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Environmental economics and ecological economics: the contribution of interdisciplinarity to understanding, influence and effectiveness

THEMATIC SECTION
Interdisciplinary Progress in Environmental Science & Management

SHARON BEDER*
SSMAC, Faculty of Arts, University of Wollongong, Northfields Avenue, Wollongong, NSW 2522, Australia
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SUMMARY

This paper reviews developments in both environmental economics and ecological economics with respect to their progress towards environmental interdisciplinarity and towards providing solutions to environmental problems. The concepts, methods, theories and assumptions of each field of knowledge are reviewed and the extent to which they depart from the dominant neoclassical paradigm of economics is assessed. The contribution that interdisciplinarity has made to the success of each field is analysed in terms of understanding, influence and effectiveness and the constraints that it has imposed upon that success. Environmental economics has adopted the dominant economic neoclassical paradigm, including the power of the market to allocate environmental resources efficiently and in a socially optimal way. The solution to environmental problems is thus seen as a matter of ensuring that the environment is properly priced to reflect the relative scarcity of natural resources and assets and to ensure that environmental values are incorporated into the market. This specialized view of environmental problems is now reflected in government policy around the world including the use of extended cost benefit analyses, contingent valuations, environmental charges and emissions trading. Nevertheless, environmental problems continue to grow in severity and the solutions provided by environmental economists have proven ineffective. Thus lack of interdisciplinarity does not prevent a field of knowledge from gaining influence and dominance, however its effectiveness in terms of understanding environmental problems and solving them is impeded. Ecological economics seeks to incorporate the research of economists, ecologists, philosophers and social scientists, however its influence seems to be have been limited to areas in which it retains the standard economics framework, and this limits its effectiveness in terms of environmental solutions. Thus interdisciplinarity may increase understanding of the real world but it cannot overcome political and social barriers to translating that understanding into the widespread implementation of effective environmental measures.

Keywords: ecological economics, environmental economics, environmental solutions, interdisciplinary progress, neoclassical economics, political influence

INTRODUCTION

Environmental and resource economics were established as sub-disciplines of economics after the second world war, particularly in North American universities. They adopted rather than critiqued the dominant neoclassical paradigm of economics (Spash 1999, p. 414). Neoclassical economists argue that the free-market system can attain the best possible allocation of resources through individuals acting in their own best interests and without government regulation.

Mainstream economic theory has tended to assume that economic systems were independent of environmental restraints and therefore these could be ignored. At best environmental pollution was treated as an externality that occurs when production or consumption by a firm or consumer directly affects the welfare of another firm or consumer and those causing the damage are not financially accountable for it. Externalities, whilst examples of market failure, were not considered to be significant flaws in the market system, although Arthur Pigou had advocated government intervention in the form of taxes and subsidies to discourage externalities (Pearce 2002).

In the 1950s, a group of economists started to take the environment more seriously. Resource economists sought to develop models of how industries that relied on environmental resources, such as fisheries, forestry and agriculture, could use them in an efficient and optimal way (Spash 1999). Resources for the Future (RFF) was established in 1952 following the publication in the USA of the Paley Report about the potential exhaustibility of resource (Pearce 2002).

Environmental economics emerged in the 1960s as public concerns with environmental pollution grew. Limits to markets due to the constraints of nature were recognized, in particular the indivisibility of nature that inhibited the allocation of property rights to many environmental benefits. Economic modelling expanded to cover resource depletion and pollution. The *Journal of Environmental Economics*

*Correspondence: Dr Sharon Beder, University of Wollongong, NSW 2522, Australia e-mail: sharonb@uow.edu.au

and Management (*JEEM*) was established in 1974 and the Association of Environmental and Resource Economists (AERE) was established in the USA in 1979, with close associations to RFF. For many years *JEEM* was the primary academic outlet for environmental and resource economists as mainstream economic journals rarely published their research. The European Association of Environmental and Resource Economists (EAERE) was not established until after the second wave of environmentalism in 1991, and its journal *Environmental and Resource Economics (ERE)* followed shortly afterwards (Spash 1999).

The recognition of market limitations began to fade in the 1980s. Today environmental economists believe in the power of the market to allocate environmental resources efficiently and in a socially optimal way, just as it does with economic products. To achieve this, environmental goods, services and amenities need to be given a price so that they can be incorporated into the market. If people and firms are charged real prices for using the environment, environmental considerations will be incorporated into market decisions. The solution to environmental problems is therefore to ensure that the environment is properly priced to reflect the relative scarcity of natural resources and assets.

The standard view taken by environmental economists was outlined early on (Schelling 1983; Seneca & Taussig 1984; Baumol & Oates 1988; Tietenberg 1988, 1990; Pearce *et al.* 1989; Stavins & Whitehead 1992). It was argued that environmental degradation has resulted from the failure of the market system to put any value on the environment, even though the environment does serve economic functions and provides economic and other benefits. Not all economists take this view, but the neoclassical approach which embodies this philosophy dominates research and teaching in environmental economics (Rosewarne 1993).

Resource and environmental economists attempted to include the environment into models of economic systems, in terms of its supply of raw materials and as a receptacle for waste materials. For them 'the natural environment is an important component of the economic system' and they sought 'to treat the natural environment in the same way as we treat labour and capital; that is, as an asset and a resource' (Thampapillai 1991) and as commodities that can be bought, sold, traded, saved and invested (Nadeau 2008). In this view, environmental commodities are interchangeable with other commodities rather than a serious constraint on economic activity.

