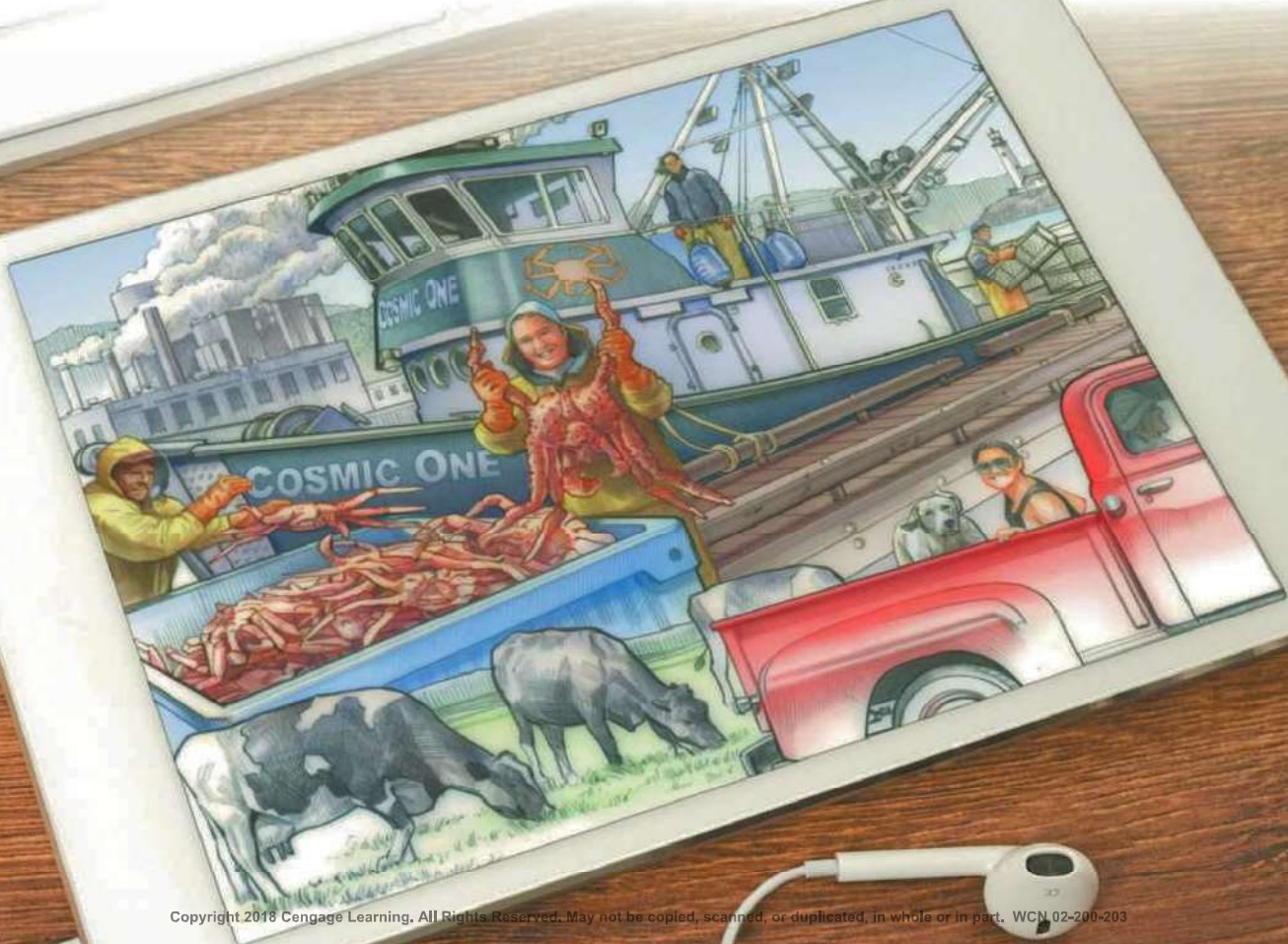


Externalities

CHAPTER 10

Firms that make and sell paper also create, as a by-product of the manufacturing process, a chemical called dioxin. Scientists believe that once dioxin enters the environment, it raises the population's risk of cancer, birth defects, and other health problems.

Is the production and release of dioxin a problem for society? In Chapters 4 through 9, we examined how markets allocate scarce resources with the forces of supply and demand, and we saw that the equilibrium of supply and demand is typically an efficient allocation of resources. To use Adam Smith's famous



metaphor, the “invisible hand” of the marketplace leads self-interested buyers and sellers in a market to maximize the total benefit that society derives from that market. This insight is the basis for one of the *Ten Principles of Economics* in Chapter 1: Markets are usually a good way to organize economic activity. Should we conclude, therefore, that the invisible hand prevents firms in the paper market from emitting too much dioxin?

Markets do many things well, but they do not do everything well. In this chapter, we begin our study of another of the *Ten Principles of Economics*: Government action can sometimes improve upon market outcomes. We examine why markets sometimes fail to allocate resources efficiently, how government policies can potentially improve the market’s allocation, and what kinds of policies are likely to work best.

externality

the uncompensated impact of one person’s actions on the well-being of a bystander

The market failures examined in this chapter fall under a general category called *externalities*. An **externality** arises when a person engages in an activity that influences the well-being of a bystander but neither pays nor receives compensation for that effect. If the impact on the bystander is adverse, it is called a *negative externality*. If it is beneficial, it is called a *positive externality*. In the presence of externalities, society’s interest in a market outcome extends beyond the well-being of buyers and sellers who participate in the market to include the well-being of bystanders who are affected indirectly. Because buyers and sellers neglect the external effects of their actions when deciding how much to demand or supply, the market equilibrium is not efficient when there are externalities. That is, the equilibrium fails to maximize the total benefit to society as a whole. The release of dioxin into the environment, for instance, is a negative externality. Self-interested paper firms will not consider the full cost of the pollution they create in their production process, and consumers of paper will not consider the full cost of the pollution they contribute to as a result of their purchasing decisions. Therefore, the firms will emit too much pollution unless the government prevents or discourages them from doing so.

