Rensselaer Working Papers in Economics

Department of Economics, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY, 12180-3590, USA. Tel: +1-518-276-6387; Fax: +1-518-276-2235; URL: http://www.rpi.edu/dept/economics/; E-Mail: keenak@rpi.edu

The Approach of Ecological Economics

John M. Gowdy
Rensselaer Polytechnic Institute

Jon D. Erickson
University of Vermont

Number 0402

February 2004

The approach of ecological economics

John Gowdy
Professor of Economics
Department of Economics
Rensselaer Polytechnic Institute
Troy, New York, USA 12180
Lgowdy@aol.com

Jon D. Erickson
Associate Professor of Ecological Economics
School of Natural Resources
University of Vermont
Burlington, Vermont, USA 05405
Jon.Erickson@uvm.edu

This paper discusses the major tenets of ecological economics – including value pluralism, methodological pluralism, and multi-criteria policy assessment. Ecological economics offers viable alternatives to the theoretical foundations and policy recommendations of neoclassical welfare economics. A revolution in neoclassical economics is currently taking place and the core assumptions of welfare economics are being replaced with more realistic models of consumer and firm behavior. But we argue that these new theoretical and empirical findings are largely ignored in applied work and policy applications in environmental economics. As the only heterodox school of economics focusing on the human economy both as a social system and as one imbedded in the biophysical universe, and thus both holistic and scientifically based, ecological economics is poised to play a leading role in recasting the scope and method of economic science.

*We would like to thank the following people for comments on an earlier draft: Jeroen C.J.M. van den Bergh, Peter Brown, Raluca Iorgulescu, Melinda Kane, Richard Norgaard, Frank Müller, Sarah Parrales, John Proops, Irmi Seidl, Barry Solomon.

1. Introduction

Ecological economics is poised to play a leading role in the on-going effort to reconcile economic theory and policy with accepted knowledge from other disciplines.[1] Neoclassical welfare economics[2] dominates economic policy discourse in the U.S. and Europe, but it is currently in a state of crisis over the dismantling of its two fundamental pillars (1) the theory of human behavior embodied in the axioms of consumer choice, and (2) the theory of production embodied in the notions of perfect competition and the marginal productivity theory of distribution. In spite of the great strides being made in expanding the scope of economic theory beyond these concepts, they are necessary foundations for neoclassical welfare economics and Pareto efficiency. Neoclassical theorists have by and large abandoned economic man and perfect competition, however, policy recommendations of economists are still based on these outdated representations of human behavior and commodity production. Neoclassical welfare economics continues to offer bad advice in dealing with some of the most pressing environmental and social issues faced in the twenty-first century, including growing income disparity, global climate change and biodiversity loss.

This paper discusses the major points of contention between neoclassical welfare economics and ecological economics. By virtue of being the only heterodox school of economics focusing on both the human economy as a social system, and as one constrained by the biophysical world, ecological economics is poised to play a leading role in recasting the scope and method of economic science. Ecological economic models of economic behavior encompass consumption and production in the broadest sense, including their ecological, social, and ethical dimensions, as well as their market consequences. As such it is a field of inquiry encompassing

much of contemporary neoclassical economics and heterodox schools of thought including behavioral economics, evolutionary economics, institutional economics, post Keynesian economics, radical economics and social economics.

Challenges to the mainstream are not new. The economic conception of human behavior has been criticized for over one hundred years. The difference today is that the most serious challenges to the standard welfare paradigm are coming from within the professional mainstream. We now have a cadre of Nobel Prize recipients who work largely outside the framework of the Walrasian general equilibrium model. It is increasingly recognized that understanding the context of economic activity requires familiarity with the relevant findings of related social and natural sciences.[3]

In the following pages, we first characterize the welfare foundations of neoclassical economic theory. We briefly present the basic neoclassical model of welfare economics discuss in detail the major points of contention between that approach and ecological economics, outlining for each issue the neoclassical position and the ecological economics alternative. We end with a call for a structuralist approach that categorizes consumption and production as a unified social and biophysical process.

2. Welfare economics

Ecological economists are continually challenged by two criticisms from neoclassical economists. The first is the "we know this already" argument that states: "The shortcomings of neoclassical economics you discuss are no longer valid. The 'new' neoclassical economics does not rely on the old axioms of consumer choice or the model of perfect competition." The second criticism is

eloquently summarized and dismissed by Bromley (1990, p. 99):

Indeed, one often encounters criticism because the full nature and scope of that alternative evaluated paradigm has not been presented. The refrain is familiar – "we (may) acknowledge that you are correct, but it is easy to criticize without offering a superior alternative. Until you can do that, we are free to pursue the conventional wisdom." This defense is disingenuous. To know that a critical aspect of economic thought is bogus and yet to swear fealty to it on the grounds that the burden of a new approach falls on those who expose its fallacies is irresponsible. Indeed, it borders on scholarly malfeasance to persist in passing off known fictions on the grounds that it is the problem of those who criticize also to create.

Regarding the "we know this already" defense, the field of economics has indeed made great strides in recent years in developing realistic models of economic behavior and production. Many of the challenges to neoclassical welfare economics discussed below are drawn from the "mainstream" literature. Nevertheless, economic policy recommendations remain firmly grounded in the two fundamental theorems of welfare economics. The first asserts that Pareto efficiency is implied by maximization of preferences under budget constraints and maximization of profits under given technology. The second follows that almost any Pareto efficient outcome can be supported with appropriate lump sum transfers.[4]

The stringent conditions for the achievement of Pareto efficient outcomes are well-known[5], yet this goal still dominates economic policy. As Lockwood (1987, p. 811) asserts about the second Pareto theorem:

It is no exaggeration to say that the entire modern microeconomic theory of government policy intervention in the economy (including cost-benefit analysis) is predicated on this idea.