Mainstream economists take a very specific view of the term 'value', which relates to the exchange value of a commodity rather than any broader concept that might include aesthetic, spiritual and ethical dimensions. When environmental economists speak of valuing the environment, they mean giving it a market price based on supply and demand and individual preferences.

This paper will examine the extent to which this adoption of the neoclassical economic paradigm by environmental economics and the blindness of researchers to other disciplinary views have affected the success of environmental economics in terms of its understanding of real world environmental problems, its political influence and its environmental effectiveness. It will then consider efforts by ecological economists to make the field more interdisciplinary, the extent to which they have been successful in these efforts, and the impact this has had on their influence and environmental effectiveness.

ENVIRONMENTAL ECONOMICS

Modified cost-benefit analysis

Environmental economists sought to incorporate environmental factors into project appraisals by modifying cost benefit analysis (CBA) to include environmental costs and benefits. RFF was an early advocate of the inclusion of environmental costs and benefits in CBA (Spash 1999; Pearce 2002). According to Pearce (2002), 'Two of the triumphs of environmental economics have been to emphasize the incompleteness of appraisals that omit environmental change and to develop the means of incorporating environmental values into appraisal'.

CBA involves comparing aggregate benefits with aggregate costs. It has been argued that CBA should be applied to all private and public projects, because they all have economic effects that are not priced in the market place, i.e. 'externalities'. For environmental externalities to be included in a CBA they have to be converted into monetary measures. CBA, like the notion of weak sustainability (see below), assumes that environmental 'goods' and human-made goods are interchangeable and substitutable and what matters is the aggregate.

By confining decisions to a comparison of costs and benefits, not only are broader policy and political issues ignored, but there is also an underlying assumption 'that efficiency in allocation is the criterion that society deems paramount when making decision' whereas 'other criteria such as equity and political acceptability may be of greater concern to environmental policymakers' and to the community (Cooper & Hart 1992).

Neoclassical economists do not concern themselves with moral, political and ethical concerns because they assume that the market is an ethical system and that political decisions should be made separately. They dismiss the idea that aggregating costs and benefits clouds distributional and equity issues of who gets the benefits and who suffers the losses, by arguing that in theory those benefiting could compensate the losers ensuring that no one is worse off (Pareto criterion) (Pearce 2002). However, whether this actually happens is not of concern to these economists who dismiss it as a political question outside their field; what matters is that aggregate benefits outweigh aggregate costs.

Similarly CBA tends to be used to avoid considering the moral dimensions of a decision; it is efficiency that matters to economists. The moral value of averting injury, saving life and

ensuring healthy working conditions is normally ignored in a CBA (Waring 1988). As a result of discounting future costs and benefits in CBAs, future cancer cases are discounted so that 100 cancer cases in 20 years are equivalent to 26 cancers today (using a 7% discount rate) (Ackerman & Heinzerling 2004) and 'one death next year counts for more than a billion deaths in five hundred years' (Shrader-Frechette 2002).

Normally, future costs and benefits are discounted because it is assumed that they are not worth as much to people as present costs and benefits, and that economic growth and technological innovation will ensure that future generations are better off. But discount rates based on individual private preferences are inappropriate for societal decisions regarding environmental protection. While discounting money may make sense, discounting environmental values seems to be an example of what Daly and Cobb (1989) called 'misplaced concreteness': in other words, getting mixed up between the measure (in this case, money) and the real world (the environment), and assuming that the real world behaves as the measure does. Just because people would rather have money now than later, so they can invest it or to be sure of having it, this does not mean that they will value the maintenance of an area of environmental significance less each year into the future.

Economists lack the ecological knowledge to realize that individual CBAs are unable to take into account the cumulative loss of many small decisions in many communities. Over time these could in fact destroy ecosystems, cause extinctions of species and threaten human survival. Ecological systems are not like economic systems where trends can be plotted in smooth continuous lines. Rather, such systems may be able to withstand many small assaults and then collapse suddenly once a threshold is crossed. Scientists are often unable to identify such thresholds, but it makes little sense for economists to ignore them (Pearce 1994).

Putting a price on the environment

Environmental economists differentiate between different types of environmental values. 'User' values cover benefits that individuals get from the environment, including those from recreation, sport, or just viewing pleasure. 'Option' values are potential user values, namely the value to a person who might use the environment in the future. 'Existence' values are people's preferences that are outside 'use' values, such things as 'concern for, sympathy with and respect for the rights or welfare of non-human beings' (Pearce *et al.* 1989). The economist's notion of 'existence' or 'intrinsic' values is different from the environmentalist's idea of intrinsic values, which are values that the environment might have quite apart from their value to humans.

For most economists, the environment can be priced because option and existence values can be translated into the preferences of individuals and those preferences in turn can be measured. Individual preferences are often derived from surveys, for example 'contingent valuation'. These surveys may ask people how much they are willing to pay to preserve or improve the environment (willingness to pay) or how much monetary compensation a person is willing to accept for loss of environmental amenity (willingness to sell).

However, individual preferences are shaped to a large extent by the information available to people about the consequences of their choices, and that information is usually partial, often distorted and mostly shaped by the media. Those surveyed may think a wetland area is unattractive and worthless and will be unwilling to pay to protect it, even though the wetland has important ecological value of which they are unaware. Contingent valuation surveys only take account of the functions of parts of an ecosystem to the extent that the people surveyed are knowledgeable about them.

