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Striking the balance: economics and the environment

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The environment has many of the properties that economists associate with the concept of a public good. It has long been realized that, if left to itself, the market economy is likely to lead to an undersupply of public goods and, in the environmental area, to an insufficient use of resources to preserve environmental quality. Economics research in this area has concentrated on three central issues. First, exactly why is it that a market economy fails to allocate resources efficiently in the presence of environmental public goods or externalities? Second, how can one assess the economic value of environmental goods? Third, what kinds of policy are best suited for the protection of the environment, e.g. should one rely on tax and price incentives or on quantitative regulations? This article discusses these questions and also describes the evolution of the economic perspective on the environment, from a concern with local problems to focus on international and global issues of environmental pollution.

Introduction

The economics of the environment is the scientific study of the interaction between economic activity and the state of the environment. The issues studied in this area of economics may be local, national as well as global, and they may be related both to the natural and the man-made environment. As regards the natural environment, people may be concerned both by the air pollution created by a local chemical plant and by the national problems that stem from the activity of the whole chemical industry of the country. The negative effects on water quality from the use of fertilizers in agriculture can become political issues both at the local and national level. Internationally, we are all aware of the problems of global warming and the changes in the climate that may arise from the unregulated commercial exploitation of the tropical rain forest.

Most people's concern with environmental problems comes no doubt from their

belief that environmental deterioration will reduce the quality of life, both their own and that of others. From this point of view it is not only the natural environment that is of importance but also the quality of our cultural or man-made environment. Traffic congestion, noise and dilapidated buildings have harmful consequences for the standard of living of city dwellers. People's satisfaction with the society that they live in is, to a large extent, determined by the visual aspects of it, whether it is the cultural landscape of the countryside or the architecture of city streets. The resources devoted to preserving or improving the natural or cultural environment must necessarily compete with alternative uses of resources to produce other goods and services that are important for our standard of living. There is, as always, a need to strike a balance between alternative uses of productive resources in society.

In earlier times it was common to refer to such concerns as non-economic. This is now widely regarded as a misguided point of view. Environmental values are also economic values. We spend resources on preserving them, and, at least implicitly, we compare environmental with more conventional economic values each time we decide whether some project of environmental improvement is worth the resources that we use on it, and which could have been used to produce other goods and services.

The increasing concern with environmental issues has affected research priorities in many academic disciplines, including economics. As a matter of fact, economics has a fairly long tradition in the area. The English economist A. C. Pigou wrote about environmental problems with great insight in his 1920 book *The Economics of Welfare*[1] and created a theoretical frame of reference that is still recognizable in the literature. The modern economics of the environment is now well established as an area of specialization with its own journals and research conferences. However, it should be stressed that the economics of the environment does not represent a fundamentally different approach to economic and social problems from that of economics in general. Environmental economics is simply the application of economic theory and empirical methodology to problems of the environment.

In the following, I shall mainly try to characterize the economic theory of the environment with an emphasis on the implications of the theory for the design of environmental policy; a more extensive and technical survey of the theoretical literature is Sandmo.[2] Limitations of space and time prevent me from surveying the extensive empirical work that has been carried out in the area; here the reader is referred to Cropper and Oates[3] and to the articles in the *Handbook of Environmental Economics*.[4]

Private goods, public goods and market failure

A recurrent theme in economic theory since the time of Adam Smith has been

to clarify the conditions under which a market economy will allocate resources in a socially efficient manner, i.e. without waste of resources. Waste is said to occur if it is possible to improve the welfare or standard of living for some individuals or groups without at the same time reducing it for others; conversely, social efficiency is said to prevail if such an improvement is *not* possible. A central result of economic theory is that competitive markets under certain assumptions will bring about social efficiency (also referred to as Pareto optimality). An intuitive interpretation of the result is that the price mechanism works as a channel of information between producers and consumers in the economy. On the one hand prices inform producers about the preferences of the consumers; on the other hand they convey information to consumers about the costs of production. When markets work so as to bring about a balance between demand and supply, prices lead to an adjustment of consumer preferences to the economic resources of society. Firms will find it profitable to produce what consumers want, while consumers will adjust their consumption to the costs of production.

