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COMMENTARY

The value of systemic reasoning

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Abstract

In a coevolutionary world view efficiency will call for more than lowering a specific input. First, if one of the decisive advantages of systems is their capability to achieve a level of efficiency beyond any individual effort, the wealth of any society depends not only on its factor endowments, but also on its capability to organize itself accordingly. Second, integrated diversity should be regarded as the source for the potential development of any system. To continue with marginal reasoning due to a lack of consensus is problematic. A partial perspective tends to reduce functional diversity to raise a specific, narrowly defined efficiency, while a systemic perspective tends to improve a comprising efficiency by raising integrated functional diversity. The willingness to understand these insights combined with the capacity to express them accordingly is called 'systemic competence'. It will be suggested that integrated diversity, cooperative structures, and systemic competence are interrelated key elements determining the achievable efficiency level of any future sustainable economy. © 1999 Elsevier Science B.V. All rights reserved.

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1. Introduction

The quest for sustainability confronts economic reasoning with the question of what efficiency means in a coevolutionary world. Economic theory should be able to answer questions such as 'what is the value of a system? What makes systems valuable?' Ecological economics is certainly aware of the dependence of any economic system upon the biosphere (Costanza et al., 1997). Nevertheless, there seems to be no easy way to deal with the insight on which the wealth of a society depends, not only in its factor endowments, but increasingly in it's capability to organize itself as a coherent system. Similarly, how is it possible for ecological economics to consider integrated diversity as the source of the potential development of any system? What does ecological economics do when the development of a (sub)system is contingent upon the future general well-being of its environment? Or whenever a

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partial perspective tends to reduce functional diversity to raise a specific, narrowly defined efficiency, while a systemic perspective tends to improve a comprising efficiency by raising integrated functional diversity? Is ecological economics really capable of formulating an enabling perspective that calls for a general strategy of upgrading the environment and maintaining the potentials of the larger system beyond any willingness to pay?

One might argue that there is no possibility to conceptualize an efficiency concept beyond a marginal or individual perspective. Yet ecological economics, as any other economic theory based on a coevolutionary world view (Brinkman 1981; Boulding, 1985; Norgaard, 1994; Capra, 1996; Bossel, 1998), must nevertheless come to terms with the implicit central hypothesis of this 'new' world view: systems are 'more' than the sum of their elements. So far, sustainability is quite frequently interpreted as the marginal perspectives in a non-linear framework (Anderson et al., 1988; Checkland, 1993), where market prices and willingness to pay serve as fall back solutions for evaluations (Costanza et al., 1998). This strategy is not only contingent on a strong positive correlation behind ecologically 'correct' economic efficiency and its entailing concepts of industrial metabolism (Daly, 1991; Young, 1992; Ayres, 1996), it is also unable to honor the fundamental role diversity plays in establishing the necessary conditions for the emergence of any viable 'more', both within human society and with respect to the biosphere.

2. Principles of systemic efficiency

If a context is considered as non-constitutive, partial efficiency evaluations ask for relaxing limiting restrictions to unfold the system's current full potential by either exploiting given resources and diminishing, or even eliminating any competitors. In this way, the average efficiency of the (sub)system in question will undoubtedly rise. Whenever the former members of the system will not just disappear after being restricted or expelled, but will be taken up by the encompassing system to which the respective (sub)system belongs, the difference between the specific average efficiency of the 'fit' (sub)system and the encompassing system will grow. From a more complete, hierarchically 'higher' point of view, a marginal perspective is then no longer sufficient for efficiency evaluations (Giampietro, 1997). The problem is endemic to any multi-level systems approach, which allows for differing assigned system purposes (Giampietro, 1997; Schütz, 1997b). Thus in a systemic world view, there might never be a clear-cut answer to the central economic question of what is efficient. The question then becomes: when is an individual strategy to raise the efficiency of a system in conflict with the more complete, 'higher' strategy of the system? And what should we do about it? Answers may vary according to how far we extend the relevant borders of the system under consideration, and according to the importance we place on the environment as an enabling factor (Funtowicz and Ravetz, 1994; Schütz, 1996).

