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ANALYSIS

Environmental economics and ecological economics: Where they can converge?

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ABSTRACT

Environmental economics and ecological economics share the common objective of understanding the human–economy–environment interaction in order to redirect the economies towards sustainability. In pursuing this objective, these two perspectives utilise different types of analytical framework and are opposed to each other on many of the fundamental theoretical and methodological issues. While the environmental economics has progressed within a narrowly, but sharply, focused neoclassical analytical approach, the ecological economics has expanded by adopting a 'diversified approach', which led to widen the gap between the two. This article makes an attempt to highlight the divergence between these two perspectives on different issues and identifies certain research avenues that would potentially bring convergence between these two perspectives.

1. Introduction

The environmental economics has gradually become a full-fledged sub-discipline of economics after Pigou (1920) who dealt extensively with the analysis of 'negative externality' within the neoclassical framework to correct the 'market failure' (Verhoef, 1999). This Pigouvian neoclassical tradition still continues to dominate the analytical foundation of all stretches of environmental economics (Cropper and Oates, 1992) such as, Coasian solution (Coase, 1960); 'second-best solution' in the area of pollution control (Baumol and Oates, 1988); non-market valuation within micro cost-benefit analysis (Smith, 1993); sustainable development (Pearce and Turner, 1990) and environmental accounting (Ahmed et al., 1989) within macroeconomics of environment (Munasinghe, 2002), making this subject as an 'economically holistic' as well as a powerful branch of modern normative welfare economics. Though the Pigouvian neoclassical tradition embracing methodological individualism, unbounded rationality assumption and efficiency as a criterion for resource allocation had strengthened the analytical foundation of modern environmental economics, this sub-discipline has its own weakness as well. While its strength lies in its analytical rigour and its ability to provide concrete, first-hand solutions to some of the major environmental problems, its weakness is that it adopts a narrow approach which has prevented us from thinking about the 'larger features' (Lazear, 2000) of the environmental and ecological issues. On the other hand, the ecological economics (see Costanza et al., 1997a) emerged in the late 1980s to 'capitalise' this weakness by making effort to incorporate those 'larger features' in the analysis of human–economy–environment interaction. The 'distinguished' analytical approaches used in the ecological economics (see van den Bergh, 2001; Turner et al., 1997; Sahu and Nayak, 1994) in the past have enriched our understanding of the importance of ecological dynamisms in the economic processes. But at the same time, the progress in ecological

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economics during the past one and half decades leads us to ask the following questions: Have the ecological economists succeeded in their objective of 'capitalising' the weakness of environmental economists, despite heavy opportunity cost incurred by them? Have the environmental economists responded adequately to the challenges provided by the ecological economists? Has the gap between these two perspectives converged? What common lessons that the environmental and ecological economists can learn from the recent developments in mainstream economics, especially from the behavioral economics so as to narrow down the gap? This present article makes an attempt to investigate these questions rigorously.

1.1. *On the theoretical and methodological approach*

At the outset, the environmental economics and the ecological economics differ on the basic theoretical framework that they utilise to analyse the underlying objective of understanding the human–economy–environment dynamism. While the former extends the basic premises of neoclassical economics namely, methodological individualism, rationality, marginalism, efficiency criterion and general equilibrium models to analyse the environmental issues, the latter adopts 'diversified' approaches such as energy/entropy analysis and ecological modeling (see Proops and Safonov, 2004). More precisely, environmental economics assumes that environmental issues form part of overall economic issues and therefore, these issues could be well analyzed by extending the existing neoclassical economic tools and principles without altering the fundamental structure of them. At the micro level, for example, the environmental economists extend the 'tractable' models of neoclassical economics such as random utility model (Domencich and McFadden, 1975) or household production function approach (Becker, 1965) to understand how both marketed and environmental goods are being combined by the individuals and the households to produce 'economic' welfare. Various standard non-market valuation techniques are based on the 'weak complementarity' principle suggesting that the marginal utility derived from environmental goods becomes positive *only if* marketed goods are combined with the non-market environmental goods. The major task of an environmental economist here is to employ the standard utility models to analyse how the individuals combine the market and non-market commodities to produce economic welfare, and how this welfare changes in relation to change in the combination of the goods. This implies that the existing neoclassical micro models are capable of dealing with any number of 'sub-sets', including the environment sub-set. At macro level also, the macroeconomists take a similar kind of position. For example, Solow (1974) showed how environmental scarcity could be incorporated within the neoclassical growth models without disturbing the 'tractability' of the models. Similarly, the micro-based macro models developed by Hotelling (1931) and Hartwick (1977) demonstrated how the 'individual rationality' based models can be used to understand the long term relationship between the resource use behavior of the economic agents guided by market forces and its impact on the sustainability of resource use. In recent years, specific efforts were made to incorporate the environment into the neoclassical IS-LM models at the theoretical level (e.g. Heyes, 2000) without altering the fundamental structure. All these suggest that the existing neoclassical economics, in one way or other, could respond adequately to the emerging concerns about the environmental issues as along as the neoclassical tools and principles are understood and used appropriately (see Solow, 1997).

