The current orthodoxy in Environmental Economics: A review and a challenge

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Abstract

Perhaps the most noticeable feature in the burgeoning literature devoted to environmental economics has been the primacy of the neo-classical model (or what is often referred to as the "market solution"). This strategy, embodying individual property rights and the use of the private discount rate, assumes that market signals will elicit satisfactory solutions to the problems of excessive resource depletion and pollution. It has been argued, however, that methodological problems have undermined the feasibility of the orthodox approach to environmental economics. Furthermore, it has been suggested that this approach is fundamentally anthropocentric in character and therefore unsuited to resolving problems which are seen to be essentially ecological in character. Accordingly, this paper seeks to review the neo-classical model of environmental economics and outlines the challenges posed by the alternative strategies of sustainable development and ecological economics, as well as some of the conceptual problems which still remain to be resolved.

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1 Introduction

The classical school of economics, which is popularly associated with the work of Adam Smith, John Stuart Mill and David Ricardo, emerged as the dominant form of economic orthodoxy during the late eighteenth and early nineteenth centuries. The classical economists were concerned with macroeconomic issues – the workings of the capitalist economy as a whole, especially its growth over time – and this approach shaped the development of economic thought throughout much of the nineteenth century. After the 1870s, however, classical economics (or, more properly, classical political economy) turned its attention to detailed studies of the decision-making processes of individuals and individual enterprises – that is, a consideration of microeconomic issues. This shift in focus was broad enough and deep enough to warrant a new name for classical economics – neo-classical economics – and it continues to hold sway as the fundamental methodology of mainstream economists down to the present day (Katouzian, 1980).

It is one of the major ironies of modern economic history that while the emergence of microeconomics was widely accepted as a major step forward in the evolution of economic thought, it carried with it a significant step backward in terms of humanity's concern for the environment. While it is acknowledged that classical economists such as Malthus, Smith and Ricardo paid some attention to environmental constraints on economic growth – primarily through the scarcity of land which underlies the theory of diminishing returns (Oser & Blanchfield, 1975) – this concern almost completely disappeared in the wake of the "marginalist revolution" of the 1870s. Thus Perrings (1987: 153) has pointed out that: "Despite the fact that the scarcity of resources was enshrined as a *raison d'être* of the theory of resource allocation by Robbins (1932), it has disappeared as a meaningful concept from modern dynamic general equilibrium theory." Neo-classical economists from

Marshall onwards have either assumed away the environment or, at best, assumed an unlimited supply of substitutable resources. Furthermore, Martinez-Alier (1987) has argued that, with a few notable exceptions such as Marx (1906) himself, Podolinsky and Bahro (1986), Marxian economists also tended to shun the environmental movement.

For almost a hundred years, then, economists of whatever ideological conviction more or less ignored the impact of economic activities on the environment and the environmental constraints on economic growth and development. Only during the last three decades have economists shown a renewed interest in the relationship between economic activity and the environment. Broadly speaking, while environmentalists have taken a pessimistic view, based on uncontrolled population growth, the rapid depletion of natural resources and the effects of pollution, economists have tended to be more optimistic. With some notable exceptions, economists have argued that shifts in free market prices, the imposition of taxes and/or subsidies and technological innovation can be relied upon to elicit satisfactory solutions. In short, environmentalists have condemned what they have called the "reckless growth orientation" of modern economics (Meadows *et al.*, 1972), while the neo-classical economic approach to the solution of environmental problems has been dominated by the so-called "market solution".

If, however, it is believed that the "market solution" is not only inappropriate but fundamentally flawed, then the resultant macroeconomic policies based on this approach will inevitably fail to achieve the desired environmental objectives. Accordingly, this paper seeks to review the neo-classical orthodoxy in environmental economics and, in the process, highlight the shortcomings of the so-called "market solution". The challenges posed by the alternative approaches of sustainable development and ecological economics are outlined, together with a brief comment on some of the conceptual problems which still remain to be resolved.

