ENVIRONMENTAL ECONOMICS AND SUSTAINABILITY IN THE AGE OF GLOBAL CHANGE

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Keywords: Environmental Economics, Sustainability, Neoclassic Approach, Ecological Economics, Institutional Environmental Economics.

Contents

Summary

Three basic concepts to develop economic recommendations for environmental policy and the distribution of financial burdens to protect environmental resources are presented: neoclassical models of environmental economics, the argumentation within an ecological economics framework and the methodology of an institutional approach to analyze environmental policy. These concepts serve in general to discuss solutions for three basic problems of environmental policy in a modern society: growing and changing uncertainties about environmental cause-effect-interrelationships, innovations to prevent environmental damages and their evaluation, legitimation of restrictions to use scarce environmental resources in a pluralistic and globalized society, and coordination of competing claims on environmental resources according to general objectives of efficiency and sustainability in a world with diminishing powers of the nation states. By describing and comparing the lines of arguments and remaining questions within the concepts, the contribution stresses the relevance of a combination of the different approaches by institutional procedures which connects the creative power and decentralized processing of information by private markets with new measures to overcome social dilemma situations and asymmetries of information. The limits of public power to enforce restrictions to use environmental resources will lead to new developments of institutional solutions which depend heavily on the initiative of private consumers, entrepreneurs and organizations. Thus, environmental economics has to be integrated into a general discussion of sustainable institutional pathways for modern societies.

1. Imperatives of Environmental Economics and Environmental Policy-making

1.1. Environmental Economics and Life Support Systems

The growing scarcity of basic environmental functions has been accompanied in recent decades by the increasing importance of environmental economics within general economic policy-making. From the economic viewpoint, all decisions relating to the planning, implementation and financing of action to protect the environment are calculations in which the respective costs and benefits of preserving ecological functions (life support systems) are weighed up over the respective time frame. The scarcity of ecological functions and the options for preserving them, compel decision makers to choose between competing, situational and individually specific plans for protection and use of resources, whereby competition also operates at international and intergenerational level. Environmental or resource protection are the terms generally used in the following. Given that use of environmental resources may also help to preserve life support systems, and that specific decisions regarding measures to protect the environment invariably involve weighing up the anticipated benefits of available life support systems against the costs, including opportunity costs, that are generated, the actual use of life support systems is also being referred to at the same time. The lack of coordination between separate plans for environmental resource management leads to overexploitation, and hence to a greater likelihood of life support systems being lost within a short time frame. The field of environmental economics is concerned with the legitimation and specification of procedures for coordinating competing plans for natural resource management, whereas environmental policy-making, based on economic considerations is aimed at implementing these theoretical concepts in actual practice.

In the past, applying economic concepts was often rejected by environmental policy-makers because it was deemed unethical to monetarize natural processes. The incessant threat to the natural basis of life, a threat that political decisions frequently exacerbate rather than mitigate, underlines the importance of thrifty, efficient stewardship of those resources that are still available. Today, this principle is all the more relevant in view of the different environmental problems now being faced. Formerly, pollution problems were predominantly local, temporary, manageable and perceptible—how to achieve clean air, protect the quality and supply of freshwater resources, or eliminate hazardous waste sites—the sheer complexity of the problems is now mounting in a context of increasingly international and intergenerational dimension of environmental conflicts. Not only are environmental changes observed throughout the world at more and more places and with ever-greater diversity and intensity, such changes are also linked to each other in the context of 'global change' by ecosystemic interdependencies and economic integration. Broader concepts of resource protection are therefore discussed in terms of sustainability, which encompasses not only the observance of international and intergenerational impacts on the environment, but also the interactions between the use of environmental resources, the organization of society, economic efficiency and social security. With this more fundamental task in mind, three paradigms of environmental economics are presented below, each of which arose at a different time and with a different focal direction. These paradigms are

(a) environmental economics of the neoclassic variety;
(b) ecological economics; and
(c) institutional environmental economics.

A comparison is drawn between their respective

- understanding of the coordination problem from the viewpoint of environmental economics;
- methods for surmounting the coordination problem; and
- recommendations for political action.

To illustrate the basic observations made by each, the comparison refers to the implications for three environmental problems viewed as typical for modern conflicts with international and intergenerational dimensions:

- mitigating the anthropogenic greenhouse effect;
- preserving global biodiversity; and
- decisions on how to manage substances whose opportunities and risks are largely unknown.