Ecological economics, on the other hand, challenges the entire 'tractability' postulation of neoclassical models in dealing with natural resource and environmental scarcity, even though some of the ecological economists themselves are moving closer to using the neoclassical models in their analyses (see Gowdy and Erickson, 2004). The ecological economists treat the entire economic system as a dissipative structure or a sub-system of global ecosystem (see Gowdy and O'Hara, 1997; Sollner, 1997) which is more complex than understood by the environmental economists. It is argued that with a meager level of understanding of the environmental system, the existing neoclassical models are capable of addressing only a very few environmental issues but are inadequate to incorporate variety of other issues. This is because, the neoclassical models: (a) ignore the natural limits to growth; (b) neglect the important interdependency between economy and environment; and (c) downplay the role of time (Sollner, 1997). Therefore, the ecological economists prescribe not a single approach but a variety of them in order to 'broaden' the neoclassical models to accommodate the larger ecological issues. They rely mainly on the 'methodological pluralism' (Norgaard, 1985) in which important conceptual frameworks such as macroeconomic scale, ecological footprint, long-term sustainability and ecological complexity are constantly used to analyse the environment–economy interaction. Some ecological economists adopt alternative approaches such as institutional approach to analyse this interaction (e.g. Soderbaum, 2000). The insistence on the multiplicity of approaches calls for shifting the focus from the 'abstract model building' of the neoclassical economics towards constructing plural models that would accommodate the 'real' issues. Some of the ecological economists even go to that extent to argue that the present 'narrow' environmental economics approach needs to be replaced with a 'transdisciplinary' approach 'that takes the integration of disciplines a stage further, where not only does one transcend the boundaries of the discipline in seeking understanding, but actually generates new concepts and mental structures which subsume and extend the approaches of even an interdisciplinary approach' (Proops, 1999:1232).

The above discussion suggests that the theoretical and methodological approaches used between the two perspectives have not yet converged adequately. There are obvious reasons for this. It should be noted that environmental economists strongly believe in Adamsmith's 'specialisation' through 'division of labour' which helps them to gain 'comparative advantage' in using the neoclassical economic tools to environmental problems in a more rigorous way. The specialisation sometimes is expected to set the agenda for experts in other disciplines as well. For example, environmental economists argue that the environmental standard-setting by scientists and policy makers should be based purely on the 'economic criterion' namely, the optimal level of pollution determined by the marginal costs and marginal benefits of controlling pollution. This kind of strong view is supported by the ideological position that 'economics' as a powerful subject has not only enriched its own analytical rigour but also created an 'imperialism' by way of explaining the subject matter of other social sciences through its own tools and principles (see Lazear, 2000). Though this 'imperialism' reflected in the environmental economics helped us to solve some of the major environmental problems, the 'narrowness' of the 'tractable' models used prevented us from understanding some of the important environmental and ecological issues such as global warming, loss of biodiversity, etc. One needs to accept the fact that 'specialisation' in environmental economics has gone 'too far'. In contrast, the ecological economics adopts 'too many approaches' such that in recent years some of the ecological economists themselves argue for 'delimiting' the scope of this perspective (Ropke, 2005). One possible way of 'delimiting' the scope is to focus the attention on understanding the 'behavioral issues' involved in environmental decision-making of individuals. In recent years, behavioral and experimental economists demonstrate, using experiments, that how the unbounded rationality assumption of neoclassical economics would lead to non-Pareto optimal outcomes because of existence of boundedly rational behavior of the individuals in real world (see Camerer et al., 2004). The bounded rationality framework has the potential to provide new insights into understanding the human–economy–environment interaction. For example, the bounded rationality school argues that many of the individuals in reality tend to adopt a 'targeting' or a 'satisfying' (Simon, 1986) objective, rather than the 'maximizing' objective as predicted by the neoclassical models. This implies that the interaction of the boundedly rational individuals with the environment would be entirely different from that of the one predicted by the neoclassical economics and therefore, just by understanding the real world behavior of the individuals itself the ecological economists could construct concrete alternative models for analyzing the human–environment relationship. While the environmental economists have already started adopting behavioral issues in their environmental analysis (e.g. Knetsch, 1997), the ecological economists may also adopt a similar kind of approach so that a possible convergence in the theoretical frameworks used could be realized.

