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Commentary

TOWARD SOME OPERATIONAL PRINCIPLES OF SUSTAINABLE DEVELOPMENT [1]

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The terms 'sustainable development' and 'sustainable growth' have become very familiar while their meanings have remained vague. A first step toward clarity would be to adopt the dictionary distinction between growth and development. *To grow* means 'to increase naturally in size by the addition of material through assimilation or accretion'. *To develop* means 'to expand or realize the potentialities of; bring gradually to a fuller, greater, or better state'. In short, growth is quantitative increase in physical scale, while development is qualitative improvement or unfolding of potentialities. An economy can grow without developing, or develop without growing, or do both or neither. Since the human economy is a subsystem of a finite global ecosystem which does not grow, even though it does develop, it is clear that growth of the economy cannot be sustainable over long periods of time. The term sustainable growth should be rejected as a bad oxymoron. The term sustainable development is much more apt. Qualitative development of nongrowing systems has been observed for long periods of time.

The Brundtland Commission Report (World Commission on Environment and Development, 1987) has made a great contribution by emphasizing the importance of sustainable development and in effect forcing it to the top of the agenda of the United Nations and the multilateral development banks. To achieve this remarkable consensus, the Commission had to be less than rigorous in avoiding self-contradiction. One hoped that the glaring contradiction of a world economy growing by a factor of 5 or 10 and at the same time respecting ecological limits, which was present but subdued in the Report, would be resolved in future discussion. In fact, however, Mrs. Brundtland has subsequently urged economic growth by a factor of 5 or 10

[1] The views presented here are those of the author and do not necessarily reflect the position of the World Bank.

as a necessary part of sustainable development [2]. In this regard she should have said 'sustainable growth' since she has fully embraced the contradiction implicit in the latter term.

But one should not be too harsh on Mrs Brundtland. She has after all provided a political opening for the proper concept of sustainable development to evolve, and that is quite an accomplishment. Others, unencumbered by the political necessity of holding together contradictory factions, must take up the challenge of giving the basic idea of sustainable development a logically consistent and operational content. Let us here try to take a few steps in that direction.

For the management of renewable resources there are two obvious principles of sustainable development. First that harvest rates should equal regeneration rates (sustained yield). Second that waste emission rates should equal the natural assimilative capacities of the ecosystems into which the wastes are emitted. Regenerative and assimilative capacities must be treated as natural capital, and failure to maintain these capacities must be treated as capital consumption, and therefore not sustainable [3].

Capital, both natural and manmade, can be maintained at various levels. We want to maintain capital intact not just at any level but at the optimal level. For renewable resources (exploited populations of fish, cattle, trees, etc.) it has long been known that there is a stock size that gives maximum yield per time period. Although this biological maximum coincides with the economic (profit-maximizing) optimum only in the case of constant costs of harvest or capture there seems to be no reason not to follow the profit-maximizing criterion in choosing the levels at which to maintain natural capital intact. Maximizing sustainable annual profit is not the same thing as maximizing present value by discounting future costs and benefits. The present value criterion is problematic from the viewpoint of sustainability. This is an issue for further research. [4]

Of course manmade capital should also be maintained intact. This raises the problem of what is the proper mix of manmade and natural capital, which in turn raises the question of whether manmade and natural capital are substitutes or complements in production. In the past the assumption of neoclassical economics has been that manmade capital is a near perfect substitute for natural resources, and consequently for the natural capital that generates this flow of natural resources. A house is no doubt a superior substitute for a cave or a tree as a place to live, but that is not the issue. The

[2] See her Benjamin Franklin Lecture, Washington, DC, May 2, 1989.

[3] David Pearce (1988) has analyzed sustainability in terms of constant capital.

[4] See especially Talbot Page (1977).

issue is the nature of the roles played by resources and capital in the construction of a house. Are they complements or substitutes? It should be obvious that they are basically complementary and only very marginally substitutable. Having two or three times as many saws and hammers does not permit us to build a house with half the lumber. Saws can substitute for lumber only in the very marginal sense that a better saw has a thinner, sharper blade and a smaller curf which generates less sawdust, and thus uses a bit less wood per house. Or a new particle-board press could turn sawdust back into board. So capital can substitute for resources in the limited domain of minimizing and recycling waste pieces of materials in process. But this substitutability is trivial compared to the overwhelming complementarity that must necessarily exist between that being transformed (resource) and the agent of transformation (capital). [5]

In production a flow of matter and energy from nature is transformed into a flow of finished products by a stock of transformers, namely labor and capital. Capital and labor are substitutable for each other to a considerable degree because their qualitative function in production is the same – they are both agents of transformation of the flow of raw materials into finished product. But the qualitative roles of resources and capital are totally different – as different as transformer and transformed; as different as stock and flow. There also is considerable substitutability among different resources, stone for wood, or aluminium for copper, because their role in production is qualitatively similar – both are materials subject to transformation. But substitutability of capital for resources is qualitatively an entirely different matter, and is very limited.