The fundamental theorems of welfare economics are the foundation for the "market failure" approach to economic policy (Stiglitz 1994, 7). Pareto efficiency cannot be achieved if the "wrong" price signals are sent and it is a legitimate function of governments to correct these market failures. The goal of neoclassical welfare economic policy, whatever the specific problem

to be addressed, is to create the conditions of a competitive economy so as to achieve Pareto efficiency. Pareto efficiency may be expanded to include goods and services not traded in markets, or to account for un-priced externalities of consumption and production, simply by expanding the domain of prices. Methods to price externalities dominate applied work in environmental economics, where contingent valuation and other survey tools came into being in the 1970s in response to an expansion of cost-benefit analysis to environmental valuation. But here again, the solution to any problem faced – from global warming and biodiversity loss to terms of trade and income distribution – is a secondary outcome of "getting the prices right." By providing an apparently precise measure of social welfare the goal of Pareto efficiency has stifled discussion of distributional questions and social goals other than efficiency in allocation.

One of the most widely used tools in economic policy analysis is the potential Pareto improvement criterion. A *Pareto improvement* occurs when at least one person is made better off without making anyone else worse off. A *potential Pareto improvement* (PPI) involves a change that helps one person and harms another. Under the Kaldor-Hicks rule such a change is justified if the gainers from the change value their gains more than the losers value their losses, even if no actual compensation is made. Kaldor (1939) maintained that efficiency could and should be separated from questions about distribution--a problem best left outside the realm of economics. Problems with the PPI concept, and the separability assumption, arise from several sources. First, there exist insurmountable theoretical difficulties in identifying PPIs since the real income base is different before and after moving from one Pareto efficient point to another. This gives rise to a number of paradoxes in applying the Kaldor-Hicks criterion (Boadway 1974, Samuelson 1950, Scitovsky 1941) whose meaning is that one cannot compare two Pareto efficient outcomes

without making interpersonal comparisons of utility (Suzumura 1999).[6] Another source of problems for the PPI concept is a growing body of evidence contradicting the axiomatic model of consumer choice including the existence of endogenous preferences (Bowles 1998), the endowment effect (Knetsch 1989) and lexicographic ordering of preferences (Spash 2000). The axiomatic neoclassical model makes poor predictions of economic behavior (Henrich et al. 2001), calling into question not only the validity of PPI as a policy guide but also the notion of efficiency as conceived by welfare economics.

The theory of the consumer has been dominated by a goal of efficiency in utility maximization, supported by the notion of economic man and the underlying axioms of consumer choice (preferences are complete, reflexive, transitive, continuous and exhibit nonsatiation and diminishing marginal rates of substitution). Similarly, the theory of production has been dominated by a goal of efficiency in profit maximization, supported by the notion of perfect competition and the associated assumptions of firm behavior (independence of the actions of firms, no market power, constant returns to scale, perfect information, and no uncertainty).

In recent years, however, empirical and conceptual breakthroughs in consumer behavior and the theory of the firm have called into question the two props of neoclassical welfare economics. If these two foundations are given up, then the neoclassical welfare enterprise becomes unglued. There are, of course, disagreements among heterodox economists as to the importance of general equilibrium and Pareto efficiency. Nevertheless, the rejection of potential Pareto efficiency as the driver of economic policy is the defining characteristic of a number of heterodox schools of economics and this rejection can be the focal point for constructing a unified theory challenging neoclassical orthodoxy.

The example of climate change highlights the consequences of this fixation on efficiency and the resulting disconnect with other equally valid goals. A consensus of the international science and policy community on global climate change has emerged in the work of the Intergovernmental Panel on Climate Change (IPCC). IPCC scientists and policy-makers, across diverse disciplines, societies, and cultures, contend that humanity faces a significant increase in average global temperature during this century (IPCC, 2001A). Likely consequences include sea level rise, accelerated biodiversity loss, increased incidence of human disease, and rapid oscillations or "flips" between very distinctive climate regimes (IPCC, 2001B).

William Nordhaus' (1992, 2001) climate change model is the economic model most widely referred to by policy makers and has been extremely influential in justifying delays in greenhouse gas reductions. In the spirit of the neoclassical welfare model, the focus is on achieving an efficient outcome where marginal costs are equal to marginal benefits.[7] Distributional consequences, distinction between luxury vs. subsistence emissions, or increased risk to certain population segments are ignored. Other real-world difficulties such as transactions costs, pure uncertainty, and unfamiliarity with new situations (difficulties addressed in increasingly sophisticated ways by mainstream economists), are not taken into account.

The Nordhaus models assume certainty, constant returns to scale in production, all the axioms of consumer choice theory, smooth and continuous climate change impacts, and the existence of a social welfare function. They further assume that all human desires can be represented by a single omniscient consumer and that the world's economic systems can be represented by either a single global or suite of regional well-behaved production functions. Discounting the future is deemed appropriate with respect to estimating the value of a stable

climate in the distant future. Using society's scarce resources to moderate climate change is only justified if this results in a net increase in economic output. The theoretical justification for this policy is that it would result in a potential Pareto improvement.

Welfare economic models of climate change are much more than harmless academic exercises. They are widely cited by policy makers as scientific proof that aggressive policies to combat global warming are not cost effective. Organizations lobbying against action on global climate change, including the Cooler Heads Coalition and the National Consumer Coalition, cite Nordhaus' results to claim that "the economic effects of global warming will be modest" and that "implementing the Kyoto Protocol will be expensive and harmful to the economic wellbeing of the American people" (see www.globalwarming.org). Working within the framework of welfare economics, the only greenhouse consequences that count are those that affect GNP. And since the Nordhaus model relies on a surprise-free scenario of mild and predictable change, these effects are likely to be modest. This conclusion is not based on scientific objectivity, but rather on value-laden assumptions about discounting, technical change, and abatement costs at best reflecting the personal views of the analyst, and at worst the expectations of research sponsors (Chapman and Khanna, 2000). Ethical considerations are central to the global warming debate but they are set aside by neoclassical welfare theorists. Efficiency improvement is the overriding justification for policy intervention. This argument ignores the fact that existing prices and production depend on ethical factors such as income distribution, environmental policies, and the level of spending on social programs.