Externalities come in many varieties, as do the policy responses that try to deal with the market failure. Here are some examples:

- The exhaust from automobiles is a negative externality because it creates smog that other people have to breathe. Because drivers may ignore this externality when deciding what cars to buy and how much to use them, they tend to pollute too much. The federal government addresses this problem by setting emission standards for cars. It also taxes gasoline to reduce the amount that people drive.
- Restored historic buildings convey a positive externality because people who walk or ride by them can enjoy the beauty and sense of history that these buildings provide. Building owners do not get the full benefit of restoration and, therefore, tend to tear down older buildings too quickly. Many local governments respond to this problem by regulating the destruction of historic buildings and by providing tax breaks to owners who restore them.
- Barking dogs create a negative externality because neighbors are disturbed by the noise. Dog owners do not bear the full cost of the noise and, therefore, tend to take too few precautions to prevent their dogs from barking. Local governments address this problem by making it illegal to “disturb the peace.”
- Research into new technologies provides a positive externality because it creates knowledge that other people can use. If individual inventors, firms, and

universities cannot capture the benefits of their inventions, they will devote too few resources to research. The federal government addresses this problem partially through the patent system, which gives inventors exclusive use of their inventions for a limited time.

In each of these cases, some decision maker fails to take into account the external effects of his behavior. The government responds by trying to influence this behavior to protect the interests of bystanders.

10-1 Externalities and Market Inefficiency

In this section, we use the tools of welfare economics developed in Chapter 7 to examine how externalities affect economic well-being. The analysis shows precisely why externalities cause markets to allocate resources inefficiently. Later in the chapter, we examine various ways private individuals and public policymakers can remedy this type of market failure.

10-1a Welfare Economics: A Recap

We begin by recalling the key lessons of welfare economics from Chapter 7. To make our analysis concrete, we consider a specific market—the market for aluminum. Figure 1 shows the supply and demand curves in the market for aluminum.

Recall from Chapter 7 that the supply and demand curves contain important information about costs and benefits. The demand curve for aluminum reflects the value of aluminum to consumers, as measured by the prices they are willing to pay. At any given quantity, the height of the demand curve shows the willingness to pay of the marginal buyer. In other words, it shows the value to the consumer of the last unit of aluminum bought. Similarly, the supply curve reflects the costs of producing aluminum. At any given quantity, the height of the supply curve shows the cost to the marginal seller. In other words, it shows the cost to the producer of the last unit of aluminum sold.

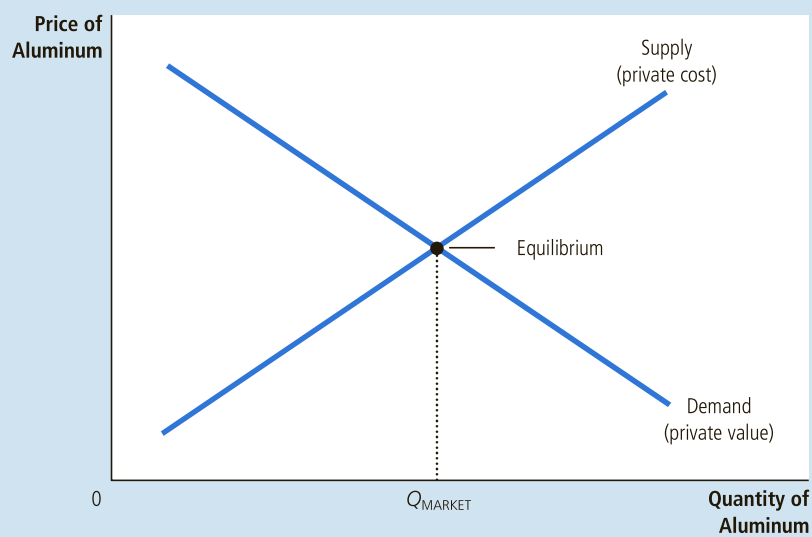


FIGURE 1

The Market for Aluminum

The demand curve reflects the value to buyers, and the supply curve reflects the costs of sellers. The equilibrium quantity, Q_{MARKET} , maximizes the total value to buyers minus the total costs of sellers. In the absence of externalities, therefore, the market equilibrium is efficient.

In the absence of government intervention, the price adjusts to balance the supply and demand for aluminum. The quantity produced and consumed in the market equilibrium, shown as Q_{MARKET} in Figure 1, is efficient in the sense that it maximizes the sum of producer and consumer surplus. That is, the market allocates resources in a way that maximizes the total value to the consumers who buy and use aluminum minus the total costs to the producers who make and sell aluminum.

10-1b Negative Externalities

Now let's suppose that aluminum factories emit pollution: For each unit of aluminum produced, a certain amount of smoke enters the atmosphere. Because this smoke creates a health risk for those who breathe the air, it is a negative externality. How does this externality affect the efficiency of the market outcome?

Because of the externality, the cost to *society* of producing aluminum is larger than the cost to the aluminum producers. For each unit of aluminum produced, the *social cost* includes the private costs of the aluminum producers plus the costs to those bystanders affected adversely by the pollution. Figure 2 shows the social cost of producing aluminum. The social-cost curve is above the supply curve because it takes into account the external costs imposed on society by aluminum production. The difference between these two curves reflects the cost of the pollution emitted.

What quantity of aluminum should be produced? To answer this question, we once again consider what a benevolent social planner would do. The planner wants to maximize the total surplus derived from the market—the value to consumers of aluminum minus the cost of producing aluminum. The planner understands, however, that the cost of producing aluminum includes the external costs of the pollution.

