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Social Science Library: Frontier Thinking in Sustainable Development and Human Well-being

"Theoretical Frameworks and Techniques" by Jonathan M. Harris

Any theoretical offering in the domain of economics will inevitably be measured against the dominant, neoclassical theory. To its proponents, neoclassical economics represents the accumulated insights of two centuries of economic theory. Further, it presents itself as a complete, axiomatic theory, building its edifice of theorems on specific, testable assumptions. Does ecological economics seek to overturn this edifice, and offer a different systematic theory to explain all economic activity? As we have seen, writers in the ecological economics area have raised many criticisms of the narrowness of neoclassical economics, and of its divorce from biophysical principles. But is there a single, sweeping alternative to put in its place? The answer is probably no. Yet the outlines of what Daniel Underwood and Paul King call an alternative "metaeconomics" does appear, and significant efforts to advance specific analysis based on this new metaeconomics have been made. Section III summarizes what the editors of this volume consider to be some of the most important contributions to the task of building new theory. As will become apparent, these efforts do not necessarily reject all of the tools and approaches of the neoclassical school, but at the least modify them significantly, and in some cases offer completely different analytical approaches.

The new theoretical contributions of ecological economics are clustered around certain key concepts. In each case the task attempted by the authors summarized here is to establish specific theoretical content for each concept. After considering some major concepts as developed in the specific articles summarized here, we will return to the issue of whether something like a complete alternative economics emerges from these efforts.

I. SUSTAINABILITY

This much-used term has two components. One is *economic sustainability* - the ability of an economic system to continue operating at some level of output. The other is *ecosystem sustainability* - referring not to an absolutely unchanged ecosystem equilibrium, but to what C.S. Holling refers to as ecosystem resilience (see the selection by Mick Common and Charles Perrings). Resilience refers to the bounce-back capacity which allows ecosystems to recover from short-term damage or disruption. True sustainability must include both components. Often only the first is considered, giving a *weak sustainability* concept which is generally compatible with the neoclassical framework. In this formulation, depletion of natural resources and degradation of ecosystem functions is acceptable provided that sufficient human-made capital is accumulated to substitute for these resources and functions. A good example would be depletion of soil fertility through erosion, with attendant substitution of mechanization, irrigation and fertilizer to give equal or higher yields.

Strong sustainability, by contrast, gives priority to ecosystem resilience, and does not accept human-made capital accumulation as an adequate substitute for *natural capital* depletion. Common and Perrings construct a model which allows rigorous comparison of the two concepts, concluding that the stability conditions for the two types of sustainability differ widely. This is an extremely important result, giving theoretical rigor to the perception that an efficient neoclassical economic growth path is not environment-friendly. Barbier offers a different formal model, starting with a neoclassical production function, but also embodying something similar to the entropy principle. He reaches similar conclusions: the benefits of "efficient" economic growth may be outweighed by increasing environmental degradation.

II. SCALE

Herman Daly has been largely responsible for introducing this central concept to debates on economic growth, and his contribution is reflected in several selections here. He points out that neoclassical economics admits no scale limits - economies in mathematical theory can grow forever - but that the *closed system* of the physical world necessarily imposes some limits on the *open system* of the economy. The real question then is, how close are we to the limits? The question was raised by Kenneth Boulding, in his famous "Spaceship Earth" article summarized here. Daly places us somewhere between the "frontier" economy, too small to affect its environment significantly, and the "spaceman" economy, which must manage its entire environment. He posits a "bull-in-the-china-shop" economy, large enough to do significant damage to ecosystem resilience. In this situation, the efficiency criterion advanced by neoclassical economists will not suffice - specific attention must be given to limits to growth, both of population and of per capita consumption. Daly proposes a *steady-state economy* which, rather than maximizing consumption, would minimize *throughput* - the use of resources and generation of wastes.

Thus to the goal of economic efficiency must be added the goals of *sustainable scale* and *equitable distribution*. The theoretical implication of this is that while neoclassical methodology might be very useful in defining economic efficiency and prescribing policies for its achievement, it is wholly inadequate to address issues of scale and distribution, which depend respectively on ecological realities and social, political, and ethical principles. Theories of macroeconomic equilibrium, employment, and income distribution which ignore these factors are therefore highly misleading. This implies a new structure for macroeconomic theory - though neither Daly nor the other authors in this section offer more than a very general indication of what this theory would look like.

