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"Economics of Sustainability: The Environmental Dimension" by Jonathan M. Harris

Serious consideration of sustainable development requires a rethinking of major elements of economic theory. The standard economic perspective must be broadened to take into account environmental and social perspectives. In this essay, we address primarily the environmental issues, then move to the social perspective in Part II.

To some extent, principles of environmental sustainability can be expressed in standard economic terms. For example, economic theory provides for the internalization of environmental costs, and natural resource economics recognizes the concept of sustainable yield in natural resource systems. But to consider the full implications of sustainability we need to look beyond these formulations to consider the social and ecological contexts of economic activity. This in turn leads to a re-examination of some of the fundamental theoretical frameworks of economics. Among the concepts that need to be re-examined are capital, valuation, distribution, savings, investment, and economic growth. As a result, both the categories of analysis and the policy implications derived from that analysis change significantly when we take sustainability seriously.

A BROADER VIEW OF CAPITAL AND PRODUCTION

Standard economic theory treats manufactured capital as the key to development, with some attention also to human capital (skills and knowledge embodied in individuals). While natural resources are acknowledged as an input to the productive process, they are not an important feature of most economic models. In addition, the social and institutional arrangements which provide the basis for economic activity remain very much in the background. Economic theories of sustainability are based on a more expansive concept of capital. Viewing capital broadly as any stock which produces or contributes to a flow of output, we can identify four kinds of capital: manufactured, natural, human, and social.

Manufactured capital is what is ordinarily referred to simply as "capital" in most economic theory. Natural capital corresponds to what standard economic theory traditionally defined as "land"; the reason for the different terminology is to emphasize the essential productive role of this factor, and to broaden the concept to include all environmental functions. Human capital refers to education and skills possessed by individuals. Social capital is used to refer to knowledge and rules embedded in culture and institutions, such as the legal system or the concept of property rights. All four kinds of capital are essential to economic activity, although standard economic theory emphasizes primarily manufactured and human capital.

Manufactured capital is maintained and accumulated through investment. This process, of course, is central to standard models of economic growth. There is a clear and reciprocal relationship between manufactured capital and economic production: more capital makes it possible to expand economic production, and the devotion of a share of production to investment makes it possible to accumulate more capital. The relationship can be defined in mathematical terms, using concepts such as the savings rate and the capital/output ratio, and is easily amenable to measurement and econometric analysis. Human capital is also fairly well represented in economic models of the labor market, and plays an important role in modern growth models. The dynamics of natural and social capital present more problems, and these kinds of capital have received less recognition and attention from economists. Yet for true sustainability, all four kinds of capital must be maintained at levels which allow both human well-being and healthy ecosystems.

MANUFACTURED AND NATURAL CAPITAL

In the first article summarized here, **Robert Costanza and Herman Daly** set forth the basic conditions for the maintenance of natural as well as manufactured capital. They point out that neoclassical economics usually treats natural and manufactured capital as fully substitutable. If this approach is accepted, there is no particular reason to conserve natural capital, so long as manufactured capital is augmented by a value equal to or greater than the depletion of natural capital. For example, it would be acceptable for a country to cut down its forests if the economic proceeds from the timber sales are used for investment in industrial development.

Even in the neoclassical perspective, however, the principle of *weak sustainability* is appropriate. A well-known principle derived from work by Solow and Hartwick (the "Hartwick rule") states that consumption may remain constant, or increase, with declining non-renewable resources provided that the rents from these resources are reinvested in reproducible capital (Hartwick 1977; Solow 1986). In this approach, sustainability requires that the *total value* of the two forms of capital remain constant over time. El Serafy has pointed out that in order to assess this value, there must be a full accounting for natural capital depletion (El Serafy, 1993; also see article by El Serafy summarized below).

