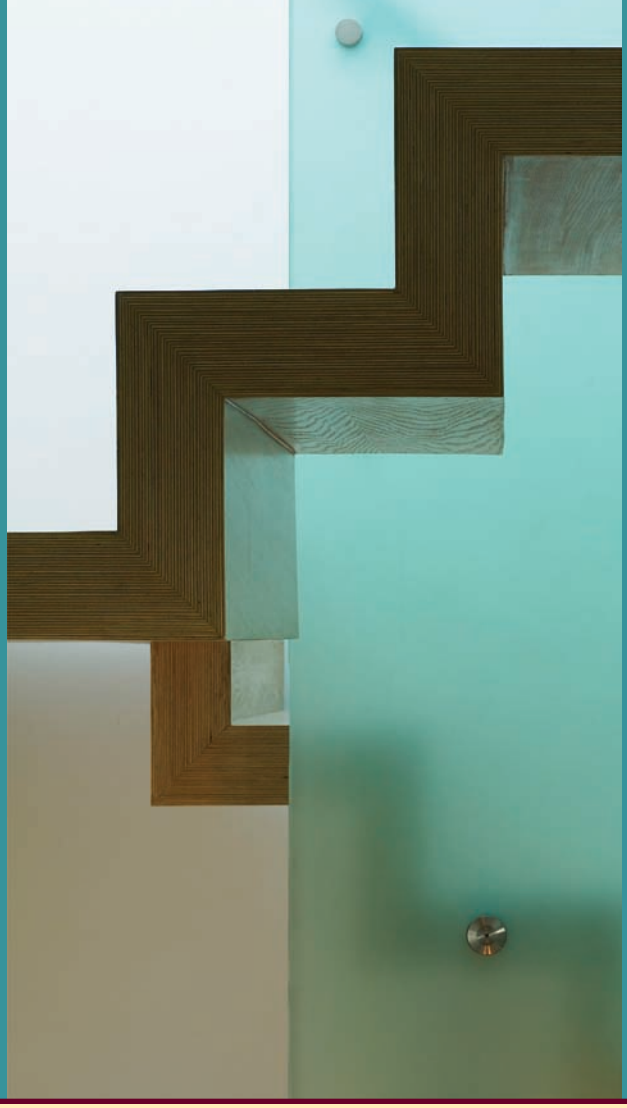
PART FOUR

Microeconomics of Government

IN THIS CHAPTER YOU WILL LEARN:

1. How public goods are distinguished from private goods.
2. The method for determining the optimal quantity of a public good.
3. The basics of cost-benefit analysis.
4. About externalities (spillover costs and benefits) and the methods to remedy them.
5. How information failures can justify government interventions in some markets.



16

Public Goods, Externalities, and Information Asymmetries

The economic activities of government affect your well-being every day. If you drive to work or classes, you are using publicly provided highways and streets. If you attend a public college or university, taxpayers subsidize your education. When you receive a check from your part-time or summer job, you see deductions for income taxes and Social Security taxes. Government antipollution laws affect the air you breathe. Laws requiring seat belts, motorcycle helmets, and auto insurance are all government mandates.

This chapter examines government and *market failure*—a circumstance in which private markets do not bring about the allocation of resources that best satisfies society's wants. Where private markets fail, an economic role for government may arise. We want to examine that role as it relates to three kinds of market failure: public goods, externalities, and information asymmetries. Our discussion of externalities in turn facilitates a discussion of pollution, climate change, and related issues.

In the next chapter—Chapter 17—we continue our discussion of the microeconomics of government by first analyzing potential government inefficiencies—called *government failure*—and then considering the economics of taxation.

PublicGood s

To understand public goods, we first need to revisit the characteristics of private goods.

Private Goods Characteristics

We have seen that a full range of **private goods** is produced through the competitive market system. These are the goods offered for sale in stores, in shops, and on the Internet. Examples include automobiles, clothing, personal computers, household appliances, and sporting goods. Private goods have two characteristics: rivalry and excludability:

- ***Rivalry*** (in consumption) means that when one person buys and consumes a product, it is not available for another person to buy and consume. When Adams purchases and drinks a bottle of mineral water, it is not available for Benson to purchase and consume.
- ***Excludability*** means that sellers can keep people who do not pay for a product from obtaining its benefits. Only people who are willing and able to pay the market price for bottles of water can obtain these drinks and the benefits they confer.

Consumers fully express their personal demands for private goods in the market. If Adams likes bottled mineral water, that fact will be known by her desire to purchase the product. Other things equal, the higher the price of bottled water, the fewer bottles she will buy. So Adams' demand for bottled water will reflect an inverse relationship between the price of bottled water and the quantity of it demanded. This is simply *individual* demand, as described in Chapter 3.

The *market* demand for a private good is the horizontal summation of the individual demand schedules (review Figure 3.2). Suppose just two consumers comprise the market for bottled water and the price is $1 per bottle. If Adams will purchase 3 bottles and Benson will buy 2, the market demand will reflect consumers' demand for 5 bottles at the $1 price. Similar summations of quantities demanded at other prices will generate the market demand schedule and curve.

Suppose the equilibrium price of bottled water is $1. Adams and Benson will buy a total of 5 bottles, and the sellers will obtain total revenue of $5 (= $1 × 5). If the sellers' cost per bottle is $.80, their total cost will be $4 (= $.80 × 5). So sellers charging $1 per bottle will obtain $5 of total revenue, incur $4 of total cost, and earn $1 of profits for the 5 bottles sold.

Because firms can profitably "tap market demand" for private goods, they will produce and offer them for sale. Consumers demand private goods, and profit-seeking suppliers produce goods that satisfy the demand. Consumers willing to pay the market price obtain the goods; nonpayers go without. A competitive market not only makes private goods available to consumers but also allocates society's resources efficiently to the particular product. There is neither underproduction nor overproduction of the product.

Public Goods Characteristics

Recall from Chapter 4 that certain other goods and services—**public goods**—have the opposite characteristics of private goods. Public goods are distinguished by nonrivalry and nonexcludability.

- ***Nonrivalry*** (in consumption) means that one person's consumption of a good does not preclude consumption of the good by others. Everyone can simultaneously obtain the benefit from a public good such as national defense, street lighting, a global positioning system, or environmental protection.
- ***Nonexcludability*** means there is no effective way of excluding individuals from the benefit of the good once it comes into existence. Once in place, you cannot exclude someone from benefiting from national defense, street lighting, a global positioning system, or environmental protection.

These two characteristics create a **free-rider problem.** Once a producer has provided a public good, everyone including nonpayers can obtain the benefit. Most people do not voluntarily pay for something they can obtain for free!

With only free riders, the demand for a public good does not get expressed in the market. With no market demand, firms have no potential to "tap the demand" for revenues and profits. The free-rider problem makes it impossible for firms to gather together resources and profitably provide the good. If society wants a public good, society will have to direct government to provide it. Government can finance the provision of such goods through taxation.

CONSIDER THIS . . .

Art for Art's Sake

Suppose an enterprising sculptor creates a piece of art costing $600 and, with permission, places it in the town square. Also suppose that Jack gets $300 of enjoyment from the art and Diane gets $400. Sensing this enjoyment and hoping to make a profit, the sculptor approaches Jack for a donation equal to his satisfaction. Jack falsely says that, unfortunately, he does not particularly like the piece. The sculptor then tries Diane, hoping to get $400 or so. Same deal: Diane professes not to like the piece either. Jack and Diane have become free riders. Although feeling a bit guilty, both reason that it makes no sense to pay for something when anyone can receive the benefits without paying for them. The artist is a quick learner; he vows never to try anything like that again.

Optimal Quantity of a Public Good

If consumers need not reveal their true demand for a public good in the marketplace, how can society determine the optimal amount of that good? The answer is that the government has to try to estimate the demand for a public good through surveys or public votes. It can then compare the marginal benefit (MB) of an added unit of the good against the government's marginal cost (MC) of providing it. Adhering to the MB = MC rule, government can provide the "right," meaning "efficient," amount of the public good.

Demand for Public Goods

The demand for a public good is somewhat unusual. Suppose Adams and Benson are the only two people in the society, and their marginal willingness to pay for a public good, national defense, is as shown in columns 1 and 2 and columns 1 and 3 in Table 16.1. Economists might have discovered these schedules through a survey asking hypothetical questions about how much each citizen was willing to pay for various types and amounts of public goods rather than go without them.

Notice that the schedules in Table 16.1 are price-quantity schedules, implying that they are demand schedules. Rather than depicting demand in the usual way—the quantity of a product someone is willing to buy at each possible price—these schedules show the price someone is willing to pay for the extra unit of each possible quantity. That is, Adams is willing to pay $4 for the first unit of the public good, $3 for the second, $2 for the third, and so on.

