Economic Analysis of Environmental Externalities

In order to perform economic analysis of pollution prevention and abatement measures, estimates of the potential benefits from controlling pollution, as well as the better-known costs of new equipment or processes, are needed. This chapter discusses the economic analysis of environmental externalities, using a wide range of valuation techniques.

Pollutants produced by industrial activities—solid wastes, toxic wastes, and substances that cause air and water pollution—may impose costs on society and individuals. The identification and quantification of these pollutants and the assessment of their monetary and nonmonetary impacts are important elements in a broader economic analysis of the benefits and costs of various production alternatives. Information on the costs of pollution is also important in helping decide what level of pollution control is economically justified.

The effects of pollution can generally be classified into four major categories: health impacts, direct and indirect effects on productivity, effects on the ecosystem, and aesthetic effects. All these are commonly encountered examples of *economic externalities* of industrial production activity, that is, the externality occurs because the individual or resource affected is not part of the enterprise's decisionmaking process. For example, a factory may emit soot that dirties surrounding buildings, increasing maintenance costs. The higher maintenance costs are a direct result of the factory's use of a resource—air—that from the plant's point of view is free but that has a cost to society. The same analogy applies to health impacts linked to air pollution. Sometimes a project makes certain groups better off, but the nature of the benefits is such that the project entity cannot extract a monetary payment for them. A sewerage and water supply project, for example, may not only improve water quality and yield direct health benefits but may also produce benefits from decreased pollution of coastal areas, in turn increasing recreational use and property values. Such externalities are real costs and benefits attributable to the project and should be included in the economic analysis as project costs or benefits.

Conceptually, the externalities problem is quite simple. Consider Figure 1, where *MPC* is the marginal production cost of a good (e.g., power produced by a coal-fired boiler), as perceived by the project entity. Suppose that the process produces a negative externality—for example, it emits soot that increases the maintenance costs of adjacent buildings. Because the production process also produces an externality, the marginal social cost is higher and is given by the line *MSC*. For any given level of output, q^*, the total cost of producing that level of output is given by the area under the curve. The difference between the areas under the two curves gives the difference between the private and the social costs. The financial costs of the project will not include the costs of the externality, and hence an evaluation of the project based on *MPC* will understate the social costs of the project and overstate its net benefits. In principle, to account for the externality, one simply works with social rather than private costs. In practice, the measurement difficulties are tremendous because often the shape of the *MSC* curve, and hence its relationship to the *MPC* curve, are unknown. Also, it is not always feasible to trace and measure all external effects. Nevertheless, an attempt should always be made to identify them and, if they appear significant, to measure them. When externalities

Figure 1. Private and Social Costs

cannot be quantified, they should be discussed qualitatively.

In some cases, it is helpful to "internalize" externalities by considering a package of closely related activities as one project—that is, to draw the "project boundary" to include them. For example, in the case of the soot-emitting factory, the externality could be internalized by treating the factory and the neighboring buildings as if they belonged to the project entity. The additional maintenance costs then become part of the maintenance costs of the project entity. If the factory pays for the additional maintenance costs, or if the factory is forced to install a stack that does not emit soot, the externality again becomes internalized. In these cases, the formerly external cost becomes an internal cost that is reflected in the accounts of the factory.

Environmental Externalities

Environmental externalities are a particular form of externalities that good economic analysis should take into account. Environmental externalities are identified as part of the environmental assessment. They are quantified where possible and are included in the economic analysis as project costs (e.g., increased illness, or reduced productivity of nearby farmlands) or benefits (such as reduction in pollution of coastal areas). A monetary value is assigned to the costs and benefits, and they are entered into the cash flow tables just as any other costs and benefits.

Project Boundaries and Time Horizon

Analysts must make two major decisions when assessing environmental impacts. First, they must decide how far to look for environmental impacts—that is, they must determine the *boundary of the economic analysis.* When the internal benefits and costs of a project are assessed, the boundaries of the analysis are clear: if the benefits accrue to the project entity or if the costs are borne by the project entity, they enter into the analysis. When attempting to assess the externalities of a project to determine its impact on society, the boundaries become blurred. Identifying externalities implies expanding the conceptual and physical boundaries of the analysis. An oil-palm mill will generate wastewater that will adversely affect downstream uses of water—drinking, irrigation, and fishing. Other impacts on the environment may be more distant or more difficult to identify: the effects of emissions from a power plant on creation of acid rain, for example. How far to expand the boundaries is a matter of judgment and depends on the individual project.