A *strong sustainability* approach is based on the idea that substitutability between natural and manufactured capital is limited. Rather, the two are seen as *complements* -- factors which must be used together to be productive. For example, a fleet of fishing boats is of no use without a stock of fish. In the case of *critical natural capital* -- for example essential water supplies -- substitutability is close to zero. While it may be possible, for example, to compensate for some water pollution with purification systems, life and economic activity is essentially impossible without access to water. The strong sustainability approach implies that specific measures distinct from the ordinary market process are necessary for the conservation of natural capital. It also implies limits on *macroeconomic scale*. The economic system cannot grow beyond the limitations set by the regeneration and waste-absorption capacities of the ecosystem.[1]

Costanza and Daly suggest that a minimum necessary condition for sustainability can be expressed in terms of the conservation of natural capital. This policy goal leads to two decision rules, one for renewable and the other for non-renewable resources. For renewables, the rule is to limit resource consumption to sustainable yield levels; for non-renewables the rule is to re-invest the proceeds from non-renewable resource exploitation into renewable natural capital. Following these two rules will maintain a constant stock of natural capital. To maintain a constant *per capita* stock of natural capital also requires a stable level of human population, a factor which Daly has emphasized elsewhere (Daly 1991b).

The rules suggested by Costanza and Daly for natural capital conservation are rough guides rather than precise theoretical principles. Nicholas Georgescu-Roegen, whose pathbreaking work *The Entropy Law and the Economic Process* outlined the dependence of the economic system on biophysical systems, argued that it is ultimately impossible to maintain a constant stock of natural capital, since all planetary resources will eventually degrade or be used up according to the Second Law of Thermodynamics (Georgescu-Roegen 1971, 1993). But at a more practical level he proposed an approach similar to Costanza and Daly's, reasoning that "the enormous disproportionality between the flow of solar energy and the much more limited stock of terrestrial free energy suggests a bioeconomic program emphasizing such factors as solar energy, organic agriculture, population limitation, product durability, moderate consumption, and international equity" (Georgescu-Roegen 1975; see also Cleveland and Ruth 1997).

The issue of conserving natural capital is part of a broader debate on reconceptualizing economic theory. **Guiseppe Munda** places the issue of natural capital conservation in the context of a contrast between the two economic paradigms of neoclassical and ecological economics. Whereas neoclassical environmental economics seeks to apply the categories of economic theory to the environment, ecological economics attempts to modify the conception of the economic system to acknowledge its role as a subsystem of a broader planetary ecosystem. In this view, standard economic approaches such as valuation in monetary terms can give at best only a partial view of reality. An analytical pluralism which takes into account social and environmental dynamics is essential to the ecological economics paradigm (Norgaard, 1989 and 1994). For an extensive treatment of the principles of ecological economics, see Volume I in this series, <u>A Survey of Ecological Economics</u> (Krishnan et al. eds. 1995). A recent evaluation of issues in ecological economics can be found in the articles by Wackernagel, Herendeen and others in <u>Ecological Economics</u> 29 (1): 13-60 (1999).

The social basis for the conservation of natural capital is explored further in the summarized article by **Talbot Page**. Page suggest that natural capital conservation requires specific recognition in law regarding the "standing" of natural capital as a social asset. He offers an analogy to constitutional law: fundamental social principles must determine the broad outlines of natural resource management. The sphere of "purely" economic analysis is thus limited to more specific decisions within this general framework.

The importance of social capital in natural resource management is evident when "marketization" breaks down traditional social institutions which have governed the use of common property resources such as forests or fisheries. In such cases, it is essential either to find ways to maintain the traditional common property management institutions, or to replace them with effective new institutions. Unfortunately, the development process has often led to a period during which neither traditional nor modern forms of social control over resources are effective, resulting in rapid and destructive resource exploitation.

Failures of social capital development are also at the root of many inequities and much human suffering in the development process. This is a central aspect of sustainability which is neglected in standard economic theory, and only partly addressed in ecological economics. In Part II of this volume we address issues of social capital and development in depth.