The key characteristics of these problems are briefly outlined in the next section.

1.2. Modern Environmental Conflicts and the Expanded Time-Space Dimension

What these three problems have in common are the global and intergenerational impacts of failing to protect the environment. Nevertheless, there are differences in the way that the underlying coordination problems are characterized, and these differences highlight the manifold challenges facing environmental policy-makers in the modern age. The core issues in combating the anthropogenic greenhouse effect are how to allocate the finite capacities of the atmosphere, to inventorize greenhouse gases and subsequently to regulate world climate. When greenhouse gases increase in the atmosphere, regardless of where emissions occur, average global temperatures are expected to rise in the long term, with consequences for vegetation, sea level, ecosystems and ultimately, therefore, for living conditions worldwide. This problem is characterized by

- the long period that elapses between greenhouse gas emissions and the anticipated climate change;
- the global dimension of temperature rise, regardless of where emissions occur;
- differences in the local impacts of temperature rise; and
- the obvious connection between greenhouse gas emissions and specific activities, ranging from the burning of fossil fuels to the clearing of boreal and tropical forests, activities that are carried out at differing intensities throughout the world.

What is needed, therefore, is global coordination regarding the imperative overall reduction in greenhouse gas emissions as well as a distribution of the costs of adjustment on the way to achieving such a reduction target. Consideration must be given here to differences worldwide in the severity of temperature rise impacts, in adaptability to a reduction target and to the volume of each country's own emissions. Furthermore, decisions are taken in a state of uncertainty, in that all predictions of climate change have been subjected to just as many changes as have forecasts of the costs of emission reduction and of adapting to climate change. Environmental economics is therefore called upon to provide statements pertaining to the legitimation of global reduction commitments and the distribution of adjustment costs in a context of scientific uncertainty and worldwide divergence in the causes and origins of damage.

In the field of global biodiversity policy, such a clear-cut ascription of causes and ensuing damage is marked by a high level of uncertainty. Such uncertainties relate to

- the stock of biodiversity and the uses that it provides today and in the future;

- specific sources of ongoing threats to biodiversity, and basic approaches to mitigating them; and
- engineering international coordination between the people involved in the economically stronger and weaker countries, given that the capacity for commercial exploitation of resources is concentrated in the economically powerful yet biodiversity-poor nations, whereas the pressure to exploit such resources is increasing in biodiversity-rich yet economically weak countries due to the lack of short-term alternatives to preserving biodiversity.

What is needed here first and foremost are incentives to show willingness to negotiate and pay in order to preserve global biodiversity, the options for using, which will not be realized in many cases until some time in the future, and which are at risk of being destroyed irreversibly before they can be activated. Solving the problem of international coordination also requires ways for overcoming the uncertainty besetting international coordination such that the variety and complexity of specific situations can be adequately taken into account.

Uncertainty is also the basic shortcoming for the third environmental problem in our analysis. In general, every use of environmental resources is confronted with the basic lack of understanding of the whole complexity of ecosystem processes. The growing number of substances in use, the interrelations between specific substances and the range of uses to which substances are put, all act to intensify the uncertainty that extends from the impacts of using a particular substance to ways of disposing of hazardous substances. This uncertainty thus relates to

- potential sources of hazard and their identifiability;
- cause–effect relationships in the development of environmental damage, which may not materialize until much later in time; and
- basic approaches for mitigating risks that ensue.

As in the case of global biodiversity, the key issue is to create incentives for expanding the socially available knowledge base. However, whereas in the case of biodiversity protection, information about use options are at least latently available and must be activated above all by surmounting the problem of international coordination, in the case of substance management policy the primary need is to generate, disseminate and apply additional knowledge, based on experience, about the risks associated with substances and how these risks can be confined. Accordingly, economics is expected to provide information about how societies can adapt to a continuously changing state of knowledge and adopt subsequent decisions on the deployment of substances.

This brief overview of problems beleaguering environmental policy-makers in the present age is a clear illustration of the complexity of tasks that environmental economics needs to master. However, quite aside from the specific characteristics of particular environmental problems, the challenges they pose for environmental economics possess some common features. A summary analysis of these shared aspects is followed by comparison of the three conceptual approaches in environmental economics.