Economists assume that individuals act to optimize their own interests; this is the principle behind the market system and 'the intelligent pursuit of private gain' is the essence of rationality (Daly & Cobb 1989). They do not consider altruistic behaviour as rational. The idea that markets are more efficient at giving people what they want than governments is based on the dubious assumption that there is no such thing as the common good outside of individual wants and preferences. However this ignores interdisciplinary knowledge about people's motivations and political behaviour. When people vote they often see themselves as part of a group, be it an occupational group, an ethnic group, a class, a nation or whatever. In politics, people are not only concerned about their self-interest, they also consider the 'good of society' (Self 1990, p. 9). This is why people support ideas such as public education when they do not have children, and environmental protection beyond their own lifetimes. 'As consumers they seek to maximise their own materialistic wants, whilst as citizens they are concerned with what constitutes a 'good' society'' (Cooper & Hart 1992, p. 22).

Contingent valuation and other methods of finding a price for parts of the environment are completely human-centred (anthropocentric) and take no account of the preferences of other living creatures. This, economists believe, is as it should be. For them value is defined in terms of exchange between humans. For many environmentalists, however, especially deep ecologists, this is unacceptable and arrogant. It denies other living things any intrinsic value, namely any value outside of their value to humans.

Ultimately, efforts to put a monetary value on the environment are based on the assumed substitutability of nature. Attaching a dollar value to a species still does not guarantee its survival, a study done by a mathematician in 1973 showing that 'it was economically preferable to kill every blue whale left in the oceans as fast as possible and reinvest the profits in growth industries rather than to wait for the species to recover to the point where it could sustain an annual catch' (Ehrenfeld 1988).

Weak sustainability and substitutability

For most economists, economic growth is necessary; they believe that economic systems must grow if they are to survive.

Since the environment was now viewed as part of the economic system, providing services for it, then any measure of the economy should include some measure of natural capital. This implied the need to modify national accounts to take account of depreciation of natural capital and environmental economists sought to find ways to do this (Pearce 2002).

Environmental economists interpreted sustainable development as development that maintains capital for future generations where capital is the total of human capital (skills, knowledge and technology) and human-made capital (such as buildings and machinery), as well as natural capital (environmental goods). This view is referred to as weak sustainability, based on work by Robert Solow (1974), which argued that the requirement to keep the total amount of capital constant 'is consistent with 'running down' natural capital—i.e. with environmental degradation' because human-made capital can be substituted for natural capital. This means that the Amazon forest can be removed so long as the proceeds from removing it 'are reinvested to build up some other form of capital' (Pearce 1991).

This assumes that a community can continue to use up its natural resources and degrade its natural environment just as long as it is increasing its wealth and infrastructure by an equivalent economic value. The fact that a region is becoming a more sterile, artificial and dangerous place in which to live is supposedly compensated for by the comforts and entertainments that residents are able to buy.

Weak sustainability provides a rationale for continuing to use non-renewable resources at ever-increasing rates. Economists claim that, although there may be temporary shortages, rising prices will ensure that new reserves will be found, substitutes discovered and more efficient use encouraged. What should remain constant is not the stocks of non-renewable resources, but the economic value of the stock (Pearce *et al.* 1989).

However, this principle requires that 'environmental assets be valued in the same way as man-made assets, otherwise we cannot know if we are on a 'sustainable development path'' (Pearce 1991, p. 2). Some environmental assets could not be 'traded-off' because they are essential for life-support systems and as yet they cannot be replaced, but valuation would generally allow trade-offs between the environment and wealth creation (Pearce 1991).

The weak sustainability view demonstrates a lack of knowledge of ecological concepts and biological processes that a more interdisciplinary approach would provide. There are many types of environmental assets for which there are no substitutes: for example, the ozone layer, the climate-regulating functions of ocean phytoplankton, the watershed protection functions of tropical forests, the pollution-cleaning and nutrient-trap functions of wetlands. There is little evidence that environmental economists draw on the knowledge of ecologists or other scientists to determine the limits of substitution. Nor that they take seriously the uncertainties associated with these scientific fields.

Weak sustainability also demonstrates a narrow economic view of environmental quality as something that can be swapped for other goods without a loss of welfare, that is the substitutability of environmental quality (Goodin 1994).

Internalizing environmental costs

Environmental economists argue that external costs and benefits should be 'internalized' by adjusting prices so that the person buying the goods or services causing the external cost is obliged to pay for it (Beder 1996; Nadeau 2008). This can be done by means of a tax or charge, for example, a firm discharging waste into a river might be charged a fee to cover the cost of lost recreational amenity and fish life, thus making external costs part of the polluter's decision.

Laws can also force the polluter to take notice of these external costs by prescribing limits to what can be discharged or emitted, but environmental economists prefer the market to perform this function: 'Advocacy of environmental taxation has been one of the hallmarks of environmental economics' (Pearce 2002). This preference for market solutions is ideologically based. 'Its first pillar comes squarely out of a philosophical tradition that grew from Adam Smith's notion that individual pursuit of self-interest would, in a regime of competitive markets, maximise the social good. That tradition is so firmly embedded in economics by now that most economists probably do not realize, unless they venture out into the world of noneconomists, that it is a proposition of moral philosophy' (Kelman 1983).

The rhetoric of internalization reinforces the premise that the central environmental problem is the failure to 'value' the environment and that markets can adequately deal with this problem when environmental costs are incorporated into market prices through mechanisms such as fees, charges and taxes.