INTERGENERATIONAL EQUITY

Sustainability is sometimes defined as intergenerational equity – ensuring that future generations have an inheritance of natural, social, manufactured, and human capital at least equal to that of the present generation. From the point of view of neoclassical economic theory, sustainability can be defined in terms of the maximization of human welfare over time. Most economists simplify further by identifying the maximization of welfare with the maximization of utility derived from consumption. This formulation certainly includes many important elements of human welfare (food, clothing, housing, transportation, health and education services, etc.), and has the analytical advantage of reducing the problem to a measurable single-dimensional indicator. But it is open to criticism as a serious oversimplification of the nature of human well-being (see, for example, Sen 1999 and Ackerman et al.eds. 1997).

Using the neoclassical definition of welfare maximization, a formal economic analysis raises the question of whether sustainability has any validity as an economic concept. According to standard economic theory, efficient resource allocation should have the effect of maximizing utility from consumption. If we accept the use of time discounting as a method of comparing the economic values of consumption in different time periods, then sustainability appears to mean nothing more than efficient resource allocation – a concept already well established in economics.

One line of criticism of this reductionist approach to sustainability centers on the use of a discount rate to compare present and future costs and benefits. Discounting has been subject to numerous critiques on account of its present bias, especially as the time period under consideration becomes longer (see overview essay for Part VI and summarized article by Lind and Schuler in that section.)

A simple example demonstrates the general point. At a discount rate of 10%, typically used for cost-benefit analysis, the value of $1 million one hundred years from now is the same as a mere $72 today. Thus it would apparently be justifiable to impose costs of up to $1 million on people 100 years from now in order to enjoy $72 worth of consumption today. By this logic, much resource depletion and environmental damage could be considered acceptable, and even optimal, according to a criterion of economic efficiency.

The problem is that by accepting the use of a discount rate we have implicitly imposed a specific pattern of preferences regarding the relative welfare of present and future generations.[2] Howarth and Norgaard have argued that the use of a discount rate is appropriate for the efficient allocation of this generation's resources, but is inappropriate when the rights of future generations are at issue (Howarth and Norgaard 1993). Use of a current market discount rate gives undue weight to the preferences of current consumers. This creates a strong bias against sustainability in the context of issues such as soil erosion or atmospheric buildup of greenhouse gases, where the most damaging impacts are felt over decades or generations.

To achieve intergenerational equity, we need some kind of sustainability rule regarding resource use and environmental impacts. The solution of what Norgaard and Howarth (1991) refer to as "the conservationist's dilemma" is not easy. By imposing a low discount rate for decision-making, we can place a higher value on the future. For example, with a low discount rate future costs associated with soil degradation or global climate change would be weighed more heavily. But at the same time, the use of a low discount rate encourages excessive current investment in manufactured capital (for example, the construction of large dams or nuclear power plants), to the likely detriment of natural capital. It is, of course, possible to use different discount rates for different planning purposes. But such an apparently arbitrary choice has little theoretical justification.

Michael Toman suggests that the issue may be resolved by recognizing that some issues can be appropriately dealt with through neoclassical market efficiency, while others require the application of a "safe minimum standard" approach to protect essential resources and environmental functions. He suggests that the criteria of possible severity and irreversibility of ecological damages should be used to decide which theoretical framework is more appropriate. Others have referred to this approach as the use of a "precautionary principle", which should supersede economic analysis when there is uncertainty about possible outcomes and large potential ecological damage is at issue (Perrings, 1991).

The adoption of this reasonable suggestion would have far-reaching implications for economic theory and policy. Note the essential role of "moral imperatives," "public decision making," and "the formation of social values" in Toman's suggested decision framework. None of these appear in the neoclassical economic model, where markets are presumed to be the best resource allocators, and the occasional correction of a "market imperfection" the only appropriate role for government. Thus Toman is in effect asserting the importance of sustainability as a concept independent of standard neoclassical economic analysis, one that requires an explicitly normative and socially determined process of decision-making.