3. The approach of ecological economics

The major conceptual issues emerging in the ecological economics literature are value monism, the rational actor model, marginal analysis, the treatment of uncertainty, the role of efficiency in economic policy, and production as a social and physical process. These issues are critical to neoclassical welfare theory and its treatment of broad environmental and social goals. Below, each methodological pillar is characterized together with an alternative approach.

Table 1. *Key conceptual issues*

3.1 Value Monism

Value monism implies that all objects of utility have some common characteristic that allows them to be compared. Until the middle of the twentieth century there was a lively debate in economics about varieties of value including use versus exchange value, labor and energy theories of value, and so on. However, in the second half of the twentieth century the field of economics adopted a narrower notion of value limited to value in market exchange. Theories of *allocation* became entrenched in a model of human behavior assuming strict rationality and methodological individualism, an assumption that people make all allocation decisions independently of others. Isolated individuals at a point in time are assumed to fully reveal their exogenously determined preferences by weighing the costs and benefits of their consumption choices. People choose what they want and what they want is revealed by the choices they make.

The chain of reasoning in cost-benefit analysis goes from “human preferences” to “choices made in a market context” to the “market value of these choices”. It is assumed that

preferences for things such as biological diversity can be determined and made compatible with those for market goods. Ecological economists, in general, argue that the links in this chain of logic are weak. If human preferences are not accurately characterized by the axioms of consumer choice, then limiting choices to those made in a market context is unnecessarily restrictive.

Empirical results support a new direction for neoclassical welfare theory, a direction more consistent with its classical roots and broader conception of value. For example, contingent valuation surveys soliciting preferences for environmental goods consistently show that preferences for many environmental features are *lexicographic*, that is, not subject to trade-offs. Results from behavioral economics and psychology indicate the existence of *endowment effects* (people place higher values on things they already possess), *hyperbolic discounting* (people discount the near future at a higher rate than the distant future), *loss aversion* (people are much more averse to taking a loss as to enjoying an equal gain), the *part-whole* problem (people consistently place higher values on the sum of individual components of an object of utility than on the whole thing itself) and many other "anomalies" in consumer choice theory (Gintis, 2000).

Value monism lies behind standard cost-benefit analysis (CBA) which uses the notion of consumer surplus to judge the desirability of public policy choices. Findings of behavioral economics also cast doubt on the validity of the model of human behavior underlying cost-benefit approaches, including contingent valuation techniques. The endowment effect, for example, is one reason for the disparity between willingness-to-pay (WTP) measures of welfare changes and the typically higher willingness to accept (WTA) measures. Although WTP measures are almost universally used to measure environmental costs and benefits, WTA is theoretically more appropriate (Brown and Gregory, 1999). The existence of hyperbolic discounting casts doubt on

the validity of CBA as a measure of costs and benefits in the medium-to-distant future.

An emerging ecological economics alternative to CBA – and value monism in general – is multi-criteria decision aide (MCDA). As the name implies, this method of policy analysis takes into account a wide variety of relevant information. MCDA methods allow for the multiple dimensions typical in many decision-making problems to be chosen, evaluated, and weighed. Valuation can be based on diverse criteria such as efficiency, equity, or sustainability, allowing for a more realistic assessment of substitutability and complementarity between criteria. MCDA allows for ethical considerations, incongruities, and concern for the distant future in a democratic decision-making framework. Numerous case studies (Barton, 1996; O'Neill and Spash, 2000; Spash, 2000) employing MCDA methods also highlight the strength of incorporating qualitative information into an economic valuation framework. The approach is most developed in Europe (Spash and Carter, 2001), but is gaining ground in applied analysis in the U.S.

3.2 The Rational Actor Model

The starting point for economic analysis is a rational actor who makes decisions without social or environmental context. Game theory experiments and laboratory results involving actual human behavior have cast doubt on the general validity of the neoclassical rational actor. These findings indicate that preferences are endogenous, that is, they depend on social context, individual histories, and conscious preference development (Albert and Hahnel 1990, Bowles 1998). Although heroic attempts have been made to reconcile endogenous preferences with the rational actor model, these attempts require such restrictive and unrealistic assumptions as to make them of little practical use.

A growing body of empirical evidence shows that people bring a sense of fairness into allocation decisions. The social framework is an important factor in economic decision-making, and people make different decisions as members of a social group than they do as isolated individuals. For instance, people frequently cooperate with complete strangers even if they know they will never meet again (Bowles and Gintis, 2002). Fehr and Gächter (2002) present evidence for "altruistic punishment", when people will punish free-riders at significant cost to themselves. Results from the ultimatum and dictator games show clearly that "fairness" is just as important as "selfishness" in predicting human behavior (Fehr and Gächter, 2000; Gowdy, Iorgulescu and Onyeiwu, 2003; Henrich *et al*., 2001). Results from these and other games show that the rational actor model is not a good predictor of human behavior. Humans have more complex social behavior than other mammals and altruism (or any other trait) can be imposed by social sanctions. Cooperative action such as consensus building or collective decision-making cannot emerge in a decision framework where only individual preferences count. Human wants are socially contingent, not atomistic. Public policy should take into account market-derived costs and benefits, but it should also recognize that social welfare involves much more than market values.

The rational actor model also relates to controversy surrounding discounting the future. Much has been written about the limitations of using a market discount rate to place a value on future social and environmental gains or losses (Georgescu-Roegen, 1976; Price, 1993). First, a reasonable decision for an individual acting in a market setting at a particular point in time might be inappropriate for society as a whole. A good case can be made for not discounting the value of natural features essential for long-term human survival such as climate stability, biodiversity, and

uncontaminated soil, water and atmospheric systems. Secondly, even within the neoclassical "choice" context, a growing body of evidence suggests that a straight-line discount rate does not accurately reflect how individual humans actually view the future. Studies by economists and psychologists have shown that people exhibit hyperbolic discounting, where higher value is place on benefits delivered in the near term, followed by a sharp drop and flattening in the medium term so that the value of something stays fairly constant out into the distant future (Laibson 1997). A hyperbolic discount rate would have a dramatic effect on cost-benefit calculations of the future benefits of global climate stability or biodiversity. But taking into account the well-being of future generations involves much more than choosing the "socially correct" discount rate.