1.2. *On treatment of resources*

Though the major objective is to understand the human–economy–environment interaction, the two perspectives approach this interaction in two different ways. According to the environmental economics, an environmental resource deserves economic treatment only if it is 'relatively scarce' and is capable of generating utility to the individuals whereas, the ecological economics treats almost all the ecological resources as equally important in their analysis, irrespective of whether a resource is 'economically' scarce or not. The utility-based approach in the environmental economics is that the resources should be protected for improving the welfare of the individuals. This implies that the resource allocation to protect those resources that generate 'no' economic welfare should be treated as a 'socially' wasteful allocation. On the other hand, the ecological economics argues that independent of the individual welfare, the environmental/ecological resources should be protected for their 'own sake' because the ecology is also part of the whole ecosystem and it deserves equal right for its own survival (Daly and Townsend, 1993). With regard to human–environment interaction, this means that it is mainly the human intervention that leads to alter the ecosystem and therefore, reducing human intervention is the best strategy for expanding the resource base. But this kind of argument provides 'no clue' on how to protect these resources since protection of the resources warrants for a particular form of human intervention. It should be noted that human beings are protecting numerous environmental resources mainly because these resources generate 'useful' benefits to them. Evidences show positive relationship between decline in human consumption and the extinction of the resource base and this suggests that resource management issue is intimately tied up with people's participation (see Lele, 1991). Moreover, protecting the resources through reduced human intervention and expanding the resources through other means are two different issues that require different types of institutional arrangements and policy instruments. If ecological economics suggests that the government has to protect the ecological resources, then it has to focus on the 'government failure' arising from issues highlighted by the utility-based public choice literature (Olson, 1965) — such as, the rent seeking behavior of the policymakers, lobbying groups and their impact on the government policies, property rights underlying the common property resource management and free-riding behavior of individuals involved in resource management, etc. The government failure may also arise from asymmetric information about the 'opportunistic behavior' of the agents involved in the resource management, which will result in unexpectedly higher level of *ex-post* transaction cost (Williamson, 2000). Behavioral and experimental economics underscore that individuals use boundedly rational models in certain circumstances and unboundedly rational models in certain other circumstances (see Conlisk, 1996) and therefore, unpredictable human behavior has some strong implications on the resource management and policy. Suppose the government's resource management policy is based on the unbounded rationality assumption while the individuals concerned utilise bounded rationality model and *vice versa*, then the government's policy would become ineffective in both the cases. For example, empirical work using behavioral game theory suggests that individuals adopt 'intrinsic' reciprocal behavior in an interdependent strategic interaction in which they receive kindness with more kindness and meanness with more meanness (Sobel, 2005). Suppose the 'free riding' behavior is a dominant strategy of few individuals in resource management, then the intrinsic reciprocal behavior implies that the other individuals will be willing to sacrifice their material pay-offs to punish free-riders and this will result in bringing collective action among group members leading to an optimal level of resource management. Since the government policy aims at changing the behavior of the individuals in relation to their resource use, any suggestion for government intervention in resource conservation requires deeper understanding of the individuals' actual behavior. Studying the behavioral issues related to environmental management is a rich, potential area for both environmental and ecological economics to converge.

