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Genuine Savings Rates in Developing Countries

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Augmented measures of savings and wealth in the national accounts are critical to conceptualizing and achieving sustainable development. After developing the theory of genuine savings—traditional net savings less the value of resource depletion and environmental degradation plus the value of investment in human capital—this article presents empirical estimates for developing countries. These calculations account for resource depletion and carbon dioxide emissions, using consistent time series data for 1970–93. The empirical evidence shows that levels of genuine savings are negative in a wide range of countries, particularly in Sub-Saharan Africa, and that these countries are being progressively impoverished. Increasing the coverage of natural resources and pollutants in our calculations would reduce the estimated levels of genuine savings overall. The use of genuine savings measures suggests a series of policy questions that are key to sustaining development. These are also explored, specifically the extent to which monetary and fiscal policies, exports of exhaustible resources, stronger resource policies, and pollution abatement measures boost genuine savings rates. For policymakers, linking sustainable development to genuine savings rates means that there are many possible interventions to increase sustainability, from the macroeconomic to the purely environmental.

However defined, achieving sustainable development necessarily entails creating and maintaining wealth. Given the centrality of savings and investment in economic theory, it is surprising that the effects of depleting natural resources and degrading the environment have not, until recently, been considered in measurements of national savings. Augmented measures of savings and wealth in the national accounts are critical to conceptualizing and achieving sustainable development, which was a prime motivation for publishing *Expanding the Measure of Wealth* (World Bank 1997).

Valuing depletion and degradation within a national accounting framework is an increasingly viable proposition, both as a result of the significant progress made in techniques of valuing environmental resources (for a recent example, see Freeman 1994) and as a result of the expanding foundation that theoretical developments are placing under the methods of "green" national accounting (Weitzman 1976, Hartwick 1990, Mäler 1991, and Hamilton 1994, 1996). The first cross-country application of these greener accounting methods to the measurement of

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net savings appears in Pearce and Atkinson (1993), who combine published estimates of depletion and degradation with standard national accounting data to calculate true savings for 20 countries. According to this measure many countries appear to be on unsustainable paths because their gross savings are less than the sum of conventional capital depreciation and natural resource depletion.

Enlarging the concept of net savings to include the depletion of natural resources is a reasonable way to extend traditional savings concepts. The depletion of a natural resource is, in effect, the liquidation of an asset and therefore should not appear as a positive contribution to net income or net savings. Although minor technical issues remain, the methods of valuing the discovery, depletion, and growth of commercial natural resources in the context of the System of National Accounts (SNA) are now well developed (Hamilton 1994 and Hill and Harrison 1994).

More problematic is the valuation of environmental degradation. While United Nations guidelines for environmental accounting favor valuation according to the cost of restoring the environment to its state at the beginning of the accounting period—the maintenance-cost method—theoretical approaches suggest that the marginal social costs of pollution are a more correct basis for valuing emissions into the environment (United Nations 1993 and Hamilton 1996).

After developing the theory of genuine savings, this article presents empirical estimates for developing countries. These calculations account for resource depletion and carbon dioxide emissions using consistent time series data for 1970–93. The article concludes with a discussion of the policy issues raised by greener national accounting.

I. Genuine Savings: A Formal Model

The notion of genuine savings is presented briefly and informally in Hamilton (1994) and Pearce, Hamilton, and Atkinson (1996). This section provides a more rigorous development using a model that, although extremely simple, identifies the adjustments to savings measures that must be made to account for natural resources, pollutants, and human capital. Sustainable development is defined to be, as in Pezzey (1989), nondeclining utility.

We assume a simple closed economy with a single resource used as an input to the production of a composite good that may be consumed, invested in produced assets or human capital, or used to abate pollution, so that $F(K,R,N) = C + \dot{K} + a + m$, where K is physical capital, R is resource use, N is human capital, C is consumption, $\dot{K}$ is investment in physical capital, a is pollution abatement expenditures, and m is investment in human capital (current education expenditures). The function $q(m)$ transforms education expenditures into human capital that does not depreciate (and can be considered as a form of disembodied knowledge), so that $\dot{N} = q(m)$.[1] Labor is fixed and therefore factored out of the production function.

1. Investing in human capital is a type of endogenous technical progress. See Weitzman and Löfgren (1997), who deal with exogenous technical change.

Pollution emissions are a function of production and abatement, $e = e(F, a)$, and pollutants accumulate in a stock X such that $\dot{X} = e - d(X)$, where d is the quantity of natural dissipation of the pollution stock. The flow of environmental services B is negatively related to the size of the pollution stock, so that $B = \alpha(X)$, $\alpha_X < 0$. Resource stocks S grow by an amount g, are depleted by extraction R so that $\dot{S} = g(S) - R$, and are assumed to be costless to produce. The utility of consumers is assumed to be a function of consumption and environmental services, $U = U(C,B)$. There is a fixed pure rate of time preference r.

Following Hartwick (1990), new green national accounting aggregates are defined on the basis of an intertemporal optimization problem. Wealth, W, is defined to be the present value of utility on the optimal path. It is assumed that a social planner wishes to maximize wealth as follows:

$$\begin{aligned} \max\ W &= \int_t^\infty U(C,B)e^{-rs}ds \quad \text{subject to:} \\ \dot{K} &= F - C - a - m \\ \dot{X} &= e - d \\ \dot{S} &= -R + g \\ \dot{N} &= q(m). \end{aligned}$$

The current-value Hamiltonian function, which is maximized at each point in time, is given by,

$$H = U + \gamma_K\dot{K} + \gamma_X\dot{X} + \gamma_S\dot{S} + \gamma_N\dot{N} \tag{1}$$

where γ_K, γ_X, γ_S, and γ_N are, respectively, the shadow prices (in utils) of capital, pollution, resources, and human capital. Deriving the first-order conditions for a maximum, the Hamiltonian function may be written as

$$H = U(C,B) + U_C[\dot{K} - (1 - be_F)F_R(R - g) - b(e - d) + q/q']$$

where b is the marginal cost of pollution abatement. These Hamiltonian equalities hold because we assume the economy is on an optimal trajectory. Hamilton (1996) shows that b is precisely equal to the marginal social cost of pollution emissions and is therefore also equal to the level of the Pigovian tax on emissions required to maximize welfare. The term be_F can thus be interpreted as the effective tax rate on production as a result of the emissions tax. So, although we started with an optimal growth problem, the prices that result are those that would prevail in a competitive economy with a Pigovian tax on pollution. Note as well that $1/q'$ is the marginal cost of creating a unit of human capital.

