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Is There Anything New in the Concept of Sustainable Development?

Peter J. Hammond

Department of Economics, Stanford University, CA 94305-6072, U.S.A.

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We do not inherit the earth from our parents; we borrow it from our children.

Popular saying of unknown origin.

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1. Introduction: Robinson Crusoe's Sustainable Yields

Economists often base their thinking on the example of Robinson Crusoe. This man, alone on a desert island, is an especially simple economic system. He gathers coconuts, catches fish, and does whatever else is needed for self-sufficiency. As long as he gathers coconuts no faster than they grow, and catches fish no faster than they breed and mature, his lifestyle is evidently sustainable — at least until he falls seriously ill, or until other problems supervene.

For Robinson Crusoe, the concept of sustainability seems rather simple. Consume whatever nature provides, but no faster than what nature can replace. This suggests sustainability in the sense of maintaining existing stocks of natural resources — including mineral deposits, biological species, the state of the atmosphere, etc. A closely related idea is the "maximum sustainable yield" of a renewable resource such as a fishery, forest, or aquifer — see for instance Hanzlik (1922), Gulland (1968), and Neher (1987). This means the maximum net flow of output

consistent with maintaining a constant stock. It, and the important distinction from the "optimal sustainable yield," are discussed in such works as those of Philip Roedel (1975), Colin Clark (1976), Anthony Fisher (1981) and Partha Dasgupta (1982) — Fisher also mentions some unpublished work by Jack Hirshleifer that dates back to 1974.

Having such constant stocks of each resource is also part of what Herman Daly (1971, 1972, 1973) calls a "steady state" economy — an idea he attributes to John Stuart Mill (1848), although Taussig (1923–6, 1987) correctly traces the origins of the idea to earlier writers such as Adam Smith, Ricardo, and James Mill. Daly (1973, p. 14) offers the following definition:

> By "steady state" is meant a constant stock of physical wealth (capital), and a constant stock of people (population). Naturally these stocks do not remain constant by themselves. People die, and wealth is physically consumed — that is, worn out, depreciated. Therefore the stocks must be maintained by a rate of inflow (birth, production) equal to the rate of outflow (death, consumption). But this equality may obtain, and the stocks remain constant, with a high rate of throughput (equal to both the rate of inflow and the rate of outflow), or with a low rate.

In fact Daly (1971) supplements this definition of a steady state with a suggestion taken from Kenneth Boulding (1949). This requires a "stationary state" to have a *minimal* flow of consumption that is consistent with the constant steady state stocks of physical wealth and of people. One rationale is that having the stock of people turn over too fast is surely undesirable because it implies that each person lives a shorter life. Boulding claims generally that it is stocks of resources that affect human welfare the most. Then, if extra consumption is needed to maintain those stocks, that is because of extra depreciation which needs to be replaced, so extra consumption generally signifies lower welfare. Surely the true picture is much more complicated, however. For instance, if Crusoe is undernourished when he arrives on his desert island, then an accelerated turnover of the stock of coconuts and of fish biomass would seem to be highly

beneficial. Generally, even if we do accept that it is some kind of stocks of accumulated consumption instead of flows are what determine individual welfare, it certainly does not follow that being able to maintain those stocks with lower flows is always beneficial. So this part of Daly's suggestion seems to be highly questionable.

Dennis Meadows (1977, p. xxii–xxiii), after reproducing the above quotation from Daly (1973), goes on to define a "sustainable state" as "one that is consistent with global limits and also acceptable to the broad spectrum of individuals and institutions whose sustained compliance with diverse ethics, laws, and norms is required to make any social system viable." He goes on to remark that: "Reliance on continuous physical growth certainly makes any system unsustainable, but attainment of a steady state does not guarantee that a society is either intrinsically worthwhile or sustainable." The minimal flow part of Daly's definition of stationary state therefore plays no role in the definition which Meadows offers.