1.3. On economic valuation

The environmental economics depends on the individual 'preference' based economic valuation that is anthropocentric in nature (Markandya, 1998) whereas the ecological economics, though critical of economic value as such, places importance on alternative values such as energy-embodied value to arrive at 'ecosystem prices' (Klauer, 2000; Judson, 1989; Hannon et al., 1986). The environmental economics justifies estimating the anthropocentric-based 'instrumental value' on the ground that this value reflects the trade-off between resource allocation decisions in relation to the environment and the resulting change in the economic welfare of the individuals. Despite the controversies in estimating the 'theoretically valid' economic values, the environmental economics has progressed tremendously on the economic valuation front (see Smith, 1993). However, since the ecological economics takes a stand that natural resources should be protected independent of human welfare, it downplays the preference-based instrumental value and emphasises more on estimating the 'intrinsic value' (see Turner, 1999). As far as the ecological economics is concerned, it seems that there is no consensus not only on the valuation techniques to be used for estimating the economic values but also on the economic value as such. Some ecological economists seem to reject the 'economic value' on the ground that it does not reflect the social institutions that they are embedded in (see Ropke, 2005). But they fail to understand that the environmental economists are fully aware of the 'institutions' that determine the economic values and some of the valuation techniques such as contingent valuation method do have in-built mechanism to capture the influence of institutions on the stated economic values. Some other ecological economists recognise the importance of economic values and make efforts to estimate the 'intrinsic values' of the ecosystem to show that these values are much higher than the 'instrumental values' estimated by the environmental economists. The famous study by Costanza et al. (1997b) estimated the total economic value of 17 ecosystems of the world using 'willingness to pay' method, which stood at US$ 33.0 trillion per year while the World's gross national product (GNP) itself was US$ 18 trillion per year. However, not only environmental economists but also some of the ecological economists themselves have criticised this valuation exercise as to reflect lack of understanding of economic valuation as such. For example, Smith (1997) criticises this study on three grounds: (i) the WTP measure used in the study is flawed; (ii) the values estimated goes 1.8 times greater than the World GNP which means that the individuals have no budget constraint; and (iii) the study used 'linear aggregation rule' without taking into account the 'ecological feedbacks'. While Norgaard et al. (1998) criticise this study for having oversimplified the 'abnormal task' of economic valuation, Turner et al. (1998) argue that this kind of exercise does not help us to advance meaningful policy debate in efficiency and equity terms, and in practical conservation versus development contexts. Similarly, the other alternative valuation methods that utilise the 'energy based value' theories in ecological economics seem to have lost their value (Ropke, 2005) because of their lack of clarity on the following issues: a) Should goods be valued in terms of direct and indirect energy that they contain? and b) Is there positive correlation between energy and price? However, this does not mean that these alternative valuation theories are less important. They are helpful in providing useful values when such values are not readily available for decision-making (Klauer, 2000). In certain other cases, ecological economists use anthropocentric-based valuation techniques such as multi-criteria analysis (see Martinez-Alier et al., 1998) which possess problems such as lack of theoretical foundation, biases in ranking and too much of importance on physical indicators that prevent any meaningful comparison of costs and benefits. Similarly, other alternative valuation approaches that utilise input–output models (see. Patterson, 1998) provide values whose 'determinism cannot be reconciled with the richness of individual behavior' (Sollner, 1997). As far as the economic valuation is concerned, the approaches between the two perspectives are too diversified.

Though environmental economists depend mainly on the 'behavioral models' for economic valuation, both the environmental and the ecological economists have to learn more from the behavioral economists in order to understand deeper issues involved in the linkage between economic values and human behavior. For example, the environmental economists' tradition of using the stated preference (SP) techniques to elicit the non-use values of environment is being vehemently criticized by some of the behavioral economists. The latter argue that the economic values coming from the SP techniques do not reflect the 'true preferences' of the individuals but they reflect the individuals' attitudes such as 'warm glow' influenced by psychological factors (Kahneman and Knetsch, 1992). The disparity between individuals' willingness to pay (WTP) and willingness to accept (WTA) compensation for commensurate changes in the environment, embedding and scope effects occurring in the results from SP studies are attributed mainly to the behavioral pattern of the individuals that deviates from the 'conventional rationality' behavior. These kinds of behavioral issues have profound implications on the economic values, the process of economic valuation and the resulting environmental policies and this is an area where the ecological economics and the environmental economics could probably devote more attention to.