Environmental economists argue that the market is able to find the optimal level of environmental damage, that is, the one that is most economically efficient (Beder 1996; Pearce 2002). The optimal level of pollution is the level at which the costs to the company of cleaning up the pollution equal the cost of environmental damage caused by that pollution. If the pollution charge is equivalent to the cost of environmental damage then the theory is that the company will clean up its pollution until any further incremental reduction in pollution would cost more than the remaining charge, that is, until it is cheaper to pay the charge than reduce the pollution. This is said to be economically efficient because if the polluter spends any more than this, the costs to the firm of extra pollution control will outweigh the benefits to those suffering the adverse affects of the pollution.

This might seem to be a less than optimal goal to the community but economists argue that the polluter is better off than if it had paid to eliminate the pollution altogether and the community is no worse off because it is being compensated by the firm for the damage through the payments of the tax or charge to the government (Beder 1996). In theory the

payments can be used to correct the environmental damage they cause.

This is where theory and reality diverge and where economists' lack of interdisciplinary knowledge becomes evident because there is considerable doubt about whether money payments can correct environmental damage in many circumstances. Economists argue that if the money is spent on something equally worthwhile then the community is still no worse off, a view that those who suffer from the pollution might find hard to accept. This also assumes that the benefits that arise from the environment can be substituted for by products and services bought in the market. The assumption in internalizing the costs is that environmental damage can be paid for and that this is as good as, or even preferable, to avoiding the damage in the first place (Beder 1996).

All this supposes that the charges are in some way equivalent to the damage done, but this is seldom the case. Even where environmental taxes do not internalize the full cost of environmental damage, they are favoured by environmental economists because they are believed to stimulate technological change and provide an incentive for polluters to reduce their emissions: 'For any tax rate, each polluter will abate pollution up to the point where his marginal abatement costs just equal the tax' (Pearce 2002). This belief stands without any examination of the real world behaviour of companies in the face of increased taxes.

The assumption here is one that rests on economic determinism, that is, given the right economic conditions the desirable technological change will automatically occur. This demonstrates a lack of knowledge of mechanisms and drivers of technological change that a more interdisciplinary approach might afford. It ignores the social and political factors that shape technology and which have been the basis for so much scholarship in the academic discipline of science and technology studies (Bijker *et al.* 1987; MacKenzie & Wajcman 1985). Adding costs to a firm's operations may impose pressure on it to reduce its costs, but there is no guarantee that it will do so in the area where the cost is imposed (Rosenberg 1976, chapter 23). It may find it easier, cheaper, or even more profitable to apply new technology and methods in other parts of its operation, or simply pass the increased cost on to the consumer, especially in oligopolistic sectors (Beder 2006).

The degree of incentive provided will also obviously depend on how large the charge or tax or subsidy is: 'if it is low, and environmental improvement is primarily achieved through major investments in plant and equipment which occur rarely, there may be little effect' (M. Jacobs, unpublished paper 1993).

The need to own the environment

The market does not deal very well with resources that are not individually owned, such as the atmosphere, waterways and some areas of land. These are called public or social goods by economists. Many environmental economists argue that because the commons is not privately owned and access is open, there is a tendency to overuse it, this is referred to as the 'tragedy of the commons' (Hardin 1968).

Legal sanctions in the form of environmental laws and regulations are the modern way of preventing 'tragedy of the commons' situations. Economists prefer to incorporate the commons into the market system through the use of economic instruments that create artificial property rights. They believe this ensures that public goods are allocated in a more 'efficient' manner. 'Coase claimed that the primary reason the mechanisms of market processes cannot resolve environmental problems is that many environmental resources are not owned and ... the most effective way to internalize negative environmental externalities was to revise the legal system to allow for the assignment of ownership rights to environmental resources. If these resources were owned, argued Coase, the invisible hand would eliminate undesirable uses and adverse environmental impacts would disappear without the need for government intervention.' (Nadeau 2008).

Rights-based economic instruments create ownership or property rights 'to use environmental resources, or to pollute the environment, up to a pre-determined limit', and allow these rights to be traded (Commonwealth Government of Australia 1990). They include emissions trading where the right to discharge a certain amount of pollution is allocated to individual firms, sometimes for a price, and markets are set up to allow those rights to be bought and sold. Firms that can reduce their pollution more cheaply than others can sell their excess rights to firms for whom it would be expensive to reduce their pollution. In this way, economists argue, a given level of air quality can be achieved more efficiently with a lower aggregate cost to the firms involved (Stavins 1989; Beder 2006).

Emissions trading schemes aim to maximize economic efficiency rather than environmental effectiveness, that is, they aim to achieve a given level of environmental protection at least cost to industry, and to enable continued economic growth despite restrictions on air pollution. If substantial pollution reductions are necessary then more expensive reductions also have to be made and there is little point in setting up markets that enable some firms to avoid making those expensive reductions so as to minimize overall costs. In other words, the more rigorous the emission reduction required, the less scope there is to find cheap solutions and trade excess emission allowances.

Market-based environmental policies are an indirect method of achieving environmental goals. They are aimed at altering conditions in which decisions are made rather than directly prescribing actions. However regulators cannot be sure that the changed conditions will bring about the desired decisions. In practice, the benefits of economic instruments are far more theoretical than real. The use of emissions trading has not led to significant environmental quality improvements (Beder 2006).