In new game theoretic and behavioral models of consumer behavior *Homo economicus* is being out-competed by other species of economic actors (Fehr and Gächter, 2000; Gintis, 2000; Kirman, 1989). Likewise, the neoclassical theory of the firm as independent of historical time, space, and the behavior of other firms is being replaced by more realistic models. Radner (1968) found that firm managers also have a sense of "fairness" when it comes to hiring and firing workers. The heart of the neoclassical theory of the firm, profit maximization, has failed the predictability test and is being replaced by more sophisticated models of cooperation, altruistic punishment, and other forms of strategic behavior. The barriers to adopting alternative views stem from their lack of congruity with the Walrasian welfare model.

3.3 Marginal Analysis

The notion of the margin embodies the basic assumptions of neoclassical economics including substitution, value monism, opportunity cost, and equilibrium. The limits to marginal analysis

are apparent in the case of ecosystem valuation (Gowdy 1997). Removing or adding one species to an ecosystem, for example, will affect other species and the general integrity of the system in unpredictable ways. Furthermore, the effects are likely to be different each time a change is made. For some species the changes may be small. Removing or adding other, keystone species, may flip the entire ecosystem to another state. Since biodiversity is characterized by "functional transparency" (Vatn and Bromley, 1994), the contribution of one feature of the ecosystem cannot be known until it is added or subtracted from the system. In addition, even in a market context, people consider some goods and services to be essential and not subject to trade-offs at the margin (*lexicographic* preferences).

Ingrained in the notion of the margin is a view of economic change as gradual, continuous and progressive. This is an incomplete view of evolutionary processes. Random, non-marginal shocks are a driving force in evolutionary change in economic as well as biological systems. The differences in the distribution of animals 64 and 66 million years ago cannot be understood without knowing a meteor hit the earth 65 million years ago drastically changing the climate. The current economic situation of the insurance and airline industries cannot be understood without taking into account the attack on the World Trade Center on September 11, 2001. Evolutionary change is characterized by hierarchies of selection, historical contingency and random events (O'Neill *et al*., 1986). In evolutionary systems it is impossible to change one thing and hold everything else constant. The existence of qualitative and non-marginal change is a powerful argument for rejecting microeconomic theory as a foundation for macroeconomic analysis (van den Bergh and Gowdy, 2003).

One ecological economics alternative to marginal analysis is complex adaptive systems

analysis (Gunderson *et al*., 1995; Holling *et al*, 2000; Scheffer *et al*., 2001). The current state of theory is summarized in the final report of the Resilience Project, designed around two general observations on socio-ecological biocomplexity. First, in response to problems and crises, current development policies may succeed in the near-term, but over time they lead to rigidity and myopia. Economic sectors become dependent, ecosystems become more fragile, and the public loses trust in governance. Second, complexity, diversity, and opportunity in complex regional systems emerge from a handful of critical variables and processes operating over distinctly different scales in space and time. One of the most powerful conclusions from the study of complex adaptive systems is that stocks and flows must be adequately differentiated. Recognition of natural capital depreciation as a negative flow would favor management regimes focused on natural capital resilience and the maintenance of broad systems boundaries capable of stability. This ecological economic vision is that resilience is a key feature of healthy ecosystems. The ability to adapt to unforeseen and unforeseeable changes is an important aspect of firm behavior and macroeconomic stability.

Another alternative to marginal analysis is the use of an expanded input-output model to examine the direct and indirect effects of large changes in economic structure. The IO Social Accounting framework allows for a much more flexible definition of economic activity than the commonly used general equilibrium concept found in most economic impact studies. Social accounting provides a systematic way to organize quantitative, as well as qualitative information and serves as the foundation on which to analyze and evaluate alternative non-marginal policy options and consider their impact in an ecological, economic, and social context (see Section 3.6 for further discussion).

3.4 The Treatment of Uncertainty

The treatment of uncertainty is a major issue dividing neo-liberal and heterodox economists. In the neoclassical synthesis following World War II the insights of Keynes' *General Theory* regarding the importance of uncertainty and "animal spirits" were discarded in favor of deterministic, micro-based theories of macroeconomic behavior. Neoclassical welfare economists also reduce uncertainty to risk to keep their general equilibrium models tractable. In a general equilibrium framework realism is sacrificed for formalism. In contrast, many ecological economists call for a structural approach where technical descriptions of particular economies are used for scenario analysis (Duchin, 1998). In terms of policy, one ecological economics alternative to assuming that uncertainty can be reduced to risk is the *precautionary principle* (Ciriacy-Wantrup, 1952) which suggests that we should err on the side of caution in the face of uncertainty.

Embracing uncertainty leads to a focus on process over outcome driven decisions. The majority of decision models in economics are built around the notion of directing a system toward an expected optimal outcome, with little attention to the path to optimality. For instance, the common practice in dynamic allocation problems is to assume away uncertainty, calculate a steady-state optimum, and specify a most-rapid-approach path (MRAP) to this carefully constructed goal. In contrast, ecological economics has supported a co-evolutionary, systems view of uncertainty and dynamic change. Coevolution is a model that by its nature cannot predict or be operationalized as conveniently as a utility maximization problem. Coevolution offers a view of the complex social-natural-physical system, providing insight into how to

structure our individual and societal choices. For example, Norgaard (1994) has investigated agricultural development in the Amazon for lessons from a coevolutionary perspective. He argues that applying presumably universal concepts of Western agriculture and a global market to a tropical ecosystem and culture has been a "resounding failure," while traditional knowledge and cultures, which coevolved with this specific ecosystem, have "repeatedly proven more reliable" (1994, p. 121). Recognizing an underlying coevolutionary process between social and natural systems can be helpful in formulating lessons to help guide social processes (Erickson, 1999). Some lessons include: (1) Experiment on a small-scale and monitor the evolutionary chain of events; (2) Experiments with long-time commitments should be avoided; (3) Diversity in coevolving systems is inherently good; without it there is likely stagnation; (4) Emphasize evolutionary processes rather than mechanical fixes.