In addition to its obvious importance for developing economies, this perspective has a special implication for the formerly communist economies. They clearly suffer from a cancerous growth of high-polluting industry. Will their present transition be simply to a more efficient kind of growth or to a truly sustainable system? Kenneth Townsend discusses this question, offering some prescriptions (transferable pollution permits) which are perfectly acceptable to neoclassical theorists, but also advocating an application of Daly's steady-state goal to Eastern economies. He fails, however, to offer many useful specifics (e.g., energy sector efficiency, agricultural reform) as to how this might be achieved.

A practical application of the scale concept is seen in the case study of Haiti by George Foy and Herman Daly. Some of the severe environmental problems of Haiti are attributed to the resource misallocation issues familiar to standard economic theorists as cases of "market failure." But population pressure and resulting deforestation and soil erosion are seen as an independent cause of environmental degradation. Perhaps a standard economic rejoinder might be that correcting the "market failures" would allow for an expanded population carrying capacity. But it is surely unarguable that so long as resource misallocation problems exist, population pressure will make the results significantly worse, as is dramatically obvious in Haiti.

III. ENTROPY

As Underwood and King point out, the "metaeconomics of the steady state" is based on the laws of thermodynamics, as opposed to the formalized mathematical assumptions of the neoclassical model. The First Law, that of conservation of matter and energy, is reflected in the emphasis on limits in ecological economic theory. The planetary stock of resources is fixed; leaving aside exotic schemes of mining other planets, we have a limited resource base to work with. The Second Law, that of increasing entropy, governs our use of the one truly "free" resource, solar energy, and of all existing resource stocks. This law implies that any economic activity, as indeed any life process, inevitably degrades energy and material resources to a more disordered, less usable form. It is not simply a question of energy supply, as some neoclassical economists have suggested. Even more significant is the issue of ecosystem capacity to absorb the high-entropy wastes which are the unavoidable result of economic activity. Herman Daly, in "Economics as a Life Science," suggests that in economics, as in biology, the critical issue is the ability of the system to adapt to limited sources of low entropy, utilizing the solar flux efficiently and avoiding a buildup of waste products which would render the environment incapable of supporting further life.

Nicholas Georgescu-Roegen, who first proposed the concept of analyzing the economic process in terms of the entropy law (in The Entropy Law and the Economic Problem) emphasizes that this perspective does not imply an energy theory of value. Writers in the "energetic" tradition have attempted to measure value in terms of embodied energy. Georgescu-Roegen finds this approach wrong-headed, and strongly differentiates his own view from neo-energetics. But he does see the entropy theory as a fundamental challenge to mainstream economists. Economic growth, he argues, has been dependent on a "mineral bonanza" which is unrepeatable. Mechanistic theories of economic growth which ignore thermodynamic limits are therefore unreliable. This criticism applies to essentially all of neoclassical growth theory.

The introduction of the entropy concept to economic theory raises a question which is well posed by Burness et al. in the article "Thermodynamic and Economic Concepts as Related to Resource Use Policies." That is, is there a specific role for entropy analysis as distinct from ordinary market price rationing? Is it not true that scarcity of low-entropy resources will be reflected in a high market price? And if so what does entropy analysis have to add to standard market analysis? Herman Daly's reply to this crucial question is to the effect that we should not seek a new energy theory of value, but rather use the awareness of Second Law constraints to formulate policies for long term sustainability. These policies (such as taxes on energy and virgin resources) would then work through the market price mechanism, internalizing into market decision-making a social awareness of ecological limits. Burness et al. feel that this is simply the imposition of an ethical decision, not a modification in theory.