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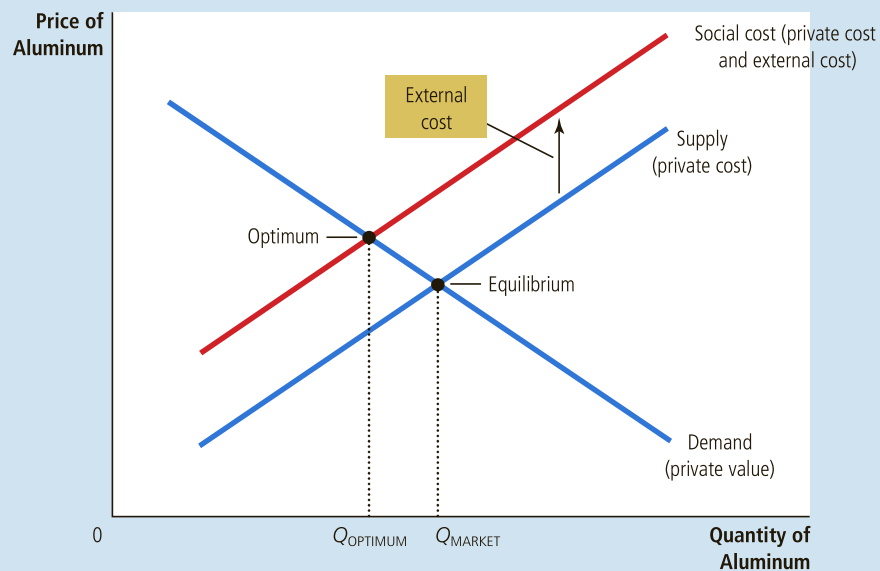


"All I can say is that if being a leading manufacturer means being a leading polluter, so be it."

FIGURE 2

Pollution and the Social Optimum

In the presence of a negative externality, such as pollution, the social cost of the good exceeds the private cost. The optimal quantity, Q_{OPTIMUM} , is therefore smaller than the equilibrium quantity, Q_{MARKET} .



The planner would choose the level of aluminum production at which the demand curve crosses the social-cost curve. This intersection determines the optimal amount of aluminum from the standpoint of society as a whole. Below this level of production, the value of the aluminum to consumers (as measured by the height of the demand curve) exceeds the social cost of producing it (as measured by the height of the social-cost curve). Above this level of production, the social cost of producing additional aluminum exceeds the value to consumers.

Note that the equilibrium quantity of aluminum, Q_{MARKET} , is larger than the socially optimal quantity, Q_{OPTIMUM} . This inefficiency occurs because the market equilibrium reflects only the private costs of production. In the market equilibrium, the marginal consumer values aluminum at less than the social cost of producing it. That is, at Q_{MARKET} the demand curve lies below the social-cost curve. Thus, reducing aluminum production and consumption below the market equilibrium level raises total economic well-being.

How can the social planner achieve the optimal outcome? One way would be to tax aluminum producers for each ton of aluminum sold. The tax would shift the supply curve for aluminum upward by the size of the tax. If the tax accurately reflected the external cost of pollutants released into the atmosphere, the new supply curve would coincide with the social-cost curve. In the new market equilibrium, aluminum producers would produce the socially optimal quantity of aluminum.

The use of such a tax is called **internalizing the externality** because it gives buyers and sellers in the market an incentive to take into account the external effects of their actions. Aluminum producers would, in essence, take the costs of pollution into account when deciding how much aluminum to supply because the tax would make them pay for these external costs. And, because the market price would reflect the tax on producers, consumers of aluminum would have an incentive to buy a smaller quantity. The policy is based on one of the *Ten Principles of Economics*: People respond to incentives. Later in this chapter, we consider in more detail how policymakers can deal with externalities.

internalizing the externality

altering incentives so that people take into account the external effects of their actions

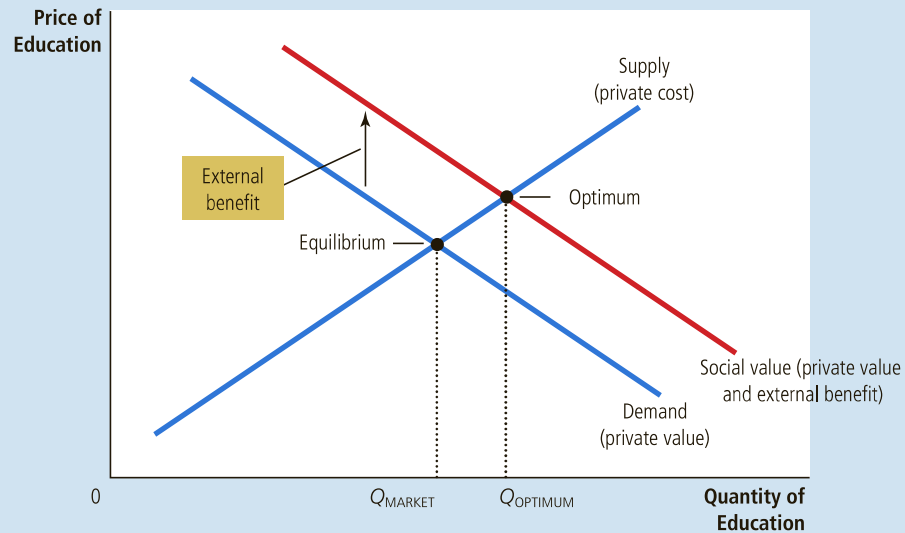
10-1c Positive Externalities

Although some activities impose costs on third parties, others yield benefits. Consider education, for example. To a large extent, the benefit of education is private: The consumer of education becomes a more productive worker and thus reaps much of the benefit in the form of higher wages. Beyond these private benefits, however, education also yields positive externalities. One externality is that a more educated population leads to more informed voters, which means better government for everyone. Another externality is that a more educated population tends to result in lower crime rates. A third externality is that a more educated population may encourage the development and dissemination of technological advances, leading to higher productivity and wages for everyone. Because of these three positive externalities, a person may prefer to have neighbors who are well educated.

The analysis of positive externalities is similar to the analysis of negative externalities. As Figure 3 shows, the demand curve does not reflect the value to society of the good. Because the social value is greater than the private value, the social-value curve lies above the demand curve. The optimal quantity is found where the social-value curve and the supply curve intersect. Hence, the socially optimal quantity is greater than the quantity that the private market would naturally reach on its own.

FIGURE 3**Education and the Social Optimum**

In the presence of a positive externality, the social value of the good exceeds the private value. The optimal quantity, Q_{OPTIMUM} , is therefore larger than the equilibrium quantity, Q_{MARKET} .



