the supply of land below demand. The only way to expand production would be to bring additional, less fertile land (more costly to farm) into production; consequently, additional production does not lower price, as it does in a constant-cost industry. As we shall see, other circumstances also give rise to scarcity rent for natural resources.

Externalities as a Source of Market Failure

The Concept Introduced

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 imposes 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.

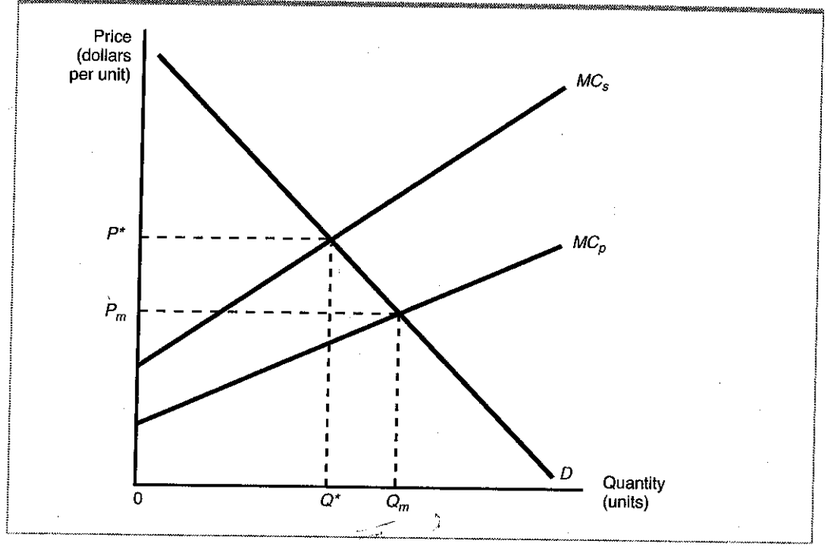
The effect of this external cost on the steel industry is illustrated in Figure 4.4, which shows the market for steel. Steel production inevitably involves producing pollution as well as steel. The demand for steel is shown by the demand curve D, and the private marginal cost of producing the steel (exclusive of pollution control and damage) is depicted as MC_p. Because society considers both the cost of pollution and the cost of producing the steel, the social marginal-cost function (MC_s) includes both of these costs as well.

If the steel industry faced no outside control on its emission levels, it would seek to produce Q_m. That choice, in a competitive setting, would maximize its private producer surplus. But that is clearly not efficient, since the net benefit is maximized at Q^* not Q_m.

With the assistance of Figure 4.4, we can draw a number of conclusions about market allocations of commodities causing pollution externalities:

- The output of the commodity is too large.
- Too much pollution is produced.
- The prices of products responsible for pollution are too low.
- As long as the costs are external, no incentives to search for ways to yield less pollution per unit of output are introduced by the market.
- Recycling and reuse of the polluting substances are discouraged because release into the environment is so inefficiently cheap.

FIGURE 4.4 The Market for Steel



The effects of a market imperfection for one commodity end up affecting the demands for raw materials, labor, and so on. The ultimate effects are felt through the entire economy.

Types of Externalities

External effects 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 purchase a particularly scenic area that is visible to the public 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.

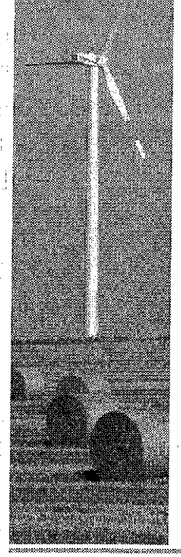
This pecuniary diseconomy, however, does not cause a market failure because the resulting higher rents are reflecting the scarcity of land. The land market provides a mechanism by which

the parties can bid for land; the prices that result 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 scarcity of the water resource is not signaled to the steel firm. An essential feedback mechanism that is present for pecuniary externalities is not present for the pollution case.

The externalities concept is a broad one covering a multitude of sources of market failure (Example 4.2 illustrates one). The next step is to investigate some specific circumstances that can give rise to externalities.