Since $\dot{S} = g - R$, $\dot{X} = e - d$, and $\dot{N} = q$, the bracketed expression in the second term of the right side of the Hamiltonian is equal to the change in the real value of all assets in this simple economy, where human capital is valued at its marginal creation cost, pollution stocks are valued at marginal abatement costs, and natural resources are valued at the resource rental rate, F_R, net of the effective tax rate on production associated with pollution emissions. Therefore the bracketed expression also serves to define genuine savings, G,

$$G \equiv \dot{K} - (1 - be_F)F_R(R - g) - b(e - d) + q/q'. \tag{2}$$

For nonliving resources g is equal to zero, and for "pure" cumulative pollutants d is also zero.

Genuine savings consists therefore of investment in produced assets and human capital, less the value of depletion of natural resources and the value of accumulated pollutants. As shown in Hamilton (1997),

$$U_C G = \dot{W} = rW - U. \tag{3}$$

Expression 3 implies the following: negative genuine savings at a point in time means that future utility must be less than current utility over some period on the optimal path. In other words, negative genuine savings serves as an indicator of nonsustainability. This expression also implies that Hicksian income, the maximum amount of produced output that could be consumed while leaving total wealth instantaneously constant, is given by

$$NNP = C + \dot{K} - (1 - be_F)F_R(R - g) - b(e - d) + q/q'. \tag{4}$$

Asheim (1994) points out that prices observed in the marketplace will generally differ from those required to support a sustainable (constant-utility) path. However, Asheim is working with a model in which the optimal path is not sustainable. He uses the model of Dasgupta and Heal (1979), in which fixed technology, exhaustible resources, and a fixed pure rate of time preference lead to an economy where welfare declines asymptotically to zero along the optimal path. For this economy the maximal sustainable path is supported by the Hartwick rule (Hartwick 1977): genuine savings are set to be identically zero at each point in time, and as a result utility is constant. Within the confines of the fixed-technology model, Asheim's point stands.

For a suitable specification of the human capital accumulation function, the model used in this article is one in which the optimal path is sustainable. Even if resources are exhaustible and pollution stocks do not dissipate, the endogenous technical progress inherent in human capital formation will yield an optimal path along which utility rises asymptotically to a positive maximum value. The interesting question for this model concerns divergences between observed "real world" prices and theoretical shadow prices on the optimal path. Hamilton, Atkinson, and Pearce (1998) argue that policy distortions in a typical economy lead to overextraction of natural resources and excess pollution emissions. Under these conditions it can be shown that real world resource rents exceed their optimal levels, as do marginal pollution damages. More efficient resource and environmental policies will reduce this bias and also increase genuine savings.

The current model can easily be extended to include foreign trade and depreciation of produced assets. If produced capital depreciates at a percentage rate equal to δ, then the accounting identity for these assets becomes

$$\dot{K} = F - C - a - m - \delta K$$

where $\dot{K}$ now measures *net* investment.

Turning to foreign trade, net foreign assets, A, accumulate as a result of exports, E, and decumulate with imports, M. For a fixed international rate of return, i, therefore, the asset accounting identity is

$$\dot{A} = iA + E - M.$$

Under these assumptions the measure of Hicksian income, NNP, for an open economy is given by

$$NNP = C + \dot{K} + E - M + iA - (1 - be_F)F_R(R - g) - b(e - d) + q/q'.$$

The first six terms in this expression are precisely the standard measure of NNP. An expanded conception of the asset base implies that the standard NNP should be adjusted by deducting net depletion of natural resources and the marginal damages from net accumulation of pollution and by adding investments in human capital.

Vincent, Panayotou, and Hartwick (1997) show that for a small resource-exporting economy, taking international prices as given, NNP should include the present value of future capital gains on resource exports. Hamilton (1997) argues that given the long-term flat-to-declining trend in real resource prices (at least for subsoil resources), this potential annuity can be considered to be zero. It was precisely the unwarranted presumption that prices of resource exports would continue to rise that led many natural resource exporters into difficulty in the 1980s.

The treatment of education and pollution abatement expenditures requires more elaboration. Hamilton (1994) essentially argues that current education expenditures are not consumption and therefore should be included in savings. Defining net marginal resource rents as $n \equiv (1 - be_F)F_R$, NNP can be defined as

$$NNP = GNP - \delta K - a - n(R - g) - b(e - d) + q/q' - m \tag{5}$$

where GNP is gross national product.

But $$q/q' - m = \left(\frac{q}{mq'} - 1\right)m = \left(\frac{1/q'}{m/q} - 1\right)m.$$

Since $1/q'$ is the *marginal* cost of creating a unit of human capital, and m/q is the *average* cost, expression 5 suggests that the value of investments in human capital should be greater than current education expenditures (under the usual assumptions about convexity) and that these current expenditures can therefore serve as a lower-bound estimate of the investment in human capital.

Expression 5 says that pollution abatement expenditures, a, are essentially intermediate in character and should be deducted in measuring genuine savings. In practice, most current abatement expenditures are already treated as intermediate inputs in standard national accounting.

Finally, it is important to present the formula for calculating genuine savings from real data. For produced asset depreciation δK, net marginal resource rental rate n, and marginal social cost of pollution σ, this is given by,

$$G = GNP - C - \delta K - n(R - g) - \sigma(e - d) + m. \tag{6}$$

Here, $GNP - C$ is traditional gross savings, which includes foreign savings, while $GNP - C - \delta K$ is traditional net savings. Since carbon dioxide is the only pollutant considered in what follows, be_F can be assumed to be close to zero, so the adjustment to net resource rents $(1 - be_F)$ can safely be assumed to be near 1, while dissipation, d, is assumed to be small relative to emissions, e.[2]

Net natural growth of living resources $(R - g)$ is not added to genuine savings when it is positive, but net depletion (that is, when $R > g$) is deducted. Although this will bias the results against sustainability, Vitousek and others (1986) estimate that less than 33 percent of standing forests are merchantable. Empirical examination of regions where growth exceeds harvest reveals a number of heavily forested countries (including Bolivia, Central African Republic, Republic of Congo, and Guyana), where valuing net growth at current unit rents would equal 20–50 percent of GNP. A clear dichotomy is at work: all of the timber in net depletion countries is merchantable, by definition, while probably less than one-third is merchantable in net growth countries. It is likely that mechanically adding net forest growth to GNP and savings would implicitly include the growth of many uneconomic trees (those with zero rental value).

II. Measuring Resource Depletion and Environmental Degradation

Building on the theory of green national accounting, this article provides a first set of calculations of genuine savings from a consistently derived and reasonably comprehensive time series data set on resource depletion and carbon dioxide emissions. Previous studies, such as Repetto and others (1989), Sadoff (1992), and Kellenberg (1995), deal with particular countries in depth. The calculations presented here necessarily trade off some amount of accuracy against wider coverage.

