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Genuine Savings Rates in Developing Countries

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Abstract. A formal model of green national accounting demonstrates that 'genuine' saving, net saving less the value of resource depletion and environmental degradation, is a useful indicator of sustainability. Country-level and regional calculations of genuine savings are presented for the period 1970-1993. Sub-Saharan Africa stands out as the region where the greatest dissipation of wealth is occurring. Policy issues are explored.

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Introduction

However it may be defined in detail, achieving sustainable development necessarily entails creating and maintaining wealth. Given the centrality of savings and investment in economic theory, it is perhaps surprising that the effects of depleting natural resources and degrading the environment have not, until recently, been considered in the measurement of national savings. Augmented measures of savings and wealth in the national accounts offer promise, therefore, as indicators of sustainable development, which was a prime motivation for the publication of *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 the techniques of valuation of environmental resources (see, for a recent example, 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; Hamilton 1994, 1996). The first cross-country application of these greener accounting methods to the measurement of net savings appeared in Pearce and Atkinson (1993), who combined published estimates of depletion and degradation for 20 countries with standard national accounting data to examine true savings behaviour. By this measure many countries appear to be unsustainable because their gross savings are less than the combined sum of conventional capital depreciation and natural resource depletion.

Enlarging the concept of net saving to include the depletion of natural resources is a natural extension of traditional savings concepts. This is because the depletion of a natural resource is, in effect, the liquidation of an asset and so should not appear as a positive contribution to net income or net savings. While minor technical issues remain, the methods of valuing the depletion, discovery and growth of commercial natural resources in the context of the SNA are by now well developed (Hamilton 1994; Hill and Harrison 1994).

More problematic is the valuation of environmental degradation. While UN guidelines for environmental accounting (United Nations 1993) favour valuing this degradation in terms of maintenance costs (the cost of restoring the environment to its state at the beginning of the accounting period), theoretical approaches (Hamilton 1996) suggest that the marginal social costs of pollution are the correct basis for valuing waste emissions to the environment.

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

Genuine Savings: a Formal Model

The notion of genuine saving was presented briefly and informally in Hamilton (1994) and Pearce *et al.* (1996). This section provides a more rigorous development of these ideas, using a model that, while extremely simple, serves to identify the adjustments needed to savings measures in order to account for natural resources, pollutants and human capital. Sustainable development is defined to be, as in Pezzey (1989), non-declining 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 *R* is resource use, *a* is pollution abatement expenditures, *N* is human capital, and *m* is investment in human capital (current education expenditures). Function *q(m)* transforms education expenditures into human capital that does not depreciate (it can be considered to be a form of disembodied knowledge), so that $\dot{N} = q(m)$[3]. Labour is fixed and is therefore factored out of the production function.

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* and are depleted by extraction *R*, so that $\dot{S} = -R + g(S)$, and resources 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,

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

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

$$H = U + \gamma_K \dot{K} + \gamma_X \dot{X} + \gamma_S \dot{S} + \gamma_N \dot{N}, \qquad (1)$$

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 static first-order conditions for a maximum, the Hamiltonian function may be written as,

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[3] Human capital provides a type of endogenous technical progress. Cf. Weitzman and Löfgren (1997), who deal with exogenous technical change.

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

Note that *b* is the marginal cost of pollution abatement. It is shown in Hamilton (1996) that this is precisely equal to the marginal social cost of pollution emissions, and that this in turn is equal to the level of a tax - the Pigovian tax required to maximize welfare - on emissions. These equalities hold because the economy is at the optimum. The term be_F is the effective tax rate on production as a result of the emissions tax. Therefore, although we have 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 $\dot{S} = -R + g$, $\dot{M} = e - d$ and $\dot{N} = q$, the parenthesized expression in the second term of this expression is equal to the change in the real value of 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 at the resource rental rate, F_R, net of the effective tax rate on production associated with pollution emissions. This expression serves to define genuine saving, *G*,

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

For non-living resources the term in growth *g* can be dropped from expression (2), while for cumulative pollutants the term in dissipation *d* can be discarded.

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

$$U_C G = \dot{W} = rW - U. \qquad (3)$$

Expression (3) entails the following property: measuring negative genuine saving at a point in time implies that future utility is less than current utility over some period of time on the optimal path. Negative genuine saving therefore serves as an indicator of non-sustainability.