1.4. On resource scarcity and maintaining capital stock

The environmental economics considers environmental resource scarcity as the Ricardian 'relative scarcity' phenomenon (Barbier, 1989), whereas the ecological economics perceives it as Malthusian 'absolute scarcity' phenomenon. The relative scarcity notion suggests that the physical constraints imposed by environmental scarcity on economic growth can be overcome by incurring additional cost in the economy. The Environmental Kuznets' Curve (EKC) hypothesis (Grossman and Krueger, 1995) is based on this premise only. The analysis of resource scarcity and its impact on the capital stock is embedded in the 'weak sustainability' paradigm which is based on certain important premises, namely: (a) biophysical limits are not relevant for economic analysis of environmental scarcity since the environmental resources come from 'open system' and the biophysical limits are 'technologically dependent' (Young, 1991; Burness et al., 1980); (b) ecosystem possesses heterogenous characteristics which provide flexibility for substitution between different types of resources (Solow, 1997) and therefore, it is not the specific resource that we need to care about but the services provided by these resources that matter to us (see Dasgupta and Maler, 1991); (d) as long as one can exploit the natural capital and invest part of the revenue from its sales proceedings on the man-made capital, the overall income of the economy can be maintained on a sustainable basis (Hartwick, 1977; El Serafy, 1989); and (e) as long as the economic value of the natural capital stock is properly measured, the total economic value of the overall capital stock (man-made and natural) can be maintained in real terms (see Pearce and Turner, 1990) which is a sufficient condition for sustainability. In the case of renewable resources, environmental economists assume that: (i) the renewable resources have the capacity to regenerate in a given time period; and (ii) if the characteristics of a renewable resource become 'non-renewable', then the economic framework used to deal with the non-renewable resources may readily be extended to analyse the renewable resources as well. As we have already discussed, the environmental economists seem to take a strong position that the environmental scarcity can be appropriately dealt with by the neoclassical tools and principles. The neoclassical prescription of maintaining the total capital stock basically underestimate the role of bio-physical constraints in slowing down the economic growth, if not hampering it. But, some of the environmental economists (e.g. Pearce and Turner, 1990; Pearce et al., 1990) do recognise that the natural capital stock plays a multi-functional role and there are irreversibilities and uncertainties and therefore, they support the idea of maintaining the natural capital stock 'independent' of man-made capital stock. More precisely, the 'existing level of natural capital stock' (what actually exists after use) is found to be lower than the 'natural level of capital stock' (that could exist under undisturbed natural condition) and the 'optimal level of capital stock' (determined by neoclassical optimality principle) and hence, the environmental economists seem to agree that at least the 'existing level of capital stock' should be maintained independently (Pearce et al., 1990).

The ecological economists, on the other hand, extend the absolute scarcity framework to show how the irreversibility and other bio-physical limits of the 'closed' ecosystem would constraint the growth of economic sub-system (Costanza and Daly, 1992). The policy implication is that the 'critical natural capital' which performs important and irreplaceable functions with the dynamic feedback effects on the economy need to be protected via standards and regulations rather than by *in situ* valuation underlying the notion of maintaining the total capital stock (Turner, 1999). Moreover, the weak sustainability argument of the environmental economists does not reveal whether the substitutability or commensurability is good or bad (Ekins, 2003). Since this is not a problem in the 'strong sustainability' paradigm, it is argued that one has to start with the strong sustainability and then cautiously move on to weak sustainability (Ekins, 2003). Since this idea presumes that the resource is 'initially not scarce', this does not work well under the following conditions: a) when an economy's existing level of natural capital stock is much lower than a level required for strong sustainability; (b) when the social discount rate for the natural capital is high due to some binding reasons such as poverty eradication; and (c) when the *ex-post* transaction cost of moving from strong sustainability to weak sustainability is prohibitively high. The last point suggests that since the transaction cost of the choices of resource use plays a major role in alternative environmental decisions, important resource use decisions depend on how 'economically critical' the natural capital is. This again places importance on the behavioral issues in relation to resource use, where inputs from behavioral economics can enrich our understanding of maintaining the natural capital stock in an economy consisting of individuals with different mental models. Take for example, the discount rate which plays a crucial role in assessing the sustainability of resource use. The environmental economists rely mainly on the exponential discount rates for assessing the sustainability through cost–benefit analysis, which suggests that the preferences are constant across time period. But, the 'experimental evidences' show that the discount rate used by the individuals to value the benefits and costs across time period is 'hyperbolic' or 'present-biased' (Laibson, 2003) affecting the sustainability in a different manner. Similarly, behavioral economists have found that individuals follow 'mental accounting' principle which suggests that the substitution between different environmental goods and services in consumption and production functions is not smooth (Knetsch, 2005). These kinds of behavioral issues complicate the decision on which sustainability paradigm one has to start with and therefore, achieving environmental sustainability lies mainly in understanding the behavior of the individuals and designing institutions accordingly.

