The Research on Environmental Problems and Economic Efficiency

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Abstract. The chief normative economic criterion for choosing among various outcomes occurring at the same point in time is called static efficiency, or merely efficiency. An allocation of resources is said to satisfy the static efficiency criterion if the economic surplus derived from those resources is maximized by that allocation. Economic surplus, in turn, is the sum of consumer’s surplus and producer’s surplus.

1. Introduction
This paper insight from the natural and physical sciences, literature, political science, and other disciplines are scattered liberally throughout the text. In some cases these references raise outstanding issues that economic analysis can help resolve, while in other cases they affect the structure of the economic analysis or provide a contrasting point of view. They play an important role in overcoming the tendency to accept the material uncritically at a superficial level by highlighting those characteristics that make the economics approach unique.

2. Static Efficiency
Consumer surplus is the value that consumers receive from an allocation minus. What it costs them to obtain it. Consumer surplus is measured as the area under the demand curve minus the consumer’s cost. The cost to the consumer is the area under the price line, bounded from the left by the vertical axis and the right by the quantity of the good. This rectangle, which captures price time’s quantity, represents consumer expenditure on this quantity of the good.

Why is this area thought of as a surplus? For each quantity purchased, the corresponding point on the market demand curve represents the amount of money some person would have been willing to pay for the last unit of the good. The total willingness to pay for some quantity of this good—say, three units—is the sum of the willingness to pay for each of the three units. Thus, the total willingness to pay for three units would be measured by the sum of the willingness to pay for the first, second, and third units, respectively. It is now a simple extension to note that the total willingness to pay is the area under the continuous market demand curve to the left of the allocation in question. For example, in Figure 1 the total willingness to pay for Quds units of the commodity is the shaded area. Total willingness to pay is the concept we shall use to define the total value a consumer would receive from the five units of the good. Thus, total value the consumer would receive is equal to the area under the market demand curve from the origin to the allocation of interest. Consumer surplus is thus the excess of total willingness to pay over the (Lower) actual cost. Meanwhile, sellers face a similar choice. Given price P*, the
Seller maximizes his or her own producer surplus by choosing to sell $Q_s$ units. The producer surplus is designated by area $B$, the area under the price line that lies over the marginal cost curve, bounded from the left by the vertical axis and the right by the quantity of the good.

![Figure 1 The Consumer’s Choice](image)

3. Property Rights and Efficient Market Allocations
The manner in which producers and consumers use environmental resources depends on the property rights governing those resources. In economics, property right refers to a bundle of entitlements defining the owner’s rights, privileges, and limitations for use of the resource. By examining such entitlements and how they affect human behavior, we will better understand how environmental problems arise from government and market allocations. These property rights can be vested either with individuals, as in a capitalist economy, or with the state, as in a centrally planned socialist economy. How can we tell when the pursuit of profits is consistent with efficiency [1] and when it is not? Let’s begin by describing the structure of property rights that could produce efficient allocations in a well-functioning market economy. An efficient structure has three main characteristics:

1. Exclusivity—all benefits and costs accrued as a result of owning and using the resources should accrue to the owner, and only to the owner, either directly or indirectly by sale to others.
2. Transferability—all property rights should be transferable from one owner to another in a voluntary exchange.
3. Enforceability—Property rights [2-5] should be secure from involuntary seizure or encroachment by others.

An owner of a resource with a well-defined property right (one exhibiting these three characteristics) has a powerful incentive to use that resource efficiently because a decline in the value of that resource represents a personal loss. Farmers who own the land have an incentive to fertilize and irrigate it because the resulting increased production raises income. Similarly, they have an incentive to rotate crops when that raises the productivity of their land. When well-defined property rights are exchanged, as in a market economy, this exchange facilitates efficiency. We can illustrate this point by examining the incentives consumers and producers face when a well-defined system of property rights is in place. Because the seller has the right to prevent the consumer from consuming the product in the absence of payment, the consumer must pay to receive the product. Given a market price, the consumer decides how much to purchase by choosing the amount that maximizes his or her individual consumer surplus. Is this allocation efficient? According to our definition of static efficiency, it is clear the answer is yes. The economic surplus is maximized by the market allocation and, as seen in Figure 2, it is equal to the sum of consumer and producer Surpluses (areas $A + B$). Thus, we have
established a procedure for measuring efficiency, and a means of describing how the surplus is distributed between consumers and producers.

This distinction is crucially significant. Efficiency is not achieved because consumers and producers are seeking efficiency. They aren’t! In a system with well-defined property rights and competitive markets in which to sell those rights, producers try to maximize their surplus and consumers try to maximize their surplus. The price system, then, induces those self-interested parties to make choices that are efficient from the point of view of society as a whole. It channels the energy motivated by self-interest into socially productive paths. Familiarity may have dulled our appreciation, but it is noteworthy that a system designed to produce a harmonious and congenial outcome could function effectively while allowing consumers and producers so much individual freedom in making choices. This is truly a remarkable accomplishment.

![Figure 2 Market Equilibrium](image)

**4. Producer’s Surplus, Scarcity Rent, and Long-Run Competitive Equilibrium**

Since the area under the price line is total revenue, and the area under the marginal cost curve is total variable cost, producer’s surplus is related to profits. In the short run when some costs are fixed, producer’s surplus is equal to profits plus fixed cost. In the long run when all costs are variable, producer’s surplus is equal to profits plus rent, the return to scarce inputs owned by the producer. As long as new firms can enter into profitable industries without raising the prices of purchased inputs, long run profits and rent will equal zero.