This represents a fundamental shift in the economic paradigm. Much as the Keynesian revolution validated the concept of government intervention to achieve macroeconomic balance, the acceptance of sustainability as a valid social goal places a new complexion on all policy issues concerning the relationship between human economic activity and the environment. Markets may be valuable and essential means, but they cannot determine the ends, which must be arrived at by a social decision process informed by different disciplinary viewpoints. This will require an unaccustomed humility on the part of economists, and a willingness to work together with other social and natural scientists.

ISSUES OF DISTRIBUTION AND VALUATION

The advocacy of intergenerational equity also has implications for equity and property rights in the current generation. It makes little sense to talk about equity between generations without acknowledging the great current inequalities of wealth and income. In terms of natural capital and environmental assets, many questions arise as to private and social property "rights" over these assets. Who, for example, has rights to genetic resources, fish stocks, forests, or water? These issues are interlinked with distributional questions. A more equitable distribution of income would have major implications for the use and conservation of water resources, since clean water is a major unmet need in many areas of the developing world. (In neoclassical terms, the "demand" for water is not an "effective demand" if people lack income to back it up).

Juan Martinez-Alier addresses the question of the relationship between environmental sustainability and social equity. He rejects the idea that the environment can be treated as a luxury good, something which the rich can afford to care about while the poor must focus only on immediate needs. The poor often depend heavily on common property resources, and suffer the most serious consequences of pollution and environmental damage. Thus the battle for a more equitable society often involves resistance to the abuse of natural capital by powerful market actors including corporations and rich individuals. While there may be cases where the needs of the poor for greater material consumption may require environmental trade-offs, it is the much larger demands of the affluent which directly or indirectly threaten the natural resource base.

Martinez-Alier also deals with some of the paradoxes of economic valuation. He sees this not as a neutral analytic exercise, but as a function of economic power. The valuation of environmental damage may depend strongly on who that damage affects. Negative externalities suffered by the poor are typically undervalued, both in the market and by economic analysts. Like Talbot Page, Martinez-Alier points out that a rights-based legal analysis may give a very different weighting to environmental factors as they affect individuals and communities. Market-based valuation is only one measuring rod.

This is consistent with the point made by Guiseppe Munda regarding the *incommensurability* of economic and environmental values. Decisions made on such issues ultimately reflect social values, and these in turn are -- and should be -- shaped by social movements, not just by market outcomes. Sen (1999, pp. 76-85) has similarly emphasized the function of social choice in deciding what weights to give to individual preferences , arguing that the economist's "preference for market-based price evaluation" must be balanced with a more public discussion of appropriate social goals. His argument is more general, not limited to environmental issues, but the essential point is similar.

One of the trickiest issues in this area is whether it is possible, or advisable, to provide an effective monetary measure of environmental values. There has been an extensive debate on the issue of the valuation of ecosystem services.[3] Gouldner and Kennedy (1997) argue that the issue is as much a philosophical debate on the basis of value as it is an issue of economic techniques. Costanza and Folke (1997) suggest that valuation should take into account social fairness, economic efficiency, and environmental sustainability. However, they acknowledge the difficulty of integrating these dimensions.

Costanza and colleagues (1998) have put forward an estimate of $16-54 trillion for the value of the world's ecosystem services, an extraordinarily ambitious undertaking which relies heavily on fairly standard economic valuation techniques. Their work has been subject to criticism for a reductionist methodology and for failing to capture the complexity and interdependence of natural functions (Rees 1998; Toman 1998). The size of their estimate is also heavily dependent on a very high estimate for the value of oceanic nutrient cycling. A research team of biologists from Cornell have suggested a significantly lower estimate of $2.9 trillion for global ecosystem services (Pimentel et al., 1997). This large variation in estimates demonstrates the inherent uncertainty in such calculations. At the same time, some of the critics acknowledge the importance of the "benchmark for environmental discourse" provided by admittedly imprecise figures indicating, in rough terms, the value of ecosystem services to human well-being (Norgaard et al. 1998; for a survey of responses to the ecosystem valuation by Costanza et al., see also Herendeen (1998) and other contributions to the 1998 Special Issue of <u>Ecological Economics</u> (Vol. 25 No. 1) on ecosystem services).