3. Economics, marginal reasoning, and (bio)diversity

It seems fair to say that standard economic reality considers absolute limits more relevant than historical and contextual relationships, hence the current drive to determine 'safe' threshold levels in sustainable science. Given this rather defensive role of the environment for the existence of a subject or a (sub)system, standard economic reasoning will consider the following strategies 'reasonable' ways to enhance efficiency within existential thresholds:

1. decrease input;
2. cooperate within marginally evaluated win-win strategies;
3. change the environment according to ones' desire;
4. exclude competitors;
5. exclude 'weak' performers.

In such circumstances it seems to be appropriate to 'set inefficient elements free'. Provocatively, it could be said that economic efficiency is achieved by the exclusion of the financially inefficient from

productive economic processes, and by copying the remaining processes. This currently socially legitimized strategy to become ever more efficient measured in terms of cost minimization, will lead through diffusion of the cheapest production processes and the inherent cost bias for mass production to a homogenization and reduction of diversity within human artifacts, labor, and resources. These unifying tendencies are not countered by introducing a diversity of brands or styles. Diversity must be interpreted as the existence of different viable patterns of self-organization with distinct coordinated sub-systems of knowledge.

Certainly, the systemic argument in favor of integrated diversity holds both for the social as well as the biological sphere. Without ignoring or diminishing the social dimensions of the previous arguments (Schütz, 1990; Sen, 1997), I wish to reflect upon the suggestion to protect biodiversity mainly by financial incentives (Perrings et al., 1995). Biodiversity is the basis for any human society; yet it is very difficult. There are severe specification problems of what constitutes diversity or an ecosystem. The question of what is an appropriate specification of time and space is as crucial for the obtained results as the question of what species we are looking at (Shrader-Frechete and McCoy, 1994). Positions range from succession as an orderly pattern of development, to succession as a myth, a random assemblage of species with no underlying patterns (McIntosh, 1980). This illustrates the difficulties that may arise, if an epistemological systems analysis is ontologically 'tested'.

Nevertheless, I would argue that, based on an epistemological systemic coevolutionary world view as an analytical perspective device, recent work from Brown (1991), Naem et al. (1994), and Holdgate (1996) backs the general systemic point that the more positive externalities are produced by the elements of a system, the more (energy) reserves (NPP) are left for potential differentiation. This fact will enhance the chances that the system may reach a higher level of systems efficiency, securing the long-term survival of most species of an ecosystem in the presence of competing interests, if individualistic and altruistic behavior at the individual level can be integrated within a working circular system structure (Odum, 1971; Eigen and Schuster, 1979; Odum, 1983). Efficiency of vulnerable ecosystems is thus (with rare exceptions) not achieved by a reduction of diversity, or by a simple unrelated increase of diversity in one area. It is achieved rather through a level of highly interrelated functional diversity and the capability of constant renewal and change of the total system. One should note that the arguments do not rely on the traditional diversity-stability hypothesis. The systemic argument put forth here hinges on the evolutionary integration of functional diversity, where resilience has a positive, but limited, role in establishing and securing desired mutual relationships. A more adequate metaphor might be one of 'flowing (eco)systems', which generate long swings entailing the possibility of collapse.