Data availability limits the adjustments to savings measures to the following: valuing resource rents for nonrenewable resources, valuing depletion of forests beyond replacement levels, and valuing the marginal social costs of carbon dioxide (CO_2) emissions.

2. Carbon dioxide has an atmospheric residency time of 200 years, or a dissipation rate of roughly 0.5 percent a year. For an average growth rate in emissions of 5 percent a year, therefore, the equilibrium ratio of d to e is 1/11.

The basic approach to calculating resource rents for nonrenewable resources is to subtract country- or region-specific average costs of extraction from the world price for the resource in question, all expressed in current U.S. dollars. Many world prices were derived from World Bank (1993): where multiple markets—for example, London and New York—are reported, a simple average of these market prices serves as the world price. So, for minerals the total resource rents are calculated as the world price minus mining costs minus milling and beneficiation costs minus smelting costs minus transport to port minus "normal" return to capital. Cost data are derived from U.S. Bureau of Mines (1987).

For crude oil, unit rents are calculated as the world price minus lifting costs. These lifting costs were estimated based on data from the Inter-American Development Bank (IDB 1981), International Energy Agency (IEA 1994b, 1995c, 1995d, 1996), Jenkins (1989), Sagers, Kryukov, and Shmat (1995), and Smith (1992).

Natural gas, although its international trade has soared in recent years, cannot yet be said to possess a single world price. A world price was estimated by averaging free-on-board prices from several points of export worldwide, after which the unit rents were calculated like those for oil. Production costs were taken from Adelman (1991), Cornot-Gandolphe (1994), IEA (1995d), Julius and Mashayekhi (1990), Khan (1986), Liefert (1988), Mashayekhi (1983), and Meyer (1994).

For hard coal a world price was calculated by combining data on steam and coking coals after adjusting for differences in heat content and quality. A world price for lignite was obtained by analyzing national-level differences in prices between hard coal and lignite in various countries and estimating a similar proportion of values to hold true with respect to the world price for hard coal. Unit rents for both hard coal and lignite were then calculated as for oil. Coal production costs were taken from Bhattacharya (1995), Doyle (1987), IEA (1994a, 1995b, 1995d, 1995e,), Tretyakova and Heinemeier (1986), and World Bank data.

For forest resources only rent on the portion of wood production that exceeds the country's mean annual increment in commercial wood mass was subtracted from savings. A price for the wood of each country was calculated based on the proportions of fuelwood, coniferous softwood, nonconiferous softwood, and tropical hardwood found in total annual production. Representative world prices were used for each type of wood, and a price for fuelwood was estimated using World Bank data. Unit rents were calculated by subtracting average unit harvest costs from the world price.

There are several further points to note about this methodology:

- From a theoretical viewpoint depletion estimates depend on scarcity rents, which should be measured as price minus *marginal* cost of extraction (including a normal return to capital). In practice, data on marginal production costs are almost never available, and practitioners (as evidenced by the green national accounting literature) fall back on using average extraction costs. This tends to overstate calculated resource rents and hence to understate genuine savings.

- Countries may or may not be selling their natural resources for internal consumption at world market prices, although they have good incentives to do so. Moreover, the use of uniform world prices tends to overstate rents for countries with lower-grade resources.
- Extraction costs are measured at a fixed point in time, which differs from country to country and resource to resource according to the availability of data. Extraction costs are held constant (in real terms) during 1970–94. World prices vary over time, leading to corresponding variations in calculated rental rates.
- If the extraction cost data are region- rather than country-specific, the regional cost structure is applied to all of the producing countries in the region.
- Rents on minerals are generally viewed as accruing to the resource owner for the production of the crude form of the material in question, typically an ore. In practice, most mineral operations are vertically integrated to a considerable extent, and the only price and cost data are for refined forms of the materials. Measuring resource rents as described above for these vertically integrated mineral operations therefore implicitly ascribes to the resource rent any excess returns to capital for the milling and refining stages.

Table 1 presents the calculated average rental rates for several resources. The table also shows which cost components, subject to data availability, went into the calculation of rental rates. In most (but not all) cases an explicit rate of return on capital appears as a cost component. Missing cost components lead, of course, to overestimates of resource rents. In line with the formal green national accounting methods of the preceding section, the country-specific unit resource rents in each year are multiplied by the quantities of resource extraction for each of the resources in table 1 to arrive at the total value of resource depletion.

For tropical forest resources, valuing depletion is much more complicated. Where deforestation is occurring, the issue is essentially one of land use, with standing forests being one use among many for a particular land area. This suggests that the correct way to value deforestation is to measure the change in land value (which should represent the present value of the net returns under the chosen use for land); this is essentially the result in Hartwick (1992). The formal model suggests that, where deforestation is not occurring but harvest exceeds growth, it is the net depletion of the resource that should be valued.

Because data on the value of forested land before and after clearance are not widely available, deforestation is not treated explicitly, and forest depletion is simply valued as the stumpage value (price minus average logging cost) of the volume of commercial timber and fuelwood harvested in excess of natural growth in commercially valuable wood mass for that year. Harvest rates by country are as given in FAO (1994). The annual increment is estimated using World Bank data and Duvigneaud (1971), Lamprecht (1989), FAO/UNECE (1992), and Kanowski and others (1992). Stumpage rates come from World Bank data, Openshaw and

Table 1. *Rental Rates for Natural Resources*
(share of world price)

Natural resource	*Mean*	*Standard deviation*	*Cost components*
Bauxite	0.61	0.13	Mining, milling
Copper	0.49	0.20	Mining, milling, smelting, 15 percent return on capital
Crude oil	0.65	0.26	Production costs
Forestry	0.45	0.13	Logging and transport
Gold	0.29	0.15	Mining, milling, transport, 15 percent return on capital
Hard coal	0.28	0.17	Mining and transport
Iron ore	0.58	0.24	Mining, beneficiation, transport
Lead	0.23	0.12	Mining, milling, smelting, transport, 15 percent return on capital
Lignite	0.38	0.17	Mining and transport
Natural gas	0.59	0.24	Production costs
Nickel	0.35	0.21	Mining, milling, smelting
Phosphate rock	0.26	0.14	Mining, milling, transport, 15 percent return on capital
Silver	0.31	0.22	Mining, milling, transport, 15 percent return on capital
Tin	0.35	0.16	Mining, milling, 15 percent return on capital
Zinc	0.21	0.13	Mining, milling, smelting, transport, 15 percent return on capital

Note: Values are for unweighted pooled data from 1985–94 (except silver and tin, 1975–94), excluding negative values.

Source: Authors' estimates.