2 Neo-classical economics and the environment

At the outset, it should be stressed that the two broad categories of environmental problems that have captured the attention of neo-classical economists – the depletion of natural resources and pollution – are not independent problems. Through the first law of thermodynamics – the physical law of the conservation of mass – materials extracted from the environment must eventually be returned there in approximately equal mass (Perrings, 1986). Thus the rate of natural resource usage has necessary implications for the rate of production of wastes and, where these are not in assimilable amounts or forms, for pollution. Curiously, the natural affinity of resource depletion and pollution, readily recognised by environmentalists, has rarely been reflected in the literature on environmental economics. Furthermore, economists have traditionally drawn a distinction between renewable and non-renewable resources, although the analysis is fundamentally similar. With non-renewable natural resources, the availability of a finite stock in the future, necessitates the use of the discounting technique to determine the optimal depletion path, whereas in the case of renewable natural resources, it is necessary to take into account the natural growth rate of resource stocks.

2.1 Economics of resource depletion

The origins of the modern theory of resource depletion can be traced back to an article published by Hotelling in 1931. Hotelling's use of discounting, at a time when it was generally frowned upon, probably explains why his work was largely ignored for more than thirty years. Prior to the 1960s, the essential thrust of neo-classical economics was highly critical of the notion of discounting the future; amongst the sternest critics of discounting were Ramsay (1928), Pigou (1932) and Harrod (1948). By the early 1970s, however, at least two factors served to reverse this critical stance: the emergence of a strong technological optimism among economists (which followed in the wake of the Club of Rome debate) and the change in the perception of the role of the state following the apparent failure of Keynesian orthodoxy (Perrings, 1987). These developments not only gave many economists sufficient reassurance to accept discounting, but also to prefer the private (as opposed to the social) discount rate. Thus, the way was cleared for the resuscitation of Hotelling's work and for the formulation of a "market solution" to the problem of resource depletion.

The key concept in the Hotelling theory of optimal resource depletion is that "depletion is an activity in which the opportunity cost of production today is production at some future date" (Perrings, 1987: 133). In a perfectly competitive world, where the social rate of discount is equivalent to the market rate of interest, Hotelling believed that there would not be an over-rapid extraction of resources. Furthermore, the so-called "Hotelling rule" stipulates that for an individual (or firm) to be indifferent between extracting a resource (with zero extraction costs) in one period or the next, the sale price of that resource in the second period should be greater than its price in the first period by a factor equal to the expected rate of return obtainable from holding any other asset. In recent years, Hotelling's analysis has been extended to incorporate the problem of common property resource exploitation in imperfect markets (Dasgupta & Heal, 1974; Khalarbari, 1977), while related studies have focused on the issues of technological change and uncertainty (Kamien & Schwartz, 1978; Dasgupta & Stiglitz, 1981). Nevertheless, the economic question has remained fundamentally the same: what is the optimal rate of natural resource exploitation?

Two issues – common property and uncertainty – are important ones which require brief elaboration. Economists have long recognised that there is a strong tendency towards the over-exploitation of common property resources, such as the ocean's fish stocks (Gordon, 1954). Because of the lack of private ownership, it is rational for an individual (or firm) to exploit common property resources as far as possible; and if all interested individuals (or firms) follow the same private cost-benefit logic, then society as a whole is likely to be worse off. This problem – where individual rationality can lead to collective failure – is a classic example of the famous "prisoner's dilemma" game (Dryzek, 1987: 128-132). This is the kind of perverse situation which Hardin (1968) referred to as "the tragedy of the commons". The appropriate response, it is argued, is not to convert common property into private property (which would be impossible for practical reasons), but to convert it into public property so that exploitation can be regulated by legislation and/or international agreement (Seneca & Taussig, 1979). Not surprisingly, the efficacy of this solution, based on international co-operation, has been seriously questioned.