3.5 Efficiency, Stability and Equity: Market Preferences and Social Values

Neoclassical policy is concerned almost exclusively with efficiency in allocation. Production is separated from consumption so that efficiency in production is equivalent to maximizing social welfare. The goal of the firm of reducing costs has been expanded to become the goal of the macroeconomy and human society as a whole. As Bromley (1990) argues, this goal is ideological not scientific, that is, it is a value judgment that colors economic analysis. As formulated by standard welfare theory, the goal of economic efficiency has no logical claim to objectivity. Without interpersonal comparisons of utility, neoclassical welfare economists have little to say about the general desirability of alternative social states (Suzumura, 1999). When Marshall and Pigou wrote about the general well-being of people, they were free to argue for policies that

promoted certain social states. Sometime after World War II, "economics ceased to be about people and their relationships to one another as it had been before, and *began to be about commodities*" (Bromley, 1990, p. 91). Narrowing the choice of economic policy to the realm of efficiency leads to the conclusion that the market mechanism should drive social choices. Yet the market is not well suited to make social choices. Market outcomes only reflect the consumption decisions of millions of isolated individuals, not human choice as a social phenomenon. Again, the current literature on endogenous preferences calls into question the rational choice model.

Ecological economics distinguishes between individual values and social choices. As Vatn and Bromley (1994, p. 142) write, "Just as *preferences* count for consumer choice within constraints, *judgments* can be used as the driving concept for citizens choosing basic norms or modifying existing constraints." This is where the importance of institutions manifests itself. Mary Douglas (1986, p. 124) concludes, "The most profound decisions about justice are not made by individuals as such, but by individuals within and on behalf of institutions."

3.6 The Physical Nature of Production

Neoclassical "production theory" is not a theory of production, but rather a theory of allocation of a fixed amount and given distribution of production inputs. Likewise, neoclassical "growth theory" is not a theory of growth, but rather a theory of the optimal allocation of input growth rates. Pasinetti (1977) wrote of the neoclassical theory of production:

> The model clearly has nothing whatsoever to do with the phenomenon of production. The problem it deals with is optimal allocation, through exchange, of a certain initial endowment and distribution of resources.

Ecological economics began with the insight that the economy must be in a materials balance between raw materials entering the process and waste leaving (Ayres and Kneese, 1969; Boulding, 1966; Daly, 1977; Faber, Manstetten and Proops, 1996; Georgescu-Roegen, 1976; Mayumi, 2001). A well-developed alternative to the neoclassical production function is input-output (IO) analysis. Dynamic input-output models may be cast in an equilibrium framework but the IO and Computable General Equilibrium (CGE) approaches are distinctly different. An IO table can be seen as snapshot of a particular economy at a particular point in time. It need not be interpreted as an equilibrium model in the sense of optimization, stability, or having a tendency to return to equilibrium if disturbed. IO analysis has been criticized for its fixed coefficient assumption, but a growing body of evidence suggests that this is a more accurate representation of actual production than the twice differentiable isoquant of neoclassical theory.[8] Ecological economists have made progress in describing the relationship between economic activity, social institutions and environmental features using input-output analysis and systems of social accounts. The extended version of input-output analysis, the Social Accounting Matrix (SAM), gives a concise view of economic activity and the interconnections between economic sectors, household characteristics, and social institutions. A further extension with natural resource accounts (NRAs) provides for a supporting environmental/natural resource base in terms of inputs and outputs. Figure 1 highlights matrices of interdependencies in a SAM-NRA model, corresponding to the common ecological economics framework of the economy supported by a social framework further supported by an ecosystem base. Economic, social, and environmental transactions are captured by IO, SAM, and NR accounts, respectively. With a quantitative description of these flows, a SAM-NRA model can be used to analyze complex

scenarios of economic, social, and environmental change.

Figure 1. *An ecological economic view of nested systems of accounts*

4. Conclusion

It is often argued that economists must follow the narrow path of neoclassicism because "there is no well-developed alternative". As outlined above, however, the alternative is there but it requires abandoning the flawed "grand unification theory" of neoclassical welfare economics. Rather than a Theory of Everything we appear to need Theories of Theories of Things. Understanding the human economy requires an appreciation of the importance of hierarchies, contingency and self-organization, and recognition of the fragility of market economies in biophysical space and cultural specificity.

The policy dilemma is this: given the fact that a significant part of our well-being is derived from money flows from the market economy – an economy isolated from direct influences of the natural world – how do we create policies to preserve the life support systems of the planet? Ecological economics is still struggling with this question and there are no satisfactory answers yet. But of all the conventional and heterodox schools of economic thought, ecological economics is the only one poised to address the problems of human survival in the coming centuries. It is the school of thought that explicitly recognizes the interconnections and interdependence of the economic, biophysical and social worlds. We offer no grand theory, but rather a flexible approach recognizing the uniqueness of specific cultures and ecosystems. Norgaard (1989) called for a pluralism of approaches to economic theory and policy in the first

issue of *Ecological Economics* more than a decade ago. Ecological economics is barely ten years old and it has not yet coalesced into a coherent school of thought, but it is a leading contender among heterodox schools to become a comprehensive alternative to neoclassical orthodoxy.

Bibliography

Albert, M. and R. Hahnel. 1990. *A Quiet Revolution in Welfare Economics*, Princeton, NJ, Princeton University Press

Arrow, K. and Debreu, G. 1954. Existence of an equilibrium for a competitive economy, *Econometrica*, vol. 22, 265-90

Ayres, R. U. and Kneese, A.V. 1969. Production, consumption and externalities, *American Economic* Review, vol. 59, 282-97

Barton, H. 1996. The Isle of Harris Superquarry: concepts of the environment and sustainability, *Environmental Values*, vol. 5, 97-122

Bergh, C. J. M. van den. 2000. Ecological economics: themes, approaches, and differences with environmental economics, *Regional Environmental Change*, vol. 2, 13-23

Bergh, C. J. M. van den and Gowdy, J. 2003. The microfoundations of macroeconomics: an evolutionary perspective, *Cambridge Journal of Economics*, vol. 27, 65-84.