Once again, the government can correct the market failure by inducing market participants to internalize the externality. The appropriate response in the case of positive externalities is exactly the opposite to the case of negative externalities. To move the market equilibrium closer to the social optimum, a positive externality requires a subsidy. In fact, that is exactly the policy the government follows: Education is heavily subsidized through public schools and government scholarships.

To summarize: *Negative externalities lead markets to produce a larger quantity than is socially desirable. Positive externalities lead markets to produce a smaller quantity than is socially desirable. To remedy the problem, the government can internalize the externality by taxing goods that have negative externalities and subsidizing goods that have positive externalities.*

CASE STUDY**TECHNOLOGY SPILLOVERS, INDUSTRIAL POLICY, AND PATENT PROTECTION**

A potentially important type of positive externality is called a *technology spillover*—the impact of one firm’s research and production efforts on other firms’ access to technological advance. For example, consider the market for industrial robots. Robots are at the frontier of a rapidly changing technology. Whenever a firm builds a robot, there is some chance that the firm will discover a new and better design. This new design may benefit not only this firm but also society as a whole because the design will enter society’s pool of technological knowledge. That is, the new design may have positive externalities for other producers in the economy.

In this case, the government can internalize the externality by subsidizing the production of robots. If the government paid firms a subsidy for each robot produced, the supply curve would shift down by the amount of the subsidy, and this shift would increase the equilibrium quantity of robots. To ensure that the market equilibrium equals the social optimum, the subsidy should equal the value of the technology spillover.

How large are technology spillovers, and what do they imply for public policy? This is an important question because technological progress is the key to raising living standards over time. Yet it is also a difficult question about which economists often disagree.

Some economists believe that technology spillovers are pervasive and that the government should encourage those industries that yield the largest spillovers. For instance, these economists argue that if making computer chips yields greater spillovers than making potato chips, the government should encourage the production of computer chips relative to the production of potato chips. The U.S. tax code does this in a limited way by offering special tax breaks for expenditures on research and development. Some nations go further by subsidizing specific industries that supposedly yield large technology spillovers. Government intervention that aims to promote technology-enhancing industries is sometimes called *industrial policy*.

Other economists are skeptical about industrial policy. Even if technology spillovers are common, pursuing an industrial policy requires the government to gauge the size of the spillovers from different markets. This measurement problem is difficult at best. Without accurate measurements, the political system may end up subsidizing industries with the most political clout rather than those that yield the largest positive externalities.

Another way to deal with technology spillovers is patent protection. The patent laws protect the rights of inventors by giving them exclusive use of their inventions for a period of time. When a firm makes a technological breakthrough, it can patent the idea and capture much of the economic benefit for itself. The patent internalizes the externality by giving the firm a *property right* over its invention. If other firms want to use the new technology, they have to obtain permission from the inventing firm and pay it a royalty. Thus, the patent system gives firms a greater incentive to engage in research and other activities that advance technology. ●

QuickQuiz

Give an example of a negative externality and a positive externality. Explain why market outcomes are inefficient in the presence of these externalities.

10-2 Public Policies toward Externalities

We have discussed why externalities lead markets to allocate resources inefficiently but have mentioned only briefly how this inefficiency can be remedied. In practice, both public policymakers and private individuals respond to externalities in various ways. All of the remedies share the goal of moving the allocation of resources closer to the social optimum.

This section considers governmental solutions. As a general matter, the government can respond to externalities in one of two ways. *Command-and-control policies* regulate behavior directly. *Market-based policies* provide incentives so that private decision makers will choose to solve the problem on their own.

10-2a Command-and-Control Policies: Regulation

The government can remedy an externality by either requiring or forbidding certain behaviors. For example, it is a crime to dump poisonous chemicals into the water supply. In this case, the external costs to society far exceed the benefits to the polluter. The government therefore institutes a command-and-control policy that prohibits this act altogether.

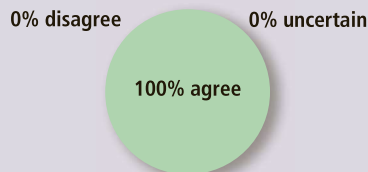


ASK THE EXPERTS

Vaccines

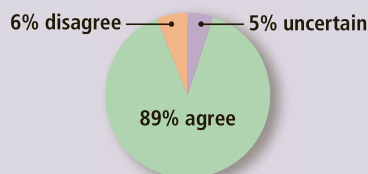
“Declining to be vaccinated against contagious diseases such as measles imposes costs on other people, which is a negative externality.”

What do economists say?



“Considering the costs of restricting free choice, and the share of people in the US who choose not to vaccinate their children for measles, the social benefit of mandating measles vaccines for all Americans (except those with compelling medical reasons) would exceed the social cost.”

What do economists say?



Source: IGM Economic Experts Panel, March 10, 2015.

corrective tax

a tax designed to induce private decision makers to take into account the social costs that arise from a negative externality

In most cases of pollution, however, the situation is not this simple. Despite the stated goals of some environmentalists, it would be impossible to prohibit all polluting activity. For example, virtually all forms of transportation—even the horse—produce some undesirable polluting by-products. But it would not be sensible for the government to ban all transportation. As a result, instead of trying to eradicate pollution entirely, society has to weigh the costs and benefits to decide the kinds and quantities of pollution it will allow. In the United States, the Environmental Protection Agency (EPA) is the government agency tasked with developing and enforcing regulations aimed at protecting the environment.

Environmental regulations can take many forms. Sometimes the EPA dictates a maximum level of pollution that a factory may emit. Other times the EPA requires that firms adopt a particular technology to reduce emissions. In all cases, to design good rules, the government regulators need to know the details about specific industries and about the alternative technologies that those industries could adopt. This information is often difficult for government regulators to obtain.

10-2b Market-Based Policy 1: Corrective Taxes and Subsidies

Instead of regulating behavior in response to an externality, the government can use market-based policies to align private incentives with social efficiency. For instance, as we saw earlier, the government can internalize the externality by taxing activities that have negative externalities and subsidizing activities that have positive externalities. Taxes enacted to deal with the effects of negative externalities are called **corrective taxes**. They are also called *Pigovian taxes* after economist Arthur Pigou (1877–1959), an early advocate of their use. An ideal corrective tax would equal the external cost from an activity with negative externalities, and an ideal corrective subsidy would equal the external benefit from an activity with positive externalities.