With regard to the issue of future uncertainty in resource depletion, it is necessary to take into account the real-world problems surrounding reliable knowledge about the precise size of the natural resource reserves available for future use and future prices (and profits) – an assumption underlying virtually all analyses based on the Hotelling model. Furthermore, the very dependence of extractive industries on exactions from the environment makes them particularly prone to uncertainty (Perrings, 1986). The problem here is not one of risk or "probabilistic uncertainty", which, in many cases, may be dealt with satisfactorily by trading on contingent markets, but uncertainty in the sense of the impossibility of knowing the future (Knight, 1921; Shackle, 1955). After all, resource extraction at some future time not only depends on present economic activities, but on a wide range of unobserved environmental effects that remain external to the price system (Perrings, 1987). In the face of such uncertainty, Gregory (1979: 24) has argued that "a known certain level of current profits must typically be preferred to uncertain future profits with the same expected present value". Thus the result is likely to be an excessively high private discount rate which will raise the current rate of resource depletion. And, as Perrings (1987: 136) has noted, the problem is aggravated further because "a high discount rate that raises the current rate of exploitation of environmental resources will be associated with increasing levels of disposals, increasing environmental change, increasing uncertainty, and consequent higher discount rates in the future." Thus the likelihood of a high discount rate results in a problem of excessive resource depletion which feeds upon itself and, of course, complicates the related problem of environmental pollution.

If it is accepted that current rates of resource depletion are likely to be excessively high, it is argued that resource use can be curbed in various ways. In the case of private natural resources, the solution traditionally favoured by economists is to raise resource prices by the imposition of a tax. This is equivalent to adjusting the market price to equal the shadow price implied by society's evaluation of the actual or future scarcity of the resource. An alternative solution is the payment of subsidies for facilities which promote the conservation of resources (Baumol & Oates, 1975). In its direct effects, the payment of subsidies replicates the tax solution, but the former provides little or no stimulus to technological change which, it is alleged, would be prompted by higher resource prices. It must be stressed that the imposition of such taxes and/or subsidies does not mark a complete return to the Pigouvian tradition of state intervention which rested on the assumption that the state had privileged knowledge which allowed it to impose appropriate remedies (Oser & Blanchfield, 1975). The use of taxes and/or subsidies is merely intended to facilitate, rather than undermine, the so-called "market solution".

2.2 Economics of pollution

Whereas most of the work on environmental economics has focused on the issue of limited natural resources, the more recent literature has argued that the major problem has been the pollution associated with waste disposal (Seneca & Taussig, 1979). Given the conservation of mass principle embodied in the first law of thermodynamics, the intensification of the pollution problem is usually explained as an inevitable by-product of both demographic increase and industrial growth. However, Perrings (1987: 43) has pointed out that the problem has been compounded by the very nature of the modern production process: "The conversion of non-durable, non-toxic raw materials into highly durable, highly toxic waste products."

In the context of environmental economics, pollution is traditionally regarded as a classic example of a negative externality – that is, an example of the divergence between private and social costs. Although the economic analysis of externalities – sometimes referred to as "spillovers", "neighbourhood effects" or "third-party effects" – dates back to Marshall and Pigou, the modern theory of external effects originated with Meade (1952) and Scitovsky (1954). Because individuals (or firms) in a competitive market economy respond only to private costs and profits, they will ignore the external (or social) costs of pollution. Hence, externalities such as pollution are usually regarded as an example of market failure because market prices cannot be regarded as an accurate reflection of the social value of an activity. A complicating factor arises from the fact that most environmental goods have the characteristics of a "public good". While private goods are supplied on an exclusive basis, public goods are characterised as being "non-excludable" and "non-rival", for example, clean air and unpolluted oceans. Even in a perfect market, public goods will tend to be underprovided because, generally speaking, payment cannot be enforced where a consumer cannot be excluded. This is the well-known "free-rider" problem (Dryzek, 1987). For these two reasons – pollution is an externality and often affects public goods – the competitive market system cannot be relied upon to establish the socially optimal levels of environmental quality.

