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Measuring Sustainable Economic Development in Africa

May 1999
(pdf version August 2000)

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Abstract

This paper elaborates key economic considerations essential to sustainable growth and development. Part one reviews key findings from the literature on sustainability and economic growth. Part two presents a dynamic optimization model that explicitly incorporates sustainability and biodiversity dimensions. Part three reviews recent growth and environmental trends in Africa. Part four presents an index of sustainable growth based on a sample of countries in Sub-Saharan Africa. Part five draws conclusions on the necessity of appropriate property rights regimes and the development of economic incentives that can achieve sustainable rates of growth in stocks of natural and environmental capital. A version of this paper is found in the *Scandinavian Journal of Development Alternatives* 18:2-3 (June & September 1999), pp. 265-282.

On Measuring Sustainable Economic Development in Africa

Introduction

What is meant by sustainable economic development, can it be achieved, and what is required for its success? This is not a new question, but one in which a stream of continuing research provides insight and guidance in terms of emerging alternatives. In this paper, we look at the question of sustainable economic development issue in terms of existing theory as applied to Sub-Saharan Africa, a region where sustainability has taken on particular importance in recent years. We develop an index of sustainable economic growth, with applications to a sample of countries in Africa, and which may serve as a guide to future policy.

Economic and Environmental Sustainability

Economic development generally has been interpreted as increases in a country's real per capita income that affect broad segments of the population and in which the productivity of resources is enhanced as new stocks of resources are generated. Rising levels of purchasing power parity (PPP) real GDP per capita serve as a benchmark for economic growth, while broader measures such as the UNDP's Human Development Index (HDI) serve as indicators of development. While neither of these measures captures all of the dimensions of growth and development, they serve as useful proxies in the present context.

If the economic benchmarks for economic growth and development are fairly well established, what do we mean by sustainability? Goldin and Winters (1995) offer a straightforward general definition based on the Brundtland Report of 1987 and the 1992 Rio Summit: "'Sustainable' is often defined as development that meets the needs of present generations without compromising the ability of future generations to meet their needs."[1] As such, this corresponds to a definition offered by John Hicks (1939), where income is defined as "the maximum amount that could be spent without reducing real consumption in the future".[2]

It is reasonable to translate the Brundtland-Rio definition of "meeting the needs" into the economic statement that each generation seeks to maximize a level of utility subject to the resource constraints and technology at each moment in time. However, at this level of generality, "sustainability" makes no explicit prior stipulation on the level of per capita resource use over time, nor does it make any explicit prior stipulation on the composition of per capita resource use. Although the general definition of sustainability only states that each generation shall be able to meets its needs, for our purposes, we will define sustainability within the context of constant or increasing levels of real PPP per capita income over time. Within this definition, we then will derive the conditions for the level and composition of resource use.[3]

Achieving constant or rising levels of real per capita income requires either that the stock of capital resources must remain stable or increase over time or the technical efficiency with which they are used must increase. If population is expanding, then there must be some combination of increases in the stock of capital resources and technical efficiency if per capita income is to at least remain stable over time.

Sustainable growth becomes more meaningful when we translate the stock of capital resources to include not only reproducible but also exhaustible and renewal natural capital, along with with an economy’s environmental assets. For some, such as Daley (1991), and Pearce, Markandya, and Barbier (1990), sustainability requires that natural capital stocks must remain intact of sustainable growth is to be achieved.[4] This is fairly restrictive in that it rules out technical substitution in response to changes in relative prices, much as one would find in a fixed coefficient input-output model. Moreover, if exhaustible natural resources are a necessary part of the definition of natural capital, sustainability is impossible as long as current technology, relative prices, and prevailing rates of discount make it economic to consume at least some portion of the stock of exhaustible resources over time.[5] Although the allocation of exhaustible resources has been well examined elsewhere, as in Hotelling (1931), and in Dasgupta and Heal (1979), our primary focus here is on the management of renewable natural resources.[6]

Statement of the Problem

We can simplify the issue of sustainable growth in terms of a neo-classical constrained optimization model. Formally, the problem is to maximize the present discounted utility of consumption of a natural capital stock, which can be stated as:

$$(1)\quad Max\int_0^\infty u(c_t)e^{-\delta t}dt \quad s.t. \quad s_t \geq 0 \quad and\ \dot{s}_t = -c_t,$$

where: u = utility from consumption (c) at a given rate of discount, d, subject to the stock of natural resources remaining greater than or equal to zero in each and every time period, and the rate of change in the stock of natural resources is equal to the amount of consumption in each and every time period. Given that changes in utility are a function of the level of consumption, and that consumption is in turn a function of the stock of natural resources, one can restate the problem as a Hamiltonian dynamic optimization problem:

$$(2)\quad H = u(c_t)e^{-\delta t} - \lambda_t e^{-\delta t} c_t,$$

where λ_t is the current value of the adjoint variable and $\lambda_t e^{-\delta t}$ is the present value shadow price, or adjoint variable, of the utility function. The solution to this problem requires that whenever consumption of the resource is positive, the rate of change of the present value of the shadow price must equal the negative of the derivative of the Hamiltonian with respect to the state variable. If the present value shadow price is constant, the present value of the contribution to utility of an increment of consumption should be the same at all dates.