The faith of environmental economists in market mechanisms shows a lack of knowledge of the mechanisms and drivers of technological change that a more interdisciplinary approach would provide. Their assumption that financial incentives are all that is required to change behaviour

in a particular way is naïve and simplistic. The market often favours technologies that are cheapest in the short term, such as capturing end-of-pipe emissions from an existing facility, even though more capital-expensive options such as renewable energy projects have broader benefits and can be more economical in the long term (Lohmann 2004). Substantial changes to technological paradigms require institutional changes that decision-makers prefer to avoid. It is usually cheaper to retrofit old plants than switch to cleaner technologies. By allowing firms to pay for pollution, technological innovation is stifled rather than encouraged (Beder 2006). For example, an electricity supplier can pay less to offset its emissions by planting trees in a developing nation than it would cost to reduce its own emissions (Driesen 1998).

Success of environmental economics

Rather than being an interdisciplinary expansion of the discipline of economics, environmental economics has adopted the theory, assumptions and paradigms of neoclassical economics and applied them to incorporate environmental problems into economic analysis. Given the workings of the market in reality, and the well-elaborated imperfections and problems associated with it, what is surprising is that neoclassical economics has not only dominated environmental economics but has also increasingly dominated the whole public discussion of sustainable development and environmental policy.

Environmental economics has been enormously influential. As well as being taught in universities, it is 'practised in government agencies and development banks' (Nadeau 2008). The discussion surrounding sustainable development borrows heavily from the language and concepts of environmental economics. Sustainable development policies around the world call for environmental assets to be appropriately valued, implying that putting a price on the environment will help protect it, that the 'free' market is the best way of allocating environmental resources, and that businesses should base their decisions about polluting behaviour on economic considerations and the quest for profit.

Much of the discussion of sustainable development describes nature and the environment in economic terms, as natural resources or natural capital, and as part of the community's stock of assets. Even the term 'value' has been usurped by economists. In the 1980s, the *Oxford English Dictionary* began listing its principal meaning in economic terms: 'that amount of some commodity, medium of exchange, etc., which is considered to be an equivalent for something else; a fair or adequate equivalent or return' (Waring 1988).

Environmental groups have found it necessary to employ their own economists in order to be heard in an increasingly economics-dominated environmental policy arena and they have taken advice from those economists (Rosewarne 1993).

Contingent valuation is routinely used by government agencies and departments in more than 40 nations, as well as by the World Bank, to value environmental goods and services (Nadeau 2008). In particular, legislation and court assessments in the USA have encouraged the use of contingent valuation (Pearce 2002).

Environmental taxes and charges are now used extensively in OECD (Organization for Economic Cooperation and Development) nations and are spreading to developing nations (Pearce 2002). Tradeable environmental property rights are used for air pollutants, fisheries, water allocation and water pollutants, as well as biodiversity banks (Beder 2006). Emissions trading is increasingly being used as the main policy measure to reduce regional and global pollution. (Drury *et al.* 1999) Emissions trading is used in Chile, Canada, Australia, Europe and the USA (Robinson & Ryan 2002).

The environmental economist's view that environmental degradation is caused by a failure to 'value' the environment and a lack of properly defined property rights not only forestalls criticism of the market system, but in fact promotes an extension of markets as the only way to solve the problem. Within the market framework 'issues of 'capitalist development' and 'ecological sustainability' have tended to congeal around the theme of environmental costs and how best to reduce these. The social relations of the market itself are not brought into question; the solution is not seen as involving a major social transformation or radical economic restructuring' (White 1992).

By focusing on policy measures that leave the existing market unchanged, environmental issues remain subordinate to economic interests and the logic of the system, which is based on unlimited economic growth, is left unchallenged (White 1992, p. 150).

The renewed push for the use of economic instruments in the 1980s was due in part to the influence of the ideology of neoliberalism in many Western governments with its advocacy of deregulation and privatization (Steiner 1992). Economic instruments make a virtue out of the profit motive and the pursuit of self-interest, whereas those arguing for a new environmental ethic took the traditional approach of trying to combat self-interest through morality (Beder 1996).

The promotion of market-based instruments was a way of resurrecting the role of the market in the face of environmental failure. Advocates claimed that market instruments provided a way that the power of the market could be harnessed to environmental goals (Stavins 1989; Tietenberg 1990). They served a political purpose in that they reinforced the role of the 'free market' at a time when environmentalism most threatened it.

Environmental economists sought to enrol industry by emphasizing the flexibility of market-based economic instruments: they give firms a choice and allow them to make their own decisions. They juxtaposed economic instruments with legislative instruments which dictated how firms should behave, legislative instruments being termed 'command-and-control': 'market-based incentives provide freedom of choice for businesses and consumers to determine the best way to reduce pollution' (Stavins & Whitehead 1992). Additionally, environmental taxes and charges were promoted as a way

of replacing other charges and taxes that firms would normally have to pay anyway (Repetto *et al.* 1992; M. Jacobs, unpublished paper 1993).

As public pressure mounted to toughen regulation, the argument for market instruments became more compelling. Industry preferred to retain the choice of discharging wastes into the environment, even if it had to pay for the privilege. Charges made the costs explicit and placed a ceiling on them (Repetto *et al.* 1992), whereas legislation had the potential to impose clean-up costs of unknown magnitudes.

