# Are Oil-Producers Rich?

# Accounting and the Resource Curse

Geoffrey Heal*

December 2004 Revised December 2005

Abstract

What can national income accounting tell us about whether resource-depleting nations are rich or poor? I argue that most conventional statements of national income overestimate the incomes of such countries by failing to account for resource depletion. Perhaps more important, they typically overestimate investment. A correct measure of trends in sustainable welfare is the value of the changes in all capital stocks, including stocks of natural capital. This includes resource depletion. I provide calculations of this measure which confirm that most oil-exporting countries are currently consuming too much too quickly.

**Key Words**: resource curse, exhaustible resource, national income, genuine savings, resource depletion.

**JEL codes**: Q 330, Q 390, E 010, E 200

* Paul Garret Professor of Public Policy and Corporate Responsibility, Columbia Business School and School of International Affairs. gmh1@columbia.edu. I am grateful to Macartan Humphreys for valuable comments on an earlier draft.

## I Introduction

There is a popular image of an oil producing country, a real stereotype: it is of a very rich land where no-one needs to work and everything is provided by the state. True, there are some other aspects of the image that are typically less attractive, particularly post 9/11, but the essential economics of the popular image relates to extreme abundance. Yet in a sharp contrast to this we find a vast and growing literature on the "resource curse" that document how and why an abundance of natural resources in fact leads to social and economic problems. How can we reconcile these conflicting images? How can we reconcile the seemingly obvious fact that oil makes a country rich with the equally undeniable fact that no countries that rely heavily on the production of oil are in any real sense developed (rich) and none even appear to be moving towards that goal? Perhaps even more puzzling is the fact that even the richest of the oil-producing countries, Saudi Arabia, is still at best a middle income country, even after decades of dominating the world oil market and in spite of owning over half of the world's proven crude oil reserves. If ever a country should be rich, Saudi Arabia, it seems, is that country. Yet the statistics tell us otherwise.

This chapter focuses on features of this paradox that can be illuminated by thinking clearly about the basic ideas of income and wealth, and about how these ideas relate to accounts of national income and national wealth, that is to national income statements and national balance sheets. The role of capital markets proves to be central to the apparent paradox of poor resource-exporting countries. I shall argue that the exhaustibility of oil makes income generated from oil quite different from income generated from other sources in terms of its implications for the country's underlying wealth, and that a failure to see this explains much of the apparent paradox.

Before developing these arguments in detail, some facts may shed light on the problem. Take Saudi Arabia again, the extreme case and the poster child for the oil producer as economic utopia: its proven reserves of oil are 262.7 billion barrels, and its population is 25 million. So at $30 per barrel, a typical oil price for 2003 and 2004, its oil wealth per capita is $315,240. Investing that at a 4% real return gives a family of four about $50,000 per year.

Comfortable indeed but not rich by Western standards. Doing the same calculation for the Middle East as a whole the number for a family of four is closer to $8,000.[1] If we move the oil price up to its present level, say $60, then we double these numbers, implying that an average Saudi family, if it could invest its share of the country's oil wealth, could earn $100,000 per year, and that an average family in a typical Middle Eastern oil producer would make about $16,000 per year. So even at current elevated oil prices, these numbers are not consistent with the image of abundance. But there is another way of looking at the data which makes them seem even smaller. Saudi Arabia produces about 8 million barrels of oil daily, for an annual oil revenue of $175 billion. Expressed per family of four, this is $28,000 per year. Barely above the U.S. poverty line—even at $60 per barrel. At the average oil price for the last decade, the figure is well below the U.S. poverty level—even for Saudi Arabia! Furthermore, this income, if used for consumption, is not sustainable since it depends on the depletion of a finite stock. Looking at oil revenues is the more realistic of the two approaches, as Saudi Arabia is not in a position to invest its oil wealth: most of this wealth lies in the ground earning no income. This is where capital markets matter.