This sounds like a pure apology for *laissez-faire*, but it is not. It is important to be aware that the result about the social efficiency of competitive markets holds only under a particular set of assumptions. I will not go into a full discussion of these assumptions, but will focus on one of them.

The market mechanism applies to *private goods*, i.e. goods for which the total quantity consumed is the sum of the quantities consumed by all individuals in the economy. By contrast, the market economy is not well suited for the production of so-called *public goods*. For public goods, such as national defence, there is no meaningful distinction between the individual and total 'consumption' of the good; the defence provided for me protects you to exactly the same extent. Leaving the amount of defence services provided to voluntary contributions from market agents runs into the free rider problem; each agent is likely to contribute little or nothing to the provision of the public good, because he knows that if others contribute, he will in fact be able to benefit from the public good in any case. Since such goods will not normally be provided by the market, the responsibility for their provision has typically come to rest with the public sector.

Environmental goods like the state of the climate, clean air, clean water, the absence of traffic congestion, and biological diversity, are other examples of public goods, but they are of a different kind than the example of national defence. Unlike defence, they are not produced by the authority of some public body. Instead, their availability is determined by countless decisions taken by individual consumers and firms regarding the use of fossil fuels for transportation and heating, car use and hunting activities. This means that individual decisions about

production and consumption of private goods are tied to the production – usually in a negative sense – of public environmental goods. Environmental quality becomes a by-product of private decisions by market agents. This is what is known in the economic literature as *externalities*. With the existence of externalities, individual incentives in the market economy will no longer lead to an efficient allocation of resources. This is an example of what is known as *market failure*.

I will illustrate this by a simple example of the choice between private and public transportation in a situation where there are congestion externalities. Mr Smith has the choice between taking the bus to work and using his own car, and he makes his decision by weighing the pros and cons of each alternative. Buses and cars use the same roads, and it is assumed that initially there are no public regulations that influence the choice of transport. In the case of bus travel, there is both the cost of the ticket and the time cost to consider. In addition to the direct travel time, Smith has to take account of the time to walk from his home to the bus stop and from the end stop to his workplace. In the case of the car, the most important cost item may be the cost of petrol. There is of course a time cost involved here too, but that is likely to be less than is the case for the bus. Smith concludes that it pays him to take the car. Perhaps he takes the time to consider briefly the environmental consequences of his decision and whether these should not motivate him to take the bus instead. However, even if he does it is natural for him to reason along the following lines. 'There are ten thousand cars on the road in the morning and afternoon rush hours. It is of no consequence for the speed of traffic, the level of noise or the emission of greenhouse gases if the number increases to ten thousand and one. Therefore, the environmental consequences are without importance for my choice of transportation.' We have to admit that in thinking along these lines Smith is perfectly rational from an individual point of view. The catch is only that if everyone thinks like him – and everyone is after all in the same situation – there will be so many cars on the road that everybody will be frustrated about the delays, the noise and the degree of air pollution. Will this give them an incentive to leave the car in the garage and take the bus instead?

Let us take a closer look at the structure of incentives. Let us imagine that Smith converts all costs, including costs of time and inconvenience, into money, so that each choice that he makes can be characterized by a single number for costs. When thinking about the costs of car and bus travel, Smith realizes that the cost of his own choice will depend on the choices that the other travellers make. For example, if he chooses to go by car, the cost will be less if the others go by bus than if they too travel by car. Thinking of 'the others' as a simple aggregate, Smith must now consider four different outcomes, which may be summarized in the following table:

Table 1. The consequences of Smith's transport decisions in terms of travel costs

		The others' choice	
		Bus	Car
Smith's choice	Bus	(40,40)	(100,80)
	Car	(20,40)	(80,80)

The numbers in brackets are to be understood as Smith's travel cost (the first number), and the travel cost of a representative member of the group of others (the second number). Thus, for example, the parenthesis in the upper left corner means that if everyone takes the bus, Smith and everyone else will incur a travel cost of 40 each. (The absolute values of the numbers are unimportant; it is their relative magnitudes that matter.)