EXAMPLE 4.2



Shrimp Farming Externalities in Thailand

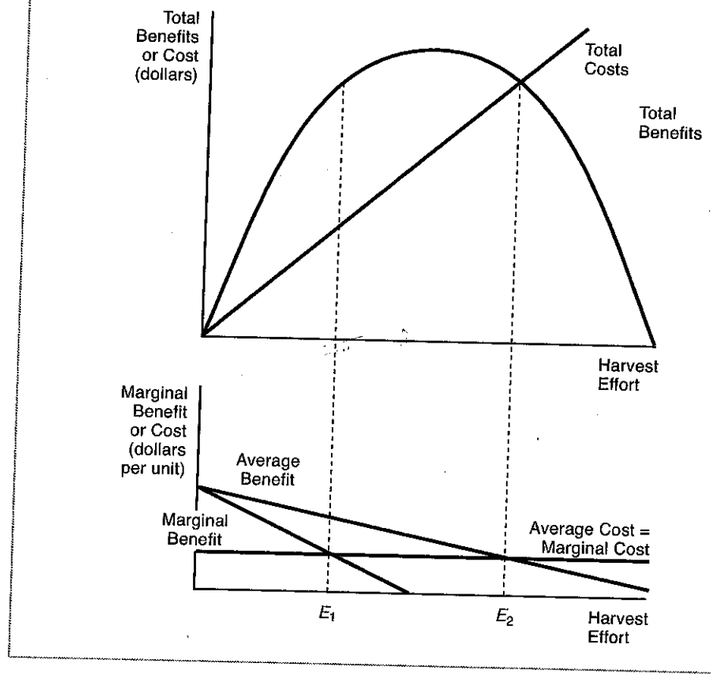
In the Tha Po village on the coast of Surat Thani Province in Thailand more than half of the 1,100 hectares of mangrove swamps have been cleared for commercial shrimp farms. Although harvesting shrimp is a lucrative undertaking, mangroves serve as nurseries for fish and as barriers for storms and soil erosion. Following the destruction of the local mangroves, Tha Po villagers experienced a decline in fish catch and suffered storm damage and water pollution. Can market forces be trusted to strike the efficient balance between preservation and development for the remaining mangroves?

Calculations by economists Sathirathai and Barbier (2001), demonstrated that the value of the ecological services that would be lost from further destruction of the mangrove swamps exceeded the value of the shrimp farms that would take their place. Preservation of the remaining mangrove swamps would be the efficient choice.

Would a potential shrimp-farming entrepreneur make the efficient choice? Unfortunately the answer is no. This study estimated the economic value of mangroves in terms of local use of forest resources, off-shore fishery linkages, and coastal protection to be in the range of $27,264 to $35,921 per hectare. In contrast, the economic returns to shrimp farming, once they are corrected for input subsidies and for the costs of water pollution, are only $194 to $209 per hectare. However, as shrimp farmers are heavily subsidized and do not have to take into account the external costs of pollution, their financial returns are typically $7,706.95 to $8,336.47 per hectare. In the absence of some sort of external control imposed by collective action, development would be the normal, if inefficient, result. The externalities associated with the ecological services provided by the mangroves support a biased decision that results in fewer social net benefits, but greater private net benefits.

Source: Suthawan Sathirathai and Edward B. Barbier, "Valuing Mangrove Conservation in Southern Thailand," Contemporary Economic Policy (19)2, April 2001: 109–122.

FIGURE 4.5 Bison Harvesting



Public Goods

Public goods, defined as those that exhibit both consumption indivisibilities and nonexcludability, present a particularly complex category of environmental resources. *Nonexcludability* refers to a circumstance where, once the resource is provided, even those who fail to pay for it cannot be excluded from enjoying the benefits it confers. *Indivisible consumption* occurs when one person's consumption of a good does not diminish the amount available for others. Several common environmental resources are public goods, including not only the "charming landscape" referred to by Emerson in the opening quote, but also clean air, clean water, and biological diversity.[3]

[3]Notice that public "bads," such as dirty air and dirty water, are also possible.

Biological diversity includes two related concepts: (1) the amount of genetic variability among individuals within a single species and (2) the number of species within a community of organisms. *Genetic diversity*, critical to species survival in the natural world, has also proved to be important in the development of new crops and livestock. It enhances the opportunities for crossbreeding and, thus, the development of superior strains. The availability of different strains was the key, for example, in developing new, disease-resistant barley.