The contrast between these two calculations foreshadows a point I shall be emphasizing in the sections that follow. If Saudi Arabia could sell all its oil now and invest the proceeds at 4%, then a typical family could earn about $100,000 per year. However, selling all that oil would surely force the price down a long way given the inelasticity of demand. But if Saudi Arabia just extracts as much oil as it can, about 8 million barrels daily, then the per family income is just over a quarter of this, at $28,000. Why the difference? The important point to learn from this is that capital markets matter to oil producing countries. Their access to these markets, and how well they use them, is a major factor in determining their living standards. In fact they depend on capital markets as much as they depend on their natural resources. Oil in the ground earns no income and contributes nothing to welfare, however envious the rest of the world may be of this asset. Envy however does not pay interest, whereas money in an investment fund does, so it clearly pays to turn oil in the ground into money in a bank

[1] Figures from the BP Statistical Review of World Energy at www.bp.com and from the CIA Factbook.

account. But this involves huge transactions, and assumptions about future oil prices. In other words it involves access to a comprehensive set of capital markets.

One message of this chapter is that if we think clearly about what we mean by income and wealth, then a resource-rich country such as Saudi Arabia is not necessarily "rich" in the conventional sense. Its income as properly measured may be low or near zero, and whether it owns wealth and can convert some of this into income depends entirely on its access to capital markets. This central role of capital markets in the welfare of resource-rich countries has perhaps not been adequately highlighted and this is another message of this chapter.

A third point that I emphasize is that *any measure of income or of wealth change must allow for the depletion of the natural resource stock*. Conventional measures of national income do not do this and therefore overstate, probably quite significantly, the real income of these countries. From the perspective of understanding the evolution of long-run welfare -the "sustainability" perspective—the important measure is what Heal and Kriström (2005) call national wealth, the change in which can be measured by the World Bank's (1997) "genuine savings." This is the value *at shadow prices* of the changes in all capital stocks, including changes in natural resource stocks. The shadow price of a good is the social value of an extra increment of the good: if there is a market price it equals the market price corrected for external costs or benefits associated with the use of the good. Depletion of natural resources has of course to be included in calculating the value of the change in capital stocks. In the last section of the paper I review some recent calculations (from Arrow et al. 2004) of trends in total capital stock per capita for a range of countries, including some oil producers. Incorporating the changes in natural capital stocks makes a big difference to our perception of a country's sustainability if it is a resource exporter. All resource exporters appear to be depleting natural capital faster than they are building up other forms of capital, and so are becoming poorer, whatever their income levels.

The next section of the chapter sets out a rather general model and some welfare conclusions to be drawn from it, and provides a framework for a series of applications to more specific models that capture key aspects of resource-rich but otherwise underdeveloped countries. A final section summarizes the arguments and suggests some policy implications. Central to these is to understand that savings and investment as reported by conventional national income accounts are grossly overstated: real investment is less than measured investment by the amount of resource depletion. Hence very high rates of savings and investment as conventionally measured are needed if there is to be real accumulation of capital to sustain future welfare.

## II General Welfare Results and Applications

We begin with a general mathematical proposition and a result on welfare in dynamic economic models. We define a *state valuation function*, $V(S)$ that tells us the present value of the benefits that can be obtained from a current level of capital stock (the "state"), $S$. It is a measure of the maximum amount of welfare that an economy can produce now and in the future. This is found by using a welfare function $u(C_t)$ that records welfare from consuming $C_t$ at each instant $t$, and then summing (integrating) this value from time $t$=0, up to $t$=∞, placing lower weights on more distant periods.Using the framework and notation in Heal and Kriström (2005), the intertemporal optimization problem of maximizing the present value of welfare given some initial state $S_0$ is given by:

$$V(S_0) = Max\int_0^{\infty} u(C_t)e^{-\delta t}dt$$

subject to a set of constraints imposed by technology, institutions and resource availability.

This is the classical optimal growth problem of which special cases are well-known (including the Hotelling model, the Solow model and the Dasgupta-Heal-Solow model). From an analysis of the solutions to such problems one can prove that:

- The rate of change of the state valuation function, $V$, equals the value of investment at shadow prices
- Both of these are equal to the rate of change of national income, where national income is defined as the present value of consumption at supporting prices.