The solutions proposed in the neo-classical theory of optimal pollution control are many and varied, and have often provoked considerable controversy. Given the complexity of effective pollution control, Barbier (1989: 79) concluded that: "It is not surprising that a mixed bag of pollution control policies – including environmental standards, pollution taxes, dumping licences and charges, marketable permits, abatement subsidies and planning zones – is resorted to." Apart from a cursory reference to the so-called "common law" solution

– which most authorities dismiss because, according to Seneca & Taussig (1979: 67), "it is generally impossible to prove that a single party is responsible for a given amount of damage to another" – most economists have recommended either the imposition of Pigouvian taxes or the establishment of environmental standards. Where the social costs of production exceed the private costs, the imposition of a tax equivalent to the additional social costs leads to the redefinition of private costs to incorporate negative external effects. Thus the external effect is internalised. The obvious practical difficulty encountered in this solution is the formidable task of measuring and valuing the damage costs of pollution (Perman *et al.*, 2003).

Given the complexities of implementing the tax solution, some have favoured the establishment of environmental standards. In principle, the setting of standards can be an alternative means of achieving the social optimum which the tax solution seeks, although the problems of determining optimal standards and of enforcement are well documented (Thomas & Callan, 2007). Generally speaking, the tax solution is seen to offer one clear economic advantage over the enforcement of standards. A tax levied on the emission of pollutants gives producers an incentive to reduce their output of pollutants, as they can save the tax on each unit eliminated. On the other hand, the establishment of legal standards, even if enforced successfully, will reduce the output of pollutants only where producers do not meet the required standards. Where their emission rates are acceptable, there is no incentive to improve them further, even though this may be regarded as socially desirable (Gregory, 1979).

An alternative solution to the orthodox taxes versus standards approach was proposed by Coase (1960) in a highly controversial paper. Coase demonstrated that, even where externalities do exist, there will be no misallocation of resources if the parties involved are in a position to negotiate to their mutual advantage at no cost. Negotiation will lead to an agreement either for the polluter(s) to compensate the sufferer(s) or for the potential sufferer(s) to pay the potential polluter(s) to curb the polluting activity. In either case, external costs will be internalised. Coase's major contribution was the recognition that the responsibility for damages is a reciprocal one, affecting the afflicted party as well as the perpetrator. However, as Coase and others readily recognised, this solution rests on the assumption that the number of parties involved is sufficiently small to make negotiation feasible. In view of the pervasive nature of pollution, and the "large-number cases" associated with common property and public goods, the practical relevance of the Coasian solution is highly questionable (Baumol & Oates, 1975).

Implicit in these disputes is the thorny problem of property rights, an issue which carries important economic implications. The boundary between market transactions and unpriced externalities depends – as Coase himself pointed out – on the structure of property rights. Consequently, Gregory (1979: 13) has suggested that "the divergence between social and private costs can be argued to result from deficiencies in the system of property rights underlying the market rather than the deficiencies in the market mechanism itself". This prompts the question of whether redefining property rights could – by internalising externalities – restore the social validity of the market. Certainly, the allocation of property rights as a solution to the problem of externalities lies at the core of the so-called "market solution". Dasgupta and Heal (1974) are well-known exponents of this solution, although they acknowledge the practical difficulties in identifying and legislating property rights. Furthermore, Perrings (1987: 94) has made the astute point that "even if property rights can be established, they will fail to generate an adequate set of signals unless accompanied by possession. What matters is control, not title." In practice, therefore, the extension of property rights is not a viable solution. It has already been established that most environmental goods are public goods; and unless our conception of them as natural amenity rights is overthrown, it is impossible to provide them to some while excluding others.

In the final analysis, then, where the market evaluation of the social benefits of environmental protection and pollution abatement is unacceptably deficient, it must be supplemented or replaced by "an evaluation based on criteria other than market values" (Kapp, 1969: 345). These include cost-benefit analysis and direct assessment through surveys. The essential feature of cost-benefit analysis is that the concept of price is extended to a shadow price which incorporates the discrepancy between private and social costs. Unfortunately, the difficulty of applying cost-benefit analysis to environmental problems is that "the level of the shadow price of environmental functions is largely indeterminate because insufficient information is available on the preferences for environmental functions" (Barbier, 1989: 85). Similarly, the survey technique – assessing the public's willingness to pay for environmental quality – is also prone to the problems of estimating a shadow price, not least of all because of the "free-rider" problem associated with public goods.