Economists usually prefer corrective taxes to regulations as a way to deal with pollution because they can reduce pollution at a lower cost to society. To see why, let us consider an example.

Suppose that two factories—a paper mill and a steel mill—are each dumping 500 tons of glop into a river every year. The EPA decides that it wants to reduce the amount of pollution. It considers two solutions:

- **Regulation:** The EPA could tell each factory to reduce its pollution to 300 tons of glop per year.
- **Corrective tax:** The EPA could levy a tax on each factory of \$50,000 for each ton of glop it emits.

The regulation would dictate a level of pollution, whereas the tax would give factory owners an economic incentive to reduce pollution. Which solution do you think is better?

Most economists prefer the tax. To explain this preference, they would first point out that a tax is just as effective as regulation in reducing the overall level of pollution. The EPA can achieve whatever level of pollution it wants by setting the tax at the appropriate level. The higher the tax, the larger the reduction in pollution. If the tax is high enough, the factories will close down altogether, reducing pollution to zero.

Although regulation and corrective taxes are both capable of reducing pollution, the tax accomplishes this goal more efficiently. The regulation requires each factory to reduce pollution by the same amount. An equal reduction, however, is not necessarily the least expensive way to clean up the water. It is possible that the paper mill can reduce pollution at lower cost than the steel mill. If so, the paper mill would respond to the tax by reducing pollution substantially to avoid the tax, whereas the steel mill would respond by reducing pollution less and paying the tax.

In essence, the corrective tax places a price on the right to pollute. Just as markets allocate goods to those buyers who value them most highly, a corrective tax allocates pollution to those factories that face the highest cost of reducing it. Thus, the EPA can achieve any level of pollution at the lowest total cost by using a tax.

Economists also argue that corrective taxes are better for the environment. Under the command-and-control policy of regulation, the factories have no reason to reduce emission further once they have reached the target of 300 tons of glop. By contrast, the tax gives the factories an incentive to develop cleaner technologies because a cleaner technology would reduce the amount of tax the factory has to pay.

Corrective taxes are unlike most other taxes. As we discussed in Chapter 8, most taxes distort incentives and move the allocation of resources away from the social optimum. The reduction in economic well-being—that is, in consumer and producer surplus—exceeds the amount of revenue the government raises, resulting in a deadweight loss. By contrast, when externalities are present, society also cares about the well-being of the affected bystanders. Corrective taxes alter incentives that market participants face to account for the presence of externalities and thereby move the allocation of resources closer to the social optimum. Thus, while corrective taxes raise revenue for the government, they also enhance economic efficiency.



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Arthur Pigou

WHY IS GASOLINE TAXED SO HEAVILY?

In many nations, gasoline is among the most heavily taxed goods. The gas tax can be viewed as a corrective tax aimed at addressing three negative externalities associated with driving:

- *Congestion:* If you have ever been stuck in bumper-to-bumper traffic, you have probably wished that there were fewer cars on the road. A gasoline tax keeps congestion down by encouraging people to take public transportation, carpool more often, and live closer to work.
- *Accidents:* Whenever people buy large cars or sport utility vehicles, they may make themselves safer but they certainly put their neighbors at risk. According to the National Highway Traffic Safety Administration, a person driving a typical car is five times as likely to die if hit by a sport utility vehicle than if hit by another car. The gas tax is an indirect way of making



people pay when their large, gas-guzzling vehicles impose risk on others. It would induce them to take this risk into account when choosing what vehicle to purchase.

- *Pollution:* Cars cause smog. Moreover, the burning of fossil fuels such as gasoline is widely believed to be the primary cause of global warming. Experts disagree about how dangerous this threat is, but there is no doubt that the gas tax reduces the threat by discouraging the use of gasoline.

So the gas tax, rather than causing deadweight losses like most taxes, actually makes the economy work better. It means less traffic congestion, safer roads, and a cleaner environment.

How high should the tax on gasoline be? Most European countries impose gasoline taxes that are much higher than those in the United States. Many observers have suggested that the United States should also tax gasoline more heavily. A 2007 study published in the *Journal of Economic Literature* summarized the research on the size of the various externalities associated with driving. It concluded that the optimal corrective tax on gasoline was \$2.28 per gallon in 2005 dollars; after adjusting for inflation, that amount is equivalent to about \$2.78 per gallon in 2015 dollars. By contrast, the actual tax in the United States in 2015 was only about 50 cents per gallon.

The tax revenue from a gasoline tax could be used to lower taxes that distort incentives and cause deadweight losses, such as income taxes. In addition, some of the burdensome government regulations that require automakers to produce more fuel-efficient cars would prove unnecessary. This idea, however, has never been politically popular. ●

IN THE NEWS

What Should We Do about Climate Change?

Many policy analysts believe that taxing carbon is the best approach to dealing with global climate change.

The Most Sensible Tax of All

By Yoram Bauman and Shi-Ling Hsu

On Sunday, the best climate policy in the world got even better: British Columbia's carbon tax—a tax on the carbon content of all fossil fuels burned in the province—increased from \$25 to \$30 per metric ton of carbon dioxide, making it more expensive to pollute.

This was good news not only for the environment but for nearly everyone who pays taxes in British Columbia, because the carbon tax is used to reduce taxes for individuals and businesses. Thanks to this tax swap, British Columbia has lowered its corporate income tax rate to 10 percent from 12 percent, a rate that is among the lowest in the Group of 8 wealthy nations. Personal income taxes for people earning less than \$119,000 per year are now the lowest in Canada, and there are targeted rebates for low-income and rural households.

The only bad news is that this is the last increase scheduled in British Columbia. In our view, the reason is simple: the province is waiting for the rest of North America to catch up so that its tax system will not become unbalanced or put energy-intensive industries at a competitive disadvantage.

The United States should jump at the chance to adopt a similar revenue-neutral tax swap. It's an opportunity to reduce existing taxes, clean up the environment and increase personal freedom and energy security.