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,

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

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 within a model economy where the optimal path is not sustainable—this is the model of Dasgupta and Heal (1979), where 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 it is straightforward to show that the current model is one where 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 where utility rises asymptotically to a finite maximum value. The more interesting question for this model concerns divergences between currently observed 'real world' prices and those on the optimal path. Hamilton *et al.* (1998) argue that policy distortions in a typical economy lead to over-extraction of natural resources and excess pollution emissions. Under these conditions it can be shown that current resource rents exceed their optimal level, as do marginal pollution damages. More optimal 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,

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

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,

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

With these added assumptions the measure of NNP (derived, as above, as extended Hicksian income) for an open economy is given by,

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

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

Vincent *et al.* (1997) show that for a small resource exporter 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 sub-soil resources), this potential annuity can be considered to be zero. It was precisely the assumption of continuously rising export prices that led many natural resource exporters into difficulty in the 1980's.

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

$$\begin{aligned} NNP &= GNP - a - m - n(R-g) - b(e-d) + q/q' \\ &= GNP - a - n(R-g) - b(e-d) + \left(\frac{mce}{ace} - 1\right)m \end{aligned} \tag{5}$$

where *mce* is the marginal cost of creating a unit of human capital (i.e., $1/q'$) and *ace* is the average cost (m/q). Assuming increasing marginal education costs, expression (5) suggests that the value of investments in human capital should be greater than current education expenditures—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 saving. 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 saving from real data. For produced asset depreciation δK, net 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 saving, which includes foreign savings, while $GNP - C - \delta K$ is traditional net saving. Similarly, since carbon dioxide is the only pollutant considered in what follows, 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*[4].

Net natural growth of living resources ($R - g$) is not added to genuine savings when it is positive, but net depletion (i.e. when $R > g$) is deducted. While this will bias the results against sustainability, Vitousek *et al.* (1986) estimate that less than 33% 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, Congo and Guyana) where valuing net growth at current unit rents would equal 20-50% of GNP. There is a clear dichotomy at work here: all of the timber in net depletion countries is merchantable, by definition, while something less than a third is likely to be 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).

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

Measuring Resource Depletion and Environmental Degradation

Building upon the theory of green national accounting, this paper 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 *et al.* (1989), Sadoff (1992) and Kellenberg (1995), have dealt with particular countries in depth. The calculations presented below necessarily trade off some amount of accuracy against wider coverage.

The adjustments to savings measures are limited by data availability to the following: (i) the valuation of resource rents for non-renewable resources; (ii) valuing depletion of forests beyond replacement levels; and (iii) valuing the marginal social costs of CO_2 emissions.

The basic approach to calculating resource rents for non-renewable 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 US dollars. Many world prices were derived from World Bank (1993a) - where multiple markets, e.g., London and New York, are reported, a simple average of these market prices serves as the world price.

For minerals the levels of total resource rents are thus calculated as:

Rent = World price - mining cost - milling and beneficiation costs
- smelting costs - transport to port
- 'normal' return to capital.

For crude oil, unit rents are calculated as the world price less lifting costs. These lifting costs were estimated based on data from IEA (1994, 1995a, 1995b, 1996), IADB (1981), Jenkins (1989), Smith (1992) and Sagers (1995).

Natural gas, though 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, following which the unit rents were calculated as for oil. Production costs were taken from IEA (1995c), Julius and Mashayekhi (1990), Mashayekhi (1983), Khan (1986), Meyer (1994), Adelman (1991), Cornot-Gandolphe (1994), and Liefert (1988).

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 analysis of 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 IEA (1994b, 1995c, 1995d, 1995e), Doyle (1987), Tretyakova and Heinemeier (1986), Bhattacharya (1995), and World Bank data.

For forest resources, only rent on that portion of wood production which exceeded 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, non-coniferous softwood, and tropical hardwood found in its 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 production costs from the world price.

There are several further points to note about this methodology:

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

- Countries may or may not be selling their natural resources for internal consumption at the world market price, although one would expect that they have every incentive to do so. Moreover, the use of uniform world prices will tend to overstate rents for countries with lower-grade resources.

- Extraction costs are measured at a fixed point in time, a point which differs from country to country and resource to resource according to data availability, and held constant (in real terms) over the period 1970-1994. World prices vary over time, leading to corresponding variations in calculated rental rates.

- Where the extraction cost data were region- rather than country-specific, the regional cost structure was 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 so 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 any excess returns to capital for the milling and refining stages to the resource rent.

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 over-estimates 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.