Feinstein (1989), Kellenberg (1995), and others; market prices are from FAO (1983, 1995), Openshaw and Feinstein (1989), van Buren (1990), Barnes (1992), and World Bank (1993).

The foregoing description of the valuation of forest depletion suggests that the calculations are quite rough. It should also be obvious that the values calculated pertain only to commercial exploitation, so that the values of biodiversity, carbon sequestration, and other uses are not captured.

Pollution damages can enter green national accounts in different ways. Although damage to produced assets (the damage to building materials caused by acid rain, for example) is in principle included in depreciation figures, in practice most statistical systems are not detailed enough to pick this up. The effects of pollution on output (damaged crops, lost production owing to morbidity) are usually not broken out explicitly, but because they are reflected implicitly in the standard national accounts, there is no need to adjust savings measures in this regard.[3] Traditionally, the key pollution adjustment is for welfare effects, valuing the willingness-to-pay to avoid excess mortality and the pain and suffering from pollution-linked morbidity. Because these marginal damage figures are locale-specific, no general treatment of pollution emissions is attempted in the following discussion.

3. However, if the productive capacity of an asset, such as soil fertility, is damaged by pollution, then the loss in asset value should be deducted from savings.

The only social costs considered here, therefore, are for carbon dioxide. Data are readily available for this pollutant, and damages are global rather than strictly local. The basic emissions data employed are from the Carbon Dioxide Information and Analysis Center (CDIAC 1994), covering fossil fuel combustion and cement manufacture. The global marginal social cost of a metric ton of carbon emitted is assumed to be $20 in 1990, taken from Fankhauser (1994). Global damages are charged to emitting countries on the assumption that the property right to a clean environment lies with the pollutee—for example, we are assuming that the Comoros Islands have the right not be inundated as a result of CO_2 emissions elsewhere.

A key element missing in the calculations is any valuation of soil erosion, owing to the lack of comprehensive data sets on either physical erosion or its value. This is an important gap considering the significance of agriculture in most developing countries—erosion is considered to be a major problem in Sub-Saharan African countries in particular. A second missing element is fish stocks, where data problems, questions of ownership, and near-zero rental values resulting from overfishing all militate against including values of depletion.

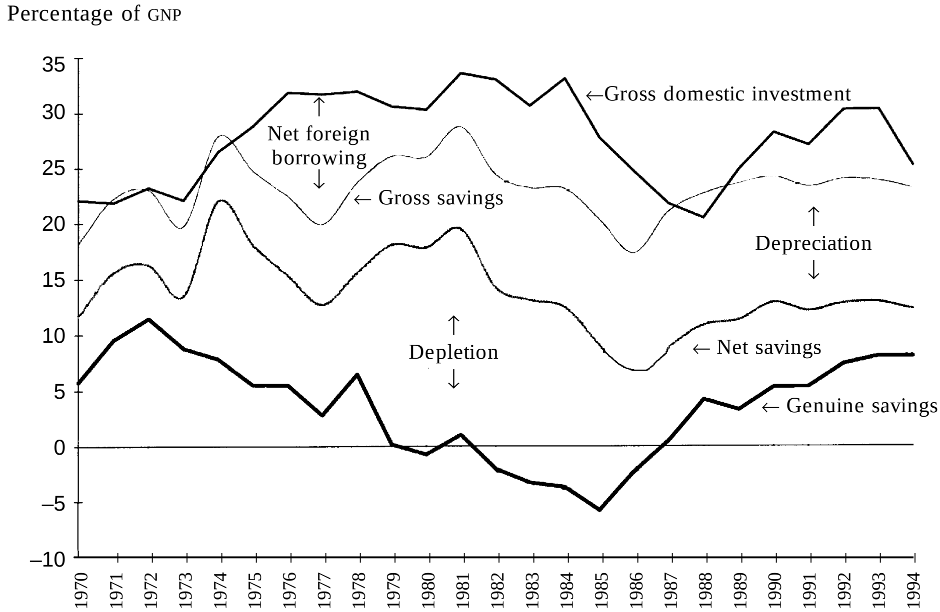
III. Empirical Estimates of Genuine Savings

The traditional measure of a nation's rate of accumulation of wealth, as reported in the World Bank's *World Development Indicators,* for instance, is *gross* savings (World Bank, various years). This is calculated as a residual: GNP minus public and private consumption. *Net* savings, gross savings less the value of depreciation of produced assets, is a first step toward a sustainability indicator. Measures of *genuine* savings address a much broader conception of sustainability than net savings by valuing changes in the natural resource base and environmental quality in addition to produced assets. Figure 1 presents the components of genuine savings as the share of GNP for Tunisia. Note that this calculation omits, for the moment, the effects of human capital investment.

The starting point in the calculation of genuine savings is just standard national accounting. The top curve in figure 1 is gross domestic investment: total investment in structures, machinery and equipment, and inventory accumulation. Net foreign borrowing, including net official transfers, is then subtracted from this top curve to give gross savings: the difference between production and consumption over the year. Next, the depreciation of produced assets is deducted, yielding the curve for net savings. Finally, the bottom line is genuine savings, which is obtained by subtracting the value of resource depletion and pollution damages from net savings.

The basic national accounts data used to derive genuine savings rates are taken from the World Bank's *World Tables* (World Bank 1995). However, these data do not include the value of depreciation of produced assets. Unofficial estimates of depreciation, as calculated from perpetual inventory models, are taken from Nehru and Dhareshwar (1993). All of the data sets employed in this article—the

Figure 1. *Genuine Savings in Tunisia, 1970–94*



Source: Authors' estimates.

World Tables data, the depreciation estimates, and the resource depletion and degradation calculations—have gaps in their coverage.[4]