In the case of a renewable natural resource, the problem can be restated in terms of the growth rate of the stock relative to consumption:

$$(3)\quad Max\int_0^\infty u(c,s)e^{-\delta t}dt \;\; s.t. \;\; \dot{s}_t = r(s_t) - c_t$$

where the present discounted utility function now depends on both consumption and the stock of the renewable natural resource, and where the growth rate of the stock is a function of the rate of natural increase in the stock minus the rate of consumption for each time period. The corresponding Hamiltonian function is:

$$(4)\quad H = u(c_t, s_t)e^{-\delta t} + \lambda_t e^{-\delta t}[r(s_t) - c_t]$$

The maximization solution requires that the marginal utility of consumption be equal to the shadow price of the natural resource. As long as the rate of extraction is equal to the rate of growth of the renewable resource, a stationary solution will result.[7] The policy problem then is to derive a set of prices of renewable natural resources that will guarantee stationarity of the capital stock and/or increases consistent with a rising capital-labor ratio as the level of per capita income increases.[8]

The set of prices needed to achieve stationarity will change according to:

$$(5)\quad \frac{d}{dt}\left(\lambda_t e^{-\delta t}\right) = -\left[u_s(c_t, s_t)e^{-\delta t} + \lambda_t e^{-\delta t} r'(s_t)\right],$$

which means that the present discounted value of the shadow price at any given moment will be equal to the negative value of the discounted value of utility deriving from the consumption and level of stock plus the discounted shadow price of the rate of growth in the stock.

Sustainable economic growth that is predicated on the constancy of reproducible natural capital poses two additional considerations, namely, the level of environmental quality, and the diversity of natural assets. Environmental quality means activities that preserve a measurable benchmark level of purity of air, water, and natural resources, as linked to a set of health and life expectancy measures.[9] If one has an index of the rate of consumption of natural resources, which are the source of environmental pollution, and the level of environmental quality, then the problem can be restated as:

$$(6)\quad H = \tilde{u}(c_t, s_t)e^{-\delta t} + \tilde{\lambda}_t\left[r(s_t) - c_t\right],$$

where the tilde denotes utility and the shadow price of natural capital that incorporates the environmental and health effects deriving from the consumption of a natural resource. Given that there is a negative environmental and health externality arising from the consumption of natural capital, the optimal consumption path will be lower and the corresponding price path will be higher. Thus, the solution now becomes:

$$(7)\quad \frac{d}{dt}\left(\tilde{\lambda}_t e^{-\delta t}\right) = -\left[\tilde{u}_s(c_t, s_t)e^{-\delta t} + \tilde{\lambda}_t e^{-\delta t} r'(s_t)\right]$$

As is well known, regulation and taxation typically have been used to internalize external environmental costs. To the extent that property rights are defined more completely, they may obviate the need for tax and regulatory solutions, though the effects on the shadow price of a natural resource may be comparable.

Biodiversity means the adoption of measures that preserve the prevailing variety of plant and animal species at the genetic, species, and community levels. Where property rights are incomplete, market prices will not reflect the relative scarcity of species, particularly if they are found in open access environments.[10] In this sense, the economic prices required to achieve biodiversity parallel the requirements for preserving environmental quality.

One standard approach to the pricing of biodiversity is the use of contingent valuation methods, that is, pricing methods that reflect the intrinsic value of natural assets when conserved as opposed to their consumption. Edward O. Wilson's appeal to the contingent value of biodiversity is as eloquent as any of this subject, even though it does answer the question of what is the socially optimal price needed to achieve a given degree of biodiversity.[11] Pearce and Moran (1994) offer some insight into the use of contingent valuation methods, as do some in Perrings, et.al. (1995), but the issue is far from resolved.[12]

From a contingent valuation framework, we first need to modify the problem to reflect a measure of biodiversity that is a function of the rate of consumption of natural resources, both plant and animal. Following Weitzmann (1995), we first define an index of biodiversity as:

$$(8)\quad D(S) = \max_{i\ s}\left[D(S \setminus i) + d(i, S \setminus i) \right],$$

where D(S) is the level of diversity defined by genes, species, or community, whose number of species ranges over 1 through i levels, and d is the rate of change in the number of species.[13] Since the prevailing degree of biodiversity contains no direct price metric, we must use contingent valuation to arrive at a value for an existing level of biodiversity. In turn, we posit that the contingent value rises with the degree of diversity up to some environmentally sustainable maximum for a given geographic space and unit of time. In so doing, we ignore here random and systemic events outside of human intervention that can affect the dynamic stability of the corresponding ecosystem in which the given degree of diversity is located. While not addressed here, at some point due consideration should be given to these factors within the framework of some known or hypothesized pattern of evolution.

We now restate the fundamental problem as:

$$(9)\quad H = \hat{\tilde{u}}(c_t, s_t, D_t)e^{-\delta t} + \hat{\tilde{\lambda}}_t\left[r\left(s_t, D_t\right) - z(c_t, d_t) \right],$$

where the tilde refers to internalized utility and shadow prices and the carot denotes inclusion of diversity in both the utility and shadow price. Equation (9) also allows for increasing diversity through increases in the stock of natural capital while the function z adjusts for both changes in the stock and the level of diversity. It is the difference in each of these at each moment of time that is incorporated into the shadow price of natural capital embodied in the Hamiltonian function.