Table 1 Rental rates for natural resources (share of world price)

Unweighted pooled data, 1985-94 (except silver and tin, 1975-94), excluding negative values

	Mean	***Std. Dev.***	***Cost Components***
Zinc	.21	.13	Mining, milling, smelting, transport, 15% ROC
Iron Ore	.58	.24	Mining, beneficiation, transport
Phosphate Rock	.26	.14	Mining, milling, transport, 15% ROC
Bauxite	.61	.13	Mining, milling
Copper	.49	.20	Mining, milling, smelting, 15% ROC
Tin	.35	.16	Mining, milling, 15% ROC
Lead	.23	.12	Mining, milling, smelting, transport, 15% ROC
Nickel	.35	.21	Mining, milling, smelting
Gold	.29	.15	Mining, milling, transport, 15% ROC
Silver	.31	.22	Mining, milling, transport, 15% ROC
Crude Oil	.65	.26	Production costs
Natural Gas	.59	.24	Production costs
Hard Coal	.28	.17	Mining and transport
Lignite	.38	.17	Mining and transport
Forestry	.45	.13	Logging and transport

ROC: Return on capital

For tropical forest resources the situation is much more complicated with regard to the valuation of depletion. 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 land use) — this is essentially the result in Hartwick (1992). The formal model above suggests that, where deforestation is not occurring but harvest exceeds growth, it is the net depletion of the resource that should be valued.

Since 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. Stocking rates (the volume of commercial timber per hectare) by country are as given in FAO (1993). Annual increment was estimated using World Bank data and FAO/UNECE (1992), Kanowski et al. (1992), Lamprecht (1989), and Duvigneaud (1971). Stumpage rates come from World Bank data, Openshaw and Feinstein (1989), Kellenberg (1995), and others ; market prices are from FAO (1983; 1995), Barnes (1992), Openshaw and Feinstein (1989), van Buren (1990), and World Bank (1993a).

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 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 several different ways. While damage to produced assets (acid rain damaging building materials, 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 (damage to crops, lost production owing to morbidity) are already reflected in the standard national accounts, but not explicitly—there is no need to adjust savings measures in this instance[5]. 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 what follows.

The only social costs considered below, therefore, are for carbon dioxide. For this pollutant data are readily available and damages are global rather than strictly local. The basic emissions data employed are from the Carbon Dioxide Information and Analysis Center (CDIAC 1993), covering fossil fuel combustion and cement manufacture. The global marginal social cost of a metric ton of C is assumed to be $20 US 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.

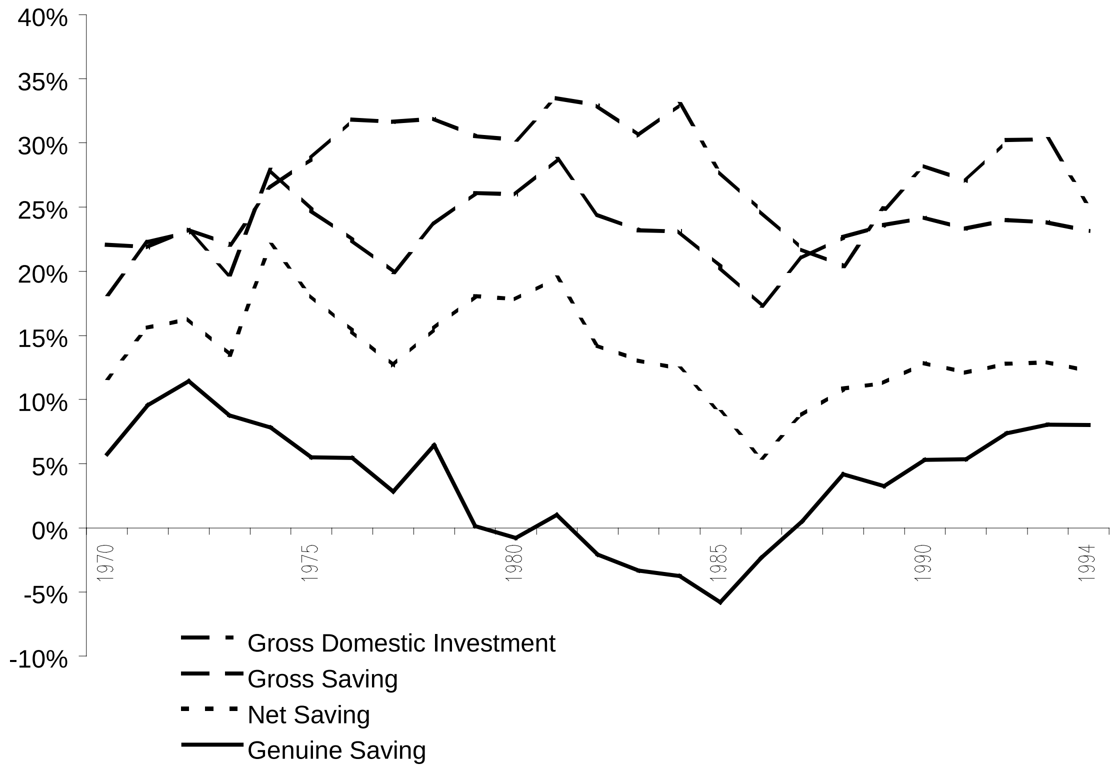
A key missing element in the calculations is any valuation of soil erosion, owing to the lack of comprehensive data sets on either physical erosion or its value. This is an important gap considering the importance of agriculture in most developing countries — erosion is considered to be a major problem 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 over-fishing all militate against including values of depletion.