1.5. *On role of technology*

Within the Ricardian relative scarcity framework, the environmental economists are optimistic that in the short run, incurring additional cost on innovative technologies can reduce the potential constraint on economic growth imposed by the resource scarcity. In the long run, the most cost effective technologies are expected to emerge in the market, since the technological advancements are considered to pass through the Darwinian evolutionary process. In the initial stages of economic development, technological inertia makes the environmental progress more sluggish because of the strong 'perception' of the economic agents on the trade-off involved in the resource allocation between environment and development. Since the technological advancements are assumed to be enhanced by income growth, the proponents of EKC hypothesis prescribe allowing the national income to grow faster so that the trade-off can be harmonized once the economy attains a particular level of per capita income (Stern, 2004). The idea of allowing the income to enhance the technological innovations, indeed, oversimplifies the welfare consequences of not addressing the environmental problems during the initial stages of development. Alternatively, it is argued that implementing stringent environmental measures themselves could provide incentives for the rational entrepreneurs to adopt innovative technologies leading to 'double-dividend' namely, improved environmental quality and increased economic efficiency (Porter and van der Linde, 1995). However, this alternative idea of pushing environmental quality into the first place also runs into difficulties. For example, the market may not provide adequate signals to the entrepreneurs about the efficient and the innovative technologies (Cleveland, 2003); the uncertainties and complexities involved in the ecological systems make technological solutions more difficult (see Turner, 1999) because the technical change relies, for example, on energy inputs of increasing quality that is constrained by entropy (Cleveland, 2003). For the above reasons, the ecological economists are skeptical about the role of technology in solving the environmental problems. It is argued that not only that the technology had not solved many of the past environmental problems but also it had created several new problems (Daly and Cobb, 1989) imposing social costs on the economies. Even though the environmental economists are optimistic about the technological solution for environmental problems, they do agree that the existing political, institutional and policy regimes in a given economy may induce technological 'inertia' (Mokyre, 2000) that prevents innovative technologies being adopted in the environment sector. For example, existence of lobbying groups with vested interests, existence of large number of resource using agents in the unorganized sectors, etc. would lead to increase the transaction cost of moving from one technological regime to another. This implies that the technology *per se* is not an issue but it is the relevant institutions in the economy that need to be set right for eliminating the technological inertia (see Fernandez and Rodrik, 1991). Apart from institutional and ecological constraints highlighted by the environmental and ecological economists, the behavioral economists bring new insights into the existing debate by showing how the 'cognitive constraints' experienced by the economic agents may lead to adopting inefficient technologies even if innovative technologies are available in the economy. In an economy which consists of large number of boundedly rational agents, the cumulative error (Akerlof and Yellen, 1985) due to adopting an inefficient technology would affect the sustainable path of the economy. Other behavioral issues such as endowment effect that will make the firms not to give up the inefficient technology in order to adopt the efficient one, status-quo bias in enjoying certain private benefits from the existing inefficient technology, incentives for the firms to behave reciprocally with other firms as well as with the government agency in an interdependent environment, incentives for the firms not to adopt environment friendly technology in order to fulfill other concerns such as labour welfare, etc. provide more deeper insights into the debate on the role of technology in addressing environmental problems. At present, there seems to be no consensus on the role of technology in achieving sustainable development but such a consensus may emerge if the focus is shifted towards understanding how the institutional and the behavioral issues potentially affect the efficacy of different technological regimes.