We now arrive at the dynamic optimizing condition in which the internalized shadow price of natural capital at each and every moment in time adjusts to net changes in stocks and to net changes in the prevailing level of biodiversity. This can be expressed as:

$$(10)\quad \frac{d}{dt}\left(\hat{\lambda}_t e^{-\delta t}\right) = -\left[\hat{u}_s(c_t, s_t D_t) e^{-\delta t} + \hat{\hat{\lambda}}_t e^{-\delta t} r'(s_t) z'(d_t)\right]$$

Under these conditions, the shadow price rises inversely with the level of utility and the decline in the level of biodiversity and stock of natural capital.

Practical Issues

As inclusive as the statement of sustainable growth may be, it does not follow that this formulation reflects either the thinking or the policies in place in any given country or group of countries at any moment in time. The are at least two reasons why this will be so. First of all, with incomplete markets, even the use of contingent valuation methods for resource conservation and the use of taxes, subsidies, or tradeable pollution permits to incorporate environmental externalities is likely to work imperfectly at best when property rights are not well defined. Second, countries may have widely different rates of social discount across income groups in space and time, and in comparison to other countries, such that a consistent time valuation of the shadow price of natural capital may not be achieved. For these reasons alone, deriving practical steps to achieve sustainable growth must begin inevitably with piecemeal efforts at both the informational and policy levels.

Two approaches have characterized the building blocks of sustainable development initiatives. One is the diffusion of appropriate technology by developed countries to developing countries to establish an information framework from which countries could development environmental action plans and related steps in support of sustainable economic development. The basis of these economic sustainability positions is straightforward: countries with low levels of per capita income generally do not enjoy access to the kinds of technologies that would enable them to adopt more prudent use of the environmental and natural resource base.[14] Despite the efforts of the international development community to identify appropriate technologies, their adoption in developing countries makes economic sense only if there is an economic return to the resources necessary for their creation and utilization. The empirical evidence in support of this proposition is significant, and it is this perspective that drives most discussions of sustainable growth and development in the international development community.[15]

The second approach focuses on developing improved market pricing incentives that are compatible with economic efficiency and sustainable development. Contingent valuations already noted represent one approach to the valuation of natural capital, while use of corrective taxes and subsidies, along with tradeable pollution permits constitutes another. Creating pricing mechanisms for sustainable resource use depends in turn on issues of governance. Good governance implies broad-based participation, and this remains the goal of many developing countries as they shift emphasis from reliance on the public sector to an expanded role of markets.[16] However, good governance by itself is not a guarantee that sustainable growth and development will occur, especially if there is no corresponding development of an efficient pricing mechanism that provide an accurate measure of the relative value of resources.[17]

The critical link between environmental and economic sustainability depends ultimately on the establishment of a system of clearly defined property rights. Property rights exist in formal contracts as well as in implicit contracts. Land reform, particularly land reform driven by such issues as redistribution, may well fail to create a system of property rights in which an efficient allocation of environmental and natural resources may be determined. Ultimately, clearly defined property rights, like civil rights, depend on the institutions of civil society. Institutions of civil society can promote clearly defined property rights within a society based on the rule of law, but civil society does not guarantee that these property rights will be established. It is for this reason that discussions of governance and civil society must make specific provisions for property rights that will help to ensure that the pricing of natural capital reflects its social opportunity cost. For our purposes, we simply note here that both developed and developing countries have yet to provide a satisfactory set of institutions for this purpose.

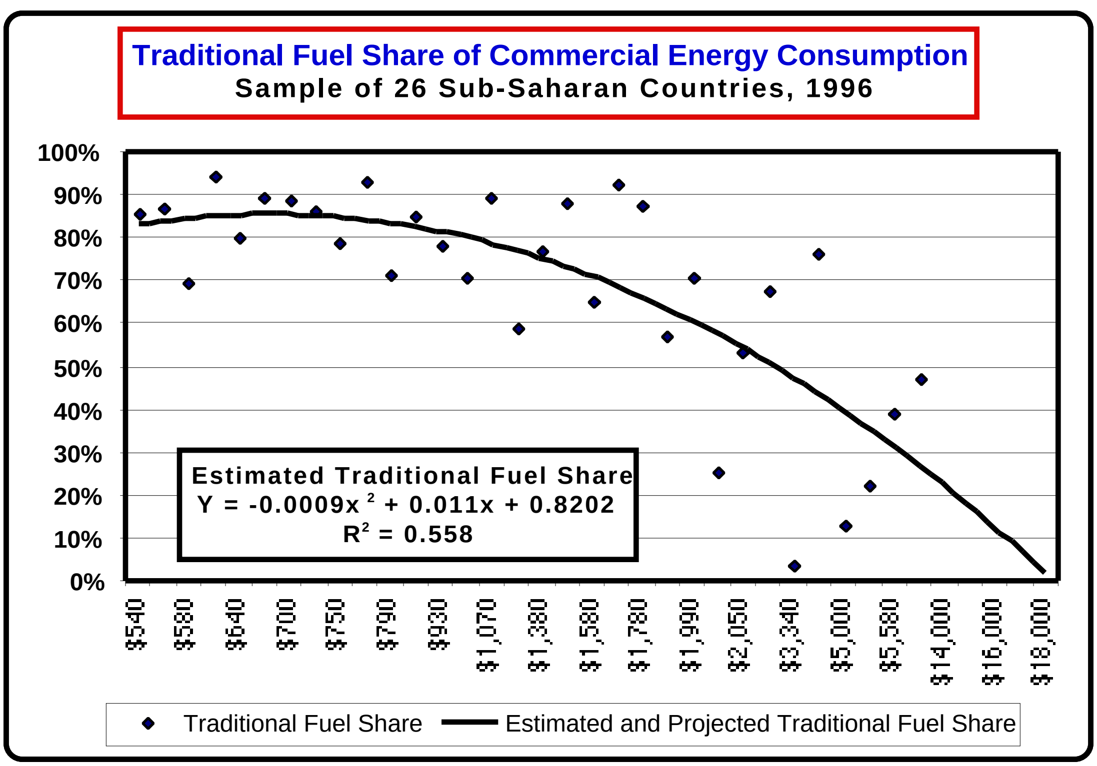
Indicators of Sustainable Economic Growth