Many bureaucrats and politicians were attracted to the idea of economic instruments by the economists' promise that they would remove decision-making from the public arena, thereby depoliticizing environmental debates (Beder 1996). Environmental controversy can be politically damaging and can interfere with the bureaucratic decision-making process. Chant *et al.* (1990) argued that market-based instruments transform environmental conflicts from political problems to economic transactions. 'A major advantage of the market as an allocational device is that it provides a non-political solution to the social conflict raised by resource scarcity' (Chant *et al.* 1990).

If the market could be used to allocate environmental resources on the basis of supply and demand, just as other choices are made (such as between growing wool or wheat on a farm), environmental economists believed they could be removed from the political arena (Bennett 1991).

Nevertheless, despite the success of environmental economists in having their proposed policies widely adopted, environmental problems continue to grow in severity. This underscores the fact that a lack of interdisciplinarity does not prevent the success of a field of knowledge in terms of influence and dominance, however it does prevent its effectiveness in terms of understanding environmental problems and how to solve them.

ECOLOGICAL ECONOMICS

The International Society for Ecological Economics (ISEE) was established in 1987 and national branches followed in the USA, Australia/New Zealand, Brazil, Canada, Europe, India, Russia and elsewhere (Spash 1999). The key people behind the establishment of ecological economics were economists Herman Daly and Joan Martinez-Alier, zoologist AnnMari Jansson and one of her students Robert Costanza; 'They were the main initiators behind the first meetings and publications, and the journal' (Ropke 2004). According to Spash (1999), ecological economics was a way of bringing economists and ecologists together: 'in the introduction to the first issue of the journal *Ecological Economics*, Bob Costanza stated that the subject would extend the overlap between neo-classical environmental economics and ecological impact studies and encourage new ways of thinking about linkages between ecological and economic systems'.

However, the journal *Ecological Economics* (*EE*), which commenced publication in 1989, covered a wide variety of research topics and tended to be more pluralistic in its approach than these early indications (Ropke 2005). EE is concerned with 'the relationship between the economic and the ecological system, and its underlying central aim is to provide knowledge for a sustainable management of this relationship' (Baumgärtner *et al.* 2008).

The popularity of ecological economics was evidenced by large attendance at its conferences beginning in 1990, the first ISEE conference in Washington attracted 370 people, and the second in Stockholm more than 450 people (Ropke 2005).

Ecological constraints and equity

What differentiated ecological economics from environmental economics was that ecological economists generally recognized that 'the Earth is materially finite and nongrowing' with the economy 'a subset of this finite global system' (Costanza *et al.* 2007). Nicholas Georgescu-Roegen had already claimed thermodynamics and energy availability limited economic growth and Herman Daly had advocated a steady-state economy (Nadeau 2008). For ecological economists, the economic system is a component of the ecological system rather than environmental inputs and outputs being components of the economic system (Costanza *et al.* 2007).

Ecological economists are far more willing than environmental economists to recognize that there are physical limits to the material growth of economies that may already have been reached. Environmental economists tend to have more faith in the ability of technology to overcome problems of resource scarcity and loss of ecosystem services, given the right price signals (Ropke 2005; Costanza *et al.* 2007).

Emerging from this recognition of physical limits there has been a focus in ecological economics on the idea of ecological footprints and how to measure them (Ropke 2005). The notion of ecological footprints makes explicit equity concerns, which is another area of difference between environmental and ecological economists. They do this by demonstrating that affluent nations have much larger footprints, particularly per person, and are therefore using more than their fair share of resources (Rees 1996).

Ecological economists are willing to explicitly consider ethical and philosophical issues, such as intergenerational and intragenerational equity, and even, in some cases, to recognize non-human values (Ropke 2005, p. 267; Spash 1993, p. 427). For example, Daly sought to expand the goals of an economic system from efficient allocation to also include equitable distribution as well as sustainable scale (cited in Nadeau 2008).

Issues of equity and scale cannot be accommodated within a neoclassical economic paradigm with its emphasis on individual preferences (Nadeau 2008). This has led many ecological economists to move away from the economist's reliance on individual preferences as the arbiter of all value and to recognise the value of social and community values (Spash 1993) as well as the social and cultural context for the economy

(Ropke 2005). It has also led to attempts to incorporate social, political and ethical considerations into economic analysis (Spash 1999) rather than, as environmental economists do, leaving such matters for politicians to deal with or, in the case of neoclassical economists, assuming that the market should be the final arbiter of ethical decisions. Further, it means that efficiency can no longer be the dominant decision-making determinant (Spash 1993).

The European Society for Ecological Economics (ESEE), established in 1996, has tended to take a more socioeconomic and political economy approach than its USA counterpart; it has encouraged 'cooperation with philosophers, sociologists and psychologists to explore ethical, social and behavioural fundamentals of human well-being' (Spash 1999).

Environmental valuation

Like environmental economics, ecological economics is however still obsessed with environmental valuation and its measurement, though not always in monetary terms (Gómez-Baggethun, *et al.* 2010). Nadeau (2008) argued that ecological economists' primary objective 'is to enlarge the framework of the neoclassical economic paradigm to include scientifically valid measures of the environmental costs of economic activities'.

Even before the ISEE was formed economists and ecologists had worked together to persuade international agencies to modify national accounting systems to include environmental factors (Costanza *et al.* 2007). Changing national accounts to reflect environmental degradation and associated costs is still a major project of ecological economics (Repetto 1989).