Boadway, R. 1974. The welfare foundations of cost-benefit analysis. *Economic Journal*, vol. 47, 926-939

Boulding, K. 1966. The economics of the coming spaceship Earth, in *Environmental Quality in a Growing Economy*, Baltimore, MD, Johns Hopkins Press

Bowles, S. 1998. Endogenous preferences: the cultural consequences of markets and other economic institutions, *Journal of Economic Literature*, vol. 36, 75-111

Bowles, S. and Gintis, H. 2002. Homo reciprocans, *Nature*, vol. 415, 125-127

Bromley, D. 1990. The ideology of efficiency: searching to a theory of policy analysis, *Journal of Environmental Economics and Management*, vol. 19, 86-107

Brown, P. 2001. *The Commonwealth of Life*, Montreal, Canada, Black Rose Books

Brown, T. and Gregory, R. 1999. Why the WTA-WTP disparity matters, *Ecological Economics*, vol. 28, 323-335

Chapman, D. and Khanna, N. 2000. Crying no wolf: why economists don't worry about climate change, and should, *Climatic Change*, vol. 47, 225-232

Christensen, P. 1989. Historical roots for ecological economics - biophysical versus allocative approaches, *Ecological Modeling*, vol. 38, 47-73

Ciriacy-Wantrup, S. V. 1952. *Resource Conservation: Economics and Policies*, Berkeley, CA, University of California Division of Agricultural Sciences

Corrado, C. and Mattey, J. 1997. Capacity utilization, *Journal of Economic Perspectives*, vol. 11, 151-67

Costanza, R., Daly, H. E., and Bartholomew, J. 1991. Goals, agenda, and policy recommendations for ecological economics, in Costanza, R. (ed), *Ecological Economics: The Science and Management of Sustainability*, New York, NY, Columbia University Press

Daly, H. E. 1977. *Steady State Economics*, San Francisco, CA, W. H. Freeman

Douglas, M. 1986. *How Institutions Think*, Syracuse, NY, Syracuse University Press

Duchin, F. 1998. *Structural Economics*, Washington, DC, Island Press

Erickson, J. D. 1999. Ecological economics: an emerging alternative to environmental economics, in Chapman, D., *Environmental Economics: Theory, Application, and Policy*, New York, NY, Addison Wesley Longman HarperCollins

Faber, M., Manstetten, R. and Proops, J. 1996. *Ecological Economics: Concepts and Methods*, Cheltenham, UK, Edward Elgar

Fehr, E. and Gächter, S. 2000. Cooperation and punishment in public goods experiments, *American Economic Review*, vol. 90, 980-994

Fehr, E. and Gächter, S. 2002. Altruistic punishment in humans, *Nature*, vol. 415, 137-140

Geanakoplos, J. 1987. Arrow-Debreu model of general equilibrium, in *The New Palgrave Dictionary of Economics*, J. Eatwell, M. Milgate and P. Newman (eds), vol. 1, London, Macmillan

Georgescu-Roegen, N. 1976. *Energy and Economic Myths*, Oxford, Pergamon Press

Gintis, H. 2000. Beyond *Homo economicus*: evidence from experimental economics, *Ecological Economics*, vol. 35, 311-322

Gowdy, J. 1997. The value of biodiversity: Markets, society and ecosystems, *Land Economics*, vol. 73, 25-41

Gowdy, J., Iorgulescu, R., Onyeiwu, S. 2003. Fairness and retaliation in a rural Nigerian village, *Journal of Economic Behavior and Organization*, vol. 52, 469-479.

Gunderson, L. H., Holling, C. S. and Light, S. S. (eds). 1995. *Barriers and Bridges to the Renewal of Ecosystems and Institutions*, New York, NY, Columbia University Press

Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., and McElreath, R. 2001. Cooperation, reciprocity and punishment in fifteen small-scale societies, *American Economic Review*, vol. 91, 73-78

Holling, C. S., Folke, C., Gunderson, L. and Maler, K. G. 2000. *Resilience of Ecosystems, Economic Systems, and Institutions*, Final Report submitted to the John D. and Catherine T. MacArthur Foundation, April 30 (www.resalliance.org/reports/)

Howarth, R. 2001. Intertemporal social choice and climate stabilization, *International Journal of Environment and Pollution*, vol. 15, 386-405

IPCC, 2001A, *Climate Change 2001: The Scientific Basis - Summary for Policymakers*, Cambridge, UK, Cambridge University Press

IPCC, 2001B, *Climate Change 2001: Impacts, Adaptation and Vulnerability - Summary for Policymakers*, Cambridge, UK, Cambridge University Press

Kaldor, N. 1939. Welfare propositions and interpersonal comparisons of utility, *Economic Journal*, vol. 49, 549-52

Kirman, A. 1989. The intrinsic limits of modern economic theory: the emperor has no clothes, *Economic Journal*, vol. 99, 126-139

Knetsch, J. 1989. The endowment effect and evidence of nonreversible indifference curves, *American Economic Review* 79, 1277-1284

Laibson, D. 1997. Golden eggs and hyperbolic discounting, *Quarterly Journal of Economics* 112, 443-477

Laitner, J., DeCanio, S., and Peters, I. 2001. Incorporating behavioral, social, and organizational phenomena in the assessment of climate change mitigation options. E. Jochem et al. (editors) In *Society, Behavior, and Climate Change Mitigation*, Dordrecht, Kluwer.