1.3. The Contribution of Environmental Economics Towards Solving Complex Coordination Problems

Basically speaking, environmental economics analyses decisions concerning the allocation of scarce environmental resources among competing consumers, whereby demand may relate to the distant future and elementary biocentric concerns. As concepts in environmental economics have developed and been applied, three problems have proved central for the identification and enforcement of a socially acceptable and lasting resolution regarding the protection of basic ecological functions. They are therefore of paramount importance for the three aforementioned environmental problems as well:

- the continuously changing, but never fully surmountable, problem of uncertainty about scientific conclusions regarding environmentally relevant cause–effect relationships;
- the consideration of normative concerns when deciding on how to distribute the available scope for using environmental resources in accordance with the sustainability principle;
- the implementation of interventions, informed by environmental economics, in individual and situation-specific decisions regarding the use of environmental resources.

In the preceding section, reference was made to *uncertainty* at several points. Uncertainty arises, first, in contexts where the boundaries of natural scientific knowledge are shifting. A constant flow of new research studies, growing experience, and assessments of existing knowledge lead to changes in the assessment of the benefits and costs of preserving natural life support systems, in the analysis of causal factors threatening the environment, in the identification of damage potential, and the development of strategies for preventing and eliminating environmental degradation. The implication for environmental economics is that it is essential, on the one hand, to emphasize the importance of incentives for developing, disseminating and applying such knowledge, in order to widen the scope for action on the part of environmental economics and to enhance the precision with which measures of this kind actually achieve their objectives. On the other hand, there is a need for greater flexibility in developing strategies for protecting life support systems, so that new knowledge can be integrated and applied. Conversely, irreversible investments in certain approaches to environmental protection could narrow the scope for action on a lasting basis.

One of the most scintillating and frequently used terms to be used in environmental policy-making in recent years is sustainability. In applying the term, reference is usually made to two different dimensions of modern environmental policy-making. On the one hand, the distributional impacts caused at international and intergenerational level by environmental resource use are becoming critical factors for policy decisions. The question is raised about the extent to which globally unequal access to environmental resources and irreversible changes in the scope available to future generations can be legitimated. On the other hand, this question is embedded within a societal context. Attention is focused not only on the long-term patterns of environmental resource use, but to an equal extent on how these patterns interact with the scope for socioeconomic, political and technological development. Sustainability is understood to involve a holistic and critical assessment of the normative goals of a given society and the extent to which these goals can be achieved. Given the global disparities in conditions and value patterns, normative goals are found to be highly differentiated. The task of environmental economics in this context is to point out ways in which these competing and sometimes mutually exclusive normative goals can be coordinated, and to draw attention to the conclusions that derive from such coordination for environmental decision-making on distributing use options in respect of environmental resources, the specific design of measures to protect the environment and ways to finance them.

Concepts in environmental economics essentially serve as legitimation for decisions concerning the exploitation of environmental resources and also for analyzing the impacts of different regulatory frameworks for protecting the environment. Key foundations are thus provided for environmental policy-making. Yet if this function is to be fulfilled and acquire relevance for societal policy, it is necessary to concentrate attention on the conditions for action that frame specific decisions on using environmental assets. The implementation of environmental economics concepts is conditional on due consideration being given to the capacities and incentives for action on the part of those affected in the particular situation; both in private contexts and in political-administrative procedures. Given the complexity of interactions in social and economic processes, and the differences in the situational conditions for action, a high level of differentiation and situational flexibility in discharging this social management task is required of environmental economics.

	Uncertainty	**Normative dimension**	**Implementation**
Climate policy	Origin of damage, options for adaptation	Distribution of the costs and burdens of adjustment	Institutional capacities for monitoring and enforcing agreements
Biodiversity policy	Options for using resources, global coordination	Allocation of potential yields from resource use	Global coordination of potential exploitation and protection of resources
Substance control policy	Causal relationships, experience of use	Risk distribution	Incentives for disclosing and applying knowledge gained from experience

Table 1. Examples for the Complexity of Coordination Tasks in Environmental Economics

Table 1 provides a short overview of the special conceptual challenges for environmental economics posed by modern environmental conflicts, and how these specifically relate to the three examples cited.