We now turn to the development of an index of sustainable economic growth and use it to develop a rank ordering of a sample of countries in Sub-Saharan Africa. Although the theoretical conditions for sustainable growth may be consistent, in practice, extraction rates of natural capital in Africa are occurring generally at rates in excess of their replacement. This is true even if we allow for the replacement of exhaustible natural resources with reproducible capital.

Africa’s depletion of its natural capital is a function of the level of per capita income, the level of technology, the mix of relative prices, and the nature of property rights regimes. As one of the poorer regions of the world, Africa’s economies depend more on subsistence production than do other countries. This means greater dependence on fuelwood rather than on exhaustible resources for primary energy. At the same time, the technology of fuelwood production and consumption also is not highly developed, with the result that the net energy efficiency from fuelwood consumption tends to be relative low. Added to this picture is that fuelwood consumption does not reflect replacement costs wherever open access and common property regimes are found. Moreover, in regions where state property regimes are found, deforestation occurs as states have sold timber in excess of replacement rates, especially in countries with poorly developed agricultural and forestry management programs. In turn, in countries where economic growth is stagnant, poorer populations become even more dependent on subsistence activity and occupy greater portions of natural forest and woodland areas. As this occurs, deforestation accelerates and the natural habitat of plant and animal species declines, thus leading to a reduction in biodiversity.

Rising levels of per capita income generally produce favorable effects on stocks of natural capital and on biodiversity. These effects occur through technological change that permits greater substitution possibilities, enhanced technical efficiency in the production and consumption of natural capital, and thus in enhancing the prospects for greater biodiversity. Figure 1 illustrates one such change, namely, the degree of dependence on traditional fuelwood consumption as the level of income increases.