TABLE 16.1 Demand for a Public Good, Two Individuals

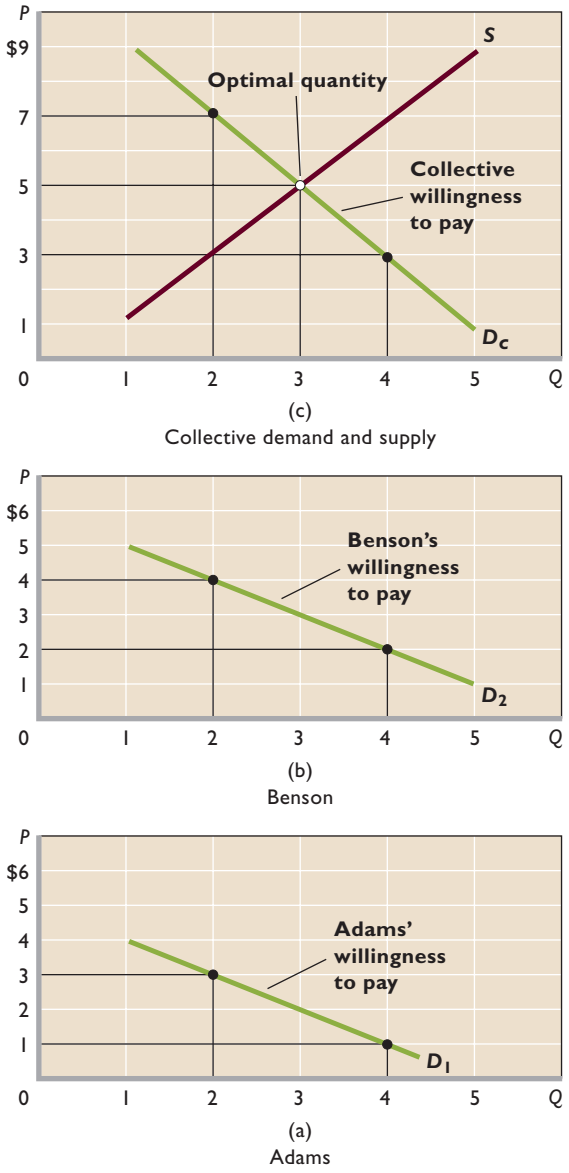
(1) Quantity of Public Good	(2) Adams' Willingness to Pay (Price)		(3) Benson's Willingness to Pay (Price)		(4) Collective Willingness to Pay (Price)
1	$4	+	$5	=	$9
2	3	+	4	=	7
3	2	+	3	=	5
4	1	+	2	=	3
5	0	+	1	=	1

Suppose the government produces 1 unit of this public good. Because of nonrivalry, Adams' consumption of the good does not preclude Benson from also consuming it, and vice versa. So both consume the good, and neither volunteers to pay for it. But from Table 16.1 we can find the amount these two people would be willing to pay, together, rather than do without this 1 unit of the good. Columns 1 and 2 show that Adams would be willing to pay $4 for the first unit of the public good; columns 1 and 3 show that Benson would be willing to pay $5 for it. So the two people are jointly willing to pay $9 (= $4 + $5) for this first unit.

For the second unit of the public good, the collective price they are willing to pay is $7 (= $3 from Adams + $4 from Benson); for the third unit they will pay $5 (= $2 + $3); and so on. By finding the collective willingness to pay for each additional unit (column 4), we can construct a collective demand schedule (a willingness-to-pay schedule) for the public good. Here we are not adding the quantities demanded at each possible price, as we do when we determine the market demand for a private good. Instead, we are adding the prices that people are willing to pay for the last unit of the public good at each possible quantity demanded.

Figure 16.1 shows the same adding procedure graphically, using the data from Table 16.1. Note that we sum Adams' and Benson's willingness-to-pay curves *vertically* to derive the collective willingness-to-pay curve (demand curve). The summing procedure is upward from the lower graph to the middle graph to the top (total) graph. For example, the height of the collective demand curve D_c at 2 units of output in the top graph is $7, the sum of the amounts that Adams and Benson are each willing to pay for the second unit (= $3 + $4). Likewise, the height of the collective demand curve at 4 units of the public good is $3 (= $1 + $2).

FIGURE 16.1 The optimal amount of a public good. The collective demand curve for a public good, as shown by D_c in (c), is found by summing vertically the individual willingness-to-pay curves D_1 in (a) and D_2 in (b) of Adams and Benson, the only two people in the economy. The supply curve of the public good represented in (c) slopes upward and to the right, reflecting rising marginal costs. The optimal amount of the public good is 3 units, determined by the intersection of D_c and S. At that output, marginal benefit (reflected in the collective demand curve D_c) equals marginal cost (reflected in the supply curve S).



What does it mean in Figure 16.1a that, for example, Adams is willing to pay $3 for the second unit of the public good? It means that Adams expects to receive $3 of extra benefit or utility from that unit. And we know from the law of diminishing marginal utility that successive units of any good yield less and less added benefit. This is also true for public goods, explaining the downward slope of the willingness-to-pay curves of Adams, Benson, and society. These curves, in essence, are marginal-benefit (MB) curves. **(Key Question 1)**

Comparing MB and MC

The supply curve for any good, private or public, is its marginal-cost (MC) curve. Marginal cost rises as more of a good is produced. The reason is the law of diminishing returns, which applies whether a society is making missiles (a public good) or mufflers (a private good). In the short run, government has fixed resources (public capital) with which to "produce" public goods such as national defense. As it adds more units of a variable resource (labor) to these fixed resources, total product eventually rises at a diminishing rate. That means that marginal product falls and marginal cost rises, explaining why curve S in Figure 16.1c slopes upward.

We can now determine the optimal quantity of the public good. The collective demand curve D_c in Figure 16.1c measures society's marginal benefit of each unit of this particular good. The supply curve S in that figure measures society's marginal cost of each unit. The optimal quantity of this public good occurs where marginal benefit equals marginal cost, or where the two curves intersect. In Figure 16.1c that point is 3 units of the public good, where the collective willingness to pay for the last (third) unit—the marginal benefit—just matches that unit's marginal cost ($5 = $5). As we saw in Chapter 1, equating marginal benefit and marginal cost efficiently allocates society's scarce resources. **(Key Question 2)**

WORKED PROBLEMS
W 16.1
Optimal amount of a public good

Cost-Benefit Analysis

The above example suggests a practical means, called **cost-benefit analysis,** for deciding whether to provide a particular public good and how much of it to provide. Like our example, cost-benefit analysis (or marginal-benefit–marginal-cost analysis) involves a comparison of marginal costs and marginal benefits.

Concept Suppose the Federal government is contemplating a highway construction plan. Because the economy's resources are limited, any decision to use more resources in the public sector will mean fewer resources for the private sector. There will be an opportunity cost, as well as a benefit. The cost is the loss of satisfaction resulting from the accompanying decline in the production of private goods; the benefit is the extra satisfaction resulting from the output of more

TABLE 16.2 Cost-Benefit Analysis for a National Highway Construction Project (in Billions)

(1) Plan	(2) Total Cost of Project	(3) Marginal Cost	(4) Total Benefit	(5) Marginal Benefit	(6) Net Benefit (4) − (2)
No new construction	$ 0		$ 0		$ 0
		$ 4		$ 5	
A: Widen existing highways	4		5		1
		6		8	
B: New 2-lane highways	10		13		3
		8		***10***	
C: New 4-lane highways	***18***		***23***		***5***
		10		3	
D: New 6-lane highways	28		26		−2

public goods. Should the needed resources be shifted from the private to the public sector? The answer is yes if the benefit from the extra public goods exceeds the cost that results from having fewer private goods. The answer is no if the cost of the forgone private goods is greater than the benefit associated with the extra public goods.

Cost-benefit analysis, however, can indicate more than whether a public program is worth doing. It can also help the government decide on the extent to which a project should be pursued. Real economic questions cannot usually be answered simply by "yes" or "no" but, rather, involve questions such as "how much" or "how little."

Illustration Although a few private toll roads exist, highways clearly have public goods characteristics because the benefits are widely diffused and highway use is difficult to price. Should the Federal government expand the Federal highway system? If so, what is the proper size or scope for the overall project?

Table 16.2 lists a series of increasingly ambitious and increasingly costly highway projects: widening existing two-lane highways; building new two-lane highways; building new four-lane highways; building new six-lane highways. The extent to which government should undertake highway construction depends on the costs and benefits. The costs are largely the costs of constructing and maintaining the highways; the benefits are improved flows of people and goods throughout the country.[1]

The table shows that total annual benefit (column 4) exceeds total annual cost (column 2) for plans A, B, and C, indicating that some highway construction is economically justifiable. We see this directly in column 6, where total costs (column 2) are subtracted from total annual benefits (column 4). Net benefits are positive for plans A, B, and C. Plan D is not economically justifiable because net benefits are negative.

But the question of optimal size or scope for this project remains. Comparing the marginal cost (the change in total cost) and the marginal benefit (the change in total benefit) relating to each plan determines the answer. The guideline is well known to you from previous discussions: Increase an activity, project, or output as long as the marginal benefit (column 5) exceeds the marginal cost (column 3). Stop the activity at, or as close as possible to, the point at which the marginal benefit equals the marginal cost. Do not undertake a project for which marginal cost exceeds marginal benefit.

In this case plan C (building new four-lane highways) is the best plan. Plans A and B are too modest; the marginal benefits exceed the marginal costs, and there is a better option. Plan D's marginal cost ($10 billion) exceeds the marginal benefit ($3 billion) and therefore cannot be justified; it overallocates resources to the project. Plan C is closest to the theoretical optimum because its marginal benefit ($10 billion) still exceeds marginal cost ($8 billion) but approaches the MB = MC (or MC = MB) ideal.

This **marginal-cost–marginal-benefit rule** actually tells us which plan provides the maximum excess of total benefits over total costs or, in other words, the plan that provides society with the maximum net benefit. You can confirm directly in column 6 that the maximum net benefit (= $5 billion) is associated with plan C.

Cost-benefit analysis shatters the myth that "economy in government" and "reduced government spending" are synonymous. "Economy" is concerned with using scarce resources efficiently. If the marginal cost of a proposed government program exceeds its marginal benefit, then the proposed public program should not be undertaken. But if the marginal benefit exceeds the marginal cost, then it would be uneconomical or "wasteful" not to spend on that government program. Economy in government does not mean minimization of public spending. It means allocating resources between the private and public sectors

[1]Because the costs of public goods typically are immediate while the benefits often accrue over longer time periods, economists convert both costs and benefits to present values for comparison. Using present value properly accounts for the time-value of money, discussed in Chapters 14 and 15.

and among public goods to achieve maximum net benefit. **(Key Question 3)**

QUICK REVIEW 16.1

- Public goods are characterized by nonrivalry and nonexcludability.
- The demand (marginal-benefit) curve for a public good is found by vertically adding the prices that all the members of society are willing to pay for the last unit of output at various output levels.
- The socially optimal amount of a public good is the amount at which the marginal cost and marginal benefit of the good are equal.
- Cost-benefit analysis is the method of evaluating alternative projects or sizes of projects by comparing the marginal cost and marginal benefit and applying the MC = MB rule.