These coordination tasks form the starting point for the following comparison of basic arguments and open issues within the various conceptual approaches. We start with the neoclassic approach to environmental economics.

2. The Neoclassic Approach to Environmental Economics

2.1. Starting Point: Optimal Protection of the Environment and the Failure of Private-Sector Markets

Environmental economics initially ensued from the transfer of general, neoclassic objectives and methods to issues involving the use and exploitation of environmental resources. The reference criterion in neoclassic models is the achievement of optimum welfare, which according to the Pareto model is usually equated with a state from which no change in the allocation of resources is possible that makes nobody worse off, but makes at least one individual better off in society. In this way, the highest surplus use possible in a society is achieved when allocating scarce resources. It has been proved, with the help of general equilibrium models, that such an optimized Pareto allocation can be achieved in markets that function in an ideal-typical manner, with atomistic competition, total market transparency, homogeneity of goods, infinite speed of response by markets, and rational economic behavior by every *homo oeconomicus*.

Deviations from this ideal model give rise to losses in welfare, and correctives must be made to markets in such cases. In view of the collective nature of most environmental resources, e.g. the Earth's atmosphere, and the manifold informational asymmetries between users of environmental resources, e.g. between producers, consumers and disposers of particular substances, markets for environmental resources can never function in an ideal-typical way. This results in externalities, the private and social costs of using environmental resources diverge, and too little resource protection is carried out from the societal perspective. Therefore, neoclassic environmental economics usually defines its responsibility as showing the consequences of inadequate internalization of external benefits and costs, based on calculations of ideal-typical pathways of environmental exploitation obtained by applying general equilibrium conditions, in order to provide environmental policy-makers with quantitative figures on imperative changes in the prices for environmental resource use and/or permissible forms of environmental resource use. This procedure is explained in the following with regard to its response to the three challenges facing modern environmental economics.

2.2 Basic Features of Neoclassic Environmental Economics

2.2.1. Cost-benefit Analyses as the Answer to Informational Problems

From the economics perspective, the informational problem that societies are facing is essentially to identify preferences for the conservation of environmental resources, the costs involved and the temporal preferences to be taken into account. Within this context, Adam Smith introduced the notion of the market's "invisible hand," which concentrates and coordinates such information in a semi-automatic way, without having to burden individuals with this complex task. Neoclassic economics elaborated this notion to obtain the ideal-typical conditions of a perfect market in which this informational service is optimally performed. At the same time, any failure to achieve these conditions, i.e. the occurrence of externalities, indicated the need for correctives to the 'invisible hand', since not all information on environmental preferences are taken into account.

To establish the extent and the distribution of essential correctives, recourse is made to cost-benefit analyses, i.e. the benefits derived from the conservation of environmental resources are compared with the costs required, and corresponding measures are economically legitimated as long as enhanced protection of the environment is expected to generate a surplus benefit. The costs involved must be allocated either to those causing such pressures on the environment, or to society in general as the beneficiary of environmental conservation. Since the conservation of environmental resources is bound up to a major degree with intrinsic values that can be objectivized and monetarized to a limited extent, various approaches have been developed over the years for identifying preferences, but without any complete inventory being achieved. Models have been increasingly refined so that long-term causal relationships and the dynamics of social and technological processes can be taken into consideration. Uncertainty about cause-effect relationships and long-term trends were included in the models using risk parameters, as were policy negotiation processes between rational economic persons in models based on game theory. However, these extensions and improvements to the basic models alter nothing as far as the fundamental direction and perceived task of such models are concerned. Numerous models for calculating the benefits and costs of global climate protection, for providing economic legitimation to the conservation of biological resources, and for identifying and assessing material flows are illustrative of the unchanging importance of this method.

2.2.2. The Unbridgeable Gap between Positivism and Implicit Value Judgments

Despite the focus on a social welfare criterion and the utilitarian foundations thus implied, neoclassic environmental economists conceive themselves as positivist scientists that analyze relationships between individual preferences, technical options, ecosystem response mechanisms and their implications for social welfare, without any explicit legitimation in the form of valuation. Normative distribution issues are subordinated to a cost-benefit understanding of optimized allocation; distributive goals represent exogenous restrictions on the models, and are neither analyzed nor endogenously legitimated in such neoclassic models. Accordingly, the sustainability paradigm as applied also by neoclassic economists pertains to the relationships between present-day decision-making on environmental resource use and its consequences for the intergenerational and international distribution of access to environmental resources. By applying social time preference rates and assumptions regarding the substitutionality between environmental resources and other production factors in society—real capital, knowledge, human capital—intergenerational pathways for resource use are calculated, that maximize social welfare over time on the basis of available exogenous assessments. Restrictions on substitutionality and distributive concerns are taken into account in such maximization as secondary conditions that must be met.