Because of the interdependence of species within ecological communities, any particular species may have a value to the community far beyond its intrinsic value. Certain species contribute balance and stability to their ecological communities by providing food sources or holding the population of the species in check.

The richness of diversity within and among species has provided new sources of food, energy, industrial chemicals, raw materials, and medicines. Yet there is considerable evidence that biological diversity is decreasing.

Can we rely on the private sector to produce the efficient amount of a public good such as biological diversity? Unfortunately, the answer is no! Suppose that in response to diminishing biological diversity we decide to take up a collection to provide some means of preserving endangered species. Would you expect the collection to yield sufficient revenue to pay for an efficient level of ecological diversity? The general answer is no. Let's see why.

In Figure 4.6 individual-demand curves for preserving biodiversity have been presented for two consumers *A* and *B*. The market demand curve is represented by the vertical summation of the two individual-demand curves. A vertical summation is necessary because everyone can simultaneously consume the same amount of biological diversity. Therefore, we are able to determine the market demand by finding the sum of the amounts of money they would be willing to pay for that level of diversity.

What is the efficient level of diversity? It can be determined by a direct application of our definition of efficiency. The efficient allocation maximizes net benefits. Net benefits, in turn, are represented geometrically by the portion of the area under the market demand curve that lies above the marginal-cost curve. The allocation that maximizes net benefits is Q^*, the allocation where the demand curve crosses the marginal-cost curve.

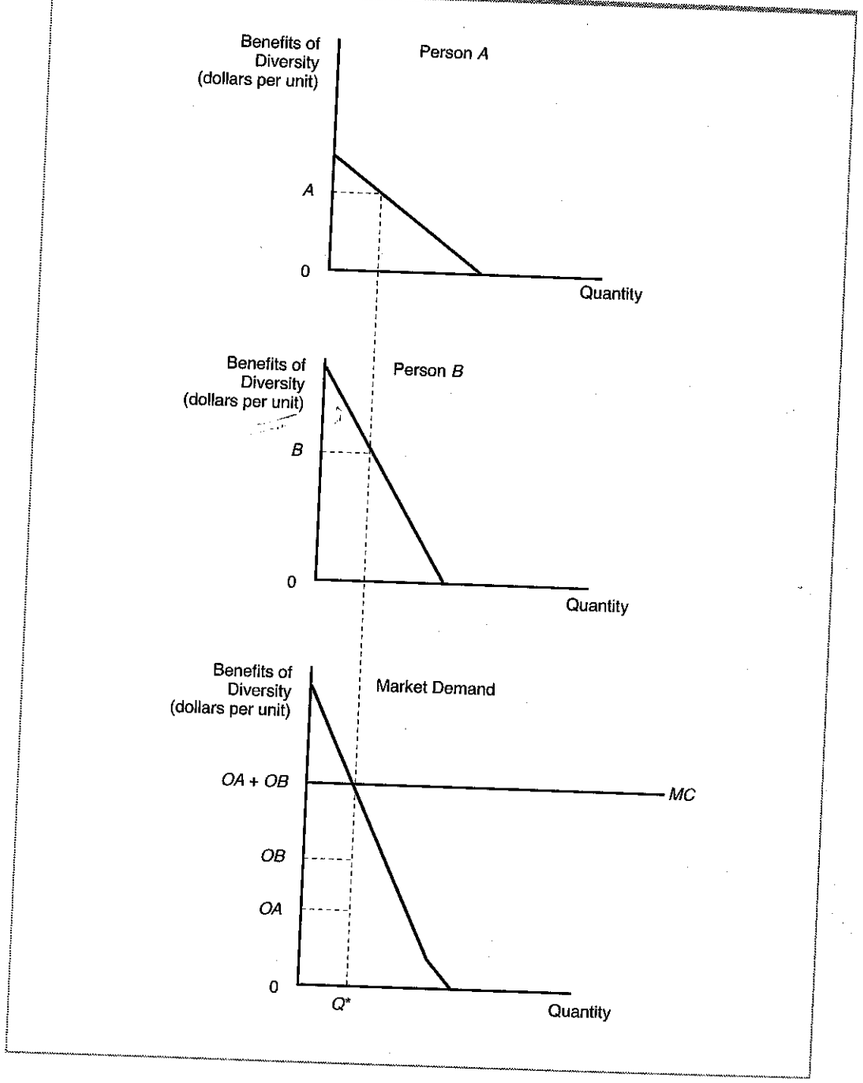
Both consumers consume this amount. At this level of availability, the marginal net benefit to person *B* is *OB* whereas the marginal net benefit to person *A* is *OA*. Adding these together produces *OA* + *OB*, society's marginal net benefit, which equates to marginal cost.