Externalities

In performing its allocation function, government not only produces public goods but also corrects for a market failure called **externalities,** or spillovers. Recall from Chapter 4 that an externality is a cost or a benefit accruing to an individual or group—a third party—that is *external* to a market transaction. An example of a negative externality is the cost of breathing polluted air; an example of a positive externality is the benefit of having everyone else inoculated against some disease. When there are negative externalities, an overproduction of the related product occurs and there is an overallocation of resources to this product. Conversely, underproduction and underallocation of resources result when positive externalities are present. We can demonstrate both graphically.

NegativeE xternalities

Figure 16.2a illustrates how negative externalities affect the allocation of resources. When producers shift some of their costs onto the community as external costs, producers' marginal costs are lower than otherwise. So their supply curves do not include or "capture" all the costs legitimately associated with the production of their goods. A polluting producer's supply curve such as S in Figure 16.2a therefore understates the total cost of production. The firm's supply curve lies to the right of (or below) the full-cost supply curve S_t, which would include the spillover cost. Through polluting and thus transferring costs to society, the firm enjoys lower production costs and has the supply curve S.

INTERACTIVE GRAPHS
G 16.1
Externalities

The outcome is shown in Figure 16.2a, where equilibrium output Q_e is larger than the optimal output Q_o. This means that resources are overallocated to the production of this commodity; too many units of it are produced.

PositiveE xternalities

Figure 16.2b shows the impact of positive externalities on resource allocation. When external benefits occur, the market demand curve D lies to the left of (or below) the full-benefits demand curve. That is, D does not include the external benefits of the product, whereas D_t does. Consider inoculations against a communicable disease. Watson and Weinberg benefit when they get vaccinated, but so do their associates Alvarez and Anderson, who are less likely to contract the disease from them. The market demand curve reflects only the direct, private benefits to Watson and Weinberg. It does not reflect the external benefits—the positive externalities—to Alvarez and Anderson, which are included in D_t.

The outcome is that the equilibrium output Q_e is less than the optimal output Q_o. The market fails to produce enough vaccinations, and resources are underallocated to this product.

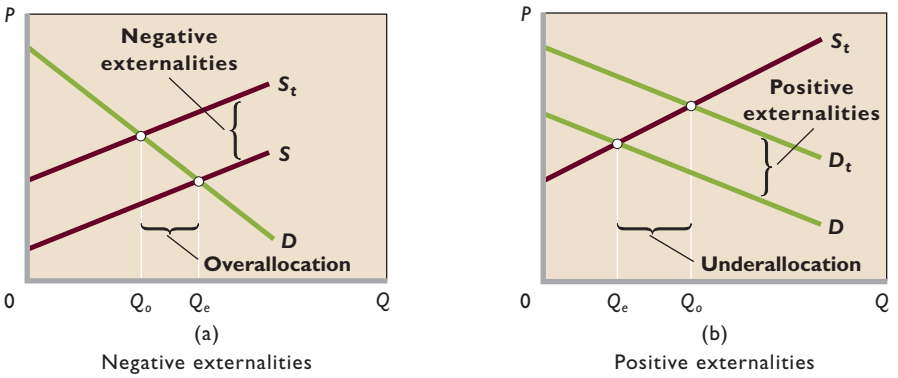


FIGURE 16.2 Negative externalities and positive externalities. (a) With negative externalities borne by society, the producers' supply curve S is to the right of (below) the full-cost curve S_t. Consequently, the equilibrium output Q_e is greater than the optimal output Q_o. (b) When positive externalities accrue to society, the market demand curve D is to the left of (below) the full-benefit demand curve D_t. As a result, the equilibrium output Q_e is less than the optimal output Q_o.

ORIGIN OF THE IDEA
O 16.1
Externalities

Economists have explored several approaches to the problems of negative externalities and positive externalities. Let's first look at situations where government intervention is not needed and then at some possible government solutions.

IndividualB argaining: Coase Theorem

In the **Coase theorem,** conceived decades ago by economist Ronald Coase at the University of Chicago, government is not needed to remedy external costs or benefits where (1) property ownership is clearly defined, (2) the number of people involved is small, and (3) bargaining costs are negligible. Under these circumstances the government should confine its role to encouraging bargaining between affected individuals or groups. Property rights place a price tag on an externality, creating opportunity costs for all parties. Because the economic self-interests of the parties are at stake, bargaining will enable them to find a mutually acceptable solution to the externality problem.

ORIGIN OF THE IDEA
O 16.2
Coase theorem

Example of the Coase Theorem

Suppose the owner of a large parcel of forestland is considering a plan to clear-cut (totally level) thousands of acres of mature fir trees. The complication is that the forest surrounds a lake with a popular resort on its shore. The resort is on land owned by the resort. The unspoiled beauty of the general area attracts vacationers from all over the nation to the resort, and the resort owner is against the clear-cutting. Should state or local government intervene to allow or prevent the tree cutting?

According to the Coase theorem, the forest owner and the resort owner can resolve this situation without government intervention. As long as one of the parties to the dispute has property rights to what is at issue, an incentive will exist for both parties to negotiate a solution acceptable to each. In our example, the owner of the timberland holds the property rights to the land to be logged and thus has the right to clear-cut it. The owner of the resort therefore has an economic incentive to negotiate with the forest owner to reduce the logging impact. Excessive logging of the forest surrounding the resort will reduce tourism and revenues to the resort owner.

But what is the economic incentive to the forest owner to negotiate with the resort owner? The answer draws directly on the idea of opportunity cost. One cost incurred in logging the forest is the forgone payment that the forest owner could obtain from the resort owner for agreeing not to clear-cut the fir trees. The resort owner might be willing to make a lump-sum or annual payment to the owner of the forest to avoid or minimize the negative externality. Or perhaps the resort owner might be willing to buy the forested land to prevent the logging. As viewed by the forest owner, a payment for not clear-cutting or a purchase price above the prior market value of the land is an opportunity cost of logging the land.

It is likely that both parties would regard a negotiated agreement as better than clear-cutting the firs.

Limitations

Unfortunately, many externalities involve large numbers of affected parties, high bargaining costs, and community property such as air and water. In such situations private bargaining cannot be used as a remedy. As an example, the global-warming problem affects millions of people in many nations. The vast number of affected parties could not individually negotiate an agreement to remedy this problem. Instead, they must rely on their governments to represent the millions of affected parties and find an acceptable solution. We discuss some of these potential solutions later in this chapter.

Liability Rules and Lawsuits

Although private negotiation may not be a realistic solution to many externality problems, clearly established property rights may help in another way. The government has erected a framework of laws that define private property and protect it from damage done by other parties. Those laws, and the damage recovery system to which they give rise, permit parties suffering negative externalities to sue for compensation.

Suppose the Ajax Degreaser Company regularly dumps leaky barrels containing solvents into a nearby canyon owned by Bar Q Ranch. Bar Q eventually discovers this dump site and, after tracing the drums to Ajax, immediately contacts its lawyer. Soon after, Bar Q sues Ajax. If Ajax loses the case, it will have to pay for the cleanup, and may also have to pay Bar Q additional damages for ruining its property.

Clearly defined property rights and government liability laws thus help remedy some externality problems. They do so directly by forcing the perpetrator of the harmful externality to pay damages to those injured. They do so indirectly by discouraging firms and individuals from generating negative externalities for fear of being sued.

It is not surprising, then, that many externalities do not involve private property but rather property held in common by society. It is the public bodies of water, the public lands, and the public air, where ownership is less clear, that often bear the brunt of negative externalities.

Caveat: Like private negotiations, private lawsuits to resolve externalities have their own limitations. Large legal fees and major time delays in the court system are commonplace. Also, the uncertainty associated with the court outcome reduces the effectiveness of this approach. Will the court accept your claim that your emphysema has resulted from the smoke emitted by the factory next door, or will it conclude that your ailment is unrelated to the plant's pollution? Can you prove that a specific firm in the area is the source of the contamination of your well? What happens to Bar Q's suit if Ajax Degreaser goes out of business during the litigation?

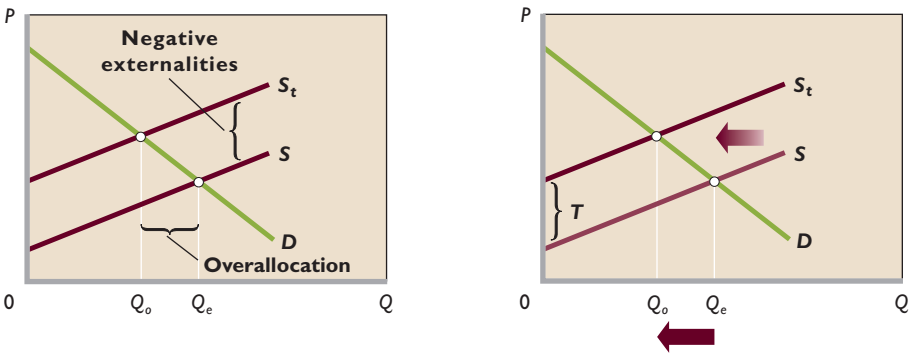
GovernmentIn tervention

Government intervention may be needed to achieve economic efficiency when externalities affect large numbers of people or when community interests are at stake. Government can use direct controls and taxes to counter negative externalities; it may provide subsidies or public goods to deal with positive externalities.

Direct Controls The direct way to reduce negative externalities from a certain activity is to pass legislation limiting that activity. Such direct controls force the offending firms to incur the actual costs of the offending activity. Historically, direct controls in the form of uniform emission standards—limits on allowable pollution—have dominated American air pollution policy. For example, the Clean Air Act of 1990 (1) forced factories and businesses to install "maximum achievable control technology" to reduce emissions of 189 toxic chemicals by 90 percent between 1990 and 2000; (2) required a 30 to 60 percent reduction in tailpipe emissions from automobiles by 2000; (3) mandated a 50 percent reduction in the use of chlorofluorocarbons (CFCs), which deplete the ozone layer (CFCs are used widely as a coolant in refrigeration, a blowing agent for foam, and a solvent in the electronics industry); and (4) forced coal-burning utilities to cut their emissions of sulfur dioxide by about 50 percent to reduce the acid-rain destruction of lakes and forests. Clean-water legislation limits the amount of heavy metals, detergents, and other pollutants firms can discharge into rivers and bays. Toxic-waste laws dictate special procedures and dump sites for disposing of contaminated soil and solvents. Violating these laws means fines and, in some cases, imprisonment.