Empirical Estimates of Genuine Saving

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* saving. This is calculated as a residual: GNP minus public and private consumption. *Net* saving, total gross saving less the value of depreciation of produced assets, is a first step towards a sustainability indicator. Measures of *genuine* saving address a much broader conception of sustainability, by valuing changes in the natural resource base and environmental quality in addition to produced assets. Figure 1 presents the components of genuine saving as shares of GNP for Tunisia. Note that this calculation omits, for the moment, the effects of human capital investment.

Figure 1 Genuine Savings for Tunisia, percent of GNP

[5] Note, however, that 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 saving.



The starting point in the calculation of genuine saving is just standard national accounting. The top curve in Figure 1 is gross domestic investment, the total of investments 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 saving, the difference between production and consumption over the year. Next the depreciation of produced assets is deducted, yielding the curve for net saving. Finally, the bottom line is genuine saving, which is obtained by subtracting the value of resource depletion and pollution damages from net saving.

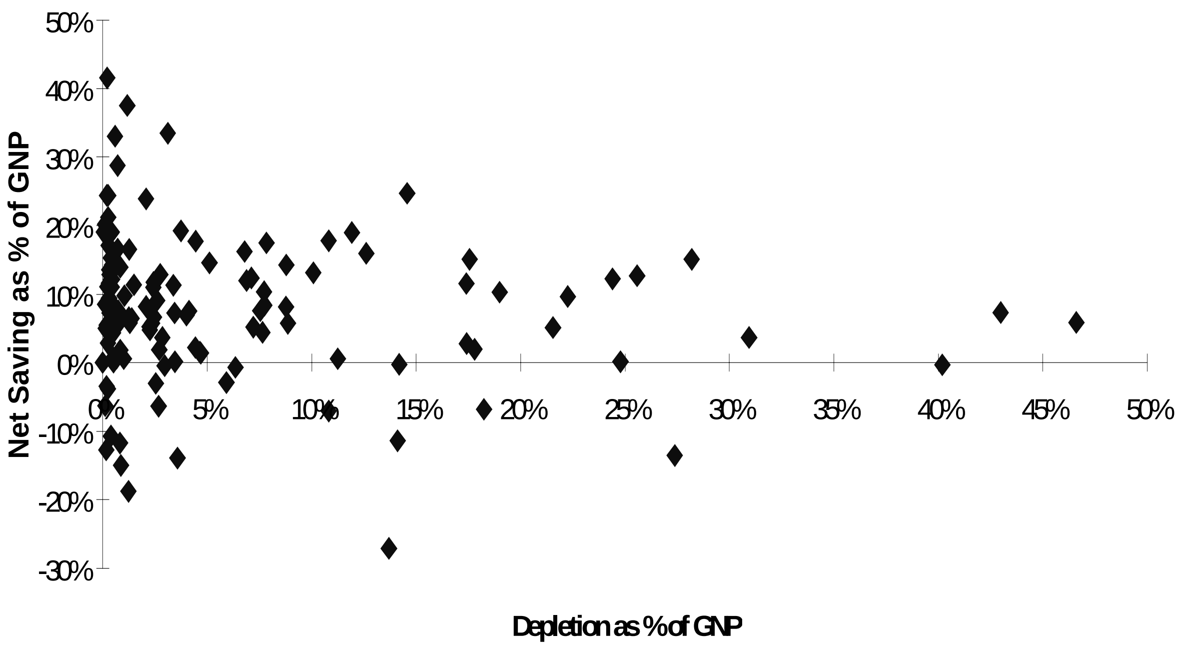
The basic national accounts data used to derive genuine savings rates are as given in the World Bank's *World Tables* (World Bank 1995b). However, these data do not include the value of depreciation of produced assets. Unofficial estimates of depreciation, as calculated from perpetual inventory models, are taken from Nehru and Dhareshwar (1993). Each of the data sets employed in this paper — the *World Tables* data, the depreciation estimates, and the resource depletion and degradation calculations — have various gaps in their coverage[6].