Thus the efficiency of government intervention and regulation is inherently subject to a significant degree of error. Indeed, Seneca and Taussig (1979) have gone so far as to suggest that the problem of market failure has been matched by an analogous problem of government failure. This is certainly true of the equity implications of environmental policy, an issue which few environmental economists or governments have addressed. The available evidence would seem to suggest that pollution control costs are regressively distributed, while the distribution of net benefits also appears to follow a regressive pattern (Baumol & Oates, 1975). Because distributional consequences have crucial implications for the formulation of an appropriate environmental policy, it is an issue which merits much more detailed research.

3 The "market solution" and the growth of ecological economics

Perhaps the most noticeable feature in the burgeoning literature on environmental economics has been the primacy of the "market solution". This strategy, embodying individual property rights and the use of discounting, assumes that market signals will elicit satisfactory solutions to the problems of resource depletion and environmental pollution. State intervention, in the form of Pigouvian taxes and/or subsidies and the establishment of emission standards, is seen merely as a supplementary measure to rectify market failures resulting from external effects.

It has already been noted, however, that the problems associated with common property resources and, more seriously, the effects of uncertainty in encouraging the adoption of a high private discount rate have undermined the feasibility of the "market solution" for resource depletion. Similarly, it was noted that because pollution is an externality which often affects public goods, the market cannot be relied upon to transmit appropriate price signals for the attainment of optimal environmental quality. Thus Moberg (1991: 513) concluded that: "the market doesn't accurately price goods so as to take account of their environmental consequences. It ignores negative and positive externalities, ill accounts for the depletion of natural resources, inappropriately measures income and welfare, and fails to take responsibility for future generations' welfare." Moberg's criticism of the current formulation of Gross National Product, which omits the depreciation of the environmental resource base, is an important one. In addition to the lack of intergenerational equity referred to in Moberg's critique, there is also the vital question of intra-generational equity, both within countries and between developed and less developed countries.

On a more general note, Perrings (1987: 139) has reminded us that "the notion that market-derived information is superior to any other is a normative judgement". What matters therefore is whether the neo-classical model which underpins the market system is capable of providing useful and accurate information. In this regard, Norgaard (1985: 382-383) has expressed his grave reservations in no uncertain terms:

> The basic assumptions of the neo-classical model do not fit the natural world... The neo-classical model is atomistic in the assumption that land, labor, and capital are separate components...which are only combined during the production of goods

and services and only relate to each other through their relative values determined in exchange.

Although Myrdal (1975: 43) did not adopt such a critical stance, he did point out that, given the "multiple layers of information" contained in market prices, market signals can be ambiguous and may therefore generate inappropriate responses.

On a more fundamental level, Wolff and Resnick (1987) have questioned the basic assumption about human behaviour which underlies neo-classical economics – that all individuals seek to maximise their satisfaction from consuming goods and services. In similar vein, Van Ierland (1993) has reiterated the basic criticism that, while the notion of Pareto efficiency may be logically consistent, its achievement depends upon the fulfilment of conditions (such as perfect competition and perfect knowledge) which are not characteristics of the real world. Meanwhile, Lecomber (1975: 42) has questioned whether the massive increase in productivity from improvements in technology disproved the Limits to Growth scenario: "It establishes the logical conceivability, not the certainty, probability or even the possibility in practice, of growth continuing indefinitely. Everything hinges on the rate of technical progress and the possibilities of substitution." Lecomber then goes on to raise some difficult questions with regard to the harmful environmental effects that have flowed from both "technical progress" and the "substitutes" that have been developed.