What will Smith do? It is clear that the travel cost that he incurs depends on what the others will do (I have simplified by letting Smith think of the others as a homogeneous group, but the principles behind the analysis remain the same under more realistic conditions). A striking feature of the table is the following: whatever the choice the others make, it pays Smith to take his own car! If the others take the bus, he will be able to drive on uncongested roads. And if the others use their cars, there is no gain for Smith in being the only one who takes the bus; in fact, the bus will move even more slowly than the cars in the dense traffic.

What will the others do? From the table it might look as if the cheapest alternative for them would be to take the bus, but that would be a misinterpretation. For the others do not in fact act in a coordinated manner; each one of them is like Smith and concludes, like him, that the individually rational solution is to take the car. The result – the equilibrium outcome – is that everyone takes the car with the resulting travel cost of 80, while they could have taken the bus and cut their costs in half. Both Smith and the others may be enlightened enough to see that the outcome is collectively irrational, but none of them has any incentive to change his or her travel strategy independently of what the others do. This is a case of market failure, since individual decisions fail to realize a socially efficient use of resources, i.e. of the road facility and individuals' time.

This is a special example, so it is fair to ask whether it is of more general interest in an environmental perspective. The answer is yes, for there are a large number of examples with a similar structure. In the choice between heavy and light oil for heating, each homeowner will have a strong incentive to choose the cheapest and most polluting alternative, even if s/he realizes that air quality will improve if homeowners as a group choose the less polluting alternative. Within agriculture there are many examples, especially in developing countries, of soil erosion that

is due to farmers cutting down the woods to extend their land or provide fuel. In an international perspective, we observe that countries are reluctant to impose regulations on the use of private cars, even though they know that car use generates a significant share of the world's emission of greenhouse gases and may contribute importantly to global warming and climate change.

The role of public policy

If the stylized example in the table were to be taken literally, it is fairly obvious what the government should do: ban private cars! If this is done, there remains only one possible equilibrium, namely the one where all travellers take the bus and aggregate transport costs are minimized. But whether the primary environmental problem in the example is congestion, noise or greenhouse gas emissions, such a solution would, in the large majority of cases, be bad environmental policy. The table is based on the assumption that all individuals are alike, whereas in more realistic settings they are different individuals with heterogeneous needs and tastes and accordingly different costs for private and public transportation. Suppose that the government wishes to reduce private car use to 50% of its present level. There are many ways in which this could be done. One is to let cars with odd plate numbers drive on Mondays, Wednesdays and Fridays, while those with even numbers are allowed to drive on Tuesdays, Thursdays and Saturdays. This is a form of rationing which has no connection with people's needs and tastes and must be deemed socially inefficient, just like the total ban, although to a smaller degree. (It also encourages families to acquire two cars, one with odd and one with even plate numbers, a striking example of resource waste.)

In order to implement a more efficient solution to the problem, the government should aim to encourage those 50% of private car users to switch to bus travel for whom it would cost the least to do so. If we think back to the elements that enter into the calculation of travel costs in Table 1, it is clear that a number of these can be changed by public policy. The government can encourage increased use of public transport by introducing toll charges for private cars, increasing taxes on petrol, or subsidizing bus tickets. It could also influence the time costs in favour of public transport by introducing separate lanes for buses and less time-consuming arrangements for ticket purchases. All these measures have the advantage that they encourage a switch to public transport for those whom it costs least to change their commuting patterns, so that the reduction of car travel is achieved in a socially cost-effective manner. The same is true about measures to control industrial emissions. Quantitative regulations provide no guarantee that emissions are reduced most where it is cheapest to do so. Charges on emissions face all polluters with the same gain from reducing pollution, and this implies that

emissions will be reduced most in the firms where the cost of emission cutbacks is lowest. From the viewpoint of social efficiency, charges or taxes are, in general, preferable to quantitative regulations and quotas.

An exception to this conclusion has to be made for transferable quotas. A reduction of CO_2 emissions can be achieved in an efficient manner by taxing emissions from all polluters at the same rate. An alternative is to introduce a quota system where polluters are allowed to trade quota units among themselves. If the number of polluters is large enough to allow the existence of a competitive market for quotas, the gain on the margin from a further reduction of emissions will be equal to the quota price, which is the same for all polluters. This leads to an allocation of emissions among polluters with the same efficiency property as the tax regime, namely that the social cost of reducing pollution to any given level will be minimized. The initial allocation of the quotas among the polluters could be achieved by an auction whereby the government grants pollution rights to the highest bidders. Just like the tax solution, a system of transferable quotas would combine an efficient environmental policy with the creation of revenue for the government.