It is in this context, that the effect of financial incentives on biodiversity becomes important. To only rely upon ecologically motivated economic surcharges might turn out to be a Mephistophelean strategy. While environmental surcharges will increase the relevance of ecological considerations, price tags on environmental goods will not interfere in any way with the usual partial analysis evaluation mechanisms or the thrust towards unfettered expansion. Even with ecological surcharges and effective environmental standards, based on physical partial efficiency analysis, economic units might continue to increase the efficiency of cultivating plants or species by eliminating their competitors. After an initial positive period, as a result of the exploitation of resiliences and redundancies, a reduced biodiversity within an existing ecosystem to cultivate a specific species will eventually trigger a negative feedback process: the lower the diversity, the lower the efficiency of the system, the lower its potential to respond upon disturbances, and the lower its potential for innovative combinations. We are used to countering such tendencies through enlargements of domesticated ecosystems, increased energy input in the form of labor, machines, fertilizers, pesticides, and, most recently, by genetic manipulation. In spite of certain positive short-term yield effects, we are likely to

start a new round of genuine diversity reduction. If, despite any efforts, we are not able to maintain a crucial level of interrelated biodiversity, the eco-system might eventually simply collapse.

Even with environmentally correct prices, cost-minimization will continue to exert an inevitable tendency towards homogenization by exclusion, which will continue to erode both ecological diversity and social integration—the pillars upon which any society rests in the long run (Daly and Cobb, 1989; Perrings et al., 1995). It is thus essential to realize that environmentally correct prices are necessary, but not sufficient. The strategic importance of diversity in the biospheric environment is hardly sustained through environmental pricing alone. The quest for ecologically safe limits and ecologically true prices in the economic mainstream seems, therefore, to be driven more by the need for monetary compensation for any damage being done to individual property rights than by systemic or even ecological insights.

4. Conceptualizing a systemic positive-sum-society

Perhaps the most important aspect in the systemic strategy is the potential to organize systems as a 'positive-sum-game'. The secret of systemic efficiency seems to be the integration of marginal approaches within a mutually stimulating systemic structure that is adequate for a given or assigned systemic purpose. Whenever individual efforts are designed, and seen, as mutually reinforcing activities according to an assigned system purpose, be it teamsports, companies, communities, states, or ecosystems, a surplus may 'emerge' and become visible.

4.1. Fundamental challenges of a systems approach

Although any attempt to organize society according to systems reasoning will face major resistance, in the following I will briefly comment on five non-trivial challenges. Firstly, any living system depends heavily on its environment, not only as a limiting factor, but also, and especially in the long run, on the enabling potentials the environment may hold for the system. However, where should an evaluation of a system end?

Secondly, if efficiency is a question of how to maintain the greatest potential for future development of a system, any efficiency statement precludes working assumptions about orientation, purposes, and hierarchies within a wider systemic perspective (Churchman, 1979; Boulding, 1981; Checkland, 1993; Norgaard, 1994; Giampietro, 1997; Schütz, 1997b). Without such an integrating concept, it is impossible to evaluate appropriately any demands at the marginal or the system level. Thus it is not sufficient to know what we do not want, or to secure 'fair' competition between marginal claims on the same hierarchical level. It is also decisive to have a distinct notion concerning desired future states, their qualitative features, adequate procedures of the respective system, and an assigned system purpose. This might happen 'automatically' in systems with only few behavioral dimensions, or little consciousness of the elements (Haken, 1978), or a widely shared implicit consensus among its members. But the more individual perspectives dominate individual behavior, the more conscious autonomy a single unity has, and the more heterogeneous these interests are, the more a system needs a convincing integrating concept for its structure (Churchman, 1979; Schütz, 1997b). In the case of human societies, we normally refer to such concepts as culture (Brinkman, 1981). Yet, how may we (re)establish cultural consensus?

Thirdly, even though individuals and their legitimate marginal perspective hold a key position in the puzzle of an ecological future economy, the capacity to organize society and its behavior within the biosphere accordingly depends crucially on the willingness and capability of our culture to explain and justify a systemic perspective. It is this social or cultural management factor, which I call 'systemic competence' (see Section 4.2), that appears to influence the various efficiency levels that might be achieved within a society by meaningfully coordinating and integrating the marginal point in view within a more comprehensive one. Yet, after the experiences of the twentieth century, is it naive to argue for a system approach?