Let's start with the economics. Substituting a carbon tax for some of our current taxes—on payroll, on investment, on businesses and on

workers—is a no-brainer. Why tax good things when you can tax bad things, like emissions? The idea has support from economists across the political spectrum, from Arthur B. Laffer and N. Gregory Mankiw on the right to Peter Orszag and Joseph E. Stiglitz on the left. That's because economists know that a carbon tax swap can reduce the economic drag created by our current tax system and increase long-run growth by nudging the economy away from consumption and borrowing and toward saving and investment.

Of course, carbon taxes also lower carbon emissions. Economic theory suggests that putting a price on pollution reduces emissions more affordably and more effectively than any other measure. This conclusion is supported by empirical evidence from previous market-based policies, like those in the 1990 amendments to the Clean Air Act that targeted sulfur dioxide emissions. British Columbia's carbon tax is only four years old, but preliminary data show that greenhouse gas emissions are down 4.5 percent even as population and gross domestic product have been growing. Sales of motor gasoline have fallen by 2 percent since 2007, compared with a 5 percent increase for Canada as a whole.

What would a British Columbia-style carbon tax look like in the United States? According to our calculations, a British Columbia-style \$30 carbon tax would generate about \$145 billion a year in the United States. That could be used to reduce individual and corporate income taxes by 10 percent, and afterward there would still be \$35 billion left over. If recent budget deals are any guide, Congress might choose to set aside half of that remainder to reduce estate taxes (to please Republicans) and the other half to offset the impacts of higher fuel and electricity prices resulting from the carbon tax on low-income



households through refundable tax credits or a targeted reduction in payroll taxes (to please Democrats).

Revenue from a carbon tax would most likely decline over time as Americans reduce their carbon emissions, but for many years to come it could pay for big reductions in existing taxes. It would also promote energy conservation and steer investment into clean technology and other productive economic activities.

Lastly, the carbon tax would actually give Americans more control over how much they pay in taxes. Households and businesses could reduce their carbon tax payments simply by reducing their use of fossil fuels. Americans would trim their carbon footprints—and their tax burdens—by investing in energy efficiency at home and at work, switching to less-polluting vehicles and pursuing countless other innovations. All of this would be driven not by government mandates but by Adam Smith's invisible hand.

A carbon tax makes sense whether you are a Republican or a Democrat, a climate change skeptic or a believer, a conservative or a conservationist (or both). We can move past the partisan fireworks over global warming by turning British Columbia's carbon tax into a made-in-America solution. ■

Mr. Bauman, an environmental economist, is a fellow at Sightline Institute in Seattle. Mr. Hsu, a law professor at Florida State University, is the author of "The Case for a Carbon Tax."

Source: *New York Times*, July 5, 2012.

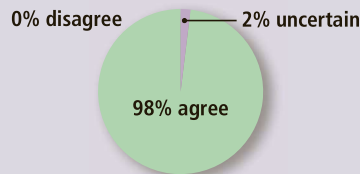


ASK THE EXPERTS

Carbon Taxes

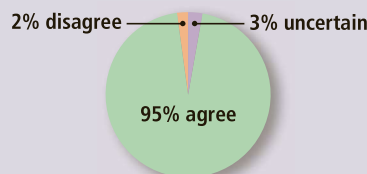
“The Brookings Institution recently described a U.S. carbon tax of \$20 per ton, increasing at 4 percent per year, which would raise an estimated \$150 billion per year in federal revenues over the next decade. Given the negative externalities created by carbon dioxide emissions, a federal carbon tax at this rate would involve fewer harmful net distortions to the U.S. economy than a tax increase that generated the same revenue by raising marginal tax rates on labor income across the board.”

What do economists say?



“A tax on the carbon content of fuels would be a less expensive way to reduce carbon-dioxide emissions than would a collection of policies such as ‘corporate average fuel economy’ requirements for automobiles.”

What do economists say?



Source: IGM Economic Experts Panel, December 4, 2012 and December 20, 2011.

10-2c Market-Based Policy 2: Tradable Pollution Permits

Returning to our example of the paper mill and the steel mill, let us suppose that, despite the advice of its economists, the EPA adopts the regulation and requires each factory to reduce its pollution to 300 tons of glop per year. Then one day, after the regulation is in place and both mills have complied, the two firms go to the EPA with a proposal. The steel mill wants to increase its emission of glop from 300 to 400 tons. The paper mill has agreed to reduce its emission from 300 to 200 tons if the steel mill pays it \$5 million. The total emission of glop would remain at 600 tons. Should the EPA allow the two factories to make this deal?

From the standpoint of economic efficiency, allowing the deal is good policy. The deal must make the owners of the two factories better off because they are voluntarily agreeing to it. Moreover, the deal does not have any external effects because the total amount of pollution stays the same. Thus, social welfare is enhanced by allowing the paper mill to sell its pollution rights to the steel mill.

The same logic applies to any voluntary transfer of the right to pollute from one firm to another. If the EPA allows firms to make these deals, it will, in essence, create a new scarce resource: pollution permits. A market to trade these permits will eventually develop, and that market will be governed by the forces of supply and demand. The invisible hand will ensure that this new market allocates the right to pollute efficiently. That is, the permits will end up in the hands of those firms that value them most highly, as judged by their willingness to pay. A firm’s willingness to pay for the right to pollute, in turn, will depend on its cost of reducing pollution: The more costly it is for a firm to cut back on pollution, the more it will be willing to pay for a permit.

An advantage of allowing a market for pollution permits is that the initial allocation of pollution permits among firms does not matter from the standpoint of economic efficiency. Those firms that can reduce pollution at a low cost will sell whatever permits they get, while firms that can reduce pollution only at a high cost will buy whatever permits they need. As long as there is a free market for the pollution rights, the final allocation will be efficient regardless of the initial allocation.