The critical elements added by the green national accounting literature are to recognize natural resources as factors of production and 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 to the

[6] Resource extraction data in physical quantity are taken from the World Bank's Economic and Social Data Base (BESD).

question of whether there are countries whose net savings rates are positive but whose genuine savings rates are negative. This is examined in Figure 2.

Figure 2 Net Saving Rate vs. Depletion Share of GNP
Average 1988-1992

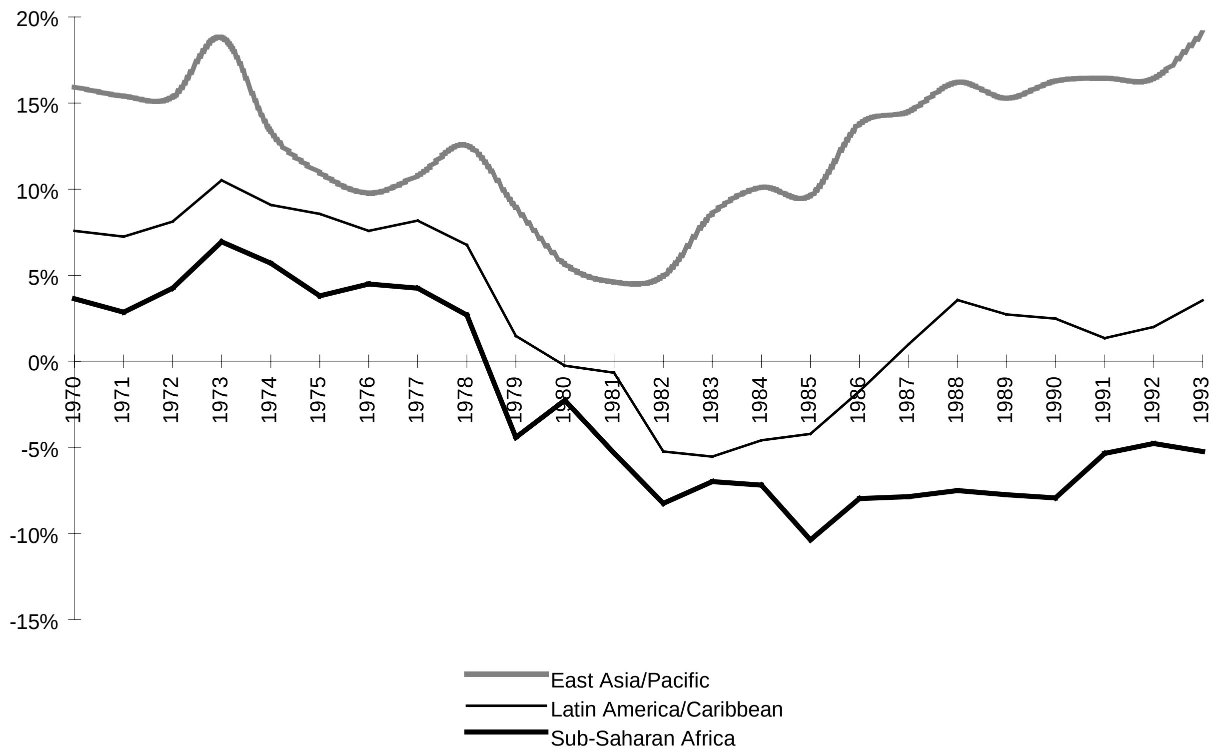


In this figure the net saving rate (for the developed and developing countries in our sample—see Appendix Table 1) is scatter-plotted against the value of depletion and CO_2 emissions as a percentage of GNP, using average figures for the period 1988-1992. The line labeled ‘Marginal Sustainability’ is the 45° line — countries falling above this line have genuine savings rates that are positive, while those falling below have negative genuine savings rates. While there are several countries that have negative net savings rates, and so are unsustainable even by conventional national accounting measures, there is clearly a considerable number with positive net savings but negative genuine savings. Measuring genuine saving therefore provides useful new information.