These features are summarized in the following proposition (note that in this national income refers to the present discounted value of consumption at all dates calculated at shadow prices):

**Proposition 1** *(Heal and Kriström 2005): The change in welfare over time is exactly equal to "genuine savings" which is itself exactly equal to the change in national income over time. Formally we have:*

$$\frac{dV}{dt} = \sum_i \lambda_i \frac{dS_i}{dt} = \frac{d}{dt}(\text{National Income}) = \frac{d}{dt}\left(\int_0^{\infty} \sum \lambda_i c_i e^{-\delta t} dt\right)$$

Here $\lambda_i$ is the shadow price of capital good $i$, the stock of which is $S_i$. The term $\sum_i \lambda_i \frac{dS_i}{dt}$ represents "**Genuine Savings**" and records the total value of investment (including resource depletion). This quantity has recently been the subject of extensive study by the World Bank (2005). Proposition 1 is critical in what follows: it tells us that both the value of investment and the change in the value of national income are good measures of future welfare changes. The more is invested today, the higher is future welfare. It is important to emphasize that welfare changes are given by the value of investment *at shadow prices*, $\sum_i \lambda_i \frac{dS_i}{dt}$, and not by the total change in wealth, $\frac{d}{dt}(\sum_i \lambda_i S_i)$ which would in addition contain a term in capital gains.[2] It is important to note that capital gains have no role to play in accounting for natural resources.

The next issue is to investigate these measures in particular contexts that relate directly to the resource curse.

---

[2] Since $\frac{d}{dt}(\sum_i \lambda_i S_i) = \sum_i \lambda_i \frac{dS_i}{dt} + \sum_i \frac{d\lambda_i}{dt} S_i$

## III Models of Resource Depletion

### III.1 The Hotelling case

Hotelling's model (Hotelling 1931) provides a simple and well-understood framework for beginning this process. There is an initial stock $S_0$ of an exhaustible resource (such as oil), consumption of which at time *t* is $C_t$, and the rate of depletion of the resource stock is given simply by the rate at which it is consumed or $\frac{dS}{dt} = -C$ , conditional on $S_t \geq 0$.

The usual way to measure Net National Product (*NNP*) is consumption plus investment. But in this framework since consumption equals the rate of depletion, net income (consumption plus investment) is always zero by definition. Formally:

$$NNP = \frac{dS}{dt} + C = 0$$

In an economy that lives purely by resource depletion, income in the sense of net national product is always zero, even though intuitively wealth is positive. In other words there is no *sustainable* positive level of spending in this framework. This makes intuitive sense: the economy has a fixed resource base that can only change in one way, downwards. So potential welfare must drop as the resource is consumed.

Access to capital markets makes a big difference to this conclusion, and in fact overturns it: with access to capital markets it is possible to get a sustainable spending level and a non-zero income. Imagine that instead of producing the resource gradually over time the country sells the *entire* stock of the resource $S_0$ at one go and invests the proceeds: now the interest on this investment gives a sustainable consumption level. Indeed it is precisely what Hicks called *income*: That is, income is the return on capital. Formally, if *r* is the interest rate and $Y_0$ is income, we have:

$$Y_0 = rS_0$$

In this modified framework with overseas investment, the depletion of the capital stock is now $\frac{dS}{dt} = rS - C$ , where the first term is income and the second is expenditure, and so net national product is now NNP , which is investment plus consumption, is given by:

$$NNP = \frac{dS}{dt} + C = rS \neq 0$$

So access to capital markets transforms NNP from zero to a positive number: it allows the transformation of non-earning assets into earning assets, making a fundamental difference to income. This is the point that is reflected in the numerical example in the introduction. Giving access to capital markets is like giving the economy a superior technology, a greater intertemporally feasible set: even though the physical resource base is unchanged, its welfare potential is improved.

**III.2 An Open Economy**

The next move is to develop this insight about capital markets further. I no longer assume that the entire stock of the resource is sold up front. I shall assume that a flow of the resource can be extracted and then either consumed at home or sold abroad and the revenues from this invested overseas. So at each date the output of the resource is either consumed $C$ or invested abroad $I_f$, and the economy's basic accounting identity is that the sum of consumption and overseas investment must equal the depletion of the resource plus any income earned on existing overseas investments:

$$C + I_f = -\frac{dS}{dt} + rK_f \qquad (2)$$

where $K_f$ is overseas capital and $r$ is the interest rate on this, and $I_f$ is overseas investment so that $I_f = \frac{dK_f}{dt}$. Consider a path that solves the maximization problem $Max\int_0^\infty u(C_t)e^{-\delta t}dt$ subject to (2).