These weaknesses serve as a salutary warning against adopting a blind faith in the "invisible hand" of the free market, especially in regard to environmental issues. This lesson for environmental economists has been underscored in recent years by the contributions made from the ecology and physics fields. The more recent work of ecologists has illuminated the complexity and diversity of natural ecosystems and humanity's reliance on them. And yet, as Odum (in Barbier, 1989: 41) has pointed out, humanity's influence on ecosystems has been destructive: "Man, of course, more than any other species attempts to modify the physical environment to meet his immediate needs, but in doing so he is increasingly disrupting, even destroying, the biotic components which are necessary for his physiological existence." Ecologists have also drawn particular attention to the need to exercise economic caution because of the existence of indeterminate "threshold effects", beyond which ecosystems may experience dramatic and perhaps irreversible decline.

An equally important related development has been the incorporation into environmental economics of the second law of thermodynamics: that low entropy energy available for use is converted through usage into high entropy energy which is unavailable for use. The second law of thermodynamics refers to the flow of energy in a system, and entropy is the measure of the qualitative state of energy in a system. The entropy of a system increases as the energy contained therein is dissipated by use. The popularisation of the so-called "entropy law" in environmental studies stems from the influential work of Georgescu-Roegen (1971: 1040), who argued that "The Entropy Law is the taproot of economic scarcity...everything that has some usefulness to us consists of low entropy. It is for these reasons that the economic process is entropic in all its material fibres." Hence production depends upon the environment for natural resources and energy, and this process inevitably transforms useful (low entropy) resources and energy into useless (high entropy) material and energy waste. In short, production, even if it does not result in economic growth, must result in environmental decay. In view of the operation of the first and second laws of thermodynamics, and humanity's dependence upon natural ecosystems, Barbier (1989: 56) drew the pessimistic conclusion that "the opportunity cost in environmental terms of supplying the material needs of the economic system with terrestrial resources is increasing ecological instability and unsustainability."

From these contributions in the fields of ecology and energy studies, emerged what may be regarded as an alternative approach to environmental economics – that is, the field of ecological economics (Ropke, 2004). Table 1 shows a summary of comparisons made by one of the founders of ecological economics, Robert

Costanza, between neo-classical economics, conventional ecology and ecological economics. According to Costanza (1989: 3), *Ecological economics*:

> is intended to be a new approach to both ecology and economics, that recognizes the need to make economics more cognizant of ecological impacts and dependencies, the need to make ecology more sensitive to economic forces, incentives and constraints, and the need to treat integrated economic-ecological systems with a common (but diverse) set of conceptual and analytical tools.

While this new approach has received some strong support (see, for example, Folke & Kaberger, 1992; Reid, 1995; Krishnan *et al.*, 2000; Common & Stagl, 2005), it is not without methodological problems of its own. While ecological economics has been described as a holistic macro-vision of "the web of interconnections uniting the economic subsystem to the global ecosystem of which it is part" (Reid, 1995: 285) – there is still considerable debate surrounding its micro-analytical tools (the counterpart to the microeconomic foundations which underpin neo-classical economics).

Notwithstanding the different strands that exist within ecological economics, two central themes distinguish it from neo-classical environmental economics. First, ecological economics recognises that human beings and the economies in which they live are part of a larger natural ecosystem – the earth's biosphere. Accordingly, instead of the environment being a subset of the economy, the economy should be seen as a subset of the global environment (Harris, 2003). Thus, ecological economics presents a more pluralistic approach to the study of environmental issues, characterised by systems perspectives, appropriate biological and physical contexts, and a focus on long-term sustainability. The second central theme relates to the issue of whether unlimited economic growth is attainable, or whether the more achievable aim should be that along the lines of a "steady state" economy (Daly, 1991).

4 Some concluding comments on the way forward

It was against this background that an alternative environmental strategy – that of "sustainable development" – was fashioned in the World Conservation Strategy unveiled in 1980, although this strategy received its most popular exposition in the well-known Brundtland Report of 1987. The rather narrow ecological interpretation of sustainable development adopted by the World Conservation Strategy – the maintenance of essential ecological processes and genetic diversity, and the sustainable utilisation of species and ecosystems – has been overtaken by the Brundtland Report (World Commission on Environment and Development, 1987) which favoured a deceptively simple definition: "Sustainable development is development which meets the needs of the present, without compromising the ability of future generations to meet their own needs." This is usually taken to mean that the natural capital stock – that is, the stock of all environmental resources – should not diminish over time, and that the achievement of this objective may necessitate some trade-off with economic growth (Redclift, 1987; Pearce, Barbier & Markandya, 1990).

