth patterns or Dutch Disease,[59] but, as we have mentioned, the empirical work has not determined that oil and mineral dependence *produces* any economic development outcome. This is an issue of causality that is very difficult to prove.

[59] Here Ross is relying on Sachs and Warner's work. We note that Sachs and Warner are careful to draw no conclusions about the impacts of low growth on levels of poverty, and in fact expressly note that their results have no bearing on the level of welfare in a nation (see Appendix A).

Ross appears to be aware of this, as his other conclusions refer to correlation rather than causation. Moreover, the Oxfam regression results, although unreliable due to simultaneity problems, show that oil economies actually have a *lower* level of poverty after controlling for GDP per capita, making the above quoted conclusion a direct contradiction of the empirical results. Yet, despite this positive association between oil production and poverty, and despite his careful use of the words "correlations" and linkages in the concluding text, the policy recommendations are all based on a negative causal relationship between mineral and oil dependence and poverty.

The economic experiences of mineral and oil dependent states are so varied, and development economics so complex, as to make any broad pronouncements about resources and development linkages, let alone causalities, unwise. Among the mineral dependent states are Sierra Leone, the nation with the lowest United Nations Human Development Index (HDI) ranking in 1995, at 174, and Norway, with a 1995 rank of 2. Among the oil dependent states are Angola, with a rank of 160, and Bahrain, with a rank of 41.

Ross pessimistically notes that 18 of the 50 resource-dependent states are classified by the World Bank as "highly-indebted poor countries," the lowest development category.[60] On the other hand, of the 47 resource-dependent states for which data exist, the United Nations classifies 32, or 68 percent, as having medium or high human development in 1995 (UNDP 1998). The resource-dependent economies are faring, as a group, about as well as nations as a whole: 75 percent of the 174 nations tracked by the UN had medium to high human development in 1995.

[60] Resource economies borrow against their resource base because they can, much as homeowners take out home equity loans because they can. Debt is not, in and of itself, bad. Whether debt is productive or not depends on the use to which the borrowed funds are being put.

Policy implications

Our analysis of the empirical work within the Oxfam report finds that, at the end of the day, there is very little reliable information on which to make any sweeping policy recommendations. Certainly, nothing can be said about the correlation between mineral dependence and poverty. And yet Oxfam takes the empirical work as definitive, and from this comes a policy recommendation reminiscent of the disastrous advice given to the Latin American countries in the 1970s: "avoid export-oriented industries altogether, and instead work to sustainably develop their agricultural and manufacturing sectors" (p. 17). This includes the suggestion that the World Bank subsidize downstream processing if it is not naturally forthcoming. In fact, those economies that have pursued state-led industrialization as an attempt to diversify away from raw materials have actually had a slower movement into manufactures than those that pursued open trade policies (Sachs and Warner 1995b). The data also repeatedly and robustly reveal these economic policies to have a negative impact on long-run growth (e.g., Sala-i-martin 1997). The link to poverty is not direct, but plausible; economies that grow faster have more potential, at least, to enact poverty-reducing programs. Oxfam recognizes this, and yet does not recognize that its policy recommendations will likely lead to slower growth in the mineral economies, and more poverty rather than less poverty in the future.

Another reality is that not every country can diversify and reduce its output of mineral commodities. Nor, if global poverty reduction is the goal, should it. Imagine, for example, if all of the OPEC oil exporting countries took the Oxfam report to heart, gradually turned off the flow of oil, and started to manufacture textiles and grow wheat. The decrease in world oil supply would drive oil price up several fold, creating

a world-wide recession that would impact those developing countries reliant on energy imports to such an extent that their poverty levels would increase enormously. We have only to remember the impacts of the oil price shocks of the 1970s to envision what this would do to developing countries.

On the other hand to what extent, one has to ask, has the drop in real energy prices over the last three decades improved the lives of the poor? By focusing on the poverty-stricken in the resource dependent countries, Oxfam is ignoring the poor in resource-poor countries, and how they may actually benefit from the continued exports of the resource-rich countries.