The two conditions that need to be satisfied at the solution are

(i) That, on the margin, investing overseas and consuming must be equally valuable ($u' = \lambda_s = \lambda_i = \lambda$); and

(ii) That the percentage change in the (shadow) price of the resource over time is equal to the difference between the discount rate and the return on overseas investment ($\frac{d\lambda}{dt}\frac{1}{\lambda} = \delta - r$). If the latter exceeds the former then the price of the resource will fall over time, because the return to investment is so large that the resource is in effect becoming more abundant.

Net national product is now $C + I_f + \frac{dS}{dt} = rK_f$ so it is equivalent to the interest on overseas investments, just as in the previous section. The change in the state valuation function, $\dot{V}$, is $\lambda\left(I_f + \frac{dS}{dt}\right)$, the value of investment including capital investment and stock depletion. This represents the change in the present value of welfare as a result of investment and depletion: welfare is increasing if the value of investment exceeds that of stock depletion.

A natural next step in extending the model is to let *r* be a function of overseas investment, $K_f$, reflecting diminishing returns to investment in overseas opportunities. Given the scale on which oil countries must invest, the possibility that they will move the market against them is real. In this case the second condition above has to change to include a term reflecting the impact of investment on the return to capital: $\frac{d\lambda}{dt}\frac{1}{\lambda} = \delta - r - \frac{dr}{dK_f}K_f$.

A stationary solution (in which $\frac{d\lambda}{dt} = 0$) would then require: $\delta = r + \frac{dr}{dK_f}K_f$. With $\frac{d\lambda}{dt} = 0$, consumption is also constant. Over time the resource stock *S* falls to zero and the overseas capital stock *K* rises to some constant value. In this case net national product NNP is $r(K_f)K_f$ and the change in welfare as a result of investment and depletion is again $\lambda\left(I_f + \frac{dS_t}{dt}\right)$.

The bottom line here is that, as the introduction suggested, access to capital markets makes a huge difference to the economic constraints on a resource-rich country. Its income, even accounting for depreciation, goes from zero to a positive number, equal to interest on overseas investments, and there is a positive consumption level that can now be sustained indefinitely.

### III.3 An Open Economy with Extraction Capital

So far we have assumed that the economy can extract any amount of the resource without incurring any costs. This is however somewhat unrealistic. Suppose instead that you have to invest in order to extract the resource, and that, as above, you can invest the proceeds from sale in overseas assets. Let $I_d$ denote domestic investment in extraction capital $K_d$, and $I_f$ investment in overseas interest-bearing assets $K_f$ with interest rate *r*. The rate at which the resource can be extracted is bounded by the amount of investment in extraction capital, so that if *R* is the extraction rate then $R \leq \alpha K_d$. As before, we maximize the welfare from all future consumption where consumption is given by the output of the resource, minus investments in domestic and overseas capital, plus interest on existing overseas investments. Assuming that the output of the resource is proportional to the capital available for resource extraction (that is, $\frac{dS}{dt} = \alpha K_d$) we have:

$$C = \alpha Kd - I_f - I_d + rK_f$$

At any solution to this problem the values of both types of capital must be equal if there is investment in both (that is, $u' = \lambda_f = \lambda_d$ if both $I_f$ and $I_d$ are positive). However, at the optimum, $\lambda_f$ and $\lambda_d$ should change at different rates, since the change in $\lambda_f$ should reflect the difference between the discount rate and the interest rate on foreign assets, while the change in $\lambda_d$ should reflect the difference between the discount rate and the efficiency of the extraction technology ($\alpha$). Hence, because they change at different rates but must be equal if both $I_f$ and $I_d$ are positive, it cannot be that the country invests in both foreign assets and in extraction for any length of time. Presumably we start off by investing in extraction capital positive and once the stock of extraction capital is built up to an appropriate level, shift investment to foreign investment, leaving extraction capital constant.