A calculation of genuine saving rates as a percentage of GNP reveals striking differences across the regions of the world. In many developing areas, decisive moments in economic performance are reflected in large movements in the genuine saving rate, shown in Figures 3 and 4. Note that these figures omit, for the time being, the effects of human capital investment.

The comparison of genuine saving rates reveals a disappointing trend for the countries of Sub-Saharan Africa (Figure 3). Here average genuine saving rates rarely exceeded five percent of GNP during the 1970s, followed by a sharp negative turn at the end of that decade from which they have never recovered. Despite slight recovery in the early nineties, regional genuine *dissaving* has recently been near seven percent. Equally importantly, negative genuine saving rates have been accompanied by persistently low regional indicators of human welfare, including education, nutrition, and medical care (World Bank, 1996a). 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 SSA performed badly by conventional measures, it is clear that the wealth inherent in the resource stocks of these countries is being liquidated and dissipated.

Figure 3 Genuine Savings Rates by Region

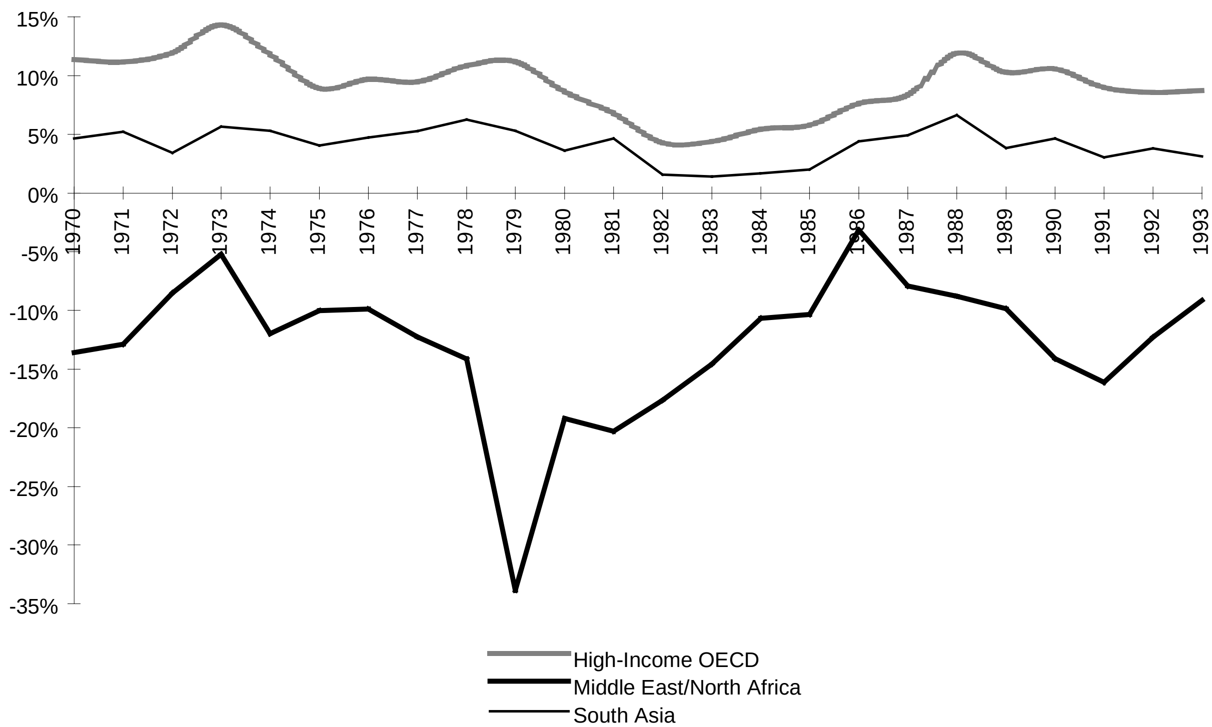


The oil crisis also coincided with a period of decline in genuine savings throughout Latin America and the Caribbean, where figures had previously remained near eight to nine percent of GNP. In 1982, the year of Mexico’s debt crisis, regional genuine savings dropped to negative five percent. As the area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

In stark contrast to the above stands the East Asia/Pacific region, with genuine saving rates topping 15 percent of GNP. It must be recalled, however, that 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 sufficient condition for strong and smooth economic growth.