1.6. On population and consumption

Regarding the question of population and environment, the environmental economists seem to take a 'revisionist' position treating population growth as not a major threat to the environment (see Birdsall, 1989), and any impact of population growth on environment is mediated through factors such as innovation, efficiency in resource use, level of human capital, technological changes prevalent in an economy and economies of scale in the production process (Panayotou, 2000). Though the neoclassical growth models predict an inverse relationship between population growth and the productivity influenced by diminishing returns (Kelley, 1998), the environmental economists take a position that the nature of this relationship depends on the level of market structure, rate of regeneration of resources, degree of vulnerability of the resource base and the existence of well-defined property rights (see Birdsall, 1989). More precisely, perfect markets accompanied by the innovative technologies are assumed to play a role in counteracting the diminishing marginal productivity of environmental resources (Barnett and Morse, 1963; Panayotou, 2000). The work on economics of demography by Becker (1991) suggests that the population control should be determined mainly by economic factors such as, increase in income and women's employment. In many developing countries, the population growth is found to be influenced by deterioration in the environmental quality that affects income of the poor households both directly and indirectly and therefore, extension of Becker's (1991) suggestion to the environment implies that population control could be effectively achieved through improvements in the environmental quality (see Dasgupta, 1993). Some optimists argue that the increased population and the resulting population density lead to improved agricultural productivity, through institutional changes (Boserup, 1980). Though this hypothesis proved to be empirically valid in some of the countries, it has failed to take off in many other countries because of the collapse of traditional institutions of the poor due mainly to consequences of population explosion (Lopez, 1992). However, the one-to-one relationship between population and environmental degradation is inconclusive, because some empirical studies have also found 'underpopulation' as the source of environmental degradation (see Lopez, 1992). In environmental economics, therefore, the economic and institutional factors play dominant role in explaining the link between population growth and environmental deterioration. But the ecological economics assumes population as the 'consuming unit' of natural resources and more population is assumed to have non-linear negative impact on the natural resource base. This reflects the view of Boulding (1966) who argued that the limited 'carrying capacity' of the environment, disturbed by increase in population growth and consumption, would ultimately lead to sink the closed system of the 'spaceship earth'. Similar 'neo-Malthusian' view was echoed by Erhlich et al. (1977) who argued that any impact on the environment is a function of population, affluence and the technology and a change in one particular variable would have its reinforcing effect on another variable ultimately affecting the environment negatively. It also implies that when there is an uncontrolled growth in population, the technology would not provide any solution to environmental crisis and in many cases, as we have already seen, the technology itself is environmentally destructive. Therefore, any solution to environmental problem fundamentally lies in compulsory population control (see also, Ehrlich and Ehrlich, 1990). This extreme idea of forced population control fails to understand the resulting negative welfare consequences of reduced population on the households, especially in developing countries. Treating population as homogenous and a single consuming unit ignores the behavioral aspects that would enhance non-environmental benefits in the economy. As Arrow et al. (1995) point out, the solution to environment related problems lies in the economic institutions that shape the 'human behavior' and this implies that it is not the population as such but the institutions shaped by human behavior that determine the level of environmental quality. For example, achieving sustainability depends on characteristics of human behavior such as labour allocation decisions determined by whether the households adopt 'targeting' objective or 'maximising' objective, the households' perception about the 'reciprocal behavior' of other agents in utilising the resource and in other dispute settlement mechanisms, the households' choice between 'exponential discount rate' and 'hyperbolic discount rate' in resource consumption decisions, individuals' perceptions about the 'losses and gains' from participation and resource use, and their beliefs about protecting the environment. Using more behavioral issues in analyzing the population–environment linkage in both environmental and ecological economics is warranted for a possible convergence of ideas in the two perspectives.