Direct controls raise the marginal cost of production because the firms must operate and maintain pollution-control equipment. The supply curve S in Figure 16.3b, which does not reflect the external costs, shifts leftward to the full-cost supply curve, S_t. Product price increases, equilibrium output falls from Q_e to Q_o, and the initial overallocation of resources shown in Figure 16.3a is corrected.

Specific Taxes A second policy approach to negative externalities is for government to levy taxes or charges specifically on the related good. For example, the government has placed a manufacturing excise tax on CFCs, which deplete the stratospheric ozone layer protecting the earth from excessive solar ultraviolet radiation. Facing such an excise tax, manufacturers must decide whether to pay the tax or expend additional funds to purchase or develop substitute products. In either case, the tax raises



(a) Negative externalities

(b) Correcting the overallocation of resources via direct controls or via a tax

FIGURE 16.3 Correcting for negative externalities. (a) Negative externalities result in an overallocation of resources. (b) Government can correct this overallocation in two ways: (1) using direct controls, which would shift the supply curve from S to S_t and reduce output from Q_e to Q_o, or (2) imposing a specific tax T, which would also shift the supply curve from S to S_t, eliminating the overallocation of resources.

the marginal cost of producing CFCs, shifting the private supply curve for this product leftward (or upward).

In Figure 16.3b, a tax equal to T per unit increases the firm's marginal cost, shifting the supply curve from S to S_t. The equilibrium price rises, and the equilibrium output declines from Q_e to the economically efficient level Q_o. The tax thus eliminates the initial overallocation of resources.

Subsidies and Government Provision

Where spillover benefits are large and diffuse, as in our earlier example of inoculations, government has three options for correcting the underallocation of resources:

- ***Subsidies to buyers*** Figure 16.4a again shows the supply-demand situation for positive externalities. Government could correct the underallocation of resources, for example, to inoculations, by subsidizing consumers of the product. It could give each new mother in the United States a discount coupon to be used to obtain a series of inoculations for her child. The coupon would reduce the "price" to the mother by, say, 50 percent. As shown in Figure 16.4b, this program would shift the demand curve for inoculations from too low D to the appropriate D_t. The number of inoculations would rise from Q_e to the economically optimal Q_o, eliminating the underallocation of resources shown in Figure 16.4a.
- ***Subsidies to producers*** A subsidy to producers is a specific tax in reverse. Taxes are payments *to* the government that increase producers' costs. Subsidies are payments *from* the government that decrease producers' costs. As shown in Figure 16.4c, a subsidy of U per inoculation to physicians and medical clinics would reduce their marginal costs and shift their supply curve rightward from S_t to S_t'. The output of inoculations would increase from Q_e to the optimal level Q_o, correcting the underallocation of resources shown in Figure 16.4a.
- ***Government provision*** Finally, where positive externalities are extremely large, the government may decide to provide the product as a public good. The U.S. government largely eradicated the crippling disease polio by administering free vaccines to all children. India ended smallpox by paying people in rural areas to come to public clinics to have their children vaccinated. **(Key Question 4)**

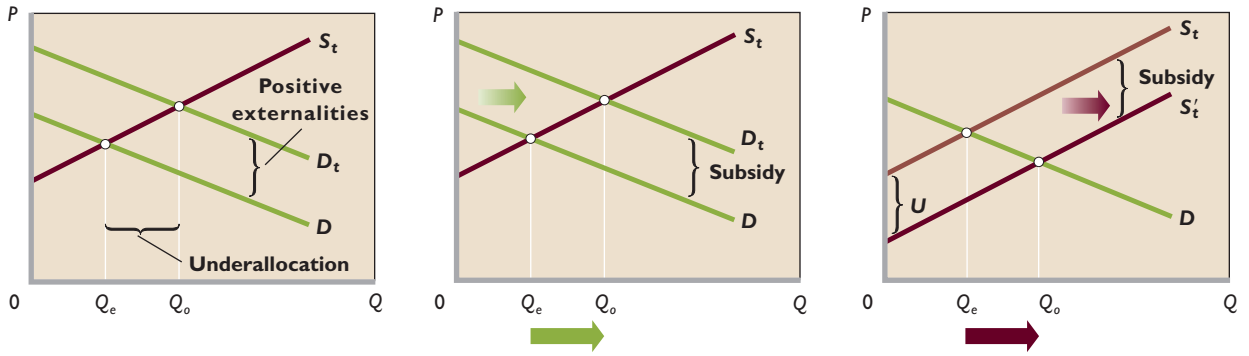
A Market-Based Approach to Negative Externalities

Another approach to negative externalities involves only limited government action. The idea is to create a market for externality rights. But before describing that approach, we first need to understand the idea called the **tragedy of the commons.**

The Tragedy of the Commons

The air, rivers, lakes, oceans, and public lands, such as parks and streets, are all objects for pollution because the rights to use those resources are held "in common" by society. No private

FIGURE 16.4 Correcting for positive externalities. (a) Positive externalities result in an underallocation of resources. (b) This underallocation can be corrected through a subsidy to consumers, which shifts market demand from D to D_t and increases output from Q_e to Q_o. (c) Alternatively, the underallocation can be eliminated by providing producers with a subsidy of U, which shifts their supply curve from S_t to S_t', increasing output from Q_e to Q_o.



individual or institution has a monetary incentive to maintain the purity or quality of such resources.

We maintain the property we own—for example, we paint and repair our homes periodically—in part because we will recoup the value of these improvements at the time of sale. But as long as "rights" to air, water, and certain land resources are commonly held and are freely available, there is no incentive to maintain them or use them carefully. As a result, these natural resources are overused and thereby degraded or polluted.

For example, a common pasture in which anyone can graze cattle will quickly be overgrazed because each rancher has an incentive to graze as many cattle as possible. Similarly, commonly owned resources such as rivers, lakes, oceans, and the air get used beyond their capacity to absorb pollution. Manufacturers will choose the least-cost combination of inputs and bear only unavoidable costs. If they can dump waste chemicals into rivers and lakes rather than pay for proper disposal, some businesses will be inclined to do so. Firms will discharge smoke into the air if they can, rather than purchase expensive abatement facilities. Even Federal, state, and local governments sometimes discharge inadequately treated waste into rivers, lakes, or oceans to avoid the expense of constructing expensive treatment facilities. Many individuals avoid the costs of proper refuse pickup and disposal by burning their garbage or dumping it in the woods.

The problem is mainly one of incentives. There is no incentive to incur internal costs associated with reducing or eliminating pollution when those costs can be transferred externally to society. The fallacy of composition (Last Word, Chapter 1) also comes into play. Each person and firm reasons their individual contribution to pollution is so small that it is of little or no overall consequence. But their actions, multiplied by hundreds, thousands, or millions, overwhelm the absorptive capacity of the common resources. Society ends up with a degradation or pollution problem.

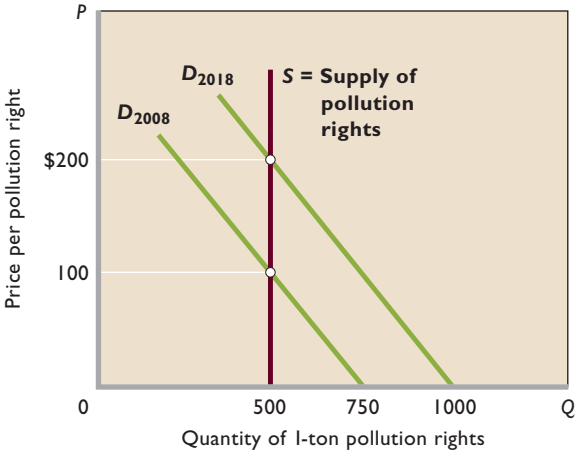
A Market for Externality Rights

This outcome gives rise to a market-based approach to correcting negative externalities. The idea is that the government can create a **market for externality rights.** We confine our discussion to pollution, although the same approach might be used with other externalities.

Operation of the Market

In this market-based approach—commonly called a **cap-and-trade program**—an appropriate pollution-control agency determines the amount of pollutants that firms can discharge into the water or air of a specific region annually while maintaining the water or air quality at some acceptable level. Suppose the agency ascertains that 500 tons of pollutants can be discharged into Metropolitan Lake and "recycled" by nature each year. Then 500 pollution rights, each entitling the owner to dump 1 ton of pollutants into the lake in 1 year, are made available for sale to producers each year. The quantity of these pollution rights is "capped," so supply is perfectly inelastic, as shown in Figure 16.5.

FIGURE 16.5 A market for pollution rights. The supply of pollution rights S is set by the government, which determines that a specific body of water can safely recycle 500 tons of waste. In 2008, the demand for pollution rights is D_{2008} and the 1-ton price is $100. The quantity of pollution is 500 tons, not the 750 tons it would have been without the pollution rights. Over time, the demand for pollution rights increases to D_{2018} and the 1-ton price rises to $200. But the amount of pollution stays at 500 tons, rather than rising to 1000 tons.



The demand for pollution rights, represented by D_{2008} in the figure, takes the same downsloping form as the demand for any other input. At higher prices, fewer pollution rights are demanded since firms substitute pollution abatement-equipment for pollution rights. An equilibrium market price for pollution rights, here $100, will be determined at which the environment-preserving quantity of pollution rights is rationed to polluters. Figure 16.5 shows that if the use of the lake as a dump site for pollutants were instead free, 750 tons of pollutants would be discharged into the lake; it would be "overconsumed," or polluted, in the amount of 250 tons.