In this model as in the earlier ones, all investment levels will feature in NNP:

$$NNP = C + r_f K_f + I_f + I_d - \alpha K_d$$

and the change in the state valuation function is $\lambda_f I_f + \lambda_d I_d - \lambda_s \alpha K_d$. Hence again, the depeletionof the resource needs to be taken into account in the measurement of welfare.

### III.4 Extraction Capital and Use in Production

As the final variant of the basic Hotelling model of resource depletion, we consider the case of a closed economy that extracts a resource and then uses it in domestic production. Extraction of the resource leads to domestic output, which can be invested. So the resource can, as in the previous sections, be transformed into a capital stock, this time through the domestic production process. Extraction of the resource is costly: to be precise, $X(R)$ is the cost of extracting at rate $R$. We assume that $X$ is increasing in $R$. Domestic production depends on inputs of capital and the resource and is given by $Y=f(K,R)$, where the capital stock, $K$, depends on investment $I$. This time we aim to maximize the integral of the welfare from consumption conditional on the constraints that $\frac{dS}{dt} = R$ and the accounting identity: $Y= C + I + X$, or equivalently: $I=f(K,R) - C - X(R)$.

A solution to this problem requires that that the shadow price of the resource equals its marginal productivity in the domestic economy ($\partial F/\partial R$); that consumption and investment are valued equally on the margin, that the resource price follows Hotelling's Rule (the percentage change in the price of the good is exactly equal to the discount rate) and remains constant in present value terms, and, finally, that the accumulation of capital follows the well-known Keynes-Ramsey rule (the percentage change in the shadow price of the capital good must be equal to the difference between the discount rate and the marginal return to capital in the economy (see e.g. Heal 1973)). This rule just specifies that the country's capital assets be efficiently used, and that the breakdown of income between consumption and investment is such that the returns to each are equal on the margin.

Net National Product in this case should be:

$$NNP = C + I - R$$

and the change in welfare is $I - R$. Once again, the possibility of transforming the resource into a capital stock means that in spite of its exhaustibility, the economy can attain a positive income level. Indeed a positive level may even be sustainable, depending on whether the resource is "essential" or not, as shown in Dasgupta and Heal 1979.

## IV Theoretical Summary

The theoretical models developed so far, which certainly capture what is unique about resource-based economies, imply very clearly that accounting for the changes in capital stocks is a prerequisite for understanding the evolution of welfare in an economy. As the natural resource stock is an important capital stock, often the most important (for data on this see World Bank 2005), this means that depletion of this stock *must be measured and recorded in national income accounts if these are to have any predictive value for welfare*. In plain English, resource depletion must be deducted from national income. This is not conventionally done and in consequence national income figures are too high and the growth of national income is overstated. But national income in the conventional sense is not the best measure if we are interested in the long-run welfare potential of the economy. The right measure instead is $\sum_i \lambda_i \frac{dS_i}{dt}$ the value of investment at current shadow prices. Again stock depletion will feature in this.

This is not the only point to emerge from this discussion: another related point is that a resource-rich country's relationship with capital markets is important in determining its living standards. Oil in the ground brings in no income and is inherently depletable. However, through trade and capital markets or through use as an input into domestic production it can be converted to a stock of wealth of another sort, which generates income and can in principle be preserved indefinitely.

In the next section we show the practical applicability of this framework, summarizing recent work by Arrow et al. 2004. This work attempts to compute the value of investment at current shadow prices $\sum_i \lambda_i \frac{dS_i}{dt}$ for a wide range of countries, from rich industrialized to poor developing and oil-producing. The calculation of trends in genuine wealth per capita, allowing for technical change, allows us to rank countries by their long-run welfare trends. A striking conclusion is that *most oil-exporting countries have a negative trend in long-run welfare*. The conclusions of Arrow et al. are supported by a recent study just released by the World Bank (2005), which presents more recent results for a wide range of countries and also shows resource-rich countries as depleting their overall capital stocks and facing declining welfare levels unless their policies are changed substantially (the World Bank study does not allow for technical progress).