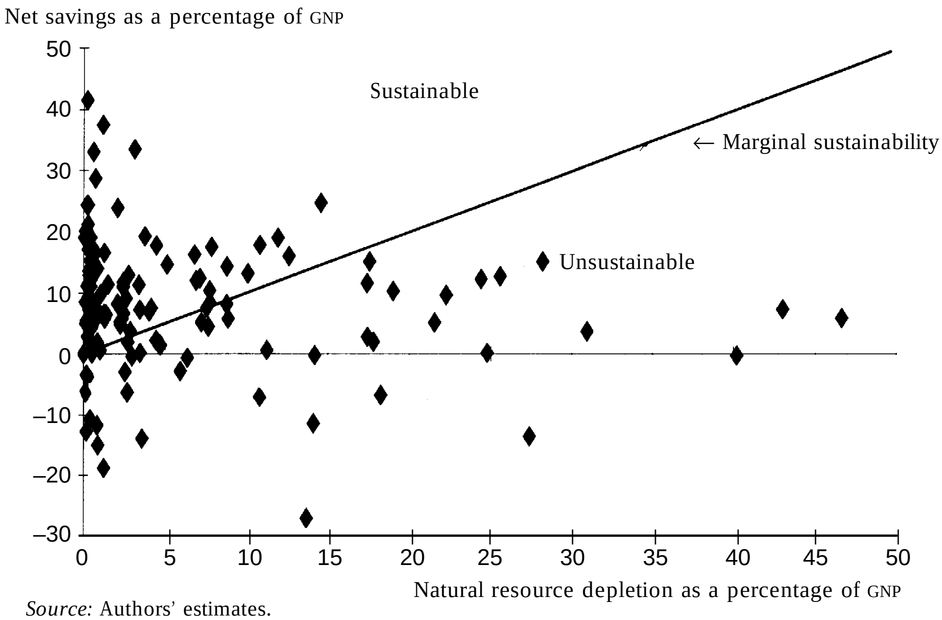
The critical elements added by the green national accounting literature are recognition of natural resources as factors of production and of environmental amenities as sources of welfare. A first question to be answered, therefore, is whether the calculation of depletion and degradation adds substantially to the picture of whether countries are on a sustainable path. This reduces the question to whether there are countries whose net savings rates are positive but whose genuine savings rates are negative.

In figure 2 the net savings rate for the industrial and developing countries in our sample is scatter-plotted against the value of depletion and CO_2 emissions, using average figures for 1988–92. The line labeled "marginal sustainability" is the 45° line—countries falling above this line have genuine savings rates that are positive, while those falling below have negative genuine savings rates. Although several countries have negative net savings rates, and so are unsustainable even by conventional national accounting measures, clearly a number have positive net savings but negative genuine savings. Measuring genuine savings, therefore provides useful new information.

A calculation of genuine savings as a percentage of GNP reveals striking differences across the regions of the world. In many developing areas decisive mo-

4. Resource extraction data in physical quantity are taken from the World Bank's Economic and Social Database.

Figure 2. *Net Savings and Natural Resource Depletion as Shares of* GNP, *Average 1988–92*



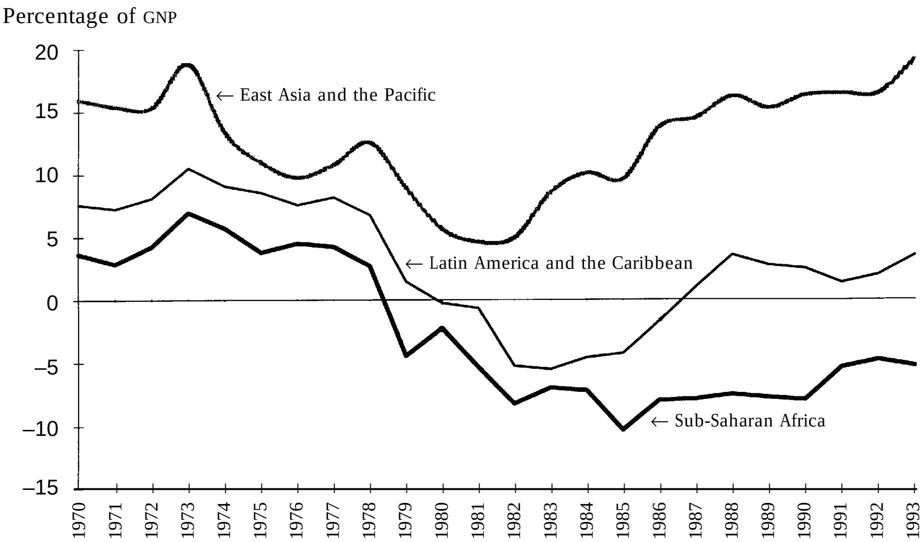
Source: Authors' estimates.

ments in economic performance are reflected in large movements in the genuine savings rate, shown in figures 3 and 4. These figures omit, for the time being, the effects of human capital investment.

The comparison of genuine savings rates reveals a disappointing trend for the countries of Sub-Saharan Africa (figure 3). Here average genuine savings rates rarely exceeded 5 percent during the 1970s, followed by a sharp negative turn at the end of that decade from which they have never recovered. Despite a slight improvement in the early 1990s, regional genuine *dissaving* has recently been near 7 percent. Equally important, negative genuine savings rates have been accompanied by persistently low regional indicators of human welfare, including education, nutrition, and medical care (World Bank 1996b). The savings analysis highlights the fact that the situation *with regard to future well-being* is worse than might otherwise be thought: not only has Sub-Saharan Africa performed badly by conventional measures, it is clear that the wealth inherent in the resource stocks of these countries is being liquidated and dissipated.

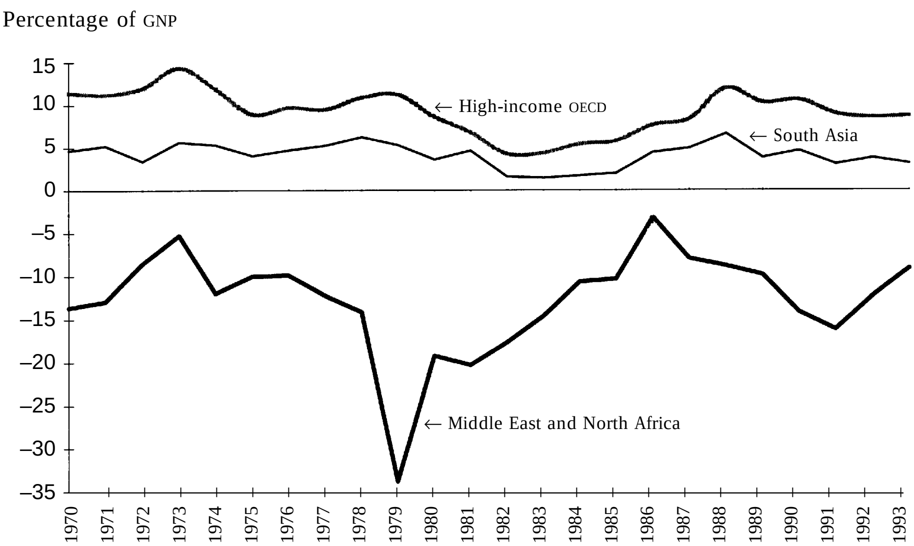
The oil crisis also coincided with a period of decline in genuine savings throughout Latin America and the Caribbean, where figures had previously remained near 8 to 9 percent of GNP. In 1982, the year of Mexico's debt crisis, regional genuine savings rates dropped to negative 5 percent. As the region has emerged from the debt crisis, returned to democratic rule, and spurred the vigorous growth of the "jaguars," genuine savings rates have shown a consistently positive trend. They remain, however, well below 5 percent.