Lockwood, B. 1987. Pareto efficiency, in *The New Palgrave Dictionary of Economics*, J. Eatwell, M. Milgate and P. Newman (eds), vol. 3, London, Mcmillan

Martinez-Alier, J. 1987. *Ecological Economics: Energy, Environment and Society*, Cambridge, MA, Blackwell

Mayumi, K. 2001. *The Origins of Ecological Economics: The Bioeconomics of Georgescu-Roegen*. London, Routledge

Miller, R. 2000. Ten cheaper spades: Production theory and cost curves in the short run, *Journal of Economic Education*, Spring, 119-130

Nordhaus, W. 1992. An optimal transition path for controlling greenhouse gases, *Science*, vol. 258, 1315-1319

Nordhaus, W. 2001. Global warming economics, *Science*, vol. 294, 1283-84

Norgaard, R. 1989. The case for methodological pluralism, *Ecological Economics*, vol. 1, 37-58

Norgaard, R. 1994. *Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future*, London/New York, Routledge

O'Neill, J. and Spash, C. 2000. Conceptions of value in environmental decision-making, *Environmental Values*, vol. 9, 521-535

O'Neill, R., De Angelis, D., Waide, J. and Allen, T. 1986. *A Hierarchical Concept of Ecosystems*, Princeton, NJ, Princeton University Press

Pasinetti, L. 1977. *Lectures on the Theory of Production*, New York, NY, Columbia University Press

Price, C. 1993. *Time, Discounting and Value*, Cambridge, MA, Basil Blackwell

Proops, J. 2002. Identification of ecological economics issues, *Encyclopedia of the Life Sciences*, UNESCO, Paris

Radner, R. 1968. Competitive equilibrium under uncertainty, *Econometrica*, vol. 36, 31-58

Samuelson, P. 1950. Evaluation of real national income, *Oxford Economic Papers*, vol. 2, 1-29

Scheffer, M., Carpenter, S., Foley, J. A., Folke, C. and Walker, B. 2001. Catastrophic shifts in ecosystems, *Nature*, vol. 413, 591-596

Scitovsky, T. 1941. A note on welfare propositions in economics, *Review of Economic Studies*, vol. 9, 77-88

Söderbaum, P. 2000. *Ecological Economics*. London, Earthscan

Spash, C. 1999. The development of environmental thinking in economics, *Environmental Values*, vol. 8, 413-435

Spash, C., 2000. Ecosystems, contingent valuation and ethics: the case of wetland re-creation, *Ecological Economics*, vol. 34, 195-215

Spash, C. 2002. *Greenhouse Economics: Values and Ethics*, London, Routledge

Spash, C. and Carter, C. 2001. *Environmental Valuation in Europe: Findings from the Concerted Action*, Cambridge Research for the Environment, Policy Research Brief, number 11, University of Cambridge, UK

Siglitz, J. 1994. *Whither Socialism?* Cambridge, MA, MIT Press

Suzumura, K. 1999. Paretian welfare judgements and Bergsonian social choice, *Economic Journal*, vol. 109, 204-221

Turner, R. K. 1999. Environmental and ecological economics perspectives, in Bergh, J. van den (ed), *Handbook of Environmental and Resource Economics*, Cheltenham, UK, Edward Elgar

Vatn, A. and Bromley, D. 1994. Choices, without prices, without apology, *Journal of Environmental Economics and Management*, vol. 26, 129-48

Wright, E. and Erickson, J. D. 2003A. Incorporating catastrophes into integrated assessment: science, impacts, and adaptation, *Climatic Change*, forthcoming

Wright, E. and Erickson, J. D. 2003B. Climate variability, economic adaptation, and investment timing, *International Journal of Global Environmental Issues*, forthcoming

Table 1. *Key conceptual issues*

Conceptual Issue	Neoclassical Welfare Economics	Ecological Economic Alternative
Value Monism	Reduce value to commensurable monetary units; utility function.	Separate value into incommensurable categories; multi-criteria assessment.
The Rational Actor	Individual consumers and firms at the center of analysis.	Analyze humans as social actors, consumers versus citizens.
Marginal Analysis	Comparative statics of marginal changes.	Recognizes discontinuous change and total effects
Evolutionary Change	Evolution as constrained optimization, survival of the fittest view of market outcomes, individual based selection.	Importance of contingency, historical accidents, path dependency. Considers altruism and group selection as well as selfishness.
Uncertainty	Reduce uncertainty to risk. Market outcome focus to decision-making.	Precautionary principle to deal with pure uncertainty. Process-oriented, coevolutionary focus to decision-making.
Decision Criteria	Efficiency as the sole criterion, usually based on potential Pareto improvements.	Equity, stability, resilience of environmental and social systems.
Production Process	Theory of allocation of fixed resources; production function.	Production as a biophysical process, thermodynamics; extended input-output approach, joint production of goods and polluting wastes.
Discounting	Straight-line discounting of future costs and benefits.	Recognizes the difference between individual and social valuation of the future; hyperbolic discounting.