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

Figure 4 Genuine Savings Rates by Region



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

Finally, rates of genuine savings in the high-income OECD countries, pushed upward by high investment, lack of dependence on natural resource depletion, and strong exports of high value-added goods and services, are near ten percent for much of the period depicted. The recessions in 1982/83 and 1990 coincided with downward turns in genuine saving rates, but the figures consistently exhibit an absence of the volatility and large rates of genuine dissaving seen in other areas.

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

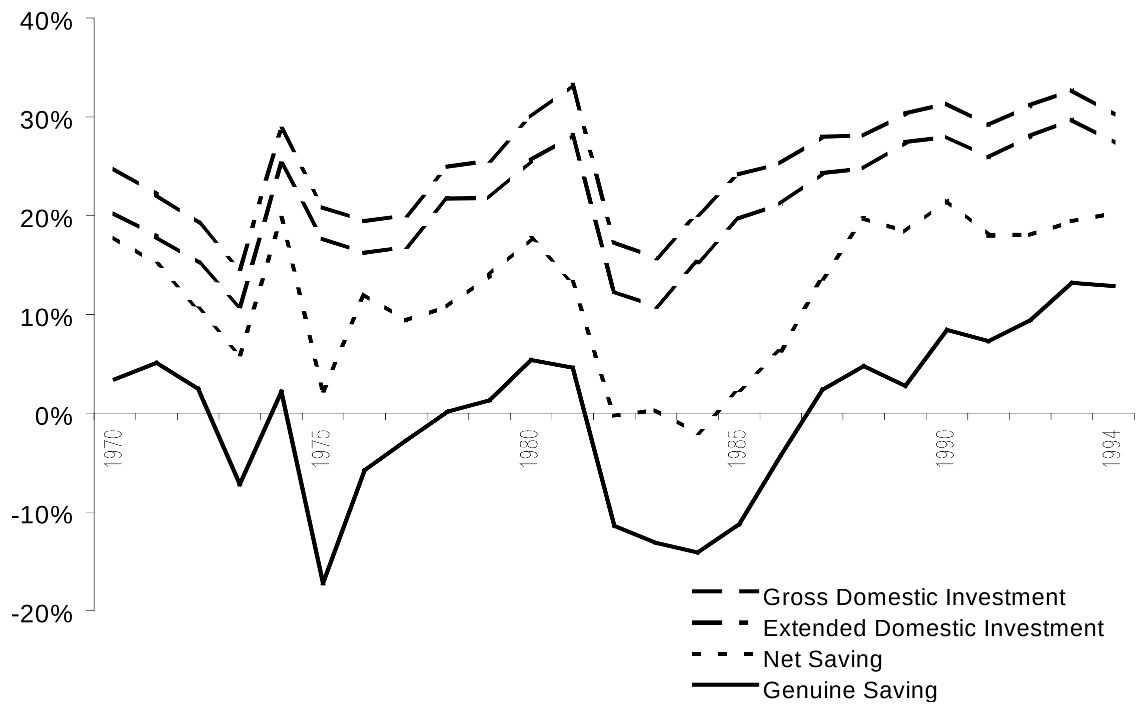
Investing in Human Capital

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 ten percent of this amount, that portion which 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 nineties (Figure 5). This level of investment helped keep genuine saving rates from becoming negative in the late eighties, and represent more than one third of the high rates seen in recent years. In 1993 and 1994, nearly half of the rents from natural resource depletion were, notionally at least, being reinvested in human capital.

Figure 5 Human Capital and Genuine Savings in Chile



Adjusting rates of genuine savings to embrace changes in human capital assets shifts regional genuine saving rates markedly upwards (Table 2). In Sub-Saharan Africa, accounting for education investment brings recent genuine saving rates close to zero. In the Middle East/North Africa region, genuine saving rates are consistently negative even after the education adjustment. Finally, high rates of education investment in high-income OECD countries and the East Asia/Pacific region sharpen the contrast between the genuine saving effort in these areas and across the rest of the globe.