On one Oxfam policy recommendation there is widespread agreement. The multilateral lending institutions should promote transparency, reward governments that are pro-poor, and monitor government's use of resource revenues. This is good advice no matter what the evidence on minerals dependence and poverty. For, as all would agree, no matter what the past patterns and links between minerals extraction and economic development, there is room for improvement.

References

Acemoglu, Daron, Simon Johnson, and James Robinson. 2001. The colonial origins of comparative development: an empirical investigation. *American Economic Review* 91(5): 1369-1401.

Ahammad, Helal, and Kenneth Clements. 1999. What does minerals growth mean to Western Australia? *Resources Policy* 25(1), 1-14.

Ardeni, Pier G. and Brian Wright. 1992. The Prebisch-Singer hypothesis: a reappraisal independent of stationarity hypotheses. *Economic Journal* 102: 802-12.

Aroca, Patricio. 2001. Impacts and development in local economies based on mining: The case of the Chilean II region. *Regional Policy* 27(2), 119-134

Auty, Richard M. 1990. *Resource-based Industrialization: Sowing the Oil in Eight Developing Countries*. Oxford: Clarendon Press.

Auty, Richard M. 1991. Managing mineral dependence: Papua New Guinea 1972-89. *Natural Resources Forum*, May: 90-99.

Auty, Richard M. 1993. *Sustaining Development in Mineral Economies: The Resource Curse Thesis*. London: Routledge.

Auty, Richard M. 1994a. Industrial policy reform in six large newly industrialized countries: the resource curse thesis. *World Development* 12: 11-26.

Auty, Richard M. 1994b. *Patterns of Development: Resources, Policy, and Economic Growth*. London: Edward Arnold.

Baldwin, Robert E. 1966. *Economic Development and Export Growth: A Study of Northern Rhodesia, 1920-1960*. Berkeley: University of California Press.

Bleaney, Michael F. and David Greenaway. 1993. Long-run trends in the relative price of primary commodities in the terms of trade of developing countries. *Oxford Economic Papers* 45: 349-63.

Bloch, Harry and David Sapsford. 2000. Whither the terms of trade? An elaboration of the Prebisch-Singer hypothesis. *Cambridge Journal of Economics* 24: 461-81.

Bohi, Douglas R. and Michael A. Toman. 1984. *Analyzing Non-Renewable Resource Supply*. Boston: John Hopkins Press published for Resources for the Future.

Boskin, Michael J., Ellen R. Dulberger, Robert J. Gordon, Zvi Griliches, and Dale Jorgenson. 1996. *Final Report of the Advisory Commission to Study the Consumer Price Index.* Washington, DC: U.S. Government Printing Office.

Bruno, Michael and Jeffrey Sachs. 1982. Energy and resource allocation: a dynamic model of the `Dutch Disease'. *Review of Economic Studies* 49: 845-859.

Clements, Kenneth W., and Peter Johnson. 2000. The minerals industry and employment in Western Australia: assessing its impacts in federal electorates. *Resources Policy* 26(2), June, 77-89.

Clements, Kenneth W. and Robert A. Greig. 1994. *Modeling Large Resource Development Projects in an Open Economy: The Case of Australia's North West Shelf Gas Project.* Blackstone.

Cordon, W. Max and J. Peter Neary. 1982. Booming sector and de-industrialization in a small open economy. *Economic Journal* 92, December: 825-848.

Davis, Graham A. 1995. Learning to love the Dutch Disease: evidence from the mineral economies. *World Development* 23: 1765-1779.

Davis, Graham A. 1998. The minerals sector, sectoral analysis, and economic development. *Resources Policy* 24(4): 217-228.

de Ferranti, David, Guillermo E. Perry, Daniel Lederman, and William F. Maloney. 2002. *From Natural Resources to the Knowledge Economic: Trade and Job Quality*. Washington DC: The World Bank.

Diamond, Jared M. 1997. *Guns, Germs and Steel: The Fate of Human Societies*. New York: WW Norton & Co.