How can we evaluate this debate? One comment might be that Daly may underrate the specific importance of energy and resource analysis. Short of seeking a comprehensive energy theory of value, we may analyze the evolution of many agricultural and industrial systems specifically in terms of energy and resource use (extensive examples of such analysis are offered in Section IV). The heavy dependence of our economy on fossil fuels is a central issue which leaps out of such an analysis, as it does not from a standard economic analysis in which energy is but one factor in costs of production. The cumulative impact of pollutants is also evident from physically-based analysis of economic activity, but will only affect market prices *after* a conscious decision by policy makers, based on non-market factors, to impose quantitative limitations or taxes. (Daly, of course, is well aware of this, and refers for example to the importance of expanding input-output analysis to include ecological stocks and flows in "Economics as a Life Science," but he does not stress it in his reply to Burness et al.

Another relevant point is that the question of inter-generational patterns of resource use is not "just" an ethical issue. It raises the next important area of theoretical difference between neoclassical and ecological economics - the treatment of time.

IV. TIME

The essential issue here is the role of the discount rate in balancing present and future values - seemingly a technical issue, but one of sweeping implications. The best work in this area has been done by Richard Norgaard and Richard Howarth, in the chapter summarized here, "Economics, Ethics, and the Environment," and other articles. They suggest that the use of the discount rate - any discount rate - to balance present and future values is fundamentally flawed. This, of course, represents a basic theoretical difference with neoclassical economics. Discounting based on prevailing commercial interest rates (say a real interest rate of 6%) heavily downgrades the interests of future generations. Costs and benefits 25 years in the future will be discounted by a factor of four, and 50 years in the future by a factor of 18. This means essentially that the interests of future generations in avoiding environmental degradation will be disregarded. Nor are we discussing the distant future - these time periods are within the lifetimes of children already born. Norgaard and Howarth show that if we take a different starting point, assuming that future generations have equal rights over resource allocation, a quite different pattern of discounting and inter-period resource allocation would emerge. In effect, using a current discount rate assigns all rights over resources to the present generation.

This point is of extraordinary importance, for it means that hidden in the apparently "neutral" principle of inter-period efficiency is a normative judgment that gives absolute primacy to short-term, present generation interests over future interests in the resource and environmental area. The only justification for this would be the assumption that future citizens are fully compensated for resource loss and environmental degradation by the accumulation of human-made capital. But since most of this capital itself has a lifetime of only 20 to 50 years, and since the substitutability of human-made and natural capital is in serious question, this clearly shortchanges the future.

The alternative approach suggested by Norgaard and Howarth separates the normative definition of goals from the positive determination of efficient means. We must first determine our principle of long-term resource allocation and environmental preservation (in accordance, they propose, with the sustainability criterion discussed above). Then we can proceed to issues of valuation and discounting to achieve these ends. Interestingly, this perspective reverses the burden of normative judgment in the Burness/Daly debate. Rather than seeing the "steady-state" advocates as imposing their own ethical criterion on resource allocation, we see that the current economic allocation imposes a present-oriented normative value in the guise of a neutral market efficiency.

V. COMPLEXITY, UNCERTAINTY, AND IRREVERSIBILITY

Another important tenet of ecological economics is advanced by Peter Söderbaum in "Neoclassical and Institutional Approaches to Development and the Environment." He argues that the inherent complexity of ecosystems is at odds with the reductionist nature of both modern industrial production and neoclassical economic theory. A similar theme is developed compellingly by Norgaard in "Economics as Mechanics and the Demise of Biological Diversity." The rapid replacement of traditional, ecologically integrated agricultural production techniques with uniform, high-input agriculture and commercial production is devastating to the maintenance of biodiversity. The spread of a global trading economy means that local production decisions must be responsive to a global supply and demand balance determined without regard to the nature and capabilities of local ecosystems. Rapid shifts in crop profitability and export demand impose impossible burdens on local ecosystem stability, destroying ecosystem resilience. Thus the spread of free trade, seen from one perspective as clearly beneficial, appears now as a relentless destructive force steadily reducing global biodiversity. Norgaard does not proceed to any theory of ecologically sustainable trade, but his analysis clearly indicates the need for such a theory (this issue will be pursued further in Section VI.)