The government revenue from environmental taxes or pollution quotas has been widely discussed under the heading of 'the double dividend' from a green tax reform. Most taxes, like indirect taxes and the income tax, have adverse effects on social efficiency. Environmental taxes are different in actually increasing the efficiency of the market mechanism. The government could now use the revenue from green taxes (or from the sale of quotas) to reduce the level of other taxes in the economy, thereby making the tax system as a whole more efficient, and this is the second dividend from the reform. This is an interesting idea that has been widely used as a 'sales argument' for a green tax reform. Although, on closer examination, it turns out that the conclusion is not as obvious as it may seem – a lot depends on exactly how the rest of the tax system is supposed to change – a green tax reform clearly has the potential to result in a double dividend. Whatever one's view of the realism of the double dividend idea, it needs to be kept in mind that the main benefit from environmental taxes is that they can be used to improve environmental quality in a manner that minimizes the cost of achieving the environmental target.

Valuing environmental benefits.

If the government is to implement a sensible environmental policy, it is not enough to know that some products or activities cause harm to the environment and that the harm can be reduced by the use of taxes and other policy instruments. Clearly, in addition to formal theoretical models, we need to have quantitative information based on empirical data. We need to decide not only that the emissions should

be reduced, but by *how much* it is sensible to reduce them. We also need to know not only that the emissions can be reduced by imposing taxes on them, but also *how large* the taxes will have to be. The most difficult issue concerns the estimation of environmental benefits. Cutting back air pollution carries a cost, so one must ask if the benefits are larger than the costs. As we have already argued, clean air is a public good, so this comes down to the question of how to estimate the benefits from public goods. In principle, we know how this should be done: estimate the benefit to each single individual and take the sum across individuals, keeping in mind that an improved air quality benefits all individuals simultaneously.

How can this be done in practice? An obvious solution is simply to ask people what their benefits are. In most cases it would be impractical to ask everybody, but one could employ the methods of survey research to poll a representative sample of individuals affected by the pollution and use the results to arrive at an estimate for the whole population. A difficulty with this procedure is that it may not be in the private interest of individuals to answer the questions truthfully. Suppose that I am asked 'How much is it worth to you to have air pollution in your area reduced by 50%?' This form of the question makes no reference to the costs, and in particular not to the share of the cost that I personally will have to pay. If I assume that I will not in fact have to bear any of the cost, I might be tempted to overstate my benefit from reduced pollution, simply because I believe that this will increase the probability that something will be done about it. If, on the other hand, I believe that my own cost will be positively related to my stated benefit, I will be tempted to understate my preferences, hoping that others will report sufficiently high benefits that pollution will be reduced anyway (the free rider problem again). Many economists are therefore very sceptical to this method of assessing environmental benefits.

Nevertheless, methods of this kind have been much used in practice under the name of *contingent evaluation*. Practitioners of the method have naturally been aware of the incentive problems that are associated with it and have tried to phrase the questions in such a way that respondents are encouraged to evaluate the benefits in a realistic setting as regards costs. Whether they have always been successful in obtaining these goals has been a matter of heated debate; some have also maintained that the method suffers from so many weaknesses that it is likely to be misleading even when used by skilled practitioners of survey research and interview methods; for a short survey of the issues see Ref. 5. Critics tend to prefer various types of indirect methods to that of contingent valuation.

The indirect methods are based on attempts to trace peoples' valuation of environmental goods through their observed market behaviour. In the case of local air pollution, one method would be to observe house prices in more or less polluted environments; the premium at which equivalent houses in unpolluted areas sell

can then be taken as a measure of the willingness to pay for a cleaner environment. Another example is one described in Pigou,[1] where the benefits of reducing air pollution in Manchester were estimated by data for household expenditure on washing and cleaning in Manchester compared with the cleaner neighbouring city of Harrogate. The reduced expenditure on such items in Harrogate, as compared with Manchester, was then taken as a measure of households' gains from reduced pollution. The strength of the indirect methods is that they do not run up against the problem of less than truthful reporting. Their weakness is that they often capture only part of the benefits; thus, in the Manchester air pollution study, the method used did not capture the possible health benefits from cleaner air, nor did it capture the aesthetic gains from a clearer sky. The contingent valuation method, by contrast, asks for a full valuation of the benefits.