Friends of the Earth. *"Treasure or Trash?": The World Bank's Flawed Defense of Mining as a Tool for Economic Development.* Internet report available at http://www.foe.org/international/, accessed September, 2002.

Garcia, Patricio, Peter F. Knights, and John E. Tilton. 2001. Labor productivity and comparative advantage in mining: the copper industry in Chile. *Resources Policy* 27: 97-105.

Gelb, Alan H. 1985a. The Impact of Oil Windfalls: Comparative Statics with an Indonesia-like Model. World Bank Development Research Department Discussion Paper No. DRD133.

Gelb, Alan H. 1985b. Are Oil Windfalls a Blessing or a Curse? Policy Exercises with an Indonesia-like Model. World Bank Development Research Department Discussion Paper.

Gelb, Alan H. 1988. *Oil Windfalls: Blessing or Curse?* New York: Oxford University Press.

Gylfason, Thorvaldur. 2001a. Natural Resources and Economic Growth: What is the Connection? CESifo Working Paper No. 530, August.

Gylfason, Thorvaldur. 2001b. Natural resources, education, and economic development. *European Economic Review* 45: 847-859.

Herrick, Bruce, and Charles P. Kindleberger. 1983. *Economic Development,* 4th ed. New York: McGraw-Hill.

Hotelling, Harold. 1931. The economics of exhaustible resources. *Journal of Political Economy* 39(2), April: 137-175.

Kindleberger, Charles P. 1958. *Economic Development*. New York: McGraw-Hill.

Krautkraemer, Jeffrey A. 1998. Nonrenewable resource scarcity. *Journal of Economic Literature* 36(4), December: 2065-2107.

Kunte, Arundhati, Kirk Hamilton, John Dixon, and Michael Clemens. 1998. Estimating National Wealth: Methodology and Results. The World Bank Environment Department Paper 57, Environmental Economics Series.

Landes, David S. 1998. *The Wealth and Poverty of Nations: Why Some are so Rich and Some so Poor*. New York: WW Norton and Co.

Lederman, Daniel and William Maloney. 2002. Open Questions About the Link Between Natural Resources and Economic Growth: Sachs and Warner Revisited. World Bank working paper, January.

McCloskey, Deirdre N. 1996. *The Vices of Economists-The Virtues of the Bourgeoisie*. Amsterdam: Amsterdam University Press.

McMahon, Gary and Felix Remy. 2001. *Large Mines and the Community: Socioeconomic and Environmental Effects in Latin America, Canada and Spain*. Ottawa: IDRC Books.

Meier, Gerald M. 1968. *The International Economics of Development*. New York: Harper & Row.

Modise, Modise D. 1999. Managing mineral revenues in Botswana. In *Development Policies in Natural Resource Economies*, pp. 78-97, ed. by Jörg Mayer, Brian Chambers, and Ayisha Farooq. Cheltenham, UK: Edward Elgar.

Nankani, G. 1979. *Development Problems of Mineral Exporting Countries: A Background Study for World Development Report 1979.* World Bank Staff Working Paper No. 354, World Bank, Washington, D.C.

Ohlin, Bertil. 1967. *Interregional and International Trade*, revised edition. Cambridge: Harvard University Press.

Powell, Andrew. 1991. Commodity and developing country terms of trade: what does the long run show? *Economic Journal* 101: 1485-96.

Prebisch. Raul. 1950. *The Economic Development of Latin America and its Principal Problems*. Lake Success, NY: United Nations.

Radetzki, Marian. 1992. Economic development and the timing of mineral exploitation. In *Mineral Wealth and Economic Development*, pp. 39-57, ed. by John E. Tilton. Washington, DC: Resources for the Future.

Rodriguez, Francisco and Jeffrey D. Sachs. 1999. Why do resource-abundant economies grow more slowly? *Journal of Economic Growth* 4: 277-303.

Ross, Michael L. 1999. The political economy of the resource curse. *World Politics* 51, January: 297-322.