Table 2 Genuine Savings as a Percentage of Gross National Product
Includes Adjustment for Current Spending on Education

	Average 1970-79	*Average 1980-89*	*1990*	*1991*	*1992*	*1993*
Region						
Sub-Saharan Africa	7.3	-3.2	-3.8	-1.2	-0.6	-1.1
Latin America/Caribbean	10.4	1.9	5.5	4.1	4.7	6.1
East Asia/Pacific	15.1	12.6	18.6	18.7	18.7	21.3
Middle East/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
High-Income OECD	15.7	12.4	15.7	14.5	14.0	13.9
Income Category						
Low Income	9.8	3.3	5.7	7.5	9.0	10.5
Middle Income	7.2	2.9	10.0	9.7	7.8	8.1
High Income	15.2%	12.3%	15.9%	14.6%	14.1%	14.1%

Source: World Bank calculations.

Appendix Table A1 presents country-level data for genuine savings rates that include current educational expenditures. 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 (cf. Gelb 1988, Sachs and Warner 1995).

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 saving (gross domestic investment less net foreign borrowing) will move all of the curves up or down. The first policy issue is therefore: to what extent do 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 extent do exports of *exhaustible* resources boost the genuine rate of saving?[7] The answer to this lies in netting out the value of resource depletion from gross export values.

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: to what extent can stronger resource policies (royalty regimes, tenure) boost the genuine rate of saving?

Similarly, reducing pollution emissions to socially optimal levels will boost the value of genuine savings. The policy issue with respect to pollution is: to what extent can more optimal pollution control policies increase the rate of genuine saving?

Note that 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 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 raised: without sound macroeconomic policies and prudent allocation of public resources, the effects of reliance upon large resource endowments can be negative for many countries.

[7] The question is also germane for unsustainable forest harvest programmes.

Conclusions

Savings rules have been criticized (e.g., Martinez-Alier 1995) because they are concerned only with *weak* sustainability[8]. One response to this criticism is to suggest that countries that fail the savings rule, exhibiting persistently negative genuine savings, probably are also failing 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 *et al.* (1996) argue, even if some amount of a critical resource must be preserved intact to meet the criteria of strong sustainability, savings rules are still required for the remaining resource 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 be concerned with the appropriate mix of produced assets and human capital as well.

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 saving are quite direct: persistently negative rates of genuine saving must lead, eventually, to declining well-being. For policy-makers the linkage of sustainable development to genuine rates of saving 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 levels of saving are negative in a wide range of countries when the environment and natural resources are included in the savings measure. Negative genuine saving is more than a theoretical possibility, therefore, and the evidence is that many countries, particularly in Sub-Saharan Africa, are being progressively impoverished as a result of poor government policies. Increasing the coverage of natural resources and pollutants in our calculations would decrease 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 develop there has been an increasing trend towards urbanization and the development of problem levels of pollution in these urban areas.

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[8] Pearce *et al.* (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.

A particularly appealing topic for further research would be the 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 developed and developing countries since the 1970's. The data developed for the genuine savings analysis should permit more precise definitions of resource dependence, permitting the hypothesis to be re-tested. In addition, the estimated genuine saving rates may turn out to have explanatory power in the resource curse model.

Appendix

Country-level calculations of genuine saving rates for the 1970's, 1980's and early 1990's appear in Table A1. High-income OECD countries are included for reference. Countries are excluded where data are missing or fundamental problems in the data exist.

Table A1. Genuine Saving Rates by Country, Including Current Education Expenditures

(% of GNP)

	Average 1970s	*Average 1980s*	*1990*	*1991*	*1992*	*1993*
Latin America / 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%
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 / Pacific						
China	14.1%	6.6%	10.5%	15.5%	16.4%	21.5%
Hong Kong	25.5%	22.0%	23.8%	21.7%	..	..
Indonesia	3.1%	2.2%	8.2%	5.3%	6.9%	13.8%
Korea, Republic 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 / North Africa						
Algeria	-1.8%	-9.0%	-11.7%	-2.2%	2.1%	6.7%

Table A1. Genuine Saving Rates by Country, Including Current Education Expenditures

(% of GNP)

	Average 1970s	*Average 1980s*	*1990*	*1991*	*1992*	*1993*
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 Rep.	8.4%	-0.2%	-4.0%	-0.3%	0.2%	-7.7%
Chad	..	..	-5.6%	-7.7%	-9.1%	-8.4%
Congo	-5.3%	-16.8%	-28.0%	-22.0%	-18.7%	-28.6%
Cote 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%
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 OECD						

Table A1. Genuine Saving Rates by Country, Including Current Education Expenditures (% of GNP)

	Average 1970s	*Average 1980s*	*1990*	*1991*	*1992*	*1993*
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 FRG	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%

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