## V Applications

The first table shows the results that Arrow et al find when we compute the value of investment at current shadow prices $\sum_i \lambda_i \frac{dS_i}{dt}$ for a wide range of countries, including two rich industrial countries, the US and the UK, two rapidly growing developing countries, India and China, two very poor developing regions, Bangladesh and Sub-Saharan Africa, and one oil-exporting region, the Middle East and North Africa. The data cover the period 1970 to 2001[3] and are taken from the World Bank (1997). The first numerical column shows domestic net investment, which is the starting point of the calculations and an estimate of investment in physical capital. To this is added expenditure on education as an indicator of investment in human capital, and we then add investment (usually disinvestment) in various types of environmental capital. The third numerical column shows an estimate of the social cost of CO2 emissions, the fourth the depletion of energy resources (particularly large for the Middle East and North Africa) and the next is forest depletion, large for Nepal and zero for the U.S. where there has actually been regrowth of forests over the period of interest.

---

[3] To be precise, the coverage is as follows: Bangladesh 1973-2001, India 1970-2001, Nepal 19702001, China 1982-2001 (without 1994), Sub-Saharan Africa 1974-82 and 1986-2001, ME and NA 1976-89 and 1991-2001, U.K. 1971-2001 and U.S. 1970-2001.

The final column gives the sum, an estimate of genuine investment as a percent of national income. This is an estimate of the value of investment at current shadow prices $\sum_i \lambda_i \frac{dS_i}{dt}$. Full details of the data and the calculations are in Arrow et al. (2004).

| | Domestic | | | | | | |
|---|---|---|---|---|---|---|---|
| | Net I | Education | CO2 | Energy | Mineral | Forest | GI |
| Bangladesh | 7.89 | 1.53 | −0.25 | −0.61 | 0.00 | −1.41 | 7.14 |
| India | 11.74 | 3.29 | −1.17 | −2.89 | −0.46 | −1.05 | 9.47 |
| Nepal | 14.82 | 2.65 | −0.20 | −0.00 | −0.30 | −3.67 | 13.31 |
| Pakistan | 10.92 | 2.02 | −0.75 | −2.60 | −0.00 | −0.84 | 8.75 |
| China | 30.06 | 1.96 | −2.48 | −6.11 | −0.50 | −0.22 | 22.72 |
| Sub-Saharan Africa | 3.49 | 4.78 | −0.81 | −7.31 | −1.71 | −0.52 | −2.09 |
| M East N Africa | 14.72 | 4.70 | −0.80 | −25.54 | −0.12 | −0.06 | −7.09 |
| UK | 3.70 | 5.21 | −0.32 | −1.20 | 0.00 | 0.00 | 7.38 |
| US | 5.73 | 5.62 | −0.42 | −1.95 | −0.05 | 0.00 | 8.94 |

**Table 1: Estimates of Genuine Investment as % of GDP for a sample of countries**

Clearly there are many shortcomings here, and I shall talk about correcting some of them shortly. Amongst the shortcomings that we do not correct are the inadequacy of educational expenditure as a measure of investment in human capital, and the incompleteness of the list of categories of environmental capital for whose depletion we allow. Both could be serious sources of error, but it has not been possible to obtain data to take this process further. Nonetheless the numbers that emerge make some intuitive sense. For example, for the Middle East and North Africa a domestic net investment of +14.72% turns into a genuine savings of -7.09% after allowing for the depletion of energy resources, drawing attention to the fact that this part of the world lives unsustainably by depleting an exhaustible resource, as in the Hotelling models reviewed earlier. Sub-Saharan Africa is also shown to be living unsustainably, a tragic and not surprising result. Allowance for the impact of HIV/AIDS on human capital would probably make their genuine investment number even worse. The remaining countries all appear from these numbers to have positive genuine investment and so to be meeting one of the criteria for sustainability, namely that the present value of future welfare obtainable from capital stocks be non-decreasing.

However, all of these numbers omit two factors that could be important: one is population change, omitted from the earlier discussion but a real issue in several countries, and the other is technical change. A higher rate of population growth will presumably increase the level of investment required to maintain living standards constant, so that the numbers in Table 1 will overstate the extent of sustainability with a growing population and vice versa. Technological progress will act in the opposite direction, allowing humans to extract more welfare from a given set of resources. So we make two more modifications to the data in Table 1, adjusting for population growth and for technological progress. Neither was a part of the theory developed in the earlier parts of this chapter, and indeed as far as I am aware there is little or no discussion of either of these issues in the literature on sustainability or on optimal growth with environmental resources. Yet intuition suggests that they are important, and the numbers in Arrow et al confirm this, indicating a lacuna in the theory developed so far.