Yet we surely *cannot* maintain even a steady state with all natural and physical stocks fixed at their existing levels. And as Daly (1971) does recognize, it would actually be stupid to try. After a hurricane has damaged the supply of coconuts on Crusoe's island, he would surely feel justified in depleting his fish stocks for a while until the coconut supply had time to recover. More relevantly, modern economies have come to rely on depleting stocks of exhaustible resources like oil, timber, and minerals. While the net rate of depletion must eventually diminish and even converge to zero, there is no reason *per se* to freeze these stocks at or even near their existing levels. We can afford to reduce these stocks for a while, though eventually we must learn to live with ever decreasing rates of net depletion.

As for the concept of "sustainability" in connection with growth or development, it appears to have originated in the work by W.W. Rostow (1956, 1960, 1963) on the history of the British

and other later industrial revolutions, leading to his idea of "take-off into (self-)sustained growth". It seems that "(self-)sustained" growth means "a long period when growth becomes normal and relatively automatic" (Rostow, 1956, p. 27). It may have been this work which inspired Meadows, Daly and others to realize that the kind of long run growth which Rostow had considered was all too likely to prove unsustainable in the very long run. Indeed, the idea that "sustainability" puts limitations on growth is mentioned in the widely read work of Meadows *et al*. (1972) on *The Limits of Growth*. The summary of their conclusions (on pp. 23–24) includes the following:

> If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. ... It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future.

2. Sustainable Development and Hartwick's Rule

Actually, it may have been the deceptive simplicity of the Robinson Crusoe analogy which has allowed the concept of sustainable development to acquire such prominence in the work of the United Nations. Indeed, many closely related ideas occur in the *Declaration of the United Nations Conference on the Human Environment* (Stockholm, 5–16 June 1972) and in the associated *Action Plan for the Human Environment.* Yet I have been unable to find the word "sustainable" itself within these early texts. Fifteen years later, however, the United Nations commission chaired by the Norwegian prime minister Mrs. Gro Harlem Brundtland placed a lot of emphasis on the concept of sustainable development. I have also seen the following description from its report quoted in more than one other source:

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:
>
> * the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
>
> * the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.
>
> Brundtland (1987, ch. 2, para. 1)

Moreover:

> Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation.
>
> Brundtland (1987, ch. 2, para. 3)

Especially since that much noticed report appeared, there has been some dispute among economists and others as to what "sustainable development" really means. Time and space do not permit me to discuss in detail all the different suggested interpretations mentioned in numerous books or in other works, including the paper by David Pearce (1991) which several of you had the opportunity to hear presented not long ago. I am also aware of a lecture on the issue by no less an authority than Robert Solow (1991), who was awarded the Nobel Prize in economics for his work on growth. Let me merely point out that some scientists, especially biologists, emphasize biological preservation. Economists, however, tend to emphasize capital preservation, though some broader minded members of the profession do interpret the word "capital" generously in order to allow for exhaustible and renewable resources, for freedom from pollution, and for other suitable forms of what one might call "environmental capital".

Nevertheless, there are two particular attempts to define "sustainable development" which I

shall heed. The first is due to Robert Repetto (1986, p. 15), who claims that sustainable development is

> a development strategy that manages all assets, natural resources, and human resources, as well as financial and physical assets, for increasing long-term wealth and well-being. Sustainable development, as a goal *rejects policies and practices that support current living standards by depleting the resource base, including natural resources,* and that leaves future generations with poorer prospects and greater risks than our own.

The second is due to David Pearce *et al*. (1990, pp. 2–3), who begin by characterizing development as "a *vector* of desirable social objectives" whose elements might include:

- increases in real income per capita;
- improvements in health and nutritional status;
- educational achievement;
- access to resources;
- a 'fairer' distribution of income;
- increases in basic freedoms.

and then define "*sustainable* development" as "a situation in which the development vector D does not decrease over time." Yet Pearce *et al.* (1990, pp. 5–6) correctly point out how the existing stocks of some natural resources (such as minerals) could be larger than optimal, in which case it would be wrong to conserve them. In fact they try to argue not very convincingly why conservation is desirable on other grounds. Then they go on (p. 10) to raise the issue of what precisely it means to maintain the capital stock. Among many other suggestions, they consider the possibility that the total value of all stocks should remain constant. Even though this idea is perhaps the most important, as I am going to argue below, it actually receives very little precise discussion.