Over time, as human and business populations expand, demand will increase, as from D_{2008} to D_{2018}. Without a market for pollution rights, pollution in 2018 would be 1000 tons, 500 tons beyond what can be assimilated by nature. With the market for pollution rights, the price would rise from $100 to $200, and the amount of pollutants would remain at 500 tons—the amount that the lake can recycle.

Advantages

This scheme has several advantages over direct controls. Most important, it reduces society's costs

by allowing pollution rights to be bought and sold. This trading of pollution rights is the "trade" portion of the "cap-and-trade" terminology given to this type of scheme. Let's see how this cost reduction works. Assume that the present equilibrium price of pollution rights is $100, as shown by the intersection of the supply curve and demand curve (2008) in Figure 16.5. Next, suppose that the pollution in question is some specific noxious discharge into Metropolitan Lake. Suppose that it costs Acme Pulp Mill $20 a year to reduce this pollution by 1 ton while it costs Zemo Chemicals $800 a year to accomplish the same 1-ton reduction. Also assume that Zemo wants to expand production, but doing so will increase its pollution discharge by 1 ton.

Without a market for pollution rights, Zemo would have to use $800 of society's scarce resources to keep the 1-ton pollution discharge from occurring. But with a market for pollution rights, Zemo has a better option: It buys 1 ton of pollution rights for the $100 price shown in Figure 16.5. Acme is willing to sell Zemo 1 ton of pollution rights for $100 because that amount is more than Acme's $20 cost of reducing its pollution by 1 ton. Zemo increases its discharge by 1 ton; Acme reduces its discharge by 1 ton. Zemo benefits (by $800 − $100), Acme benefits (by $100 − $20), and society benefits (by $800 − $20). Rather than using $800 of its scarce resources to hold the discharge at the specified level, society uses only $20 of those resources. Cap-and-trade programs, with pollution rights, thus decrease the cost of reducing pollution.

Market-based plans have other advantages. Potential polluters have a monetary incentive not to pollute because they must pay for the right to discharge effluent. Conservation groups can fight pollution by buying up and withholding pollution rights, thereby reducing pollution below governmentally determined standards. As the demand for pollution rights increases over time, the growing revenue from the sale of a fixed quantity of pollution rights could be devoted to environmental improvement. At the same time, the rising price of pollution rights should stimulate the search for improved pollution-control techniques.

Real-World Examples Administrative and political problems have kept the government from replacing direct controls—such as uniform emission limits—with a full-scale market for pollution rights. But the Environmental Protection Agency (EPA) established a system of pollution rights, or "tradeable emission allowances," in the 1980s as part of a plan to reduce the sulfur dioxide emitted by coal-burning public utilities. Those emissions are the major source of acid rain. The market for such rights was greatly expanded by legislation in the 1990s.

The Clean Air Act of 1990 established a limited market for pollution rights, similar to that shown in Figure 16.5, by allowing utilities to trade emission credits provided by government. Utilities can obtain credits by reducing sulfur-dioxide emissions by more than the specified amount. They can then sell their emission credits to other utilities that find it less costly to buy the credits than to install additional pollution-control equipment.

This market for sulfur-dioxide-emission credits complements other air pollution policies that also permit the exchange of pollution rights. The EPA now allows firms to exchange pollution rights internally and externally. Polluters are allowed to transfer air pollution internally between individual sources within their plants. That is, as long as it meets the overall pollution standard assigned to it, a firm may increase one source of pollution by offsetting it with reduced pollution from another part of its operations.

The EPA also permits external trading of pollution rights. It has set targets for reducing air pollution in regions where the minimum standards are not being met. Previously, new pollution sources could not enter these regions unless existing polluters went out of business. But under the system of external trading rights, the EPA allows firms that reduce their pollution below set standards to sell their pollution rights to other firms. A new firm that wants to locate in the Los Angeles area, for example, might be able to buy rights to emit 20 tons of nitrous oxide annually from an existing firm that has reduced its emissions 20 tons below its allowable limit. The price of these emission rights will depend on their supply and demand.

Finally, in 2003 the EPA extended the market-based approach to the Clean Water Act. Industry, agriculture, and municipalities within a defined watershed can meet their EPA-approved maximum daily discharge limits through trading "water quality credits." Entities that find reducing water pollution extremely expensive can buy credits from entities that can reduce pollution relatively inexpensively. Therefore, society incurs less total cost in improving water quality.

Table 16.3 reviews the major methods for correcting externalities.

Society's Optimal Amount of Externality Reduction

Negative externalities such as pollution reduce the utility of those affected, rather than increase it. These spillovers are not economic goods but economic "bads." If something is bad, shouldn't society eliminate it? Why should society allow firms or municipalities to discharge *any* impure waste into public waterways or to emit *any* pollution into the air?

TABLE 16.3 Methods for Dealing with Externalities

Problem	Resource Allocation Outcome	Ways to Correct
Negative externalities (spillover costs)	Overproduction of output and therefore overallocation of resources	1. Individual bargaining 2. Liability rules and lawsuits 3. Tax on producers 4. Direct controls 5. Market for externality rights
Positive externalities (spillover benefits)	Underproduction of output and therefore underallocation of resources	1. Individual bargaining 2. Subsidy to consumers 3. Subsidy to producers 4. Government provision

Reducing a negative externality has a "price." Society must decide how much of a reduction it wants to "buy." Eliminating pollution might not be desirable, even if it were technologically feasible. Because of the law of diminishing returns, cleaning up the second 10 percent of pollutants from an industrial smokestack normally is more costly than cleaning up the first 10 percent. Eliminating the third 10 percent is more costly than cleaning up the second 10 percent, and so on. Therefore, cleaning up the last 10 percent of pollutants is the most costly reduction of all.

The marginal cost (MC) to the firm and hence to society—the opportunity cost of the extra resources used—rises as pollution is reduced more and more. At some point MC may rise so high that it exceeds society's marginal benefit (MB) of further pollution abatement (reduction). Additional actions to reduce pollution will therefore lower society's well-being; total cost will rise more than total benefit.

MC, MB, and Equilibrium Quantity

Figure 16.6 shows both the rising marginal-cost curve, MC, for pollution reduction and the downsloping marginal-benefit curve, MB, for this outcome. MB slopes downward because of the law of diminishing marginal utility: The more pollution reduction society accomplishes, the lower the utility (and benefit) of the next unit of pollution reduction.

The **optimal reduction of an externality** occurs when society's marginal cost and marginal benefit of reducing that externality are equal (MC = MB). In Figure 16.6 this optimal amount of pollution abatement is Q_1 units. When MB exceeds MC, additional abatement moves society toward economic efficiency; the added benefit of cleaner air or water exceeds the benefit of any alternative use of the required resources. When MC exceeds MB, additional abatement reduces economic efficiency; there would be greater benefits from using resources in some other way than to further reduce pollution.

In reality, it is difficult to measure the marginal costs and benefits of pollution control. Nevertheless, Figure 16.6 demonstrates that some pollution may be economically efficient. This is so not because pollution is desirable but because beyond some level of control, further abatement may reduce society's net well-being.

Shifts in Locations of the Curves

The locations of the marginal-cost and marginal-benefit curves in

FIGURE 16.6 Society's optimal amount of pollution abatement. The optimal amount of externality reduction—in this case, pollution abatement—occurs at Q_1, where society's marginal cost MC and marginal benefit MB of reducing the spillover are equal.

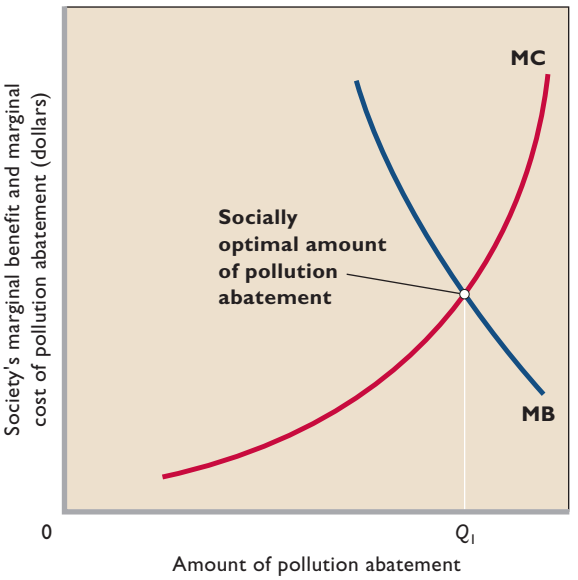


Figure 16.6 are not forever fixed. They can, and probably do, shift over time. For example, suppose that the technology of pollution-control equipment improved noticeably. We would expect the cost of pollution abatement to fall, society's MC curve to shift rightward, and the optimal level of abatement to rise. Or suppose that society were to decide that it wanted cleaner air and water because of new information about the adverse health effects of pollution. The MB curve in Figure 16.6 would shift rightward, and the optimal level of pollution control would increase beyond Q_1. Test your understanding of these statements by drawing the new MC and MB curves in Figure 16.6. **(Key Question 7)**

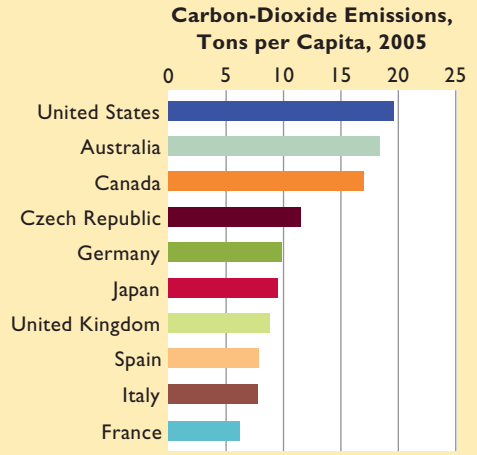
QUICK REVIEW 16.2

- Policies for coping with the overallocation of resources caused by negative externalities are (a) private bargaining, (b) liability rules and lawsuits, (c) direct controls, (d) specific taxes, and (e) markets for externality rights.
- Policies for correcting the underallocation of resources associated with positive externalities are (a) private bargaining, (b) subsidies to producers, (c) subsidies to consumers, and (d) government provision.
- The optimal amount of negative-externality reduction occurs where society's marginal cost and marginal benefit of reducing the externality are equal.