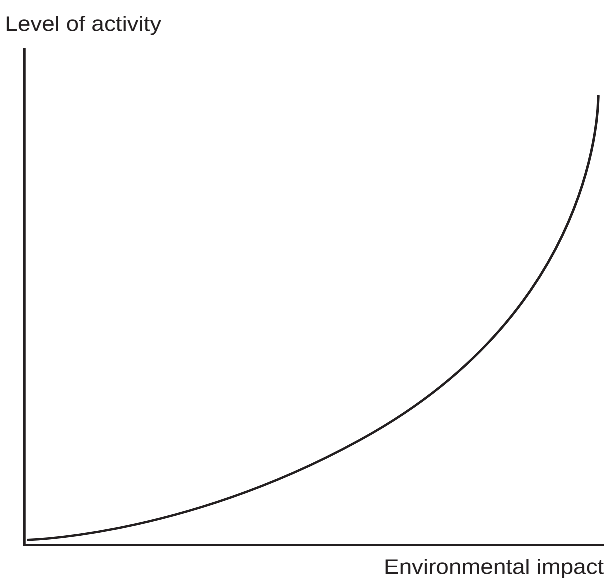
The second decision concerns the *time horizon*. Like the project's physical boundaries, its time horizon becomes blurred when moving from financial to economic analysis. A project's environmental impact may not last as long as the project, or it may outlive it. If the environmental impact is shorter-lived than the expected economic life of the project, the effects can be included in the standard economic analysis. If, however, the effects are expected to last beyond the lifetime of the project, the time horizon must be extended. This can be done in two ways: by extending the cash flow analysis a number of years, or by adding to the last year of the project the capitalized value of the part of the environmental impact that extends beyond the project's life. The latter technique treats the environmental impact much as one would treat a capital good whose life extends beyond the project's lifetime, by giving it a "salvage value."

Valuation of Environmental Impacts

The first step in assessing the costs or benefits of environmental impacts is to determine the relationship between the project and the environmental impact, that is, to determine a relationship such as that depicted in Figure 2. This *Handbook* provides detailed information on the likely environmental impacts of many classes of industrial activities. The second step is to assign a monetary value to the environmental impact. These two steps are equivalent to determining the shape of the *MSC* curve shown in Figure 1 and its relationship to the *MPC* curve. For example, suppose an objective of the project is to reduce air pollution, perhaps through installation of scrubbers at the industrial facility or by replacing an old bus or taxi fleet with new, less polluting vehicles. First, the impact of the project on air quality, as measured by some physical characteristic, is determined. Second, the monetary value of the improvement in air quality is assessed. In most cases, it is not necessary to estimate the entire cost curve; it suffices to identify the cost (or benefit) of an externality at a given level of activity. That is, it is enough to estimate the difference between the private and the social cost for a given level of activity.

In some cases, the market value of the externality is not readily available. There might also be instances where neither the market value nor the functional relationship between the level of the activity and the environmental impact is known. Arriving at a monetary estimate of impacts in such cases is very difficult. A number of functional relationships that relate the level of activity to the degree of physical damage (or benefit) have been developed for various environmental impacts. Environmental damages include changes in production (e.g., of crops or fisheries affected by polluted water), changes in health, damage to infrastructure due to air or water pollution, and even loss of aesthetic benefits or recreational opportunities. Various methods are available for valuing environmental externalities.

Figure 2. Environmental Damage as a Function of Activity Level



The choice of valuation technique depends on the impact to be valued, the data and time available for the analysis, financial resources, and the social and cultural setting within which the valuation exercise is to be carried out. Some valuation approaches are more robust, and more likely to be applied, than are others. Figure 3 presents a menu of the more commonly used valuation approaches.

Although "objective" techniques rely on observable environmental changes, use market prices, and are more "concrete" and easier to present to decisionmakers, subjectively based techniques (especially those using surrogate markets and hypothetical markets) are increasingly accepted for decisionmaking. These subjective methods offer the only practical way of measuring certain categories of environmentally related benefits and costs. For example, suppose one wishes to measure the recreational benefits from preventing damage to a marine park or a pristine forest area. Under the travel-cost approach, the time and cost of travel are used to develop estimates of the value of the park to its users. Under the various survey-based contingent valuation methods, users are asked to state the value they place on the "park experience," permitting an estimate to be made of consumer's surplus associated with park use. Both are fairly robust techniques if carefully applied.

It is important to remember that the simplest techniques are usually the most useful. In most Bank projects, the most useful valuation techniques will be those that rely on actual changes in production, on replacement costs or preventive expenditures, or on information about im-