Table 2 shows the results of these modifications. The first column is the last column from Table 1, our preliminary estimates of genuine savings. The second column gives an estimate of the growth rate of genuine wealth derived from the previous column using an assumed GDP/wealth ratio[4], and the fourth gives the growth rate of genuine wealth per capita, using the population growth rate given in the third numerical column. This is followed by an estimate of the growth rate of total factor productivity and then the growth rate of per capital genuine wealth adjusted for total factor productivity growth. For comparison purposes the last column gives the conventional figure for growth of GDP per capita.

---

[4] See Arrow et al. 2004 for details.

| | GI | Growth of Genuine Weath | Population Growth | Growth of Genuine Weath p.c. | Growth of Total Factor Productivity | Growth of p.c. genuine wealth (adjusted for total factor productivity growth) | Standard GDP p.c. growth rate |
|---|---|---|---|---|---|---|---|
| Bangladesh | 7.14 | 1.07 | 2.16 | -1.09 | 0.81 | 0.30 | 1.88 |
| India | 9.47 | 1.42 | 1.99 | -0.57 | 0.64 | 0.54 | 2.96 |
| Nepal | 13.31 | 2.00 | 2.24 | -0.24 | 0.51 | 0.63 | 1.86 |
| Pakistan | 8.75 | 1.31 | 2.66 | 2.06 | 1.13 | 0.59 | 2.21 |
| China | 22.72 | 3.41 | 1.35 | -3.05 | 3.64 | 8.33 | 7.77 |
| Sub-Saharan Africa | -2.09 | -0.31 | 2.74 | -3.05 | 0.28 | -2.58 | -0.01 |
| M East N Africa | -7.09 | -1.06 | 2.37 | -3.43 | -0.23 | -3.82 | 0.74 |
| UK | 7.38 | 1.48 | 0.18 | 1.30 | 0.58 | 2.29 | 2.19 |
| US | 8.94 | 1.79 | 1.07 | 0.72 | 0.02 | 0.75 | 1.99 |

**Table 2:** Genuine Investment as % of GDP Adjusted for Population and Technical Change

Only two estimates of the growth of genuine wealth per capita are negative, the same two as before, but many others are probably not significantly positive. The high population growth rates of Bangladesh, Nepal and Sub-Saharan Africa all act to reduce their countries' rates of genuine savings.

Although the methodology differs in some technical details, and they do not allow for technical progress, our results are very consistent with those of the World Bank 2005, which cover a much greater range of countries. The Bank concludes that most resource-dependent countries are not replacing the capital that they deplete in extracting their resources and are therefore reducing their long-run welfare potential.

A clear implication of this work is that we are measuring the income of oil-producers wrongly. We know how to measure it better: the issue is now to ensure that the data needed for this is collected and incorporated into the accounts. For oil producers the most important data is the depletion of oil and gas reserves. In addition we need data on the changes in other forms of capital stocks – other natural resources (such as water and soil), environmental impacts (such as pollution and CO2 emission) and on the accumulation or decumulation of overseas assets. As some overseas assets are privately held, measuring these may not always be straightforward.

## VI Conclusions

I began this chapter by referring to the paradox of resource-rich countries—if they are resource rich they should be rich financially too, it seems, but in fact they never (rarely?) are so. Some of the paradox can be resolved by just looking at the numbers, as I did in the introduction. This shows that even the richest of oil-rich countries are not that rich. Even Saudi Arabia with oil at $60 per barrel could barely lift its population above the U.S. poverty level if it were to spread its oil earnings equally. Of course, oil country income is usually spread far from equally. The numbers in the introduction also suggested something else that the more formal analysis corroborated: that access to capital markets matters and is a part of the resolution of the paradox. A country with modest oil reserves and no access to capital markets is not rich in any real sense.