The most commonly used aspect of national accounting is the gross national product (GNP). Various modifications to GNP have been proposed over the years as a way of incorporating social and environmental factors. However, in order for the environment to be integrated into national accounts it has to be valued in monetary terms. What is more, an adjusted GNP figure is merely a way of measuring weak sustainability. It assumes that as long as total capital, including natural capital, is increasing then welfare is increasing, a position taken by environmental economists that allows for the gradual deterioration of the environment (Beder 2006). The integration of environmental values into national accounts assumes that environmental 'goods' and human-made goods are interchangeable and that what matters is the aggregate; that environmental goods can be indefinitely traded off for human-made goods.

Many ecological economists, however, do emphasize the need for 'strong sustainability' (see above) with its rejection of the idea that natural capital is substitutable, though not entirely so (Pearce 2002). This does not, however, stop them focusing on the need to measure the economic value of nature. In a special issue of *Ecological Economics* on biodiversity and policy, biodiversity was framed as 'a scarce economic good, for which however a (proper) pricing system does not exist' and while it was acknowledged there is no framework for doing this adequately, it was argued that 'economic valuation of biodiversity is a pressing issue and the number of studies concerning monetary biodiversity evaluation is quickly growing' (Nunes & Nijkamp 2008). Nunes and Nijkamp (2008) claimed the importance of valuationwas to enable direct comparison in cost-benefit studies and to enable economists to assess environmental damage and benefits, as well as individual consumer motivations and opinions of biodiversity conservation.

In the same *Ecological Economics* issue, papers looked at the role of financial compensation for voluntary conservation measures; ways to measure biodiversity improvement and its cost; measurement of the value of conservation of genetic biodiversity for research and development; the cost of human health impacts of vulture decline in India; and contingent valuation of a nature protection programme. All demonstrated a focus on economic measurement of value, despite the recognition that ecological values, which involve maintenance and support for ecological systems, are not captured by economic valuation (Nijkamp *et al.* 2008).

Within ecological economics, another area of controversy related to valuation is the issue of incommensurability, which questions whether all value can be expressed in common units of measurement such as money. Whilst some attempt to price the environment and biodiversity in monetary terms, others insist on complementary measures and multi-criteria based decision processes (Gómez-Baggethun *et al.* 2010).

Ecosystem services

According to ecological economists, the concept of ecosystem services popularized by Daily (1997) and Costanza *et al.* (1997) was originally supposed to be a way of communicating the idea of 'nature as a fixed stock of capital that can sustain a limited flow of ecosystem services', but which cannot sustain unlimited economic growth (Norgaard 2010). The term was used to raise awareness of how dependent humans are on healthy ecosystems, however over time it became a dominant paradigm for approaching environmental management and policy. There has been an 'exponential rise in the use of the term 'ecosystem services' in academic journals' and an 'industry of professionals providing advice on ecosystem services' has flourished (Norgaard 2010).

The Millennium Ecosystem Assessment (MA) defined ecosystem services as including provisioning services (such as food, water, fibre and fuel), regulating services (such as carbon sinks, flood mitigation and waste treatment), cultural services (for example spiritual values, aesthetic pleasure and recreation) and support services (for example soil formation and nutrient recycling) (cited in Kosoy & Corbera 2010; Norgaard 2010). This was not so different from the efforts of environmental economists to translate environmental considerations into inputs and outputs for the economic system which fitted the neoclassical economic paradigm so well.

The growing popularity of ecosystem services has reinstated economic growth as a desirable and attainable goal amongst ecological economists (Gómez-Baggethun *et al.* 2010; Norgaard 2010). Ecosystem services, according to economic logic, represent the provision of services by natural capital to the economy, as well as the existence of externalities not included in market transactions. To be maintained, ecosystem services have to be paid for, thus introducing the concept of payments for ecosystem services (PES), whereby landowners and managers would be paid to conserve ecosystems on their property, and markets for ecosystem services (MES), which include emissions trading and wetland mitigation banking. Increasingly ecosystem services are seen as 'commodities on potential markets' (Gómez-Baggethun *et al.* 2010).

Some have viewed ecosystem services as interdisciplinary progress, whereby economists and ecologists have combined their knowledge bases to expand understanding of the economy/ecology interrelationship (Reyers *et al.* 2010), however the concept is likely to narrow the way that ecologists understand ecosystems (Norgaard 2010). Ecosystems may come to be considered principally in terms of stocks and flows rather than 'in terms of population dynamics, food webs, energy flows, interactive behaviors, biogeochemical cycles, spatial organization across landscapes, and co-evolutionary processes' (Norgaard 2010, pp. 1220–2). Increasingly research funding may then go to researchers engaged in this type of ecological thinking and this might greatly 'reduce scientific and public understanding of the true complexities of ecosystems' and 'lead to narrow management and future crises' (Norgaard 2010).

Some economists also believe that an emphasis on ecosystem services will narrow the way the logic and dynamic of economic systems is understood.

The ecosystem approach tends to encourage a project-by-project analysis of ecosystems where it is assumed that the system as a whole (economy and planetary) remains in equilibrium, unaffected by local impacts, thus ignoring cumulative effects. It ignores the vital role of institutions in supporting sustainability and the way institutions vary from region to region (Norgaard 2010).

The neglect of the working of ecological systems and also institutional and governance systems in which projects take place have ensured that an ecosystem services approach skews ecology to inform markets rather than informing governance (Norgaard 2010). For example wetland mitigation banks assume that the value of a wetland can be estimated in terms of acreage and that a wetland in one place is equivalent to a wetland in another watershed, even though wetlands perform specific functions for the surrounding ecosystem (Beder 2006).