1.7. On equity and welfare

Environmental economics takes a stand that environmental policy should focus more on achieving efficiency or Pareto optimal outcomes in the economy and this would lead to ensure the intragenerational equity aspect in the following ways: the environmental deterioration in real world affects the poorer section disproportionately and therefore, mitigating the environmental problems would benefit this section more than others; and, income growth is assumed to play a pivotal role in addressing the intragenerational equity issues through increased opportunities for the poor easing their hardship arising from their dependency on the deteriorated environment. So, the better way of bringing intragenerational equity is to address the environmental problems and increase the economic opportunities to the poor by way of improving the efficiency in the economy (see Dasgupta and Maler, 1991). This assumes no trade-off between efficiency and intragenerational equity in real sense but the efficiency in resource use is considered to play a 'complementary role' in dealing with intragenerational equity through expanding the size of the benefits. The environmental economists have devised some of their important instruments in such a way that they can capture the equity related issues as well. For example, in the widely used 'stated preference (SP) methods' the poors' zero willingness to pay values are *not* treated as 'no value' (against the argument of Martinez-Alier and O'Connor, 1999) but are assumed to be influenced by income constraints. So poors' value also counts in the social cost–benefit analysis and in the subsequent policy decisions such as, transfer of monetary compensation. On the intergenerational equity front, the environmental economics takes a straightforward position that maintaining the Hicksian income at least constantly over a period of time would automatically ensure the intergenerational equity (Hartwick, 1977; El Serafy, 1989). Nevertheless, the ecological economics sees distributional issues as a major cause of environmental deterioration and therefore, it favours addressing the equity and efficiency concerns 'separately' (Martinez-Alier and O'Connor, 1999) — especially, addressing the equity issues through other non-environmental means such as, reduced population growth and reduced consumption (Daly, 1999). As Howarth and Norgaard (1992) succinctly put it, the intergenerational equity and sustainability depend mainly on the commitment of each generation in transferring resources for the future generation which is determined by the endowment of property rights, income distribution, and preferences across generations. It should be noted the distributional issues are more intriguing than viewed by the environmental and the ecological economists. Recent developments in behavioral economics points to a possible disparity in the economic welfare caused by the income distribution between *ex-ante* and *ex-post* situations, which is influenced by the psychological factors such as endowment effect. For example, the environmental losses are valued greater than the commensurate gains which implies that taking away the environmental benefits enjoyed by the individuals lead to impose more welfare loss than the future welfare gain derived from equal amount of benefits (see Knetsch, 2005). This means that the smooth transfer of part of the benefits from the 'gainers' of the environmental projects to the 'losers', as predicted by the neoclassical Hicks–Kaldor compensation criterion, becomes more difficult in the presence of endowment effect. Since these behavioral issues provide new insights into the distributional issues and their welfare consequences arising from alternative environmental decision-making, more of these inputs need to be used in environmental and ecological research dealing with the distributional issues and sustainability.

2. Conclusions

The environmental economics and the ecological economics aim at understanding the issues involved in human–economy–environment relationship in order to redirect the economies towards sustainability. While the environmental economics has pursued the relevant issues within the neoclassical approach in a systematic manner, the ecological economics progressed through using a 'diversified approach'. This has resulted in making these two perspectives diverging from each other on many different aspects. Though a narrow path was followed, the environmental economics has proved to be 'analytically rigour' and more effective in influencing policymaking. The 'pluralistic' approach adopted in the ecological economics is considered to be highly 'challenging' but it seems that its scope has become 'too vast' focusing on too many areas. The ecological economics has not yet provided any concrete and widely accepted theoretical framework to deal with the ecological issues. Moreover, there are unresolved problems within other disciplines that make the 'inter-disciplinary' approach of the ecological economics a difficult task. Similarly, the strong ideological positions taken by the researchers not only among different disciplines but also within the ecological economics make hurdles for inter-disciplinary research. Therefore, the gap between the environmental economics and the ecological economics seems to be widening further. Now, the major challenge for the researchers is to narrow down this gap. The recent developments in mainstream economics provide more room for 'intra-disciplinary' research that would help us reduce the gap between these two perspectives. The developments in behavioral and experimental economics do challenge the very postulates of mainstream neoclassical economics and provide some useful insights that are relevant for the environmental and ecological economics research. The best way is to start looking at the interface between environmental economics, ecological economics and behavioral and experimental economics and set a common research agenda for an 'intra-disciplinary' research. This, however, would require the researchers to accept one aspect namely, the 'human behavior' as the central theme of the research agenda because, the entire focus of the behavioral and experimental economics is on human behavior with more emphasise on the 'methodological individualism'. Since the neoclassical economics framework used in the environmental economics can readily be extended to incorporate the 'behavioral issues' into it, it may be somewhat problematic in the case of ecological economics since some of the ecological economists are still skeptical about individual behavior and methodological individualism. It should be noted that the mainstream neoclassical economics has indeed accepted 'inter-disciplinary approach' as a useful tool for economic analysis up to that level where the inputs from other disciplines could help the economists to understand 'the human behavior'. So, subjects that do not contribute towards understanding the human behavior or that reject it will not be acceptable to the neoclassical economists and in this regard, the ecological economists can play a major role in making the neoclassical economists improve their understanding of the ecological issues, by way of focusing more on behavioral issues in future.

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