This attempt at expressly waiving any normative judgments automatically gives rise to normative consequences. Strict concentration on calculating utilization pathways providing efficient allocation can lead to socially unacceptable impacts being legitimated, for example, to the costs for conserving biodiversity being concentrated on economically weak countries, or to the under- or over-estimation of the costs of adapting to climate change, leading in turn to the irreversible loss of numerous species or to the irreversible change in the natural living conditions on Earth. Neoclassic economists have often been accused of cynicism for this reason. On the other hand, integrating secondary, distributive conditions within the sustainability paradigm makes it difficult to legitimate the model outputs, since there is no information available on how these restrictions are ascertained and substantiated. They can therefore place excessive demands on those involved when all-too-drastic changes in the use of environmental resources are demanded, or can trigger unwanted repercussions when irreversible limitations on the scope available to future generations are permitted.

The normative dimension to the conclusions of neoclassic models is further bolstered by the assumed behavioral patterns of a rationally acting *homo oeconomicus*. It is assumed as a basic principle that individual preferences are immutable, that they are influenced neither by decision-making procedures for the protection of environmental resources nor by observing the impacts of using such resources. However, this assumption is again based on a normative decision regarding the underlying principles of individual preferences and how they are formed. Thus, although neoclassic approaches provide no information substantiating implicit normative assumptions, applying these assumptions provides the economic legitimation for forms of environmental exploitation that have major normative consequences for society, for all the predominantly positivist aims of such analysis.

2.2.3. Implementation as a Sociotechnical Process

Based on the calculation of divergences between optimal welfare in markets that function along ideal-typical lines and the actual results of private markets, the political sphere is compelled to deploy environmental economic instruments so that identified externalities are internalized. The starting point for such an approach is usually the internalization levy proposed by A. C. Pigou, the level of which is adjusted continuously to the amount of externality that exists. (An internalization subsidy for protecting the environment would be a conceivable alternative here, and would be adjusted to the amount of positive externalities due to the availability of environmental resources.) In view of the problems involved in calculating such a single-case-based level, neoclassic environmental economics tends to prefer models in which such levies are designed to ensure compliance with nationally defined maximum standards of permissible environmental exploitation, based on cost-benefit calculations (the standard price approach). Also conceivable in this context are limitations on the permissible maximum standards for environmental exploitation on the basis of cost-benefit models in which tradeable permits are negotiated between those with a demand for environmental resources. In the examples cited, proposed solutions include global models for CO_2 levies and markets for tradeable permits in the fields of climate policy, land use levies and species use permits (e.g. in fisheries), or levies on the use or disposal of particular substances. The role assigned to environmental policy-makers in this context is to enforce and monitor such instruments. Given the ideal-typical calculation of the incentives generated by these instruments among rationally acting individuals, it is then anticipated that behavioral patterns in society in respect of environmental resource use will adapt accordingly. Based on observed deviations from the anticipated behavioral responses, modifications are made to the underlying assumptions of the model; for example, levies can be gradually adjusted in a process of trial and error until they ensure a level of environmental resource use that will provide optimal welfare.

The core elements of the neoclassic approach are briefly summarized in Table 2.

Characteristics	Neo-classic approach
Information	Cost-benefit analyses

management	
Sustainability approach	Maximization of social benefits under secondary, distributive conditions
Implementation	Mechanistic deployment of economic instruments based on incentives
Consequences for climate policy	Global tax and levy systems, distributing the burden of reduction on the basis of anticipated surpluses in potential resource use
Consequences for substance control policy	Material flow management by imposing levies
Consequences for biodiversity policy	Global levies and tradable permits for land use and species exploitation

Table 2. The Approach Taken by the Neoclassic Variety of Environmental Economics

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Biographical Sketches

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