At a more microeconomic level, Pearce and Moran (1997) offer methodologies for economic valuation of biodiversity which can be applied to a wide variety of areas including non-timber forest products, natural genetic resources, watershed services, and wildlife conservation. The best justification for these valuation techniques is that, absent their use, the market system will assign an effective value of zero to many environmental functions. This logic has led other economists to attempt to integrate estimates of environmental and resource values into macroeconomic measures, thereby altering our understanding of concepts such as gross national product and net investment, and creating a new focus on "greening" national accounts.

GREEN ACCOUNTING AND GENUINE SAVING

If economics cannot offer all the answers, it may at least be possible to reform some basic economic measures to give a better fit with environmental and social realities. **Salah El-Serafy** discusses "green accounting", which seeks to modify national income statistics to take account of the environment. El Serafy point out that it is very difficult to get a fully "greened" measure of GDP due to the many judgement calls required to value complex environmental impacts some of which (like species loss) are almost impossible to monetize. For this reason, green accounting has developed along two different lines.

One is the attempt to correct existing national accounts for *natural capital depreciation* using a "weak sustainability" principle (natural capital may be depleted, but this depletion should be accounted for). This is clearly desirable, since the principle of depreciation has long been accepted for manufactured capital. However, it is limited to those areas, like minerals or timber stocks, where valuation is relatively easy, or to quantifiable pollution damages.

The second direction for green accounting is *satellite accounts*, which measure environmental stocks and functions in physical terms, without necessarily attempting valuation (Lange and Duchin, 1993). El Serafy suggests that both approaches have their uses. Introducing natural capital depreciation into accounting may have significant trade and macroeconomic policy implications, especially for countries which are heavily dependent on natural resource exports. Satellite accounts, on the other hand, can give a more complete picture of the natural resource base and the state of the environment.

As a step towards integrating economic, environmental, and social policy analysis, the World Bank's Environment Department has developed a measure of *genuine saving* which includes natural capital depreciation. This measure, particularly appropriate for developing countries, indicates that what may appear to be a development "success story" can conceal serious natural capital depletion and in some cases even a net negative genuine savings rate. The summarized article by World bank researchers **Kirk Hamilton and Michael Clemens** in this section explains the basis of the Bank's calculations, and presents specific calculations of genuine savings for developing regions.

To take account also of human capital, Hamilton and Clemens also introduce a measure of *extended national investment,* which counts educational expenditures as an integral part of national investment. The combination of this with natural capital depreciation gives a revised measure which indicates the importance of public investment in education in improving the genuine savings picture in many developing nations.

Although it is tempting to seek a single socially and environmentally sound measure of economic activity, it appears that methodological problems make this impossible. (For a broad overview and critique of efforts to create alternatives to standard national income accounts is see England and Harris, 1997 and England 1997). However, specific measures such as those developed by Hamilton and Clemens are clearly of great importance in evaluating the benefits as well as the costs of economic growth. As El Serafy points out, these adjusted measures can have significant implications for macroeconomic and trade policy. Bearing this in mind, it is worthwhile to examine some other perspectives on the environmental impacts of economic growth, an issue on which there is now a well-developed literature.