The analytical models established two further points. One is that national income is measured wrongly in resource-rich countries, as they do not subtract depreciation of their asset base from their income figures. In failing to do so, they omit from their calculations the fact that their income from resource use is generated by the depletion of a non-augmentable asset. It is like augmenting the family income by selling the family silver: it cannot last and is really a form of asset disposal, and not a source of income. Indeed, in U.S. corporate accounting conventions the sale of oil or gas is recognized as asset disposal. A proper measure of income allows for resource depletion. Conventional measures of investment will greatly overstate the real investment rate in resource-based economies. And a measure of the sustainability of welfare is based on the value of the changes in all forms of capital, natural and other. This fact emphasizes the importance to resource-rich countries of a conscious policy of investing some of the income from resource sales, as noted also by the World Bank 2005. A commonly-suggested rule of thumb is to invest the revenues from resource production net of production costs, a rule known as Hartwick's Rule (see Hartwick 1977 and also for a critique Asheim et al 2002). While this rule may not be optimal under all circumstances, the fact that conventional measures overstate investment does suggest the need for very high apparent investment rates to provide a firm basis for future welfare, and the figures suggest that no resource-rich countries are attaining appropriate investment levels: all are depleting their natural capital and not replacing it with any other form of capital, a sure road to poverty in the long run. (How can they obtain such high investment returns then? Are investments made through oil funds not generating enough, or are they just not putting enough into oil funds?)

The second key lesson is that the value of resources depends on access to capital markets so that income from sales can be invested. Indeed in an ideal world resource-rich countries would be able to borrow on the security of their resources and invest the proceeds (don't many of them do this, and end up with very high debt?), or able to sell their oil forward (although political shortcomings of this solution are discussed in Chapter Z). The ability to operate in capital markets transforms the possibilities open to a resource-based economy and governments need to act on this basis.

There is still work to be done in this area. Foremost is the need for better data on capital accumulation or decumulation (for all forms of capital) for resource-rich countries. Then we need to understand better the obstacles to better access to capital markets on the part of oil-producing countries, particularly those that are underdeveloped. They would benefit from being able to sell their resources forward to a much greater degree than is now possible. It may be that this is impossible because sovereign actors cannot be bound legally, so that counterparties have no redress in the event of default. But there may be remedies for this, through clever institutional arrangements that exploit cooperative strategies from repeated games. And an obvious fact in most poor oil countries is that the income from oil wealth is usually spread very unevenly through the country. We need to understand better why this is and how to prevent the emergence of the usual syndrome linking oil, corruption and inequality. The Extractive Industries Transparency Initiative is an interesting step in this direction, though of qualified value so far.

## VII References


Asheim, Geir, B., Wolfgang Buchholz and Cees Withagen (2002). "The Hartwick Rule: Myths and Facts," Discussion Paper .No. 2002 52, CentER, available at http://greywww.kub.nl:2080/greyfiles/center/2002/doc/52.pdf.

Arrow, Kenneth, Partha Dasgupta, Lawrence Goulder, Gretchen Daily, Paul Ehrlich, Geoffrey Heal, Simon Levin, Karl-Göran Mäler, Stephen Schneider, David Starrett and Brian Walker (2004). "Are we consuming too much?" Journal of Economic Perspectives Summer 2004 Vol, 18 No. 3: 147-172.

Dasgupta, Partha S. and Geoffrey Heal (1979), Economic Theory and Exhaustible Resources, Cambridge University Press.

Hartwick, John (1977). "Intergenerational Equity and Investing the Rents from Exhaustible Resources," American Economic Review, 66, 9072-74.

Heal Geoffrey (1973). The Theory of Economic Planning. North Holland Publishing.

Heal Geoffrey and Bengt Kriström. "National income and the environment." Handbook of Environmental Economics, editors Karl-Göran Mäler and Jeffrey Vincent, forthcoming, Elsevier.

Hotelling, Harold (1931). "The Economics of Exhaustible Resources," Journal of Political Economy, 39(2),April, 137-75.

World Bank (1997). Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development. Washington, D.C.: World Bank.

World Bank (2005). Where is the Wealth of Nations? Measuring Capital for the 21st Century. The World Bank, Washington DC.