Viewing forests as providing ecosystem services such as carbon sinks has led to the growth of plantations without regard to their impact on local water supplies, biodiversity and the livelihoods of local people (Beder 2006, pp. 189–90). What is more, the institutional problems associated with deforestation are ignored in efforts to establish these biocarbon stocks (Gómez-Baggethun *et al.* 2010).

Moreover, the commodification of ecosystem services into markets ensures that they are viewed as exchangeable and therefore substitutable. It fits with the neoclassical economic paradigm of the need to price services provided by the environment, assign property rights and create markets where those rights can be exchanged so that the market can ensure the most efficient allocation of these scarce resources and services through the mechanism of individuals pursuing their individual self-interest (Kosoy & Corbera 2010).

Gómez-Baggethun *et al.* (2010) pointed out that policies that are based on financial incentives endorse the idea that acting in personal self interest is an appropriate response but this can undermine the encouragement of a conservation ethic. Consequently market-based mechanisms shift the motivation for conservation from the realm of morality and communal obligation to that of economic self-interest.

Neoclassical takeover?

All these criticisms of ecosystem services and economic valuation can be found in the ecological economic literature. But does this mean that ecological economics has achieved true interdisciplinarity? Or is the dominant neoclassical paradigm of economics gradually taking over ecological economics, as it has taken over policy agendas?

Ecological economics is interdisciplinary in that it involves the cooperation of people from different scientific disciplines (Baumgärtner *et al.* 2008). Interdisciplinary research can involve the coordination of work from different disciplines, each with their own set of concepts, methods and theories, which are brought together, integrated and analysed to reach conclusions. Interdisciplinary research may, however, go further, and involve some effort to adjust and share concepts, methods and theories to achieve interdisciplinary objectives (Baumgärtner *et al.* 2008).

In contrast, multidisciplinary projects involve people from different disciplines contributing their research results, but they do not cooperate in undertaking their research and there is no attempt to synthesize results. Pluridisciplinary research may involve some cooperation between researchers from different disciplines in undertaking research, but no coordination of research or synthesis of results (Max-Neef 2005).

The founders of ecological economics argue that, rather than creating a new disciplinary 'paradigm based in shared assumptions and theory', ecological economics 'represents a commitment among economists, ecologists, and others, both as academics and as practitioners, to learn from each other, to explore new patterns of thinking together, and to facilitate the derivation and implementation of new economic and environmental policies' (Costanza *et al.* 2007).

How much learning and integration of concepts has really occurred? As ecological economics grew in popularity and academic profile, more neoclassical economists were attracted, particularly as economics journals became more difficult to publish in (Ropke 2005). At the same time, ecological

economists were not accepted within mainstream economics, 'their work has been routinely dismissed or ignored by mainstream economists' (Nadeau 2008).

Ecological economics may be seen as 'methodologically pluralistic', accepting the analytical framework of neoclassical economics among others. (Constanza *et al.* 2007). For example, the Beijer Institute of Ecological Economics, which developed and championed the idea of ecosystem services in the early 1990s (Gómez-Baggethun *et al.* 2010), embraced neoclassical economics and brought together mainstream economists and ecologists to model interactions between ecological and economic systems (Ropke 2005).

The acceptance of neoclassical economics within ecological economics, despite its alien assumptions about substitutability and commensurability and the place of ethical considerations, and its refusal to acknowledge ecological limits, indicates that ecological economics is more multidisciplinary than interdisciplinary. In fact, in the light of developments in the field of ecosystem services, it seems likely that the prospects of interdisciplinarity are receding rather than increasing.

CONCLUSION

Environmental economists have successfully propagated the economic definition of environmental problems, namely that they are caused by a failure to properly price the environment and provide financial incentives to protect it. This approach is now reflected in government policy around the world. Nevertheless, environmental problems continue to grow in severity and the solutions provided by environmental economists have proven to be ineffective. Lack of interdisciplinarity does not prevent the success of a field of knowledge in terms of influence and dominance, however it does impede its effectiveness in terms of understanding environmental problems and how to solve them.

Ecological economics seeks a more interdisciplinary approach, incorporating the research of economists, ecologists, philosophers and social scientists. However, the success of ecological economics in terms of influence seems to be have been limited to areas where it retains the standard economics view of environmental problems (for example ecosystem services), which limits its contribution to effective environmental solutions. Interdisciplinarity, whilst increasing understanding of the real world, has been unable to overcome political and social barriers to translating that understanding into the widespread implementation of effective environmental measures.

While many academics seek interdisciplinarity in their research, the same cannot be said of government ministries, departments and agencies, which are generally divided into specialized domains dealing with stakeholders from particular sectors of the economy. Such stakeholders have a vested interest in avoiding government imposed costs, even if they are imposing environmental burdens on others.

Knowledge alone, no matter how refined and comprehensive, is insufficient to overcome the power of vested interests. It is doubtful that environmental problems can be solved whilst they continue to be defined in economic terms, yet changing the definition of environmental problems will require more than a broadening of knowledge bases. It will require a challenge to the priorities of governments and to the power of business, in particular transnational corporations and their allies. The reliance of governments around the world on economic solutions to environmental problems, for example emissions trading for climate change, is not a reflection of the accuracy or persuasiveness of the environmental economic theories on which they are based, but rather an indication that these solutions suit powerful interests of a business-managed democracy (Beder 2010).

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