ECONOMIC GROWTH AND THE ENVIRONMENTAL KUZNETS CURVE

Do environmental conditions get better or worse with economic growth? There is now an extensive literature on this topic, with widely differing results depending on which environmental factors are studied and sometimes on econometric techniques. **David Stern** reviews this literature, evaluating the "Environmental Kuznets Curve" (EKC) hypothesis according to which environmental conditions worsen during the early stages of industrial development, then improve as income levels rise.[4]

Stern finds that the EKC logic applies only in a limited number of cases, and that several other factors are important. Much depends on which pollutant is considered. While some pollutants, such as sulfur dioxide and particulates, typically rise in the initial stages of development and then decline at higher income levels, others such as urban wastes and carbon dioxide seem to increase continually with income. There is also some evidence that after a downward turning point there may be another upward turn, as expanded consumption outruns stronger environmental protection. For example, nitrogen oxide levels have remained stubbornly high in developed countries as increased automobile traffic offsets improved pollution controls.

While initial research seemed to identify a "turning point" of around $5000 per capita income for key pollutants, other studies have found significantly higher turning points, implying that global pollution will continue to increase for decades unless significant policy changes occur (Selden and Song 1994). Critics of the EKC hypothesis argue that it ignores environmental limits, implying that sufficient economic growth can solve any environmental problem (Arrow et al. 1995). Some have pointed out that while higher per capita income can be associated with reduced pollution, the effect depends on political power, with literacy, political rights, and civil liberties having strong effects on environmental quality in developing nations (Torras and Boyce 1998). Others argue that the simple EKC hypothesis ignores the effects of trade, through which higher-income consumers may displace the environmental impacts of their consumption onto others (Rothman, 1998; Suri and Chapman, 1998). In general, the simple logic that "wealthier means cleaner" is not supported by the empirical evidence, which gives a much more complex picture, especially for global pollutants and ecosystem damage.

CONCLUSION

Introducing principles of sustainability into economics leads to the re-examination of fundamental economic concepts. In the new and broader perspective which emerges, development is no longer seen in the same light. As Munda makes clear in the article summarized here, the standard economic view of development as a straight-line process leading to industrialization and mass consumption no longer applies. A more nuanced understanding of development as an interaction of social, economic, and environmental factors -- what Richard Norgaard has called *coevolution* -- is needed (Norgaard 1994). Along similar lines, Guha and Alier point to the emergence of a new field of *political ecology*, integrating issues of distribution and equity with environmental and economic perspectives.

As we pursue the varied topics of this volume, we will find that this new interpretation of development is indeed rich in theoretical and empirical insights. While economic evidence and analysis remains a central element, a multidisciplinary approach is essential. Before turning to specific topics in sustainable development in Parts IV-VI, we seek to deepen our understanding of the social and international dimensions of development in Parts II and III. In Parts VII-X, we will return to many of the institutional issues which affect policies for sustainable development.

Notes

1. The distinction between weak and strong sustainability is outlined in Daly (1994). Daly (1991a) deals with the issue of limits on macroeconomic scale. See also Pearce and Warford, 1993, Chapter 2, on substitutability between manufactured and natural capital, as well as the concept of critical natural capital. For a critique of the weak sustainability concept see Common and Perrings 1992; applicability of the concept is discussed in Gowdy and O'Hara (1997).

2. Neoclassical economists acknowledge that the choice of a discount rate affects intergenerational distribution, but generally do not regard this as a reason to replace discounting with other criteria for intertemporal resource allocation. See Hartwick 1977; Solow 1986. For further discussion of the issue of valuing the future, see the summarized article by Lind and Schuler in Part VI of this volume, and Part IV of Volume III in this series, *Human Well-Being and Economic Goals* (Ackerman et al. eds. 1997).

3. See, for example, the Symposium on Contingent Valuation in *Journal of Economic Perspectives* 8, 4 (1994), which offers a debate between the proponents (Portney 1994, Hanemann 1994) and critics (Diamond and Hausman, 1994)of a survey technique for valuation.

4. The original Kuznets Curve hypothesis was that income inequality first increased, then lessened, with economic development (Kuznets, 1955). See Volume V in this series (Ackerman et al., 2000) for a discussion and critique of this hypothesis on income inequality. Grossman and Krueger (1991), Shafik and Bandyopadhyay (1992), and Selden and Song (1994) applied a similar principle to pollution levels as related to economic development.