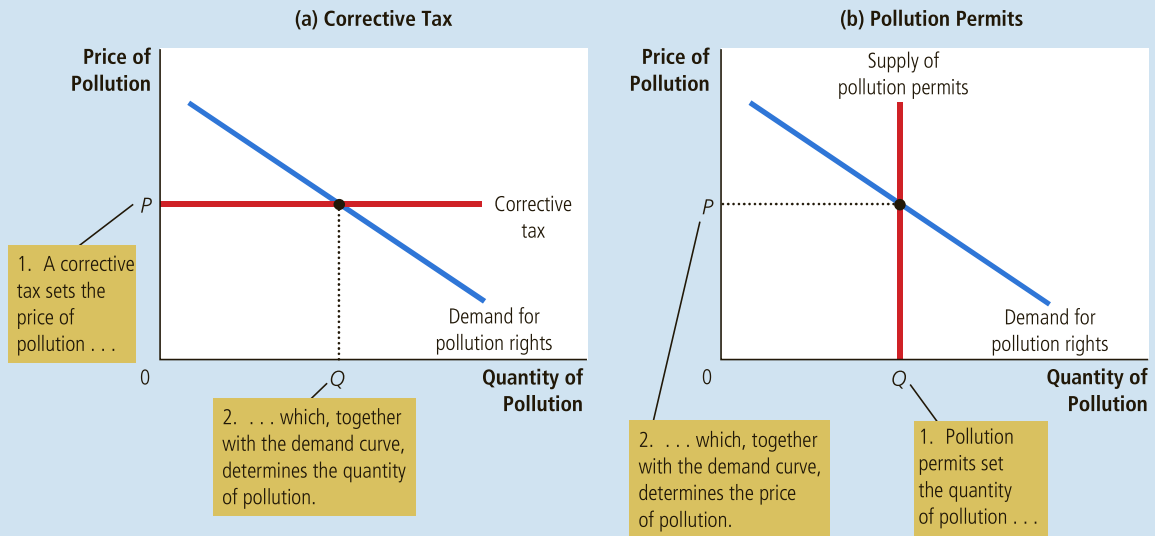
Reducing pollution using pollution permits may seem very different from using corrective taxes, but the two policies have much in common. In both cases, firms pay for their pollution. With corrective taxes, polluting firms must pay a tax to the government. With pollution permits, polluting firms must pay to buy the permits. (Even firms that already own permits must pay to pollute: The opportunity cost of polluting is what they could have received by selling their permits on the open market.) Both corrective taxes and pollution permits internalize the externality of pollution by making it costly for firms to pollute.

The similarity of the two policies can be seen by considering the market for pollution. Both panels in Figure 4 show the demand curve for the right to pollute.

In panel (a), the EPA sets a price on pollution by levying a corrective tax, and the demand curve determines the quantity of pollution. In panel (b), the EPA limits the quantity of pollution by limiting the number of pollution permits, and the demand curve determines the price of pollution. The price and quantity of pollution are the same in the two cases.

FIGURE 4

The Equivalence of Corrective Taxes and Pollution Permits



This curve shows that the lower the price of polluting, the more firms will choose to pollute. In panel (a), the EPA uses a corrective tax to set a price for pollution. In this case, the supply curve for pollution rights is perfectly elastic (because firms can pollute as much as they want by paying the tax), and the position of the demand curve determines the quantity of pollution. In panel (b), the EPA sets a quantity of pollution by issuing pollution permits. In this case, the supply curve for pollution rights is perfectly inelastic (because the quantity of pollution is fixed by the number of permits), and the position of the demand curve determines the price of pollution. Hence, the EPA can achieve any point on a given demand curve either by setting a price with a corrective tax or by setting a quantity with pollution permits.

In some circumstances, however, selling pollution permits may be better than levying a corrective tax. Suppose the EPA wants no more than 600 tons of glop dumped into the river. But because the EPA does not know the demand curve for pollution, it is not sure what size tax would achieve that goal. In this case, it can simply auction off 600 pollution permits. The auction price would yield the appropriate size of the corrective tax.

The idea of the government auctioning off the right to pollute may at first sound like a creature of some economist's imagination. And in fact, that is how the idea began. But increasingly, the EPA has used this system as a way to control pollution. A notable success story has been the case of sulfur dioxide (SO_2), a leading cause of acid rain. In 1990, amendments to the Clean Air Act required power plants to reduce SO_2 emissions substantially. At the same time, the amendments

set up a system that allowed plants to trade their SO₂ allowances. Initially, both industry representatives and environmentalists were skeptical of the proposal, but over time the system reduced pollution with minimal disruption. Pollution permits, like corrective taxes, are now widely viewed as a cost-effective way to keep the environment clean.

10-2d Objections to the Economic Analysis of Pollution

“We cannot give anyone the option of polluting for a fee.” This comment from the late Senator Edmund Muskie reflects the view of some environmentalists. Clean air and clean water, they argue, are fundamental human rights that should not be debased by considering them in economic terms. How can you put a price on clean air and clean water? The environment is so important, they claim, that we should protect it as much as possible, regardless of the cost.

Economists have little sympathy for this type of argument. To economists, good environmental policy begins by acknowledging the first of the *Ten Principles of Economics* in Chapter 1: People face trade-offs. Certainly, clean air and clean water have value. But their value must be compared to their opportunity cost—that is, to what one must give up to obtain them. Eliminating all pollution is impossible. Trying to eliminate all pollution would reverse many of the technological advances that allow us to enjoy a high standard of living. Few people would be willing to accept poor nutrition, inadequate medical care, or shoddy housing to make the environment as clean as possible.

Economists argue that some environmental activists hurt their own cause by not thinking in economic terms. A clean environment can be viewed as simply another good. Like all normal goods, it has a positive income elasticity: Rich countries can afford a cleaner environment than poor ones and, therefore, usually have more rigorous environmental protection. In addition, like most other goods, clean air and clean water obey the law of demand: The lower the price of environmental protection, the more the public will want. The economic approach of using pollution permits and corrective taxes reduces the cost of environmental protection and should, therefore, increase the public’s demand for a clean environment.

QuickQuiz

A glue factory and a steel mill emit smoke containing a chemical that is harmful if inhaled in large amounts. Describe three ways the town government might respond to this externality. What are the pros and cons of each solution?

10-3 Private Solutions to Externalities

Although externalities tend to cause markets to be inefficient, government action is not always needed to solve the problem. In some circumstances, people can develop private solutions.