Figure 3. *Genuine Savings as a Percentage of* GNP *for Selected Regions, 1970–93*



Source: Authors' estimates.

Figure 4. *Genuine Savings as a Percentage of* GNP *for Selected Regions, 1970–93*



Source: Authors' estimates.

In stark contrast to the situation in Latin America and the Caribbean, the East Asia and the Pacific region has genuine savings rates sometimes topping 15 percent. However, the effects of important local pollutants, such as particulate matter in air, are not included in this calculation. Moreover, the 1997 financial crisis in this region shows that a robust savings effort is a necessary but not a sufficient condition for strong and smooth economic growth.

Consistently negative genuine savings in the Middle East and North Africa region stands out in figure 4. Regional total consumption as a share of GNP rose from around 50 percent in the 1970s to more than 70 percent by the end of the 1980s, and imports of food and manufactured goods flowed into the region as many current account surpluses of the 1970s turned into deficits in the 1980s (World Bank 1996a). However, the caveats about upward biases in the depletion estimates need to be considered when judging these figures: as the most resource-dependent economies, these countries exhibit the highest downward bias in estimated genuine savings rates.

South Asia exhibits moderately positive rates of genuine savings over the period. This is consistent with the moderate rates of economic growth that have characterized the countries in the region.

Finally, genuine savings rates in the high-income industrial countries (members of the Organisation for Economic Co-operation and Development—OECD), pushed upward by high investment, lack of dependence on natural resource depletion, and strong exports of high value-added goods and services, are near 10 percent for much of the period depicted. The recessions in 1982–83 and 1990 coincided with downward turns in genuine savings rates, but the volatility and high rates of genuine dissaving seen in other areas are consistently absent.

This picture of genuine savings rates is not complete, however. Just as standard measures of savings ignore asset consumption in natural resource capital such as forests, so can it be argued that they ignore investment in one of a nation's most valuable assets: its people.

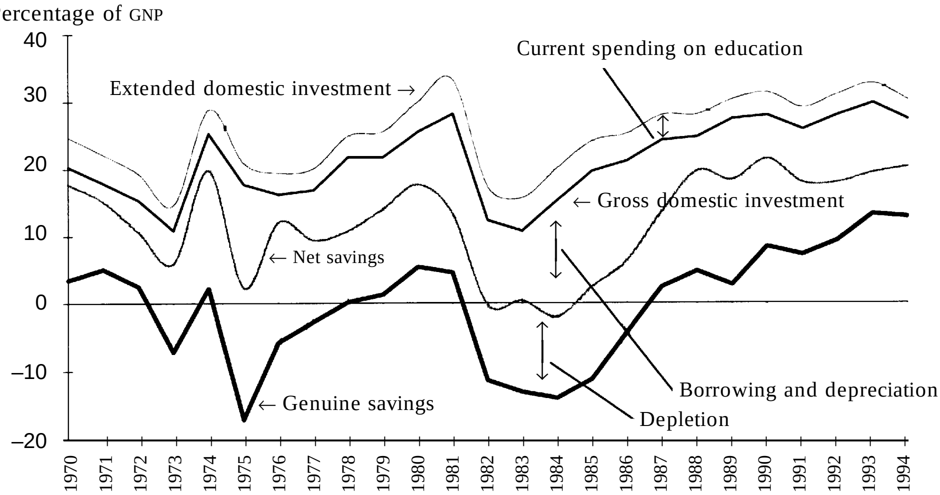
IV. INVESTING IN HUMAN CAPITAL

The process of calculating genuine savings is, in essence, one of broadening the traditional definition of what constitutes an asset. Perhaps the most important of the additions to the asset base is the knowledge, experience, and skills embodied in a nation's populace, its human capital.

The world's nations augment the stock of human capital in large part through their educational systems, into which they collectively pour trillions of dollars each year. Standard national accounts label as an *investment* less than 10 percent of this amount, the portion that is spent on fixed capital, such as school buildings. Current (as opposed to capital) expenditures on education include teachers' salaries and the purchase of books, and are treated strictly as consumption. As the formal accounting model suggests, however, this is clearly incorrect. If a country's human capital is to be regarded as a valuable asset, expenditures on its formation must be seen as an investment.

The effects of including human capital investment in the genuine savings calculation can be significant. In Chile, for example, current educational expenditures represented approximately 3.1 percent of GNP in the early 1990s (figure 5). This level of investment helped to make genuine savings rates positive after the

Figure 5. *Human Capital and Genuine Savings in Chile, 1970–93*



Source: Authors' estimates.

late 1980s. In 1993 and 1994 nearly one-half of the rents from natural resource depletion were, notionally at least, being reinvested in human capital.

Adjusting rates of genuine savings to embrace changes in human capital assets shifts regional genuine savings rates markedly upward (table 2). In Sub-Saharan Africa accounting for education investment brings recent genuine savings rates close to zero. In the Middle East and North Africa genuine savings rates are consistently negative even after adjusting for education. Finally, high rates of education investment in high-income OECD countries and in East Asia and the

Table 2. *Genuine Savings by Region and Income, 1970–93*
(percentage of GNP)

	Average					
Classification	*1970–79*	*1980–89*	*1990*	*1991*	*1992*	*1993*
Region						
East Asia and the Pacific	15.1	12.6	18.6	18.7	18.7	21.3
High-income industrial countries	15.7	12.4	15.7	14.5	14.0	13.9
Latin America and the Caribbean	10.4	1.9	5.5	4.1	4.7	6.1
Middle East and North Africa	–8.9	–7.7	–8.8	–10.8	–6.6	–1.8
South Asia	7.2	6.5	7.6	6.3	7.1	6.4
Sub-Saharan Africa	7.3	–3.2	–3.8	–1.2	–0.6	–1.1
Income category						
Low	9.8	3.3	5.7	7.5	9.0	10.5
Middle	7.2	2.9	10.0	9.7	7.8	8.1
High	15.2	12.3	15.9	14.6	14.1	14.1

Note: Values include an adjustment for spending on education.
Source: Authors' estimates.

Pacific sharpen the contrast between the genuine savings effort in these areas and across the rest of the globe.

Table 3 presents country-level data for genuine savings rates for the 1970s, 1980s, and early 1990s that include current educational expenditures for all countries for which data are available. The pattern of savings shown appears to reflect "the curse of the mineral-rich"—the greater the mineral endowment, the more likely a country is to have a low or negative savings rate (Gelb 1988 and Sachs and Warner 1995).

V. Policy Issues

Many people would argue that obtaining measures of a green *NNP* is intrinsically important. However, by measuring income rather than changes in wealth, green *NNP* will have few direct uses with regard to policies for sustainable development. In contrast, genuine savings measures suggest a series of policy questions that are key to sustaining development.