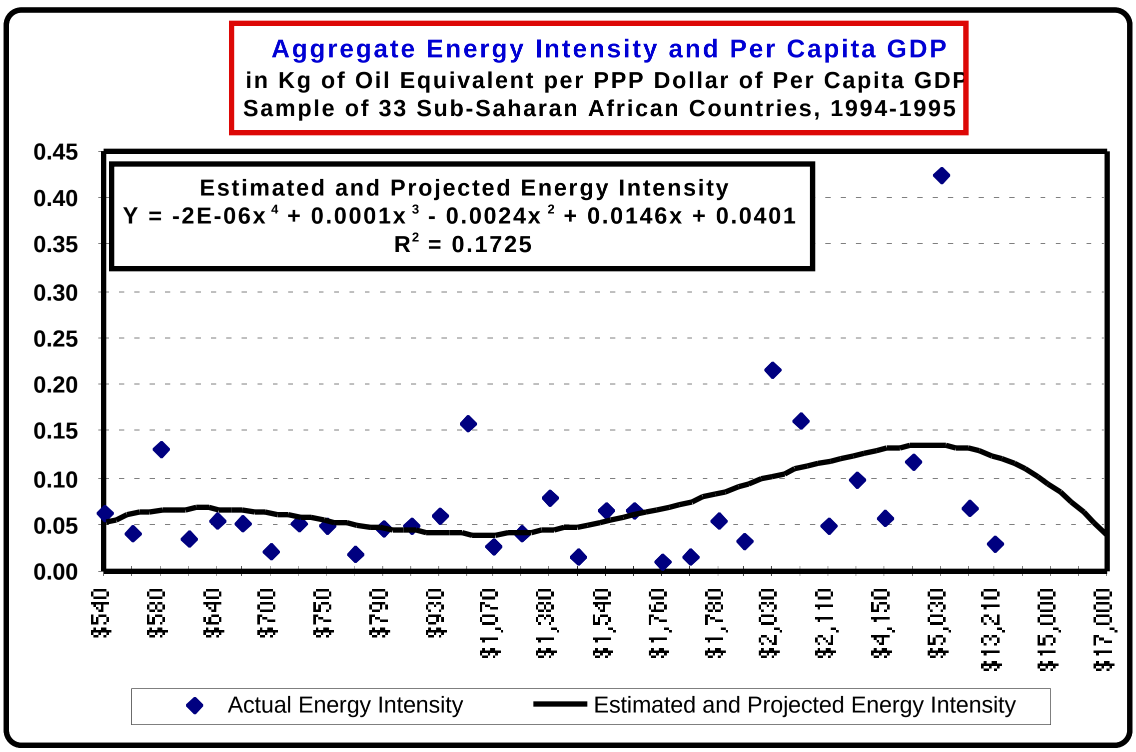
Figure 1



Source: The World Bank, *World Development Indicators*, 1997, and author's estimate.

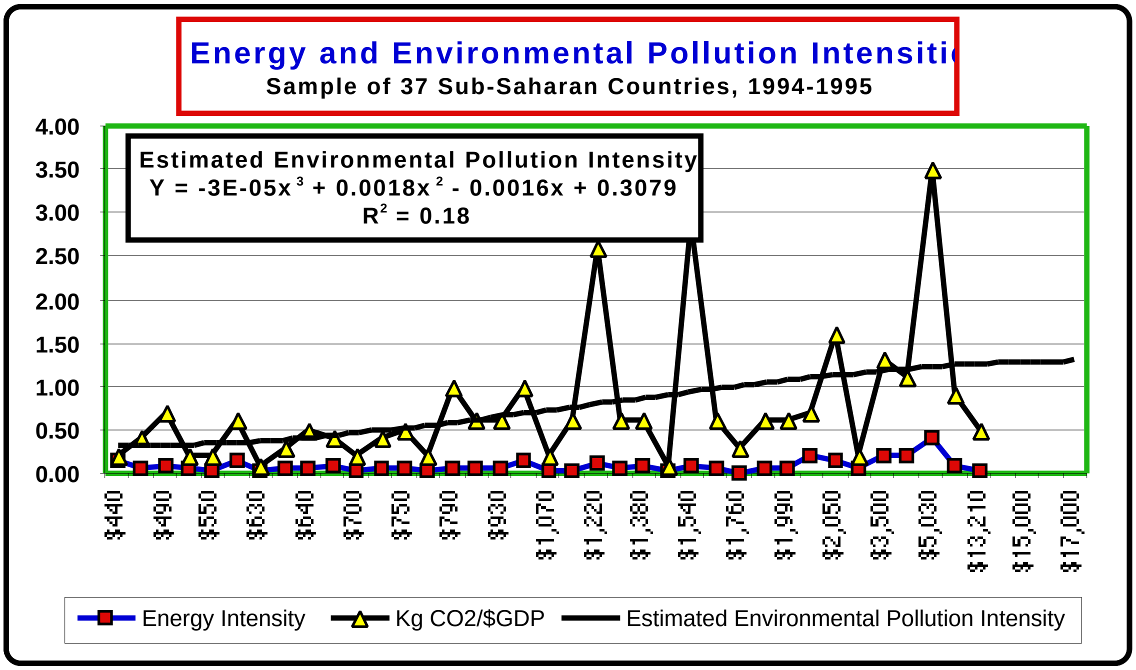
While rising per capita income can produce favorable effects on the stock of natural capital, over the medium range, it may aggravate the level of environmental quality. As countries shift their dependence from traditional to exhaustible fossil fuel technologies, and as the composition of production shifts from agriculture to manufacturing, the level of aggregate energy intensity tends to increase. As is shown in Figure 2, increases in the amount of energy consumption per dollar equivalent level of per capita GDP results in greater rates of environmental pollution, thus reducing the quality of an economy's overall environmental assets.

Figure 2



Source: The World Bank, *World Development Indicators 1997*, and author's estimate