Fourthly, when a purpose is assigned to a system, efficiency is inseparably intertwined with the philosophical dimensions of the question 'what for?'. This implies that, for human systems, scientific truth will have to give way to convincing stories. Nevertheless, what does it take for an ecological economist (scientist) to admit that he is telling 'just' stories?

Fifthly, and perhaps most sensitive, the distributional aspect of systems thinking. The relative size of the systemic factor and the marginal shares of the considered factors of production can only be determined jointly. Yet each system element is currently considered to be paid according to its appropriate marginal benefit. Furthermore, the environment of the relevant systems is hardly considered as a productive factor. In standard economic analysis, any cooperation is explained and justified from individual (marginal) perspectives only, so-called win–win constellations. What about the 'rest' to which the win–win subsystem belongs to? What about the enabling role of the system's environment? Where are the 'kick-backs' to the environment? Or should they be best considered as existential maintenance investment? In that respect, the previously outlined standard economics efficiency options numbered three to five are no feasible roads for (co)evolutionary systems thinking. And, finally, the adopted purpose of a system certainly does influence the underlying context of marginal evaluations and thus restrict the potential for generalization of marginal efficiency evaluations. However, assigned system principles are not present in distributional arguments. From a coevolutionary perspective there is no apparent way around their reintroduction (Schütz, 1990).

4.2. Systemic competence—a way out?

To organize society systemically, people must have both the capacity to understand the necessity and the capability to practice a constructively balanced approach between various marginal interests. Without these operational skills, adequate social structures cannot be maintained. This implied capability to understand the superiority of the systemic viewpoint without giving up individual interests may be called 'systemic competence'. Fig. 1 illustrates the mutual interrelationships between diversity, efficiency, cooperative structures, and systemic competence. Systemically efficient configurations are possible. However, they appear as nested constellations and the dynamic tendencies (arrows) suggest that they are inherently unstable. They are far away to constitute themselves automatically.

In quadrants one and two, we see that at any point of the system curve (bold) the marginal perspective (fine) tends to favor a reduction of diversity, be it ecological or social. A different interpretation of this conventional (economic) wisdom would be that at any given point in time an individual faces the choice between riding the systems curve or deviating. Neither way is risk free, but the consequences for the individual and for the system are qualitatively very different. If one opts to ride the system curve, the system has

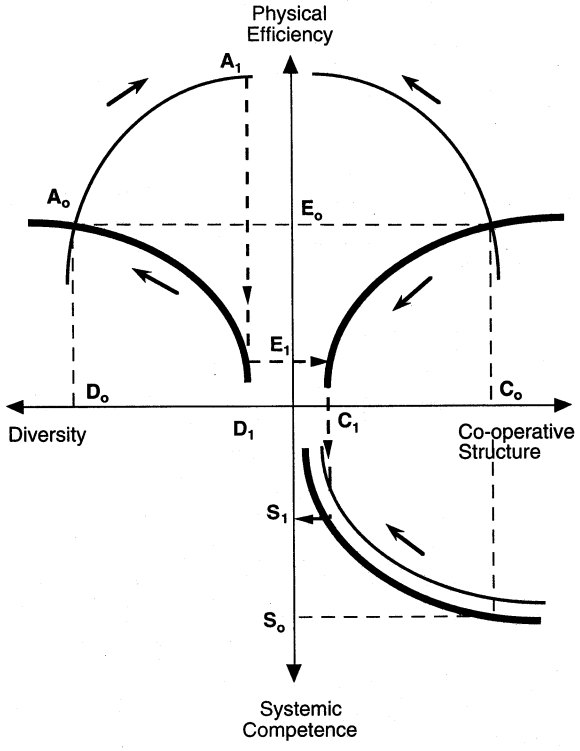

Fig. 1. The cleavages between marginal (individual) and systems thinking. Bold lines represent systemic; fine lines, a marginal perspective.