It is abundantly clear that monetary and fiscal policies are the biggest levers for boosting savings rates—for example, in figure 5 shifts in gross savings in Chile (gross domestic investment less net foreign borrowing) would move all of the curves up or down. The first policy issue is therefore the extent to which monetary and fiscal policies encourage strong domestic savings.

While natural resource exports boost foreign savings and therefore the overall savings effort, the analysis of genuine savings suggests a further question: to what

Table 3. *Genuine Savings by Region, 1970–93*
(percentage of GNP)

Economy	*Average 1970s*	*Average 1980s*	*1990*	*1991*	*1992*	*1993*
Latin America and the Caribbean						
Antigua and Barbuda	—	—	13.7	10.6	6.8	12.9
Argentina	17.6	3.8	8.2	2.9	2.8	5.1
Barbados	7.8	12.2	11.5	9.7	12.7	11.9
Belize	—	15.9	25.2	17.3	16.1	16.7
Bolivia	–3.8	–35.6	–19.5	–12.4	–12.6	–15.4
Brazil	12.6	9.4	11.7	9.3	11.0	11.8
Chile	–1.8	–3.4	8.5	7.3	9.4	13.2
Colombia	6.7	4.2	2.9	7.9	4.6	5.2
Costa Rica	13.0	12.2	12.8	15.2	14.7	—
Dominican Republic	13.2	9.7	9.0	3.8	2.5	10.3
Ecuador	0.7	–12.6	–21.3	–7.2	–3.1	–4.1
El Salvador	11.4	1.8	–0.1	–1.1	3.7	5.9
Grenada	—	22.0	16.7	15.6	16.9	9.9
Guatemala	9.2	–0.1	–2.6	0.6	–0.1	1.2
Haiti	0.3	–2.0	–1.1	–7.1	–16.3	–19.1
Jamaica	–0.6	–9.4	–4.5	–1.8	5.4	–2.4
Mexico	9.1	–3.0	0.9	2.0	1.9	3.6

Table 3. *(continued)*

Economy	*Average* 1970s	*Average* 1980s	*1990*	*1991*	*1992*	*1993*
Paraguay	14.9	13.2	10.4	6.6	1.0	1.0
Peru	5.8	–0.8	4.1	4.8	10.0	6.6
Suriname	15.6	7.3	3.8	–15.0	–2.4	15.4
Trinidad and Tobago	–5.8	–20.6	–19.9	–15.4	–11.4	–7.9
Uruguay	13.2	4.1	4.7	4.0	4.3	3.9
Venezuela	1.9	–17.6	–29.2	–17.6	–16.1	–14.5
East Asia and the Pacific						
China	14.1	6.6	10.5	15.5	16.4	21.5
Hong Kong, China	25.5	22.0	23.8	21.7	—	—
Indonesia	3.1	2.2	8.2	5.3	6.9	13.8
Korea, Rep. of	17.0	25.5	33.5	28.2	27.4	29.6
Malaysia	17.7	9.6	9.9	9.9	15.2	18.6
Myanmar	3.6	–0.4	1.4	4.7	3.6	2.4
Papua New Guinea	—	–9.4	–2.9	–1.1	–0.8	6.4
Philippines	14.1	6.3	5.7	5.8	7.8	8.0
Singapore	17.8	30.3	37.1	39.0	39.5	37.9
Taiwan (China)	23.9	22.3	18.6	19.2	17.8	17.2
Thailand	16.4	17.7	27.0	25.7	25.6	28.1
Middle East and North Africa						
Algeria	–1.8	–9.0	–11.7	–2.2	2.1	6.7
Bahrain	—	0.8	–4.3	–26.7	–11.2	–2.7
Egypt	10.5	0.5	2.6	9.4	15.2	13.6
Iran, Islamic Rep. of	—	–2.7	–11.3	–5.8	–3.3	—
Israel	15.9	14.4	18.4	18.5	18.9	16.7
Jordan	—	—	–2.9	–0.2	12.9	13.5
Morocco	12.3	11.8	19.8	15.6	15.5	15.2
Saudi Arabia	–27.6	–25.5	–27.3	–41.8	–33.0	–20.2
Syrian Arab Republic	10.3	–2.3	–9.0	–10.0	—	—
Tunisia	11.6	3.8	10.1	10.2	12.2	12.8
South Asia						
Bangladesh	–2.3	–0.9	–0.1	–2.7	–0.1	2.4
India	8.4	7.1	8.8	8.1	8.2	7.2
Nepal	–0.6	–1.5	–9.5	–8.8	–9.9	–12.3
Pakistan	3.5	5.4	3.8	1.6	5.0	4.7
Sri Lanka	12.3	8.9	7.8	5.5	9.6	12.4
Sub-Saharan Africa						
Benin	8.1	–3.9	1.9	2.0	0.1	0.8
Burkina Faso	14.8	9.1	7.0	6.7	7.4	8.6
Burundi	—	—	–4.4	–1.5	–1.2	0.0
Cameroon	15.8	7.7	–7.0	–2.5	–3.6	–0.6
Central African Republic	8.4	–0.2	–4.0	–0.3	0.2	–7.7
Chad	—	—	–5.6	–7.7	–9.1	–8.4
Congo, Rep. of	–5.3	–16.8	–28.0	–22.0	–18.7	–28.6
Côte d'Ivoire	16.5	–0.3	–9.8	–13.6	–10.7	–12.3
Gabon	19.7	–7.3	–2.7	4.5	–3.0	2.0

(Table continues on the following page.)