GLOBAL PERSPECTIVE 16.1

Carbon-Dioxide Emissions, Tons per Capita, Selected Nations

Carbon-dioxide emissions, the major type of greenhouse-gas emissions, vary per capita by nation primarily because of different degrees of industrialization and energy production from fossil fuels (coal, oil, and natural gas). The burning of such fuels is the major contributor to global warming.



Source: OECD environmental data, **www.oecd.org**.

ClimateC hange

The United States has made significant progress in cleaning its air. According to the EPA, between 1990 and 2000 clean-air laws and antipollution efforts by businesses and local governments reduced concentrations of lead by 60 percent, carbon monoxide and sulfur dioxide by 36 percent each, particulate matter by 18 percent, nitrogen dioxide by 10 percent, and smog by 4 percent.

But significant air pollution problems remain, including the controversial **climate-change problem.** The earth's surface has warmed over the last century by about 1 degree Fahrenheit, with an acceleration of warming during the past two decades. Some of this surface warming may simply reflect natural fluctuations of the earth's warming and cooling, but the balance of scientific evidence suggests that human activity is a contributing factor. According to the EPA and international study groups, carbon dioxide and other gas emissions from factories, power plants, automobiles, and other human sources are cumulating in the earth's atmosphere and creating a greenhouse effect.

Because of the greenhouse effect, average temperatures are predicted to rise by 1 to 4.5 degrees Fahrenheit over the next 50 years and 2.2 to 10 degrees by 3000. Although there will be significant regional variation, scientists say many parts of the world will experience noticeable climatic changes. Rainfall will increase, rainfall patterns will change, and ocean levels will gradually rise by as much as 2 feet. Snow accumulations may decline in some regions and rise in others. More violent storms such as tornadoes and hurricanes may occur in some regions. (Global Perspective 16.1 lists per capita carbon-dioxide emissions for selected nations.)

The world's nations have responded to the climate-change threat collectively and individually. In the Kyoto Protocol of 1997, representatives of the industrially advanced nations agreed to cut their greenhouse-gas emissions by 6 to 8 percent below their 1990 levels by 2012. Since 1997 all signatory nations except the United States have ratified the Kyoto agreement although few are actually likely to meet the 2012 goals. In 2001 the United States opted out of the Kyoto agreement on a Senate vote of 95-0, concluding that the limitations on greenhouse gas would severely damage the U.S. economy. The United States also expressed great concern that the treaty excluded rapidly developing countries such as China, one of today's leading total emitters of carbon dioxide and other greenhouse gases. A year later the United States announced a "Global Climate Change"

initiative designed to use clean-energy investments to reduce greenhouse gases per dollar of GDP by 18 percent by 2012.

Economists stress that climate-change policies that reduce greenhouse-gas emissions and thus slow or eliminate global warming create costs as well as benefits. Therefore it is imperative to consider the marginal costs and marginal benefits carefully in making policy decisions. Greenhouse-gas limits should not be so stringent that they end up costing society more than the value of the benefits they produce. But limits should not be so lenient that society forgoes substantial potential benefits that it would have otherwise achieved.

Economists also stress that the market mechanism, through its system of prices and profits and losses, will make appropriate adjustments based on new climatic realities. Air-conditioner sales may rise; snow shovel sales may fall. Some agricultural lands probably will be deserted; others farther north will be cultivated. The maple syrup industry in New England may shift to Canada. Nevertheless, the *transition costs*—the costs associated with making economic adjustments—of global warming will undoubtedly be very high unless some actions are taken to reduce greenhouse gases. But industrial economies are built on carbon-based energy sources, so the costs of reducing such gases are also quite high. The relevant question from the economic perspective becomes: Will it be less costly for society to reduce greenhouse-gas emissions or simply to try to mitigate their effects? No easy answer exists for this question. Some yet-unknown combination of "reduction" and "mitigation" may in fact turn out to be optimal.

If the Federal government decides to aggressively reduce carbon emissions, what general policies are available to it? Our prior discussion of externalities revealed two clear options:

- A carbon tax.
- A cap-and-trade program.

The Federal government could impose a carbon tax on each ton of carbon emitted. This tax would increase the marginal cost of production to all firms that emit carbon into the air through their production processes. Because of the added marginal cost, the supply curves within affected markets would shift to the left (as illustrated by the move from S to S_t in Figure 16.3). The reduced market supply would increase equilibrium price and reduce equilibrium quantity. With the lower output, carbon emissions in these industries would fall.

A carbon tax would require minimum government interference in the economy once the tax was in place. The Federal government could direct the revenues from the tax to research on cleaner production technologies or simply use the new revenues to reduce other taxes. But there would be no free lunch here: According to a 2007 study, a proposed $15 tax per ton of carbon emitted would add an estimated 14 cents to a gallon of gasoline, $1.63 to a kilowatt hour of electricity, $28.50 to a ton of coal, and $6.48 to a barrel of crude oil.

An alternative approach is a cap-and-trade program, based on the concepts embodied within Figure 16.5. The Federal government could place a cap or lid on total carbon emissions and then either hand out emission rights or auction them off. In ways previously discussed, the cap-and-trade program would reduce society's overall cost of lowering carbon emissions. In that regard, it would be more efficient than direct controls requiring each producer of greenhouse gas to reduce emissions by a fixed percentage amount. Existing cap-and-trade programs—including current European markets for carbon certificates—prove that this program can work. But such programs require considerable government oversight and enforcement of the rules.

QUICK REVIEW 16.3

- Society's pollution problem has largely resulted from increasing population, rising per capita consumption, certain changes in technology, and the so-called tragedy of the commons.
- The world's advanced industrial nations are struggling to reduce emissions of greenhouse gases, which most scientists conclude are contributing to global warming.
- Two alternative policies for reducing greenhouse gases are (a) a carbon tax and (b) a cap-and-trade system.

InformationF ailures

Thus far we have added new details and insights concerning two types of market failure: public goods and externalities. There is another, subtler, market failure. This one results when either buyers or sellers have incomplete or inaccurate information and their cost of obtaining better information is prohibitive. Technically stated, this market failure occurs because of **asymmetric information**—unequal knowledge possessed by the parties to a market transaction. Buyers and sellers do not have identical information about price, quality, or some other aspect of the good or service.

Sufficient market information normally is available to ensure that goods and services are produced and purchased efficiently. But in some cases inadequate information makes it difficult to distinguish trustworthy from untrustworthy

ORIGIN OF THE IDEA
O 16.3
Information failures

sellers or trustworthy from untrustworthy buyers. In these markets, society's scarce resources may not be used efficiently, thus implying that the government should intervene by increasing the information available to the market participants. Under rare circumstances the government may itself supply a good for which information problems have prohibited efficient production.

Inadequate Buyer Information about Sellers

Inadequate information among buyers about sellers and their products can cause market failure in the form of underallocation of resources. Two examples will help you understand this point.

Example: Gasoline Market

Assume an absurd situation: Suppose there is no system of weights and measures established by law, no government inspection of gasoline pumps, and no law against false advertising. Each gas station can use whatever measure it chooses; it can define a gallon of gas as it pleases. A station can advertise that its gas is 87 octane when in fact it is only 75. It can rig its pumps to indicate that it is providing more gas than the amount being delivered.

Obviously, the consumer's cost of obtaining reliable information under such chaotic conditions is exceptionally high, if not prohibitive. Customers or their representatives would have to buy samples of gas from various gas stations, have them tested for octane level, and test the accuracy of calibrations at the pump. And these activities would have to be repeated regularly, since a station owner could alter the product quality and the accuracy of the pump at will.

Because of the high costs of obtaining information about the seller, many consumers would opt out of this chaotic market. One tankful of a 50 percent mixture of gasoline and water would be enough to discourage most motorists from further driving. More realistically, the conditions in this market would encourage consumers to vote for political candidates who promise to provide a government solution. The oil companies and honest gasoline stations would most likely welcome government intervention. They would realize that accurate information, by enabling this market to work, would expand their total sales and profits.

The government has in fact intervened in the market for gasoline and other markets with similar potential information difficulties. It has established a system of weights and measures, employed inspectors to check the accuracy of gasoline pumps, and passed laws against fraudulent claims and misleading advertising. Clearly, these government activities have produced net benefits for society.

Example: Licensing of Surgeons

Suppose now that anyone could hang out a shingle and claim to be a surgeon, much as anyone can become a house painter. The market would eventually sort out the true surgeons from those who are "learning by doing" or are fly-by-night operators who move into and out of an area. As people died from unsuccessful surgeries, lawsuits for malpractice eventually would identify and eliminate most of the medical impostors. People needing surgery for themselves or their loved ones could obtain information from newspaper reports, Internet sites, or people who have undergone similar operations.

But this process of obtaining information for those needing surgery would take considerable time and would impose unacceptably high human and economic costs. There is a fundamental difference between getting an amateurish paint job on one's house and being on the receiving end of heart surgery by a bogus physician. The marginal cost of obtaining information about sellers in the surgery market would be excessively high. The risk of proceeding without good information would result in much less surgery than desirable—an underallocation of resources to surgery.

The government has remedied this market failure through a system of qualifying tests and licensing. The licensing provides consumers with inexpensive information about a service they only infrequently buy. The government has taken a similar role in several other areas of the economy. For example, it approves new medicines, regulates the securities industry, and requires warnings on containers of potentially hazardous substances. It also requires warning labels on cigarette packages and disseminates information about communicable diseases. And it issues warnings about unsafe toys and inspects restaurants for health-related violations.

Inadequate Seller Information about Buyers

Just as inadequate information about sellers can keep markets from achieving economic efficiency, so can inadequate information about buyers. The buyers may be consumers who buy products or firms that buy resources.