A particular problem that comes up in the estimation of environmental benefits has to do with the time dimension of the problem. Many environmental problems involve significant investments or sacrifices of present benefits against other benefits that may stretch far into the future; think for example of the benefits and costs involved in preserving endangered species. How is one to compare costs and benefits that accrue over long intervals of time? The economist's standard answer to such problems is to recommend that future benefits be discounted so as to obtain a present value to be compared to the costs. To illustrate, assume that somebody proposes an environmental protection project that will generate a benefit of €1 million per year from now to infinity, involving a present cost of €60 million. If one uses a discount rate of 5%, the present value of the benefits is 50 million, so the project should be rejected. However, many people may feel that this is very short-sighted; what should be rejected, they say, is not the project, but the economists' principle of discounting. But if we do that, the value of the project is infinite, and it should be carried out *no matter* how large the cost of the investment. Obviously, this too is open to objection; in the absence of discounting, a project with an annual benefit of €1 and a cost of €100 million would be socially profitable. Various solutions to the dilemma have been proposed in the literature, some of which involve giving up the principle of discounting at a constant rate, or substituting a method of a declining discount rate that discriminates less against projects with a long time horizon.[6] However, this is an area where a professional consensus is still lacking.

Changing perspectives

Both in the pure theory of externalities and in the literature of environmental economics, economists' views on what the central problems are have been changing over time, especially over the last three decades. In the early literature on environmental problems, the issues considered were typically quite narrow,

like local community problems with air and water pollution. Gradually, the perspective changed to the national level, focusing on problems such as the preservation of unspoilt nature in the face of threats from road construction and the development of hydroelectric power. In recent years, the problems that most of all have caught the public's attention have been international and global problems associated with pollution of the oceans and the atmosphere. This last development is especially interesting, since it raises a whole new set of issues regarding economic policy.

In the above discussion I took it for granted that there exists a political authority that could enforce environmental tax rates or regulations. Although the degree of enforcement is itself a political issue, the enforcement assumption is fairly realistic for local or national governments, but it is not a realistic assumption for the world as a whole. It may be desirable to reduce global emissions of carbon dioxide (CO_2), but there is no international body that has the authority to levy a tax on national polluters. An international agreement to limit the emission of greenhouse gases must therefore be based on the voluntary cooperation of national governments. Hopefully, national governments will come to see that they will all have to take responsibility for the state of the global environment, but one has also to be realistic enough to see that there is a problem of national incentives with regard to the attainment of global goals. Although all countries will have an interest in a better environment, they will also have an interest in minimizing their own contribution, sometimes for very good reasons, like concern for the budget deficit, unemployment, regional development etc. The challenge for economists in policy design will then take on a new aspect; global environmental policy should be designed in such a way that it not only results in an improvement for the world as a whole, but for each individual country that is party to the policy agreement. How can this be done?

As an example, take the case of a tax on sulphur dioxide, which is mainly responsible for the acid rain problem. This has been the subject of some economic research that shows up the principles involved in an interesting manner[7,8]; although the empirical basis of these studies is now somewhat dated, they serve well as an illustration of the main issues of international environmental policy. These studies found the emissions of sulphur dioxide to be very unevenly distributed between the countries of Europe, with the same being true for the incidence of acid rain. Suppose that it were deemed desirable to reduce total emissions by $x\%$. One way to achieve this would be to require that each country involved should reduce its own emissions by $x\%$. However, this would in general be inefficient, since some countries could reduce their emissions at low marginal costs, while others would find it very expensive. A better policy would be to try to equalize the marginal cost of reducing emissions across countries, and this could be achieved by a treaty that requires a uniform tax on polluters in all countries,

to be collected by some international agency. For each country, the net outcome of such a policy could be computed as the value of the improved environment minus taxes paid. But the countries that were the largest emitters would then find that they would suffer a loss, while the countries who were mainly the recipients of other countries' emissions would gain. The former group of countries would therefore be likely to be against the treaty, while the latter group would be in favour. To make the treaty work, one would have to ensure the voluntary participation of all, and especially the countries that were heavy emitters and polluters of other countries' environments.