While the 1990s and beyond witnessed an almost unseemly rush to embrace the concept of sustainable development, it is not without its own methodological problems. It is not always clear, for example, whether sustainable development means the preservation of the existing natural capital stock or the optimum stock level, an issue of particular relevance for many less developed countries where existing stocks are significantly below the optimum (Pearce, Barbier & Markandya, 1990). In a similar vein, it is not clear whether maintenance of the natural capital stock means either a constant physical stock or a constant economic value of the stock (Hall & Hall, 1984). A constant physical stock may be applicable to renewable resources, but it is obviously inapplicable to non-renewable resources (unless, of course, there is zero utilisation of these resources). On the other hand, maintaining a constant economic value of the stock would depend upon market forces and provide little meaningful information on physical supply. Another area of debate concerns the notion of discounting: while the private discount rate is generally rejected as harmful to the interests of future generations, there is no unanimity in accepting a social discount rate (Pearce, Barbier & Markandya, 1990). For those who have wrestled with these problems without much success, it comes as no surprise to learn that the concept of sustainable development has been criticised as "a 'good idea' which cannot sensibly be put into practice' (O'Riordan, 1988: 48), and as a lesson in 'how to destroy the environment with compassion" (Smith, 1991: 135).

In one sense, the emergence of both ecological economics and sustainable development can be seen as the macro-economic counterpart to the well-established microeconomic foundations that underpin the neo-classical model of environmental economics. In other words, they can be seen as different strands in a common thread with a common purpose: to seek ways in which the demands of modern economics can be meshed with the bio-physical constraints inherent in the environment in which we live. They can be seen as complementary – and not necessarily competing – approaches to reconciling economic and environmental harmony.

Table 1

Comparison of neo-classical economics with ecology and ecological economics

	Neo-classical economics	Conventional ecology	Ecological economics
Basic world view	**Mechanistic, static, atomistic** Individual preferences taken as given and the dominant force. The resource base viewed as essentially limitless due to technical progress and infinite substitutability.	**Evolutionary, atomistic** Evolution acting at the genetic level viewed as the dominant force. The resource base is limited. Humans are viewed as just another species.	**Dynamic, systems, evolutionary** Human preferences evolve to reflect broad ecological opportunities and constraints. Humans are responsible for managing the larger system for sustainability.
Time frame	**Short** 50 years maximum 1 – 4 years usual	**Multi-scale** Days to eons	**Multi-scale** Days to eons
Space frame	**Local to national** Individual for firm is basic unit of analysis.	**Local to regional** Most research focuses on single ecosystems.	**Local to global** Hierarchy of scales.
Species frame	**Humans only** Plants and animals only rarely included for contributory value.	**Non-humans only** Attempts to find pristine ecosystems untouched by humans.	**Whole ecosystems** Acknowledges inter-connections between humans and the rest of nature.
Primary macro goal	**Growth of national economy**	**Survival of species**	**Sustainability of whole planet**
Primary micro goals	**Maximise profits (firms) Maximise utility (individuals)** All agents following micro goals leads to macro goal being fulfilled.	**Maximise reproductive success** All agents following micro goals leads to macro goal being fulfilled.	**Must be adjusted to reflect system goals** Myopic pursuit of micro goals can lead to problems which must be compensated for using appropriate cultural institutions.

Assumptions re technical progress	Optimistic	Pessimistic or no option	Prudently pessimistic
Academic stance	**Disciplinary** Monistic, focus on mathematical tools.	**Disciplinary** More pluralistic than economics, but still focused on tools and techniques.	**Trans-disciplinary** Pluralistic, focus on problems.

Source: Adapted from Costanza (1991).

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