Moral Hazard Problem

Private markets may underallocate resources to a particular good or service for which there is a severe **moral hazard problem.** The moral hazard problem is the tendency of one party to a

contract or agreement to alter her or his behavior, after the contract is signed, in ways that could be costly to the other party.

Suppose a firm offers an insurance policy that pays a set amount of money per month to people who suffer divorces. The attractiveness of such insurance is that it would pool the economic risk of divorce among thousands of people and, in particular, would protect spouses and children from the economic hardship that divorce often brings. Unfortunately, the moral hazard problem reduces the likelihood that insurance companies can profitably provide this type of insurance.

After taking out such insurance, some people would alter their behavior in ways that impose heavy costs on the insurer. For example, married couples would have less of an incentive to get along and to iron out marital difficulties. At the extreme, some people might be motivated to obtain a divorce, collect the insurance, and then continue to live together. Such insurance could even promote more divorces, the very outcome it is intended to protect against. The moral hazard problem would force the insurer to charge such high premiums for this insurance that few policies would be bought. If the insurer could identify in advance those people most prone to alter their behavior, the firm could exclude them from buying it. But the firm's marginal cost of getting such information is too high compared with the marginal benefit. Thus, this market would fail.

Although divorce insurance is not available in the marketplace, society recognizes the benefits of insuring against the hardships of divorce. It has corrected for this underallocation of "hardship insurance" through child-support laws that dictate payments to the spouse who retains the children, when the economic circumstances warrant them. Alimony laws also play a role.

Since, unlike private firms, the government does not have to earn a profit when supplying services, it provides "divorce insurance" of sorts through the Temporary Assistance for Needy Families (TANF) program. If a divorce leaves a spouse with children destitute, she or he is eligible for TANF payments for a period of time. Government intervention does not eliminate the moral hazard problem, but it does offset the problem's adverse effects.

The moral hazard problem is also illustrated in the following statements:

- Drivers may be less cautious because they have car insurance.
- Medical malpractice insurance may increase the amount of malpractice.
- Guaranteed contracts for professional athletes may reduce the quality of their performance.
- Unemployment compensation insurance may lead some workers to shirk.
- Government insurance on bank deposits may encourage banks to make risky loans.

Adverse Selection Problem Another information problem resulting from inadequate information about buyers is the **adverse selection problem**. This problem arises when information known by the first party to a contract or agreement is not known by the second and, as a result, the second party incurs major costs. Unlike the moral hazard problem, which arises after a person signs a contract, the adverse selection problem arises at the time a person signs a contract.

In insurance, the adverse selection problem is that people who are most likely to need insurance payouts are those who buy insurance. For example, those in poorest health will seek to buy the most generous health insurance policies. Or, at the extreme, a person planning to hire an arsonist to "torch" his failing business has an incentive to buy fire insurance.

Our hypothetical divorce insurance sheds further light on the adverse selection problem. If the insurance firm sets the premiums on the basis of the average divorce rate, many married couples who are about to obtain a divorce will buy insurance. An insurance premium based on average probabilities will make a great buy for those about to get divorced. Meanwhile, those in highly stable marriages will not buy it.

The adverse selection problem thus tends to eliminate the pooling of low and high risks, which is the basis of profitable insurance. Insurance rates then must be so high that few people would want to (or be able to) buy such insurance.

Where private firms underprovide insurance because of information problems, the government often establishes some type of social insurance. It can require that everyone in a particular group take the insurance and thereby can overcome the adverse selection problem. Example: Although the Social Security system in the United States is partly insurance and partly an income transfer program, in its broadest sense it is insurance against poverty during old age. The Social Security program requires nearly universal participation: People who are most likely to need the minimum benefits that Social Security provides are automatically participants in the program. So, too, are those not likely to need the benefits. Consequently, no adverse selection problem emerges.

Workplace Safety The labor market also provides an example of how inadequate information about buyers (employers) can produce market failures.

CONSIDER THIS . . .

"Lemons"

Why does a new car lose substantial market value when it is purchased, even though the same car can sit on the dealer's lot for weeks, or even months, and still retain its market value? One plausible explanation for this paradox is based on the ideas of *asymmetric informatio*n nd *adverse selection*.*

Used-car owners (potential sellers) have much better information about the mechanical condition of their cars than do potential buyers. Because of this asymmetric information, an *adverse selection problem* occurs. Owners of defective used cars—so-called lemons—have an incentive to sell their cars to unsuspecting buyers, whereas owners of perfectly operating used cars have an incentive to retain their used cars. Although a mix of both good and bad used cars is offered for sale, the mix is tilted toward the poorer-quality used cars. So the average quality of the used cars is lower than that of the same makes and models that are not for sale.

The typical consumer finds it difficult to identify the higher-quality used cars from the average- (lower-) quality used cars simply by looking at them or taking them for a test drive. Anticipating repair costs, the customer is willing to pay only a price that reflects the lower quality.†

So we have a solution to the paradox: When purchased, the market values of new cars drop quickly to the value of the average-quality used cars of the same year, make, and model offered for sale in the market. This is true even though many individual used cars may be in perfect operating condition. Adverse selection, asymmetric information, and the resulting risk of "buying someone else's problem" drop the value of used cars relative to new cars still on the lot.

*This explanation is based on the work of economist George Akerlof.

†Transferable warrantees reduce, but do not eliminate, the potential repair costs of used cars. Consumers lose time in arranging repairs and forgo the use of their cars when the repairs are being done.

For several reasons employers have an economic incentive to provide safe workplaces. A safe workplace reduces the amount of disruption of the production process created by job accidents and lowers the costs of recruiting, screening, training, and retaining new workers. It also reduces a firm's workers' compensation insurance premiums (legally required insurance against job injuries).

But a safe workplace is expensive: Safe equipment, protective gear, and a slower work pace all entail costs. The firm will decide how much safety to provide by comparing the marginal cost and marginal benefit of providing a safer workplace. Will this amount of job safety achieve economic efficiency, as well as maximize the firm's profit?

The answer is yes if the labor and product markets are competitive and if workers are fully aware of the job risks at various places of employment. With full information, workers will avoid employers having unsafe workplaces. The supply of labor to these establishments will be greatly restricted, forcing them to boost their wages to attract a workforce. The higher wages will then give these employers an incentive to provide increased workplace safety; safer workplaces will reduce wage expenses. Only firms that find it very costly to provide safer workplaces will choose to pay high compensating wage differentials rather than reduce workplace hazards.

But a serious problem arises when workers do not know that particular occupations or workplaces are unsafe. Because information involving the buyer—that is, about the employer and the workplace—is inadequate, the firm may not need to pay a wage premium to attract its workforce. Its incentive to remove safety hazards therefore will be diminished, and its profit-maximizing level of workplace safety will be less than economically desirable. In brief, the labor market will fail because of asymmetric information—in this case, sellers (workers) having less information than buyers (employers).

The government has several options for remedying this information problem:

- It can directly provide information to workers about the injury experience of various employers, much as it publishes the on-time performance of airlines.
- It can require that firms provide information to workers about known workplace hazards.
- It can establish standards of workplace safety and enforce them through inspections and penalties.

Although the Federal government has mainly employed the standards and enforcement approach to improve workplace safety, some critics contend that an information strategy might be less costly and more effective. **(Key Question 12)**

Qualification

Households and businesses have found many ingenious ways to overcome information difficulties without government intervention. For example, many firms offer product warranties to overcome the lack of information about themselves and their products. Franchising also helps

LAST Word

Lojack: A Case of Positive Externalities

Economists Ian Ayres and Steven Levitt Find That an Auto Antitheft Device Called *Lojack* Produces Large Spillover Benefits.

Private expenditures to reduce crime are estimated to be $300 billion annually and are growing at a faster rate than is spending on public crime prevention. Unfortunately, some forms of private crime prevention simply redistribute crime rather than reduce it. For example, car alarm systems that have red blinking warning lights may simply divert professional auto thieves to vehicles that do not have such lights and alarms. The owner of a car with such an alarm system benefits through reduced likelihood of theft but imposes a cost on other car owners who do not have such alarms. Their cars are more likely to be targeted for theft because other cars have visible security systems.

Some private crime prevention measures, however, actually reduce crime rather than simply redistribute it. One such measure is installation of a Lojack (or some similar) car retrieval system. Lojack is a tiny radio transmitter that is hidden in one of many possible places within the car. When an owner reports a stolen car, the police can remotely activate the transmitter. Police then can determine the car's precise location and track its subsequent movements.

The owner of the car benefits because the 95 percent retrieval rate on cars with the Lojack system is higher than the 60 percent retrieval rate for cars without the system. But, according to a study by Ayres and Levitt, the benefit to the car owner is only 10 percent of the total benefit. Ninety percent of the total benefit is external; it is a spillover benefit to other car owners in the community.

There are two sources of this positive externality. First, the presence of the Lojack device sometimes enables police to intercept the car while the thief is still driving it. For example, in California the arrest rate for cars with Lojack was three times greater than that for cars without it. The arrest puts the car thief out of commission for a time and thus reduces subsequent car thefts in the community. Second, and far more important, the device enables police to trace cars to "chop shops," where crooks disassemble cars for resale of the parts. When police raid the chop shop, they put the entire theft ring out of business. In Los Angeles alone, Lojack has eliminated 45 chop shops in just a few years. The purging of the chop shop and theft ring reduces auto theft in the community. So auto owners who do not have Lojack devices in their cars benefit from car owners who do. Ayres and Levitt estimate the *marginal social benefit* of Lojack—the marginal benefit to the Lojack car owner *plus* the spillover benefit to other car owners—is 15 times greater than the marginal cost of the device.

We saw in Figure 16.4a that the existence of positive externalities causes an insufficient quantity of a product and thus an underallocation of scarce resources to its production. The two general ways to correct the outcome are to subsidize the consumer, as shown in Figure 16.4b, or to subsidize the producer, as shown in Figure 16.4c. Currently, there is only one form of government intervention in place: state-mandated insurance discounts for people who install auto retrieval systems such as Lojack. In effect, those discounts on insurance premiums subsidize the consumer by lowering the "price" of the system to consumers. The lower price raises the number of systems installed. But, on the basis of their research, Ayres and Levitt contend that the current levels of insurance discounts are far too small to correct the underallocation that results from the positive externalities created by Lojack.