Allied to the issue of complexity is that of uncertainty. While some environmental impacts are clearly definable in relation to such factors as levels of production and generation of pollutants, in many cases a high degree of uncertainty is involved with the "big" environmental issues such as global warming, biodiversity loss, ozone destruction, and cumulative ocean pollution. The range of "cost" estimates associated with these problems may be immense, and considerably complicated by the discounting issues discussed above. The *precautionary principle* suggested by Charles Perrings ("Reserved Rationality and the Precautionary Principle") implies that when worst-case possibilities involve massive and irreversible damage, standard expected-value cost/benefit methodology is unacceptable. The principle of erring on the side of precaution implies a high premium on preserving the resilience of ecosystems. As we have already seen, this will generally cut against the "efficient market" solution which ignores or downgrades ecosystem sustainability issues.

Krutilla's "Conservation Reconsidered" approaches similar issues using the more standard theoretical concept of *option value*. He suggests that it is usually impossible for the market to capture the public benefits of preserving unspoiled environments. The ecosystem services provided by these environments, whether practical (water purification), aesthetic/spiritual (enjoyment of nature), or purely ecological (biodiversity) cannot be replicated once destroyed. This argues for a conservation principle which must override market considerations to guarantee the unquantifiable "option value" of ecosystem resilience.

VI. VALUES AND MOTIVES

A theme which runs through all the topics discussed so far is the social and ethical dimension of decision-making. In the neoclassical model all actors, whether consumers or producers, are motivated by pure self-interest. Moral considerations, altruistic motives, or public-spiritedness are excluded by assumption. Thus if we agree with any of the ecological imperatives discussed above, we would somehow have to impose them from without on an otherwise self-regulating market. Both John Tomer in "The Human Firm in the Natural Environment" and Peter Söderbaum propose the contrary view: the moral/altruistic motives of protecting the environment may in fact be internalized in the decision-making of individuals and firms. Many institutions and social forces affect the behavior of economic actors, and among these is a growing consciousness of the importance of the environment. Thus "socially responsible" firms will seek to modify their own practices to minimize environmental impact; "green" consumers will give preference to sustainably produced goods, and non-governmental interest groups may effectively influence public policy toward environmental protection.

The significance of this point is that it breaks down the disciplinary barriers between economics, sociology, political science, and philosophy. Neoclassical economists may perhaps try to preserve the purity of their mathematical models by arguing that these considerations simply create new "objective functions" for firms and consumers. But this really begs the question - the elegance of the original model derives from the simplicity of the profit or utility-maximizing goal. Once a tangled web of social, ethical, and ecological considerations enter the picture, it will no longer be possible for economists to defend the frontier of their discipline against the incursions of other social and physical scientists and even of philosophers. (Perhaps Adam Smith, author of "The Theory of Moral Sentiments," would agree with today's ecological economists that they should not try.)

In summary, three elements of new economic theory emerge from these selections:

1) **Meta-theoretical framework:** The interlocking concepts discussed above clearly form an alternative perspective or world-view which contrasts with the neoclassical model. The ramifications of this new perspective are extensive, with major theoretical and policy implications.

2) **Formal models:** Both Barbier and Common/Perrings construct formal mathematical models which resemble standard neoclassical models, but include ecologically derived principles which significantly affect their results. Variations on this technique can be used in many kinds of economic/ecological modelling, some further examples of which will be seen in the Sections VI-VII.

3) **Alternative theories and techniques for specific fields of study:** The Norgaard/Howarth critique of discounting implies a completely different approach to cost/benefit analysis and project evaluation. Tomer and Söderbaum suggest new approaches to the theory of the firm and public choice theory. Norgaard's analysis of trade reverses the standard conception of the benefits of free trade, with profound implications for trade and development policy. Daly suggests (but does not fully develop) a new macroeconomics including limits on growth, bringing to the fore issues of employment and distribution which have hitherto been "solved" by the assumption of continuous growth. Townsend suggests a different goal than that currently being pursued for the post-communist economic transition - a transition to ecological sustainability as well as market efficiency. Though not developed in detail, the issue raised is of critical importance for this area of analysis and policy.

Two additional specific areas of analysis appropriate to the ecological economics perspective will be added in Sections IV and V: energy/resource flow analysis (deriving from entropy theory) and modified national income accounts. The alternative approaches to trade, development, and social/ethical/institutional analysis which have been suggested here are also more fully developed in Sections VI and VII.