In fact for the main part of this paper, rather than look at what work has appeared since the Brundtland Commission's report, I am going to go backwards and consider some older work with which I was involved several years ago. That work, even though the word "sustainable" probably never appears in it, still seems to me about as close to the heart of the matter as it is possible for rigorous economic theory to get. I am speaking of "Hartwick's rule", which appeared in several papers by John Hartwick in 1977 and shortly thereafter. Nor am I alone in noting the connection, since both Solow (1991) and Markku Ollikainen (1992) cite Hartwick's work in their discussions of sustainability. Ollikainen, however, seems not to see the special relevance of Hartwick's rule, since he mentions it only in passing as one of several different interpretations of sustainability. Solow does pay it more attention, but says that "it is a very simple rule, and it is really true only for very simple economies". This may have been an accurate description of Hartwick's original rule, but Avinash Dixit, Michael Hoel and myself published a substantial generalization in the *Review of Economic Studies*, 1980. A later paper by Robert Becker (1982) elaborates some aspects of the rule as well, paying special attention to resource amenities which we had left implicit.

3. Hicks' Sustainable Income

It is to this extension of Hartwick's rule that I am eventually going to return in this paper. Before doing so, however, let me begin even earlier with the late Sir John Hicks, and his definition of "income" in *Value and Capital* (p. 172 of the Second Edition):

> The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning. Thus, when a person saves, he plans to be better off in the future; when he lives beyond his

> income, he plans to be worse off. Remembering that the practical purpose of income is to serve as a guide for prudent conduct, I think it is fairly clear that this is what the central meaning must be.

Though the word "sustainable" occurs nowhere in this paragraph, I make no apology for claiming that this really serves to define "sustainable income" or "sustainable expenditure". Exactly the same point, using exactly the same quotation from Hicks, has been made by Daly (1989, p. 8 — see also 1991, pp. 248ff.). Moreover, Stefano Zamagni tells me that, in his last year of life, Hicks himself expressed the view that his concept of income would be more useful in connection with exhaustible resources and environmental economics than it had been in "mainstream" economics.

Thus income is what can be spent while sustaining one's assets. This comes very close to Crusoe's sustainable lifestyle, of course, but in a much more general economic setting. And I should hastily add that Hicks went on to discuss how difficult it is to apply his concept of income in practice. These difficulties can be ascribed to the well known "index number problem" which is the curse of applied quantitative economics. Both the "value of consumption" and "be[ing] as well off at the end of the week as at the beginning" involve weighing many different and uncertain factors in order to form an aggregate index of consumption and, even harder, an index of possible future well being.

Nevertheless, Hicks' concept of sustainable income proves a highly useful and relatively familiar analogy for what I shall discuss below. In particular, it is worth noting the following feature. If a consumer maintains a sustainable level of expenditure over a certain period such as Hicks' week, then the value of the consumer's assets at the end of the week should be exactly what it would have been in the absence of any additions to or subtractions from the portfolio of assets. In particular, the proceeds of any asset sales must not be simply withdrawn and spent, but must be re-invested in purchases of new assets having equivalent value.