**5. Externalities as a Source of Market Failure**

Exclusivity is one of the chief characteristics of an efficient property rights structure. This characteristic is frequently violated in practice. One broad class of violations occurs when an agent making a decision does not bear all of the consequences of his or her action. Suppose two firms are located by a river. The first produces steel, while the second, somewhat downstream, operates a resort hotel. Both use the river, although in different ways. The steel firm uses it as a receptacle for its waste, while the hotel uses it to attract customers seeking water recreation. If these two facilities have different owners, an efficient use of the water is not likely to result. Because the steel plant does not bear the cost of reduced business at the resort resulting from waste being dumped into the river, it is not likely to be very sensitive to that cost in its decision making. As a result, it could be expected to dump too much waste into the river, and an efficient allocation of the river would not be attained. This situation is called an externality. An externality exists whenever the welfare of some agent, either a
firm or household, depends not only on his or her activities, but also on activities under the control of some other agent. In the example, the increased waste in the river imposed an external cost on the resort, a cost the steel firm could not be counted upon to consider appropriately in deciding the amount of waste to dump.

6. Types of Externalities

External effects, or externalities, can be positive or negative. Historically, the terms external diseconomy and external economy have been used to refer, respectively, to circumstances in which the affected party is damaged by or benefits from the externality. Clearly, the water pollution example represents an external diseconomy. External economies are not hard to find, however. Private individuals who preserve a particularly scenic area provide an external economy to all who pass. Generally, when external economies are present, the market will undersupply the resources.

One other distinction is important. One class of externalities, known as pecuniary externalities, does not present the same kinds of problems as pollution does. Pecuniary externalities arise when the external effect is transmitted through altered prices. Suppose that a new firm moves into an area and drives up the rental price of land. That increase creates a negative effect on all those paying rent and, therefore, is an external diseconomy.

This pecuniary diseconomy, however, does not cause a market failure because the resulting higher rents are reflecting the scarcity of land. The land market provides a mechanism by which the parties can bid for land; the resulting prices reflect the value of the land in its various uses. Without pecuniary externalities, the price signals would fail to sustain an efficient allocation.

The pollution example is not a pecuniary externality because the effect is not transmitted through prices. In this example, prices do not adjust to reflect the increasing waste load. The damage to the water resource is not reflected in the steel firm’s costs. An essential feedback mechanism that is present for pecuniary externalities is not present for the pollution case.

7. Impact Analysis

What can be done when the information needed to perform a benefit–cost analysis or a cost-effectiveness analysis is not available? The analytical technique designed to deal with this problem is called impact analysis. An impact analysis, regardless of whether it focuses on economic impact or environmental impact or both, attempts to quantify the consequences of various actions. In contrast to benefit–cost analysis, a pure impact analysis makes no attempt to convert all these consequences into a one-dimensional measure, such as dollars, to ensure comparability. In contrast to cost-effectiveness analysis, impact analysis does not necessarily attempt to optimize. Impact analysis places a large amount of relatively undigested information at the disposal of the policy-maker. It is up to the policymaker to assess the importance of the various consequences and act accordingly.

Current environmental impact statements are more sophisticated than their early predecessors and may contain a benefit–cost analysis or a cost-effectiveness analysis in addition to other more traditional impact measurements. Historically, however, the tendency had been to issue huge environmental impact statements that are virtually impossible to comprehend in their entirety.

In response, the Council on Environmental Quality, which, by law, administers the environmental impact statement process, has set content standards that are now resulting in shorter, more concise statements. To the extent that they merely quantify consequences, statements can avoid the problem of “hidden value judgments” that sometimes plague benefit–cost analysis, but they do so only by bombarding the policy-makers with masses of noncomparable information.

8. Summary

Finding a balance in the relationship between humanity and the environment requires many choices. Some basis for making rational choices is absolutely necessary. If not made by design, decisions will be made by default. Normative economics uses benefit–cost analysis for judging the desirability of the level and composition of provided services. Cost-effectiveness analysis and impact analysis offer
alternatives to benefit–cost analysis. All of these techniques offer valuable information for decision making and all have shortcomings.

A static efficient allocation is one that maximizes the net benefit over all possible uses of those resources. The dynamic efficiency criterion, which is appropriate when time is an important consideration, is satisfied when the outcome maximizes the present value of net benefits from all possible uses of the resources. In this paper examine the degree to which our social institutions yield allocations that conform to these criteria.

Even when benefits are difficult to calculate, however, economic analysis in the form of cost-effectiveness can be valuable. This technique can establish the least expensive ways to accomplish predetermined policy goals and to assess the extra costs involved when policies other than the least-cost policy are chosen. What it cannot do is answer the question of whether those predetermined policy goals are efficient. At the other end of the spectrum is impact analysis, which merely identifies and quantifies the impacts of particular policies without any pretense of optimality or even comparability of the information generated. Impact analysis does not guarantee an efficient outcome. All three of the techniques discussed in this paper are useful, but none of them can stake a claim as being universally the “best” approach. The nature of the information that is available and its reliability make a difference.

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