It must be clear to anyone who can see beyond paper-and-pencil operations on a neoclassical production function, that material transformed and tools of transformation are complements, not substitutes. Do extra sawmills substitute for diminishing forests? Do more refineries substitute for depleted oil wells? Do larger nets substitute for declining fish populations? On the contrary, the productivity of sawmills, refineries, and fishing nets (manmade capital) will decline with the decline in forests, oil deposits, and fish. Natural capital as a provider of raw material and energy is complementary to manmade capital. Natural capital as absorber of waste products is also complementary to the manmade capital which generates those wastes.

Once the complementarity of natural and manmade capital is accepted then it becomes clear that development is limited by the one in shortest

[5] On the problems of a production function which fails to recognize natural capital and its relation to manmade capital, see Nicholas Georgescu-Roegen (1971) and Charles Perrings (1987).

supply. In the past era of 'empty-world economics' manmade capital was limitative. We are now entering an era of 'full-world economics' in which natural capital will be increasingly limitative. Sustainable development requires that natural capital be maintained intact, and the rules given above accomplish this for renewable natural capital.

There remains the category of nonrenewable resources which strictly speaking cannot be maintained intact short of nonuse (and if they are never to be used then there is no need to maintain them for the future!). Yet it is possible to exploit nonrenewables in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation of renewable substitutes.

The quasi-sustainable use of nonrenewables requires that any investment in the exploitation of a nonrenewable resource must be paired with a compensating investment in a renewable substitute (e.g., oil extraction paired with tree planting for wood alcohol). The idea is to divide the net receipts from the nonrenewable into an income component that can be consumed currently each year, and a capital component that must be invested in the renewable substitute. The division is made in such a way that the renewable will be yielding, by the end of the life of the nonrenewable, an annual sustainable yield equal to the income component of the nonrenewable receipts. Economist Salah El Serafy (1989) has shown how this separation into income and capital depends on the life expectancy of the nonrenewable (reserves divided by rate of depletion), and on the discount rate, in this case the rate of growth of the renewable alternative. The income component is larger the greater is the rate of growth of the renewable substitute and the longer is the life expectancy of the nonrenewable resource. In this way the reduced consumption stream from the nonrenewable is converted into true income (sustainable consumption) because it is continued into perpetuity by the yield on the new renewable asset.

The general principle is clear, even though questions remain about the exact nature of the pairing rule: Must the parallel renewable project be a close substitute for the nonrenewable, or could it be any renewable project that generates an equivalent value of sustainable consumption? Perhaps the less restrictive rule should be tried first. In addition to assuring the renewable substitute for the nonrenewable resource, we must also assure the continued existence of complementary natural capital, such as the ecosystem's capacity to absorb wastes. In the case of coal, for example, waste absorption capacity is more limiting than is the coal in the ground – i.e., the throughput of coal is limited by sink capacity rather than source capacity. The paired renewable investment should therefore be in expanding sink capacity. In the case of coal planting trees serves both as a sink for CO_2 and as an alternative source of energy, but the sink function dominates.

Regarding technology the rule of sustainable development would be to emphasize technologies that increase resource productivity (development), the amount of value extracted per unit of resource, rather than technologies for increasing the resource throughput itself (growth). This means, for example, more efficient light bulbs rather than more power plants, as well as design of products and processes so as to facilitate materials recycling both within the economy and via natural ecosystem cycles (biodegradability). Improving end use efficiency of resources is desirable regardless of whether the resource is renewable or nonrenewable.

From a macroeconomic perspective the scale of the economy (population times per capita resource use) must be within the carrying capacity of the region in the sense that the human scale can be maintained without resorting to capital consumption. Ultimately this will imply a limit on total scale of resource throughput, which in turn implies limits on and a tradeoff between population size and per capita resource use in the region. Poor countries which cannot afford any reduction in per-capita resource use will perforce have to concentrate their efforts on population control. Countries that have high rates of per-capita resource usage frequently have low rates of demographic growth and consequently must aim their efforts more at consumption control than population control, although the latter cannot be neglected in any country. Quantitative growth in populations of both people and commodities must ultimately end, but qualitative improvement can continue in a regime of sustainable development. However, the 5 to 10-fold increase in the side of the economy deemed imperative by the Brundtland Report will, even with the maximum emphasis on development, require an enormous growth of throughput that would be ecologically devastating.

Fighting poverty will be much more difficult without growth. Development can help, but serious poverty reduction will require population control and redistribution aimed at limiting wealth inequality. These two implications of sustainable development are too radical to be openly affirmed, and to evade them a bit of self-contradiction must seem to politicians a small price to pay for remaining in office. But they cannot be 'sustainably' evaded.

In closing it is worth trying to avoid a likely misunderstanding. By long habit the word growth is in the minds of many people synonymous with increase in wealth. These people say that we must have growth because only if we become wealthier will we be able to afford the cost of environmental protection. That all problems are easier to solve if we are truly wealthier is not in dispute. What is in dispute is whether growth, at the current margin, is really making us wealthier. As growth in the physical dimensions of the human economy pushes beyond the optimal scale relative to the biosphere it in fact makes us poorer. Growth, like anything else, can cost more than it is worth at the margin. Growth, which we have habitually come to refer to as 'economic growth' while we were below the optimum scale, becomes 'anti-economic growth' once that optimum has been passed.

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