One method by which to ensure voluntary participation might be to redistribute the tax revenue in such a way that the countries that would otherwise be losers by the agreement would come out with a net gain. Such a redistributive scheme would have to be constructed with some care so as not to neutralize the effects on individual polluters' incentives. It is important to keep in mind the basic idea: if an environmental agreement leads to gains for the world as a whole, there must be a way to divide the gain between nations so that all come out as net gainers by the agreement. If this can be done, it makes it much simpler to agree on policies that are globally efficient in the sense of achieving environmental gains at a minimum of cost. For further discussions of the relationship between equity and efficiency in an international context see Refs 9 and 10.

The international perspective is a challenging one for the analysis of economic policy. There has always been a debate within the economics profession about the extent to which economic advice should take account of what is politically feasible and realistic. The area of international environmental policy is one in which I believe that we have no choice. We have to take seriously the fact that proposals to improve the global environment have to be acceptable to all countries – or at least to a large majority – in order to lead to the desired results.

Environmental issues and human motivation

The economic approach to social issues, including the problems of the environment, has been criticized from both within and outside the economics profession, and much of the criticism has been concerned with the economic view of human motivation. It seems fitting to close with some reflections on the nature of this criticism in relation to problems of the environment.

One common view is that economic theory takes a too narrow view of the forces that motivate individuals in their 'daily business of life', which, according to Alfred Marshall,[11] was the subject matter of economics. Mr Smith in the transportation example above chooses his mode of transportation according to his personal travel cost, not according to a broader view of what is good for society. It is clear that there are persons who try to act in such a way that their actions

can serve as a role model for society; in fact I believe that the large majority of us occasionally act in a way that is inconsistent with a narrow view of what constitutes our self-interest. But in many areas our incentives clearly are of the same kind as those facing Smith, and to act against our self-interest would simply mean that we incur significant costs in the form of money outlay and personal inconvenience without making a noticeable contribution to a better environment. Moreover, it is by taking this view of incentives that we are able to explain why in fact we have environmental problems in the first place; if we were to assume that everyone always acted for the common good, it would be difficult to explain social phenomena like traffic congestion, over-fishing or the threat of animal extinction. This does not imply that we should refrain from studying more complex notions of motivation, but we have to keep an eye on the real environmental problems that need explanation and policy intervention.

While critics of the economists' view of human motivation may be interpreted as saying that it is too cynical, economists' view of the motivation of politicians is frequently said to be too naïve. Economists' policy advice is maintained to be based on the assumption that politicians always act for the common good, and if only economists tell them what a good policy looks like, they will immediately implement it. This criticism is in fact based on a fundamental misunderstanding of the relationship between normative and positive economic theories.

In the discussion above I have suggested that environmental policy should try to achieve production efficiency; environmental goals should be achieved at a minimum cost to society. Production efficiency is derived from the premise that social efficiency or Pareto optimality is desirable. This is not a normative principle of the same type as the Ten Commandments; it is a *contingent* normative statement in the sense that if you accept the desirability of Pareto optimality, then you should strive to achieve production efficiency by, for example, preferring emission taxes to non-transferable quotas. The economist obviously cannot tell politicians which values they should hold, but s/he can still point out that their choice of values has implications for the kind of policy instruments that they should use.

It should be clear from this that the normative theory makes no claim to be a positive theory of political behaviour. In order to understand how politicians actually act in the environmental field, we clearly have to study their individual motivation like we study the motivation of individual consumers and firms. This is an interesting and worthwhile area of research, but it is no substitute for the normative approach. If one's ambition is to contribute to enlightened discussion of one of the most important areas of economic policy in our time, one should clarify the nature of market failure, the policy options before us and the consequences that the choice between them is likely to have. To believe that politicians and administrators are likely to be interested in the economists' contribution is not, I think, a too naïve view of human motivation.

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