a chance to become more efficient on the basis of a higher integrated diversity. However, it may not be all that clear how the improvement could come about and to what extent one might participate in an improved systems efficiency. If an individual opts to deviate, any short-run success will eventually be based on reduced diversity, which will tend to lower the potential system efficiency. If, during this process, diversity of a specific system crosses a minimum threshold level, the system will collapse $A_0 \Rightarrow A_1 \Rightarrow \Rightarrow E_0 \Rightarrow E_1$. In doing so, the risk of deviation is, therefore, that the deviator might erode the initial bases for the initially individually profitable behavior. In the end, both the deviating individual and the system can be worse off.

The second quadrant shows that the previous arguments also hold in the sphere of social organization. It relates the potential efficiency level with the degree of integration various forms of social organization may provide. From a partial point of view cooperative structures will eventually hamper individual efficiency, while, from a systemic point of view, cooperative structures are significant for raising the efficiency of a system. As before, cooperative structures depend on constant approval through people accepting and maintaining them. If systemic competence (third quadrant) is not high enough, or if a sufficient number of individuals exploit cooperative structures, cooperative behavior may break down, leading to reinforced tendencies of maximizing individual behavior. If this happens, massive declines in the material basis for the human system due to ever decreasing systemic efficiency are very likely ($S_0 \Rightarrow S_1 \Rightarrow C_0 \Rightarrow C_1 \Rightarrow A_0 \Rightarrow A_1 \Rightarrow D_0 \Rightarrow D_1 \Rightarrow E_0 \Rightarrow E_1$). Yet the dependence between the social and ecological capabilities to maintain diverse systems seems to be mutual. Even within a cooperatively structured society disregarding the biosphere might have as severe consequences as the neglect of establishing a sufficient standard of cooperative structures and systemic competence (Stokes, 1992).

Certainly, it may be argued that cooperative behavior among individuals does not necessarily preclude systemic competence. Many forms of insurances or 'win–win' arrangements may be explained by pure individualistic reasoning. Yet marginally based cooperation will always forego both the potential synergetic effects built on trust (Axelrod, 1984), and the evolutionary chances a creative interplay of the system elements may hold. Furthermore, if marginally based win–win agreements are made at the expense of a third party, and if this 'third party' is an enabling environment, this strategy might be fatal for all. It seems therefore safe to hold that (insurances and win–win arrangements notwithstanding) a high degree of efficiency in (human) systems seems to be contingent upon a high degree of functionally integrated (bio)diversity, wide cooperative behavior, and a high standard of systemic competence.

5. Final remarks

It is the unfolding of the individual potential beyond one's necessities that forms the material basis for further development of other individuals and the system (Eigen and Schuster, 1979). While egocentric behavior favored from a marginal or individual point of view is necessary to survive competition, without the balance of coexisting individualistic and altruistic behavior at the individual level, integrated within a working circular system structure, the efficiency level of a system and thus the average wealth of every element, will not be very high. Thus there seems to be no way to achieve a high level of system efficiency under conditions of low diversity, non-cooperative behavior, and a low standard of systemic competence as it is favored by current economic reasoning. On the contrary, the currently favored strategy to achieve sustainability mainly through price instruments clearly runs the risk that our culture locks itself in a configuration of low diversity, low system efficiency, low cooperative behavior, and a low standard of systemic competence (D1, E1, C1, S1). The perspective of economic reasoning must, therefore, change from maximization to integrative thinking.

We suggest that besides environmental pricing ecological economics focuses on finding and establishing the balance and organization of the individual purposes within an agreed system purpose; and to strengthen the well-being of the

environment to which the human systems belong (Schütz, 1997a). This would firstly require acceptance of the functional necessity of a system purpose (Schütz, 1997b). Secondly, it calls for the institutionalization of a process of determining and assigning such system purposes. Thirdly, it needs the institutionalization of a balancing procedure, and finally, the respect and honor of the larger biosphere system of which we are a part.

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