Figure 3



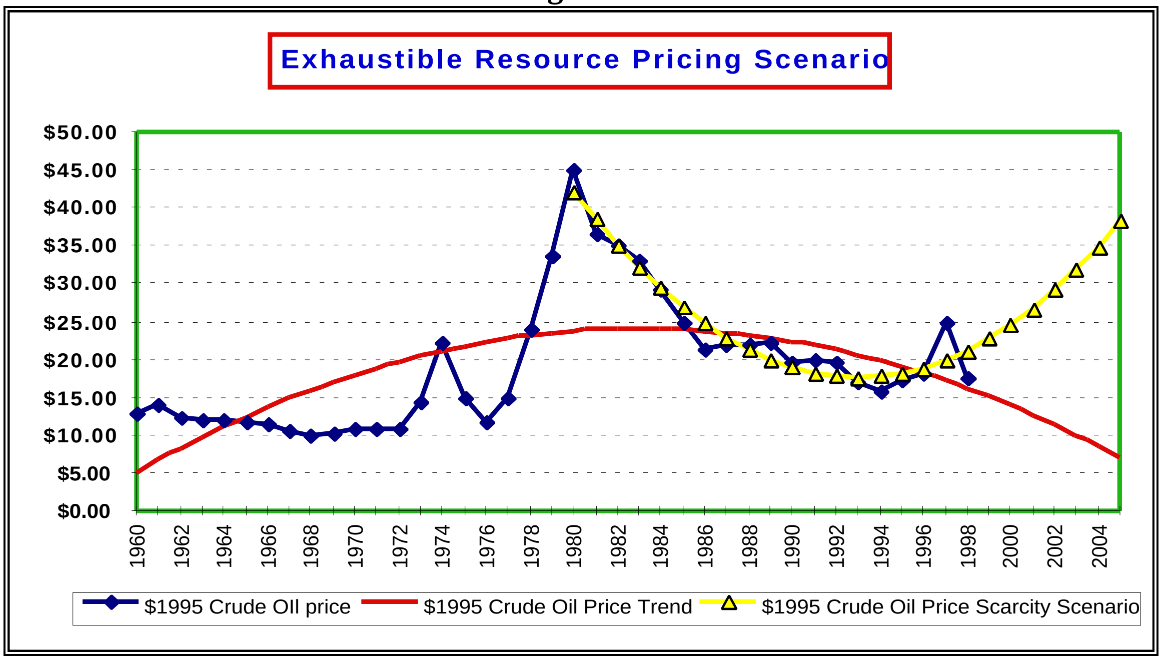
Source: The World Bank, *World Development Indicators 1997*, and author's estimate

One final dimension completes our basic profile of African economic and environmental performance, namely, the relative price of exhaustible and renewable energy resources. Sub-Saharan Africa is both a producer and consumer of exhaustible fossil fuels, primarily oil and coal. As countries experience economic growth, they tend to shift their dependence on traditional natural capital fuelwood supplies to exhaustible fossil fuels. How rapidly they do so is a function of the relative price of resources, both among competing types of fuels and as a share of per capita income.

During the energy crisis of the 1970's, Sub-Saharan Africa underwent a commodity boom in both agricultural and fossil fuel prices. In the short-run, low-own price elasticities of demand for exhaustible fossil fuels slowed the shift from traditional natural capital, in addition to accelerating inflation and balance of payments deficits. As the commodity price boom ended in the 1980's and continued into the 1990's, it eased pressures on inflation, the balance of payments, as well as on stocks of natural capital. Whether this will continue into the new millennium is problematic.

Should primary commodity prices remain low, then to the extent that economic growth policies are pursued, this would reduce the pressure on natural resources. At the same time, unless otherwise corrected, it would foster accelerated aggregate energy intensities, thus increasing the level of environmental intensity. Thus, much of what may occur depends on the relative price of energy, for which we show in Figure 4 two alternative scenarios that could occur for global crude oil prices.

Figure 4



Source: World Bank data, using a 1992 energy price deflator re-centered for 1995, and author's estimates.

An Index of Sustainable Economic Growth

Let us now consider an index of sustainable economic growth for Africa. At a macroeconomic level the basic index is defined as:

(10) $$PCSGI = PPPGDPPC + (a)(ARA) + (1-a)AGRAP,$$

where: PCSGI = the per capita sustainable growth index

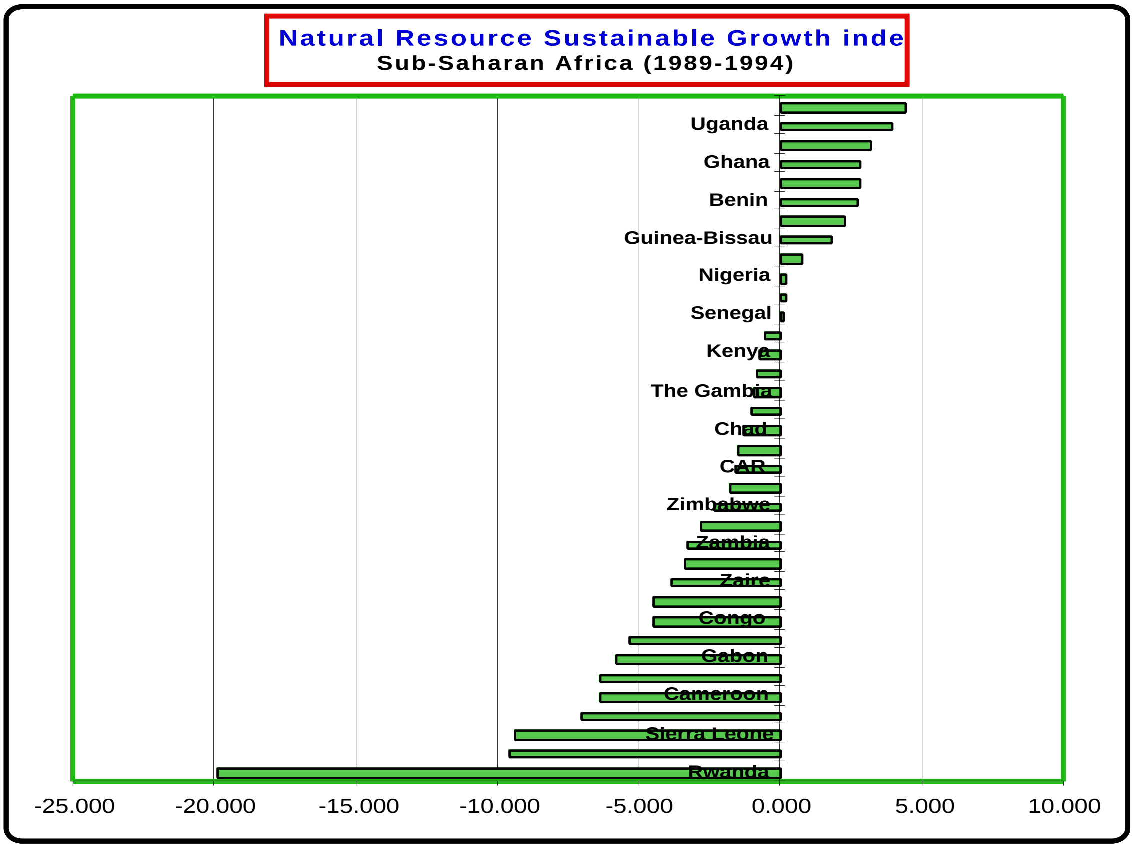
PPPGDPPC = the PPP GDP per capita inflation adjusted growth rate