Ross, Michael L. 2001. *Extractive Sectors and the Poor: An Oxfam Report*. Boston: Oxfam America.

Sachs, Jeffrey D. and Andrew Warner. 1995a. Natural Resource Abundance and Economic Growth. NBER Working Paper No. 5398, December.

Sachs, Jeffrey D. and Andrew Warner. 1995b. Economic Reform and the Process of Global Integration. NBER Working Paper No. 5039. Reprinted in *Brookings Papers on Economic Activity* 95(1), August, pp. 1-95, 108-118, ed. by William Brainard and George Perry.

Sachs, Jeffrey D. and Andrew Warner. 1997a. Natural Resource Abundance and Economic Growth. HIID Working Paper, November.

Sachs, Jeffrey D. and Andrew M. Warner. 1997b. Sources of slow growth in African economies. *Journal of African Economies* 6(3): 335-376.

Sachs, Jeffrey D. and Andrew M. Warner. 1999a. The big push, natural resource booms and growth. *Journal of Development Economics* 59: 43-76.

Sachs, Jeffrey D. and Andrew Warner. 1999b. Natural resource intensity and economic growth. In *Development Policies in Natural Resource Economies*, pp. 13-38, ed. by Jörg Mayer, Brian Chambers, and Ayisha Farooq. Cheltenham, UK: Edward Elgar.

Sachs, Jeffrey D. and Andrew M. Warner. 2000. Globalization and international competitiveness: some broad lessons of the past decade. In *The Global Competitiveness Report 2000*, ed. by Michael E. Porter et al. New York: Oxford UP.

Sachs, Jeffrey D. and Andrew M. Warner. 2001. Natural resources and economic development: the curse of natural resources. *European Economic Review* 45: 827-838.

Sala-i-martin, Xavier. 1996. I just ran four million regressions. NBER Working Paper 6252, November.

Sala-i-martin, Xavier. 1997. I just ran two million regressions. *American Economic Review* 87(2): 178-83.

Sapsford, David. 1990. Primary product prices and the terms of trade. *Economic Record* 65: 342-56.

Singer, Hans W. 1950. The distribution of gains between investing and borrowing. *American Economic Review* 40(2): 473-485.

Stilwell, L.C., R.C.A. Minnitt, T.D. Monson, and G. Kuhn. 2000. An input-output analysis of the impact of mining on the South African Economy. *Resources Policy* 26(1): 17 - 30.

Svedberg, Peter, and John E. Tilton. 2002. The *real*, real price of nonrenewable resources: the case of copper, unpublished working paper available from the authors.

Tilton, John E., and Hans H. Landsberg. 1999. Innovation, productivity growth, and the survival of the U.S. copper industry. In *Productivity in Natural Resource Industries*, pp. 109-39, ed. by R. D. Simpson. Washington, DC: Resources for the Future.

Tilton, John E. 2002a. Long-term trends in copper prices. *Mining Engineering*, July: 25-32.

Tilton, John E. 2002b. *On Borrowed Time? Assessing the Threat of Mineral Depletion*. Washington, DC: Resources for the Future.

Torvik, Ragnar. 2001. Learning by Doing and the Dutch Disease. *European Economic Review* 45: 285-306.

Torvik, Ragnar. 2002. Natural resources, rent seeking, and welfare. *Journal of Development Economics* 67: 455-470.

United Nations Conference on Trade and Development. 2002. *The Least Developed Countries Report 2002*. New York: United Nations.

United Nations Development Programme. 1997. *Human Development Report 1997*. New York: Oxford University Press.

United Nations Development Programme. 1998. *Human Development Report 1998*. New York: Oxford University Press.

United Nations Development Programme. 2001. *Human Development Report 2001*. New York: Oxford University Press.

van Wijnbergen, Sweder. 1984. The 'Dutch Disease': a disease after all? *Economic Journal* 94: 41-55.

Wacziarg, Romain. 2002. Review of Easterly's *The Elusive Quest for Growth*. *Journal of Economic Literature* XL: 907-918.