Would a private market supply this amount? In general, the answer is that it would not. The typical market will undersupply diversity.

One further insight can be gained from Figure 4.6, and it is this insight that led to characterizing public-good problems as "complex" in the opening sentence of this section. The efficient market equilibrium for a public good requires different prices for each consumer. In Figure 4.6 if consumer *A* is charged price P_a (=*OA*), and consumer *B* is charged price P_b (=*OB*), then both consumers will be satisfied with the efficient allocation (the efficient allocation would have maximized their net benefits given the prices).

Furthermore, the revenue collected will be sufficient to finance the supply of the public good (because $P_b \times Q^* + P_a \times Q^* = MC \times Q^*$). Thus, although an efficient pricing system exists, it is very difficult to implement. The efficient pricing system requires charging a different price to each consumer; in the absence of excludability, consumers may not choose to reveal the strength

FIGURE 4.6 Efficient Provision of Public Goods

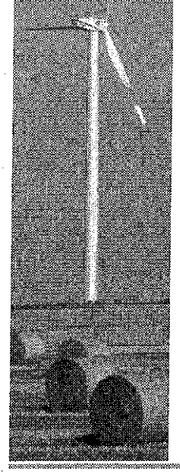


of their preference for this commodity. Therefore, the producer could not possibly know what prices to charge.

Inefficiency results because each person is able to become a free rider on the other's contribution. A *free rider* is someone who derives the benefits from a commodity without contributing to its supply. Because of the consumption indivisibility and nonexcludability properties of the public good, consumers receive the benefits of any diversity purchased by other people. When this happens it tends to diminish incentives to contribute, and the contributions are not sufficiently large to finance the efficient amount of the public good; it would be undersupplied.

The privately supplied amount may not be zero. Some diversity would be privately supplied. Indeed, as suggested by Example 4.3, the privately supplied amount may be considerable.

EXAMPLE 4.3



Public Goods Privately Provided: The Nature Conservancy

Can the demand for a public good such as biological diversity be observed in practice? Would the market respond to that demand? Apparently so, according to the existence of an organization called The Nature Conservancy.

The Nature Conservancy was born of an older organization called the Ecologist Union on September 11, 1950, for the purpose of establishing natural area reserves to aid in the preservation of areas, objects, and fauna and flora that have scientific, educational, or aesthetic significance. This organization purchases, or accepts as donations, land that has some unique ecological or aesthetic significance, to keep it from being used for other purposes. In so doing it preserves many species by preserving the habitat.

From humble beginnings, The Nature Conservancy has, as of 2008, been responsible for the preservation of 119 million acres of forests, marshes, prairies, mounds, and islands around the world. Additionally, The Nature Conservancy has protected 5,000 miles of rivers and operates 100 marine conservation projects. These areas serve as home to rare and endangered species of wildlife and plants. The Conservancy owns and manages the largest privately owned nature preserve system in the world.

This approach has considerable merit. A private organization can move more rapidly than the public sector. Because it has a limited budget, The Nature Conservancy sets priorities and concentrates on acquiring the most ecologically unique areas. Yet the theory of public goods reminds us that if this were to be the sole approach to the preservation of biological diversity, it would preserve a smaller-than-efficient amount.

Source: The Nature Conservancy, http://nature.org/aboutus/.

Imperfect Market Structures

Environmental problems also occur when one of the participants in an exchange of property rights is able to exercise an inordinate amount of power over the outcome. This can occur, for example, when a product is sold by a single seller, or *monopoly*.