ARA = the annual rate of afforestation (measured in hectare densities)

AGRAP = the annual rate of growth in agricultural productivity.

Figure 5 illustrates the rank ordering of countries in Sub-Saharan Africa, using the sustainable growth index for the period 1989-1994. While the correlation between per capita income and sustainable growth has an expected positive sign (0.2815), the relatively low value indicates that there are wide variations in policies in support of economic growth and those affecting natural and environmental assets.

Figure 5



Source: World Bank data, using a 1992 energy price deflator re-centered for 1995, and author's estimate.

The sustainable growth index represents only a first order approximation. It does not contain perfect congruence across the respective time series. Second, it does not include other relevant dimensions of an economy's stock of natural capital such as fisheries and wildlife, and it is not adjusted for the prevailing degree of biodiversity as defined in equation (8). Further, because the index incorporates four separate variables, the rate of sustainable growth and the corresponding rank ordering will change from year to year, depending on changes in the determinants of each of these variables. Finally, deforestation rates should be measured in terms of biomass rather than in terms of forest area. Still, with these caveats, one does have some indication of the linkage between economic growth and environmental sustainability.

Conclusion

Several conclusions can be drawn from the sustainable growth framework presented here. First, as long as population is increasing, investment in renewable resources must be made at rates that generate at least a constant stock per capita. Achieving such growth requires not only incentives to rural producers, but also creating a property rights framework that provides adjusted market valuation of biodiversity at the genetic, species, and community levels. This also includes incentives to enhance both biodiversity and natural resource productivity. Third, property rights initiatives must be grounded as closely as possible to those who most directly manage an economy's stock of natural resources. Finally, if sustainable growth is to succeed, resources must also be allocated in support of broadly accountable governance systems that are grounded in the institutions of civil society.

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[1] Alan Goldin and L. Alan Winters, *The Economics of Sustainable Development* (Cambridge, U.K.: Cambridge University Press, 1996), p. 1. See also United Nations, *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992, Vol I. Resolutions Adopted by the Conference* (New York: United Nations, 1992); World Commission on Environment and Development, *Our Common Future* (The Brundtland Report). (New York: Oxford University Press, 1987);

[2] John Hicks, *Value and Capital*, second edition (New York: Oxford University Press, 1965 reprint of 1946 edition), p. 172. Hicks' actual statement is "we ought to define a man's income is the maximum value he can consume during a week and still be as well off at the end of the week as he was at the beginning."

[3] While this definition may be sufficient, there are additional issues still un-addressed, notably intergenerational equity. In his *Wealth of Nations* (1776), Adam Smith suggested that once an economy has achieved a level of development, it would then enter into a steady-state in which the notion of continuous increases in per capita income would no longer be a goal. This theme is echoed in Herman E. Daly and John B. Cobb, Jr., *For the Common Good* (Boston: Beacon Press, 1989), and in Herman Daly's *Steady-State Economics* (San Francisco: W.H. Freeman, 1977). Daly argues that there are intergenerational equity issues that call for the adoption of a steady-state policy, a point that may have some support in developed countries, but which developing countries largely reject on the grounds that they are not yet developed.

[4] Herman Daley, *Steady State Economics*, second edition (Washington, D.C.: Island Press, 1991); David W. Pearce, Anil Markandya, and Edward Barbier, *Sustainable Development: Economy and Environment in the Third World* (London: Earthscan Publications, 1990).

[5] This would be true even under zero economic and zero population growth, depending on the state of technology of an economy. This question might be thought of as Jevons' problem, after William Stanley Jevons (1835-1882), who wrote *The Coal Question* (1865), in which he predicted that at current rates of extraction, England would run out of coal in approximately 100 years. Jevons' prediction did not come true partly because of substitution, as in the rise of oil and natural gas, and later, nuclear, and solar energy technologies.