Source: Based on Ian Ayres and Steven D. Levitt, "Measuring Positive Externalities from Unobservable Victim Precaution: An Empirical Analysis of Lojack," *Quarterly Journal of Economics*, February 1998, pp. 43–77. The authors point out that Lojack did not fund their work in any way, nor do they have any financial stake in Lojack.

overcome this problem. When you visit a Wendy's or a Marriott, you know what you are going to get, as opposed to stopping at Slim's Hamburger Shop or the Triple Six Motel.

Also, some private firms and organizations specialize in providing information to buyers and sellers. *Consumer Reports*, *Mobil Travel Guide*, and numerous Internet sites provide product information; labor unions collect and disseminate information about job safety; and credit bureaus provide information about credit histories and past bankruptcies to lending institutions and insurance companies. Brokers, bonding agencies, and intermediaries also provide information to clients.

Economists agree, however, that the private sector cannot remedy all information problems. In some situations, government intervention is desirable to promote an efficient allocation of society's scarce resources.

QUICK REVIEW 16.4

- Asymmetric information is a source of potential market failure, causing society's scarce resources to be allocated inefficiently.
- Inadequate information about sellers and their products may lead to an underallocation of resources to those products.
- The moral hazard problem is the tendency of one party to a contract or agreement to alter its behavior in ways that are costly to the other party; for example, a person who buys insurance may willingly incur added risk.
- The adverse selection problem arises when one party to a contract or agreement has less information than the other party and incurs a cost because of that asymmetrical information. For example, an insurance company offering "no-medical-exam-required" life insurance policies may attract customers who have life-threatening diseases.

Summary

1. Public goods are distinguished from private goods. Private goods are characterized by rivalry (in consumption) and excludability. One person's purchase and consumption of a private good precludes others from also buying and consuming it. Producers can exclude nonpayers (free riders) from receiving the benefits. In contrast, public goods are characterized by nonrivalry (in consumption) and nonexcludability. Public goods are not profitable to private firms because nonpayers (free riders) can obtain and consume those goods. Only government is willing to provide desirable public goods, financing them through taxation.
2. The collective demand schedule for a particular public good is found by summing the prices that each individual is willing to pay for an additional unit. Graphically, that demand curve is therefore found by summing vertically the individual demand curves for that good. The resulting total demand curve indicates the collective willingness to pay for (or marginal benefit of) the last unit of any given amount of the public good.
3. The optimal quantity of a public good occurs where the society's willingness to pay for the last unit—the marginal benefit of the good—equals the marginal cost of the good.
4. Externalities, or spillovers, are costs or benefits that accrue to someone other than the immediate buyer or seller. Such costs or benefits are not captured in market demand or supply curves and therefore cause the output of certain goods to vary from society's optimal output. Negative externalities (or spillover costs or external costs) result in an overallocation of resources to a particular product. Positive externalities (or spillover benefits or external benefits) are accompanied by an underallocaton of resources to a particular product.
5. The Coase theorem suggests that private bargaining is capable of solving potential externality problems where (a) the property rights are clearly defined, (b) the number of people involved is small, and (c) bargaining costs are negligible.
6. Clearly established property rights and liability rules permit some negative externalities to be prevented or remedied through private lawsuits. Lawsuits, however, can be costly, time-consuming, and uncertain as to their results.
7. Direct controls and specific taxes can improve resource allocation in situations where negative externalities affect many people and community resources. Both direct controls (for example, smokestack emission standards) and specific taxes (for example, taxes on firms producing toxic chemicals) increase production costs and hence product price. As product price rises, the externality and overallocation of resources are reduced since less of the output is bought and sold.
8. Government can correct the underallocation of resources that results from positive externalities in a particular market either by subsidizing consumers (which increases market demand) or by subsidizing producers (which increases market supply). Such subsidies increase the equilibrium output, reducing or eliminating the positive externality and consequent underallocation of resources.
9. Markets for pollution rights, where firms can buy and sell the right to discharge a fixed amount of pollution, put a price on pollution and encourage firms to reduce or eliminate it.

10. The socially optimal amount of externality abatement occurs where society's marginal cost and marginal benefit of reducing the externality are equal. This optimal amount of pollution abatement is likely to be less than a 100 percent reduction. Changes in technology or changes in society's attitudes toward pollution can affect the optimal amount of pollution abatement.
11. A growing body of scientific evidence suggests that accumulation of carbon dioxide and other greenhouse gases in the earth's atmosphere may be contributing to a climate-change problem. In addressing the problem, society needs to assess the costs and benefits of reducing greenhouse gases as well as the costs and benefits of allowing the emission to rise and then mitigating the effects. Two distinct policies for reducing greenhouse gases are (a) a carbon tax on such emissions and (b) a cap-and-trade system that places a lid on the emissions and allows for trading of the pollution rights.
12. Asymmetric information between sellers and buyers can cause markets to fail. The moral hazard problem occurs when people alter their behavior after they sign a contract or reach an agreement, imposing costs on the other party. The adverse selection problem occurs when one party to a contract or agreement takes advantage of the other party's inadequate information, resulting in an unanticipated loss to the latter party.

Terms and Concepts

private goods
public goods
free-rider problem
cost-benefit analysis
marginal-cost–marginal-benefit rule
externalities
Coase theorem
tragedy of the commons
market for externality rights
cap-and-trade program
optimal reduction of an externality
climate-change problem
asymmetric information
moral hazard problem
adverse selection problem

Study Questions

1. **KEY QUESTION** On the basis of the three individual demand schedules below, and assuming these three people are the only ones in the society, determine (*a*) the market demand schedule on the assumption that the good is a private good and (*b*) the collective demand schedule on the assumption that the good is a public good. Explain the differences, if any, in your schedules. **LO1**

Individual 1		Individual 2		Individual 3	
P	Q_d	*P*	Q_d	*P*	Q_d
$8	0	$8	1	$8	0
7	0	7	2	7	0
6	0	6	3	6	1
5	1	5	4	5	2
4	2	4	5	4	3
3	3	3	6	3	4
2	4	2	7	2	5
1	5	1	8	1	6

2. **KEY QUESTION** Use your demand schedule for a public good, determined in question 1, and the following supply schedule to ascertain the optimal quantity of this public good. Why is this the optimal quantity? **LO2**

P	Q_d
$19	10
16	8
13	6
10	4
7	2
4	1

3. **KEY QUESTION** The following table shows the total costs and total benefits in billions for four different antipollution programs of increasing scope. Which program should be undertaken? Why? **LO3**

Program	Total Cost	Total Benefit
A	$ 3	$ 7
B	7	12
C	12	16
D	18	19

4. **KEY QUESTION** Why are spillover costs and spillover benefits also called negative and positive externalities?

Show graphically how a tax can correct for a negative externality and how a subsidy to producers can correct for a positive externality. How does a subsidy to consumers differ from a subsidy to producers in correcting for a positive externality? LO4

5. An apple grower's orchard provides nectar to a neighbor's bees, while the beekeeper's bees help the apple grower by pollinating the apple blossoms. Use Figure 16.2b to explain why this situation of dual positive externalities might lead to an underallocation of resources to apple growing and to beekeeping. How might this underallocation get resolved via the means suggested by the Coase theorem? LO4
6. Explain: "Without a market for pollution rights, dumping pollutants into the air or water is costless; in the presence of the right to buy and sell pollution rights, dumping pollutants creates an opportunity cost for the polluter." What is the significance of this opportunity cost to the search for better technology to reduce pollution? LO4
7. KEY QUESTION Explain the following statement, using the MB curve in Figure 16.6 to illustrate: "The optimal amount of pollution abatement for some substances, say, water from storm drains, is very low; the optimal amount of abatement for other substances, say, cyanide poison, is close to 100 percent." LO4
8. Explain the tragedy of the commons, as it relates to pollution. LO4
9. What is the climate-change problem? Using an example other than one in the text, explain how climate-change might hurt one industry, particular region, or country but help another. Distinguish between a carbon-tax and a cap-and-trade strategy for reducing greenhouse gases. Which of the two strategies do you think would have the most political support in an election in your home state? Explain your thinking. LO4
10. Explain how marketable emission credits add to overall economic efficiency, compared to across-the-board limitations on maximum discharges of air pollutants by firms. LO4
11. Why is it in the interest of new homebuyers and builders of new homes to have government building codes and building inspectors? LO5
12. KEY QUESTION Place an "M" beside the items in the following list that describe a moral hazard problem and an "A" beside those that describe an adverse selection problem: LO5
    a. A person with a terminal illness buys several life insurance policies through the mail.
    b. A person drives carelessly because he or she has automobile insurance.
    c. A person who intends to "torch" his warehouse takes out a large fire insurance policy.
    d. A professional athlete who has a guaranteed contract fails to stay in shape during the off-season.
    e. A woman who anticipates having a large family takes a job with a firm that offers exceptional child care benefits.
13. LAST WORD Explain how a global-positioning antitheft device installed by one car owner can produce a positive spillover to thousands of others in a city.

Web-Based Questions

1. GLOBAL WARMING—THE EPA'S VIEW Go to **www.epa.gov** and select Climate Change. What are the major greenhouse gases? How much greenhouse gas does the United States emit per person? What is the trend of emissions on a per-person basis? What is the trend of emissions per dollar of GDP in the United States? Use your own analysis to explain how total emissions can rise even though emissions per dollar of GDP substantially decline. Which of the two is more relevant for climate change?
2. WORKPLACE SAFETY—OSHA'S ROLE Visit **www.osha.gov** and first select Workers (under Audiences). How does a worker file a complaint or report a hazard? Where is the nearest OSHA office to you? Go back to the OSHA home page and select News Releases. In a sentence or two each, summarize three recent news releases that relate to fines or other penalties imposed by OSHA on employers for violations of workers' safety and health rules.

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