Table 3. *(continued)*

Economy	*Average 1970s*	*Average 1980s*	*1990*	*1991*	*1992*	*1993*
Gambia, The	0.3	3.5	15.4	12.8	20.2	7.7
Ghana	4.1	–6.0	1.4	1.8	–3.2	–4.6
Guinea	—	—	–11.6	–13.5	–9.4	0.1
Guinea-Bissau	—	—	8.8	0.1	–9.4	6.4
Kenya	5.8	5.1	2.8	7.0	3.9	1.4
Madagascar	6.0	–1.3	1.1	–8.7	–3.9	–0.2
Malawi	10.3	–2.9	3.5	–2.2	–9.8	–7.9
Mali	7.3	3.5	11.1	12.5	9.5	9.7
Mauritania	–18.4	–15.8	–10.2	–12.0	–11.4	–14.9
Mauritius	13.3	11.3	19.5	18.7	19.8	18.3
Namibia	—	–5.4	–2.0	16.1	16.2	11.4
Niger	8.5	1.9	–5.8	–1.7	–7.5	–6.5
Nigeria	3.3	–25.3	–46.4	–33.9	–30.2	–37.1
Rwanda	4.1	5.6	2.2	–3.2	–4.0	–1.4
Senegal	6.5	–4.1	8.0	2.3	1.6	3.2
Sierra Leone	–2.5	0.5	–10.4	–2.7	—	—
South Africa	10.4	5.4	5.5	6.2	4.7	5.2
Togo	13.9	13.0	12.4	5.6	2.3	–12.5
Uganda	—	–23.2	–13.7	–0.6	–0.2	–8.6
Zambia	–5.7	–27.3	–32.0	–14.5	–5.3	–16.1
Zimbabwe	9.1	7.4	15.6	6.1	–0.8	8.7
High-income industrial countries						
Australia	11.8	7.5	6.1	6.9	7.2	5.5
Austria	18.3	13.4	18.8	20.2	19.2	16.2
Belgium	17.9	9.3	18.3	15.6	15.9	16.7
Canada	16.1	9.8	10.3	6.7	6.2	7.4
Denmark	16.0	8.4	17.4	14.9	15.5	14.2
Finland	15.4	13.9	18.5	9.4	7.0	5.5
France	19.3	12.8	18.6	16.0	15.4	13.5
Germany	—	—	—	11.1	10.8	10.0
Germany, former Federal Rep.	19.9	13.5	14.3	15.0	13.8	12.2
Greece	15.8	4.6	7.6	9.1	8.0	8.0
Ireland	9.5	9.3	15.9	18.5	16.9	17.4
Italy	17.3	13.3	16.9	12.9	11.8	12.3
Japan	26.5	21.7	31.2	28.7	28.3	26.2
Luxembourg	10.1	9.7	15.8	14.6	12.8	13.9
Netherlands	21.0	13.8	20.8	17.8	16.9	15.6
New Zealand	16.3	9.2	9.1	7.4	9.7	13.6
Norway	14.5	8.7	11.1	15.6	14.2	7.0
Portugal	15.2	12.6	23.4	19.7	20.4	18.1
Spain	16.2	11.0	18.8	14.3	12.5	12.3
Sweden	18.3	12.1	16.1	10.8	7.5	5.6
Switzerland	17.1	19.1	25.7	24.0	22.0	19.9
Turkey	16.3	12.3	18.9	13.1	11.9	15.4
United Kingdom	11.0	8.4	11.4	7.0	6.7	6.6
United States	11.0	9.0	8.2	8.8	8.3	9.6

— Not available.

Note: Values include current education expenditures.

Source: Authors' estimates.

extent do exports of *exhaustible* resources boost the rate of genuine savings?[5] The answer to this lies in netting out the value of resource depletion from the value of gross exports.

More optimal natural resource extraction paths will, other things being equal, boost the value of genuine savings. The policy question for natural resource management is therefore the extent to which stronger resource policies (royalty regimes, tenure) can boost the rate of genuine savings. Similarly, reducing pollution emissions to socially optimal levels will boost the value of genuine savings. The policy issue with respect to pollution is the extent to which more optimal pollution control policies can increase the rate of genuine savings.

The policy prescriptions for boosting genuine savings should never be to stop extracting resources or emitting pollutants altogether. Rather, pricing resources and pollutants correctly and enforcing property rights will lead to efficient levels of exploitation of the environment, reducing incentives to "high-grade" resources (meaning, to take the cheapest and most accessible resources first, without considering dynamic efficiency) or pollute indiscriminately. Optimal resource and environmental policies will maximize genuine savings, subject to the macroeconomic policy regime in place. However, the sorts of issues raised by Gelb (1988) about the nature and effects of oil windfalls in developing countries are particularly relevant to the policy issues just addressed: without sound macroeconomic policies and prudent allocation of public resources, the effects of reliance on large resource endowments can be negative for many countries.

VI. Conclusions

Savings rules have been criticized because they are concerned only with *weak* sustainability (see, for example, Martínez-Alier 1995).[6] One response to this criticism is to suggest that countries that fail the savings rule—exhibit persistently negative genuine savings—probably also fail to meet the criteria for *strong* sustainability, in the sense that critical natural assets are being depleted. It would be surprising if this were not the case. And as Pearce, Hamilton, and Atkinson (1996) argue, even if some amount of a critical resource must be preserved to meet the criteria of strong sustainability, savings rules are still required for the remaining resources if sustainability is to be achieved.

Thinking about sustainable development and its measurement leads naturally to a conception of the process of development as one of portfolio management. Prudent governments will not only consider natural resources as assets and pollution stocks as liabilities in the national balance sheet, they will also be concerned with the appropriate mix of produced assets and human capital.

5. The question is also germane for unsustainable forest harvest programs.

6. Pearce, Markandya, and Barbier (1989) define weak sustainability to mean that natural and produced assets are fully substitutable. Strong sustainability implies that at least some natural assets have no substitutes and so may need to be conserved if development is to be sustainable.

Questions of the "appropriate mix" of assets are inherently questions about returns on the marginal investment. This marginal investment may be in better resource management, boosting the value of natural resources in the national balance sheet; it may be in pollution control, decreasing the size of the pollution liability to its efficient level; it may be in infrastructure, as has traditionally been the case; and it may be in primary education, as an essential building block in increasing human capital.

The policy implications of measuring genuine savings are quite direct: persistently negative rates of genuine savings must lead, eventually, to declining well-being. For policymakers, linking sustainable development to rates of genuine savings means that there are many possible interventions to increase sustainability, from the macroeconomic to the purely environmental.

There are several omissions in the foregoing empirical analysis: soils, fish, water resources, water pollutants, and air pollutants (other than CO_2), to name a few. Notwithstanding these omissions, the empirical evidence is that genuine savings is negative in a wide range of countries when the environment and natural resources are included in the savings measure. Negative genuine savings is more than a theoretical possibility, therefore, and the evidence is that many countries, particularly in Sub-Saharan Africa, are being progressively impoverished. Increasing the coverage of natural resources and pollutants in our calculations would lower the estimated levels of genuine savings overall.

In terms of further research there are obvious refinements that can be envisioned, including treating soil degradation and expanding the country coverage of data on the marginal social costs of pollution emissions. The latter is particularly important for rapidly growing countries: as countries grow, they tend to urbanize, and these urban areas tend to develop problem levels of pollution.

A particularly appealing topic for further research would be an exploration of the "resource curse" hypothesis. Sachs and Warner (1995) find that resource dependence (under a variety of definitions) is negatively correlated with economic growth, based on an analysis of industrial and developing countries since the 1970s. The data developed for the genuine savings analysis should allow more precise definitions of resource dependence, permitting the hypothesis to be retested. In addition, the estimated genuine savings rates may turn out to have explanatory power in the resource curse model.

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