[6] Harold Hotelling, "The Economics of Exhaustible Resources," *Journal of Political Economy* (1931), 39: 137-175; and Partha S. Dasgupta and Geoffrey M. Heal, *Economic Theory and Exhaustible Resources* (Cambridge, England: Cambridge University Press, 1979); and Phillip G. LeBel, *Energy Economics and Technology* (Baltimore: The Johns Hopkins University Press, 1982). Hotelling's now classic statement of the problem of exhaustible resources that the user cost of consumption rises with the rate of interest, results in the complete depletion of the exhaustible resource, which is at odds with sustainability as preserving at least some amount of all capital stocks. If one adopts a strictly neoclassical interpretation, substitution through renewable backstop technologies would preclude a complete depletion of exhaustible resources.

[7] We note that the utility function is for each individual, and hence does not present the problem of divergence between the rate of population growth and the rate of net extraction of the renewable natural resouce.

[8] Although the problem of sustainable growth can be defined in terms of discounted utility, there are intergenerational equity issues that have been raised in the literature but which we are not addressing here. One notable example is the question of the selection of an optimal rate of discount, an issue first posed by Frank Ramsey, and taken up in a somewhat different context by John Rawls, where both advocate a non-

discounted approach to intergenerational equity. See, Frank Ramsey, "A Mathematical Theory of Saving," *Economic Journal* (1928), 38: 543-559; and John Rawls, *A Theory of Justice* (Cambridge, Massachusetts: Harvard University Press, 1971).

[9] Although the presentation here is heuristic, the empirical foundations require first a statement of whether the natural resource-environmental pollution-health index relationship is inversely linear or non-linear. The problem then becomes one of deriving an augmented shadow price for the consumption of the natural resource consistent with a prevailing level of health standards. There is no currently accepted standard index from which to derive this price, but one good foundation source is the set of environmental indicators reported in The World Resource Institute, *1998-99 World Resources: A Guide to the Global Environment* (New York: Oxford University Press, 1998).

[10] A good discussion is found in Daniel W. Bromley and Michael M. Cernea, "The Management of Common Property Natural Resources: Some Conceptual and Operational Fallacies," World Bank Discussion paper number 57 (Washington, D.C.: The World Bank, 1989), in which they draw important distinctions between private, state, common, and open access property rights regimes.

[11] Edward O. Wilson, *The Diversity of Life* (New York: W.W. Norton, 1992).

[12] David Pearce and Dominic Moran, *The Economic Value of Biodiversity* (London: Earthscan Publications, 1995); and Charles Perrings, Karl-Göran Mäler, Carl Folke, C.S. Holling, and Bengt-Owe Jansson, *Biodiversity Loss: Economic and Ecological Issues* (Cambridge, U.K.: Cambridge U. Press, 1995).

[13] Martin Weitzman, "Diversity Functions", in Charles Perrings, et.al., editors, *op.cit*., pp 43.

[14] Richard Baldwin, in "Does Sustainability Require Growth?", in Goldin and Winters, *op. ci*t., pp. 51-76, contends that economic growth is a necessary condition to achieve sustainability since growth is what permits access to alternative resource conserving and substituting technologies. This conclusion is predicated on the underlying assumption that the elasticity of substitution increases with the level of income. This point is further reinforced in Gene Grossman, "Pollution and Growth: What Do We Know?" in Goldin and Winters, op.cit., pp. 19-46.

[15] See, *inter alia*, Robert Barro (1991),"Economic Growth in a Cross-Section of Countries", *Quarterly Journal of Economics,* 106(2): pp. 407-44; Greg Mankiw, D. Romer, and D. Weil (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, 107: 407-37;

[16] The World Resources Institute has devoted considerable attention to issues of good governance in natural resource use, and there is little question that in the absence of good governance that sustainable growth and development can occur. What must be understood by good governance is that it can only proceed when there is a system of clearly defined property rights. Together with civil rights, clearly defined property rights depend in turn on the strength of the institutions of civil society. See, for example, Derick W. Brinkerhoff and Peter G. Veit, "Democratic Governance and Environmental/Natural Resources Policy in Africa: Exploring the Linkages", (Washington, D.C.: Natural Resources Policy Consultative Group for Africa, World Resources Institute, October 1997); Allan Hoben, Pauline Peters, and Dianne Rocheleau, "Participation, Civil Society, and Development Assistance in Africa", Natural Resources Policy Consultative Group for Africa, Discussion Paper (Washington, D.C.: World Resources Institute, November 1996); and Aaron Zazueta, 1995, "Policy Hits the Ground: Participation, Equity and Environmental Decision-Making", (Washington, D.C.: World Resources Institute, 1994). See also, Dal O. Didia(1997), "Democracy, Political Instability, and Tropical Deforestation", *Global Environmental Change* (7):1, pp. 63-76; Gerald W. Scully (1988), "The Institutional Framework and Economic Development", *Journal of Political Economy* 96, pp. 652-662; and D.W. Brinkerhoff with George Honadle, "Co-Managing Natural

Resources in Africa: Implementing Policy and Institutional Changes in Five Countries", (Washington, D.C.: U.S. AID, Implementing Policy Change Project, IPC Monograph Number 4, October 1996).

[17] As an example, see R. Mendelsohn (1994), "Property Rights and Tropical Deforestation", *Oxford Economic Papers* 46, pp. 750-756.