2 Valuing the Environment: Concepts

When you have eliminated the impossible, whatever remains, however improbable, must be the truth.

—Sherlock Holmes, From Sir Arthur Conan Doyle's *The Sign of Four* (1890)

Introduction

Before examining specific environmental problems and the policy responses to them, it is important that we develop and clarify the economics approach, so that we will have some sense of the forest before examining each of the trees. By having a feel for the conceptual framework, it becomes easier not only to deal with individual cases, but also, perhaps more importantly, to see how they fit into a comprehensive approach.

In this chapter we develop the general conceptual framework used in economics to approach environmental problems. We begin by examining the relationship between human actions, as manifested through the economic system, and the environmental consequences of those actions. We can then establish criteria for judging the desirability of the outcomes of this relationship. These criteria provide a basis for identifying the nature and severity of environmental problems, and a foundation for designing effective policies to deal with them.

Throughout this chapter the economic point of view is contrasted with alternative points of view. These contrasts bring the economic approach into sharper focus and stimulate deeper and more critical thinking about all possible approaches.

The Human Environment Relationship

The Environment as an Asset

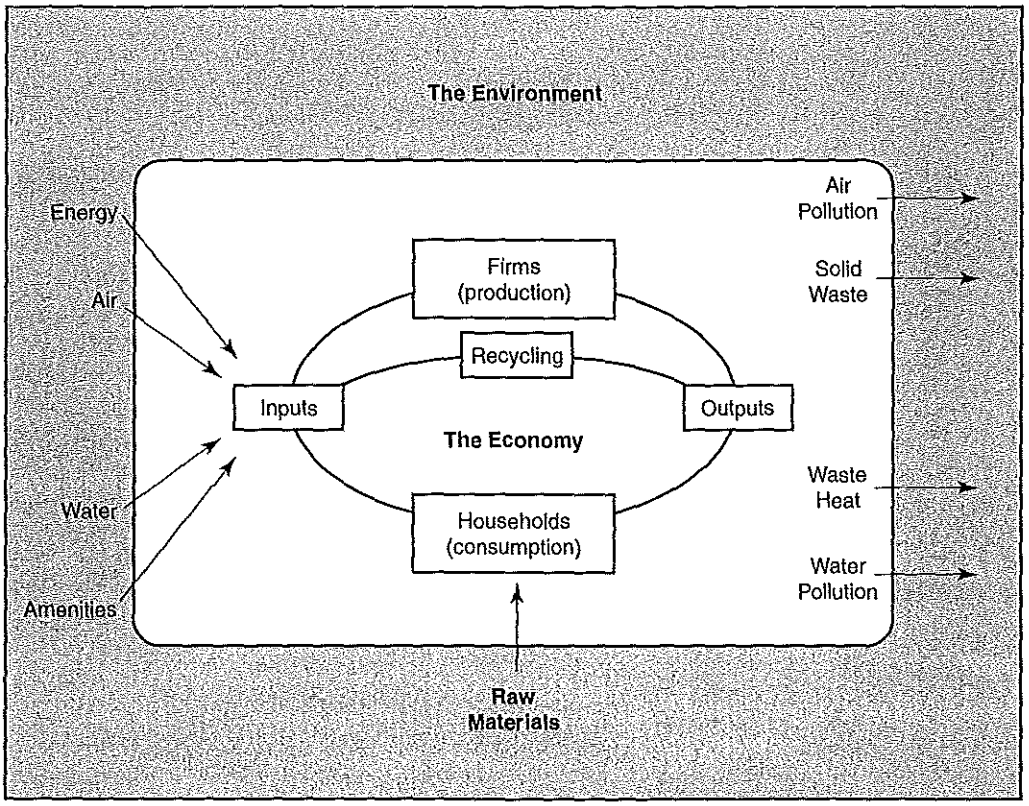
In economics the environment is viewed as a composite asset that provides a variety of services. It is a very special asset, to be sure, because it provides the life-support systems that sustain our very existence, but it is an asset nonetheless. As with other assets, we wish to enhance, or at least prevent undue depreciation of, the value of this asset so that it may continue to provide aesthetic and life-sustaining services.

The environment provides the economy with raw materials, which are transformed into consumer products by the production process, and energy, which fuels this transformation. Ultimately these raw materials and energy return to the environment as waste products (see Figure 2.1).

The environment also provides services directly to consumers. The air we breathe, the nourishment we receive from food and drink, and the protection we derive from shelter and clothing are all benefits we receive either directly or indirectly from the environment. In addition, anyone who has experienced the exhilaration of white-water canoeing, the total serenity of a wilderness trek, or the breathtaking beauty of a sunset will readily recognize that the environment provides us with a variety of amenities for which no substitute exists.

If the environment is defined broadly enough, the relationship between the environment and the economic system can be considered a *closed system*. For our purposes, a closed system is one in which no inputs (energy, matter, and so on) are received from outside the system and no outputs are transferred outside the system. An *open system*, by contrast, is one in which the system imports or exports matter or energy.

FIGURE 2.1 The Economic System and the Environment



If we restrict our conception of the relationship in Figure 2.1 to our planet and the atmosphere around it, then clearly we do not have a closed system. We derive most of our energy from the sun, either directly or indirectly. We have also sent spaceships well beyond the boundaries of our atmosphere. Nonetheless, historically speaking, for *material* inputs and outputs (not including energy), this system can be treated as a closed system because the amount of exports (such as abandoned space vehicles) and imports (for example, moon rocks) are negligible. Whether the system remains closed depends on the degree to which space exploration opens up the rest of our solar system as a source of raw materials.

The treatment of our planet and its immediate environs as a closed system has an important implication that is summed up in the *first law of thermodynamics*—energy and matter can neither be created nor destroyed.[1] The law implies that the mass of materials flowing into the economic system from the environment has either to accumulate in the economic system or return to the environment as waste. When accumulation stops, the mass of materials flowing into the economic system is equal in magnitude to the mass of waste flowing into the environment.

Excessive wastes can, of course, depreciate the asset; when they exceed the absorptive capacity of nature, wastes reduce the services that the asset provides. Examples are easy to find: air pollution can cause respiratory problems; polluted drinking water can cause cancer; smog obliterates scenic vistas; climate change can lead to flooding of coastal areas.

The relationship of people to the environment is also conditioned by another physical law, the *second law of thermodynamics*. Known popularly as the *entropy law*, this law states that "entropy increases." *Entropy* is the amount of energy unavailable for work. Applied to energy processes, this law implies that no conversion from one form of energy to another is completely efficient and that the consumption of energy is an irreversible process. Some energy is always lost during conversion, and the rest, once used, is no longer available for further work. The second law also implies that in the absence of new energy inputs, any closed system must eventually use up its available energy. Since energy is necessary for life, life ceases when useful energy flows cease.

We should remember that our planet is not even approximately a closed system with respect to energy; we gain energy from the sun. The entropy law does remind us, however, that the flow of solar energy establishes an upper limit on the flow of available energy that can be sustained. Once the stocks of stored energy (such as fossil fuels and nuclear energy) are gone, the amount of energy available for useful work will be determined solely by the solar flow and by the amount that can be stored (dams, trees, and so on). Thus, over the very long run, the growth process will be limited by the availability of solar energy and our ability to put it to work.

The Economic Approach

Two different types of economic analysis can be applied to increase our understanding of the relationship between the economic system and the environment: *Positive*

[1]We know, however, from Einstein's famous equation ($E = mc^2$) that matter can be transformed into energy. This transformation is the source of energy in nuclear power.