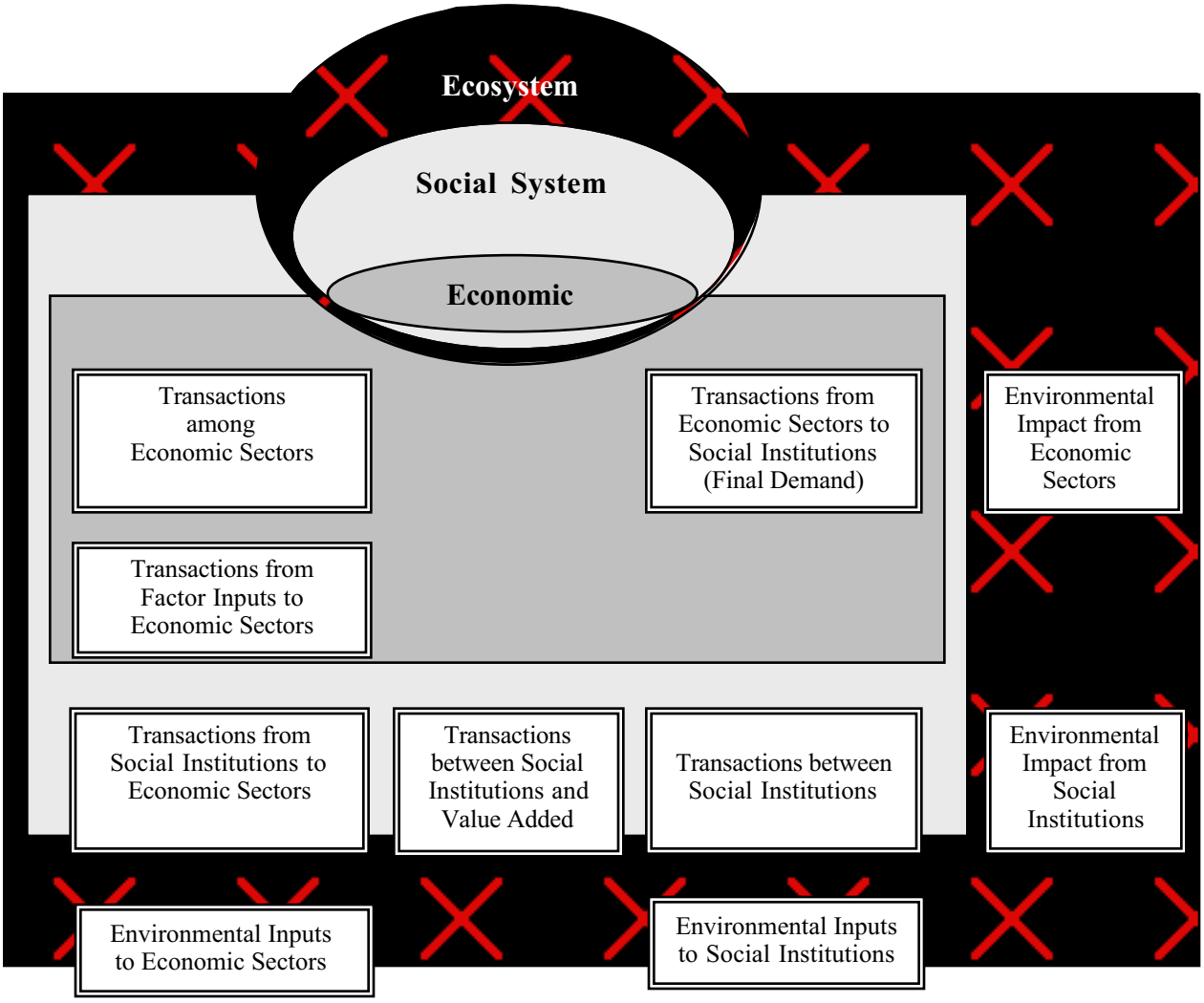

Figure 1. *An ecological economic view of nested systems of accounts*

Footnotes

1. There is now a large literature on the history and approach of ecological economics. We have especially benefited from the contributions of van den Bergh (2000), Brown (2001), Christensen (1989), Costanza et al. (1991), Daly (1977), Martinez-Alier (1987), Mayumi (2001), Norgaard (1994), Proops (2002), Söderbaum (2000), Spash (1999), and Turner (1999).

2. The field of economics is changing so rapidly that the term "neoclassical" no longer represents the monolithic core it once did. We use the term "neoclassical welfare economics" to refer to the Walrasian model based on self-interested exogenous preferences and complete and costless contracting. Related to this point, we also acknowledge that many environmentally oriented economists and ecologists are using ecological rather than economic models. These researchers are less concerned about what is happening in economics and are making their own important contributions.

3. 2002 Nobel laureate in Economics, the psychologist Daniel Kahneman, was cited by the Nobel committee for his work demonstrating "…how human decisions may systematically depart from those predicted by standard economic theory."(Press release, Royal Swedish Academy of Sciences, October 9, 2002)

4. Most economic textbooks overstate the Second Fundamental Theorem. It does not say that any Pareto outcome can be *obtained* through the market. It is well-known that competitive equilibrium is rarely unique and frequently unstable, thus the Second Welfare Theorem does not

provide a justification for many of the "free market" approaches advocated by economists. (Bryant 1994)

5. The most complete discussion of the existence of general equilibrium was that of Arrow and Debreu (1954) who based their proof on Kakutani's fixed point theorem. The Arrow-Debreu model is individualistic, assumes rational expectations, all agents are price-takers, there is no asymptotic information, and money does not appear in the model. Although the Arrow-Debreu general equilibrium model is still cited as proving the desirability of competitive markets, Arrow has always maintained that the model is most useful in demonstrating the inefficiency of real-world markets (Geanakoplos, 1987; Stiglitz 1994).

6. The basic problem with determining potential Pareto improvements is that any particular Paerto optimum is dependent on some initial allocation of resources. Consider two Pareto efficient allocations **A** and **B** on a production possibilities frontier. Point **A** is optimal given some social welfare function based on a particular initial allocation of resources. Point **B** is optimal given a social welfare function based on some other initial allocation of resources. The existence of these different bases with different relative prices and different marginal rates of substitution give rise to the variety of paradoxes plaguing welfare economics. Because of these it is impossible to unambiguously identify PPIs in a pure barter economy, much less in a real market economy. The problems pile up when the PPI concept is used to judge intergenerational welfare improvements.

7. Detailed critiques of Nordhaus' model are given by Wright and Erickson (2003A, 2003B), Spash (2002), and Howarth (2001). An excellent analysis of the welfare theory behind neoclassical climate change models is given by Laitner, DeCanio and Peters (2001).

8. See Miller (2000) for a concise summary of the evidence for horizontal average variable cost curves and other evidence that firms use the *services* of capital and labor in fixed proportions even thought capital stock is fixed. Recent U.S. studies done by the Federal Reserve Banks and the Bureau of the Census document the ubiquity of fixed proportions in manufacturing (Corrado and Mattey, 1997). These studies found that plants typically change production levels by increasing or decreasing all inputs together by shutting down or re-opening entire plants or portions of plants, not by changing the number of hours worked.