Though nobody seems to have recognized this until now, the logic behind Hartwick's rule is very similar. The rule advocates re-investing resource rents in physical capital. Hartwick showed how this could lead to the kind of economic development path considered by Solow, in the 1974 Symposium on the Economics of Exhaustible Resources which appeared as a supplement to the *Review of Economic Studies*. Specifically, for a commodity such as oil, the rate of resource extraction must converge to zero over time. Otherwise total extraction over all time into the indefinite future would definitely exceed the initial finite resource stock — which is, of course, not possible. So output and consumption would also have to fall unless capital stocks were being accumulated at a suitable rate so as to compensate for the reduced use of exhaustible resources. Solow (1974b, p. 37 and Appendix B) showed that, provided capital and resources were sufficiently good substitutes in production, this could be done in a way that maintained consumption per head constant. Partha Dasgupta and Geoffrey Heal (1974) reported similar results in the same Symposium, and later gave an elegant presentation in their textbook (1979, pp. 196–207). In closely related work, Solow (1974a, p. 11) and Joe Stiglitz (1974, p. 123) even wrote of achieving a "sustainable" level of consumption. And Ignazio Musu (1993) has recently described this line of work as a first sustainable growth model, in effect.

Hartwick, to repeat, showed how achieving constant consumption relied on resource rents being re-invested in such a way as to maintain constant what economists call a "chain" or "Divisia" index of the combined market value of resource stocks and of physical capital. Moreover, such a path would even have the highest possible level of time invariant consumption per head. The reason is that any higher level of consumption would be unsustainable, because output would have to fall eventually. On the other hand, any lower level of consumption would accumulate excess capital and/or leave some valuable resource stocks unused.

4. Generalizing Hartwick's Rule

I suspect that these are the results that Solow had in mind when he talked of them being "very special". Constant consumption per head is not a clear concept except in the special case when there is only a single consumption good. Nor has anything yet been said about the distribution of consumption between individuals. Nor about some important environmental variables like the amount of carbon dioxide in the atmosphere, which are neither exhaustible resources nor stocks of physical capital. However, many of these additional complications can be incorporated in the much more general framework of the paper with Dixit and Hoel which I have already mentioned. Indeed, there we explicitly allow many consumption goods, and many capital goods or resource stocks or other environmental stock variables. The many consumption goods can include enjoyment of leisure and of resource amenities such as access to the mountain resort of Courmayeur, as well as freedom from pollution. All are to be aggregated into a suitable index of world consumption which economists might want to call a "utility function," but for the world as a whole rather than for a single individual. One would therefore really do better to speak of a "global welfare" function. Its construction involves following Amartya Sen's (1976, 1979) idea of treating consumption by different individuals as different goods, in effect, with different prices or social values. For a later elaboration of some implications of this idea, see Hammond (1988).

Finally, then, our extension of Hartwick's rule says that the way to keep such an index at the highest possible sustainable level is to spend only current income on consumption, while maintaining constant over time a chain index of all stocks or assets — capital, resources, and biological or environmental. Though we avoided the word "sustainable" in 1980, the somewhat related paper by Edwin Burmeister and myself (1977, p. 854) did speak of "sustaining" a fixed level of utility.

Even though this sustainability rule is perhaps much more generally applicable than most people have yet realized, it does have quite severe limitations. Really, it depends on production being intertemporally efficient so that prices can be defined. And on constructing an index of *world* consumption, since this is what will be sustained at a constant level. The rule is strictly accurate only in continuous time. Much more seriously, I do not yet see how to extend it to accommodate any kind of uncertainty, let alone the very great degree of uncertainty that surrounds the greenhouse effects of carbon dioxide, methane and other gases. So, while I think that this is the best and really the only economically sensible way of understanding sustainability, there is still the question of whether the concept is at all useful in practice.

Note too that this is a concept of sustainable consumption at a steady level. It is not the kind of sustained growth considered by Rostow. Nor is it sustained development with growth rates bounded away form zero, as in the paper by Eric Fisher (1992). For sustained growth to occur, net investment would have to be positive over a long period, and for the world as a whole. In the terminology introduced by Anne Harrison (1989), the "sustainability factors" representing the accumulation of each different kind of stock should aggregate into a suitable index whose value exceeds one, indicating that stocks on the whole have expanded.

I have also remarked on how it is an index of world consumption that is being sustained. Nothing is said about whether property rights can be relied upon to solve the economic problems that externalities such as pollution create. In fact, they cannot by themselves determine the optimal supply of what economists call "public goods," which should be seen as including reduced emissions of greenhouse gases and pollutants, better preservation of biodiversity, etc. Nor is anything said about the distribution of consumption between different inhabitants of this planet who live at the same time. The Brundtland Commission was surely right to emphasize the

importance of allowing the poor and deprived a larger share of what the world as a whole can afford to consume. But let me not delve any further into distributional issues that were addressed in the paper which Partha Dasgupta (1993) prepared for this conference.

5. Sustainable World Income Accounting

In fact, I suspect the main lesson we should draw from this re-interpretation of Hicks' concept of sustainable income is the following rather obvious one. Just as individuals, households, firms and governments need income and expenditure accounts in order to know whether their consumption plans are in any sense sustainable, so does the world as a whole. Moreover, since it would seem that current patterns of economic activity and resource use are unsustainable in the long run, we need very detailed asset and liability accounts in order to tell us how fast our present unsustainable habits must change.

So in the end the concept of sustainability is probably less important than the keeping of proper accounts. Of course, such accounts need to be drawn up so that they fully reflect our legitimate environmental concerns. Some initial steps have been taken in the book by Yusuf Ahmad *et al.* (1989), as well as in some more recent work by Hartwick (1990, 1991) and others. Mines need to be properly depreciated as their stocks get used up, as Lozada (1992) has recently explained. In fact pollution costs need to be debited both to the individual accounts of polluters, and to the world as a whole. The same is true of congestion costs. Also, stocks of all biological species, including even humankind, need to be valued properly (cf. Starrett 1992). Or costed, in those cases where excessive population creates costly ecological imbalances. Such environment inclusive accounts, properly kept, can also suggest what prices should serve as the basis for actual taxes on polluters or other creators of undesirable externalities of the kind that, following the work of Pigou and others, have long been known to create appropriate economic incentives.

Proper accounts can also help us construct truer measures of national product. At the moment, as is well known, the measures that most people pay attention to do not subtract the cost of labour input, which has led me to describe them to students as “measures of national perspiration”. And it is also widely recognized that they neglect environmental effects, so I have also described them to students as “measures of national pollution”. More seriously, Daly (1971) was surely entirely justified in complaining that standard measures of GNP not only fail to decrease if there is more pollution but, even worse, will actually increase if the pollution becomes so bad that extra costs of clearing it up have to be incurred in order to make life tolerable. Later, Daly (1989) suggested how to make the necessary corrections by simply subtracting “defensive expenditures” on environmental maintenance from a measure of the net national product.

Of course, environment inclusive accounts of this kind will be very hard to draw up properly. After all, to name just one of many problems, the likely effects of adding to greenhouse gases remain a matter of considerable controversy, even among scientists. But surely rough estimates of the consequent costs are better than nothing at all.

Even so, despite the enormous difficulties, it seems to me that we really can hope to begin moving towards having some indication of whether current economic policies are treating the earth as an inheritance from our parents which we are entitled to spend, or as a loan from our children which they should expect us to repay. That simple indicator is whether we are adding to or subtracting from the properly measured value of the earth’s stock of resources. The indicator will include what economists usually think of as capital, but also biodiversity, resource stocks, the quality of the environment, etc. And if constructing this indicator greatly increases the demand for suitably trained environmental accountants, let me suggest that accountants will do less damage to the earth than will most military forces that, even if they are not actually used in wars of

aggression, still have a strong tendency to burn up enormous quantities of fuel in training for them, as well as polluting vast tracts of land and sea. Accountants will also do less damage than the excessive numbers of arms manufacturers who not only supply those military forces, but encourage them to have insatiable demands. And accountants are also less harmful than cattle ranchers who destroy tropical forests. Or than producers of agricultural surpluses in developed countries where the original forests were cleared long ago, but could now be re-grown.

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