10-3a The Types of Private Solutions

Sometimes the problem of externalities is solved with moral codes and social sanctions. Consider, for instance, why most people do not litter. Although there are laws against littering, these laws are not rigorously enforced. Most people choose not to litter just because it is the wrong thing to do. The Golden Rule taught to most children says, “Do unto others as you would have them do unto you.” This moral injunction tells us to take account of how our actions affect other people. In economic terms, it tells us to internalize externalities.

Another private solution to externalities involves charities. For example, the Sierra Club, whose goal is to protect the environment, is a nonprofit organization funded with private donations. As another example, colleges and universities receive gifts from alumni, corporations, and foundations in part because education has positive externalities for society. The government encourages this private solution to externalities through the tax system by allowing an income tax deduction for charitable donations.

The private market can often solve the problem of externalities by relying on the self-interest of the relevant parties. Sometimes the solution takes the form of integrating different types of businesses. For example, consider an apple grower and a beekeeper who are located next to each other. Each business confers a positive externality on the other: By pollinating the flowers on the trees, the bees help the orchard produce apples, while the bees use the nectar they get from the apple trees to produce honey. Nonetheless, when the apple grower is deciding how many trees to plant and the beekeeper is deciding how many bees to keep, they neglect the positive externality. As a result, the apple grower plants too few trees and the beekeeper keeps too few bees. These externalities could be internalized if the beekeeper bought the apple orchard or if the apple grower bought the beehives: Both activities would then take place within the same firm, and this single firm could choose the optimal number of trees and bees. Internalizing externalities is one reason that some firms are involved in multiple types of businesses.

Another way for the private market to deal with external effects is for the interested parties to enter into a contract. In the foregoing example, a contract between the apple grower and the beekeeper can solve the problem of too few trees and too few bees. The contract can specify the number of trees, the number of bees, and perhaps a payment from one party to the other. By setting the right number of trees and bees, the contract can solve the inefficiency that normally arises from these externalities and make both parties better off.

10-3b The Coase Theorem

How effective is the private market in dealing with externalities? A famous result, called the **Coase theorem** after economist Ronald Coase, suggests that it can be very effective in some circumstances. According to the Coase theorem, if private parties can bargain over the allocation of resources at no cost, then the private market will always solve the problem of externalities and allocate resources efficiently.

To see how the Coase theorem works, consider an example. Suppose that Dick owns a dog named Spot. Spot barks and disturbs Jane, Dick's neighbor. Dick gets a benefit from owning the dog, but the dog confers a negative externality on Jane. Should Dick be forced to send Spot to the pound, or should Jane have to suffer sleepless nights because of Spot's barking?

Consider first what outcome is socially efficient. A social planner, considering the two alternatives, would compare the benefit that Dick gets from the dog to the cost that Jane bears from the barking. If the benefit exceeds the cost, it is efficient for Dick to keep the dog and for Jane to live with the barking. Yet if the cost exceeds the benefit, then Dick should get rid of the dog.

According to the Coase theorem, the private market will reach the efficient outcome on its own. How? Jane can simply offer to pay Dick to get rid of the dog. Dick will accept the deal if the amount of money Jane offers is greater than the benefit of keeping the dog.

By bargaining over the price, Dick and Jane can always reach the efficient outcome. For instance, suppose that Dick gets a \$500 benefit from the dog and Jane

Coase theorem

the proposition that if private parties can bargain without cost over the allocation of resources, they can solve the problem of externalities on their own

bears an \$800 cost from the barking. In this case, Jane can offer Dick \$600 to get rid of the dog, and Dick will gladly accept. Both parties are better off than they were before, and the efficient outcome is reached.

It is possible, of course, that Jane would not be willing to offer any price that Dick would accept. For instance, suppose that Dick gets a \$1,000 benefit from the dog and Jane bears an \$800 cost from the barking. In this case, Dick would turn down any offer below \$1,000, while Jane would not offer any amount above \$800. Therefore, Dick ends up keeping the dog. Given these costs and benefits, however, this outcome is efficient.

So far, we have assumed that Dick has the legal right to keep a barking dog. In other words, we have assumed that Dick can keep Spot unless Jane pays him enough to induce him to give up the dog voluntarily. But how different would the outcome be if Jane had the legal right to peace and quiet?

According to the Coase theorem, the initial distribution of rights does not matter for the market's ability to reach the efficient outcome. For instance, suppose that Jane can legally compel Dick to get rid of the dog. Having this right works to Jane's advantage, but it probably will not change the outcome. In this case, Dick can offer to pay Jane to allow him to keep the dog. If the benefit of the dog to Dick exceeds the cost of the barking to Jane, then Dick and Jane will strike a bargain in which Dick keeps the dog.

Although Dick and Jane can reach the efficient outcome regardless of how rights are initially distributed, the distribution of rights is not irrelevant: It determines the distribution of economic well-being. Whether Dick has the right to a barking dog or Jane the right to peace and quiet determines who pays whom in the final bargain. But in either case, the two parties can bargain with each other and solve the externality problem. Dick will end up keeping the dog only if his benefit exceeds Jane's cost.

To sum up: *The Coase theorem says that private economic actors can potentially solve the problem of externalities among themselves. Whatever the initial distribution of rights, the interested parties can reach a bargain in which everyone is better off and the outcome is efficient.*

10-3c Why Private Solutions Do Not Always Work

Despite the appealing logic of the Coase theorem, private individuals on their own often fail to resolve the problems caused by externalities. The Coase theorem applies only when the interested parties have no trouble reaching and enforcing an agreement. In the real world, however, bargaining does not always work, even when a mutually beneficial agreement is possible.

transaction costs
the costs that parties incur during the process of agreeing to and following through on a bargain

Sometimes the interested parties fail to solve an externality problem because of **transaction costs**, the costs that parties incur in the process of agreeing to and following through on a bargain. In our example, imagine that Dick and Jane speak different languages so that, to reach an agreement, they need to hire a translator. If the benefit of solving the barking problem is less than the cost of the translator, Dick and Jane might choose to leave the problem unsolved. In more realistic examples, the transaction costs are the expenses not of translators but of lawyers required to draft and enforce contracts.

At other times, bargaining simply breaks down. The recurrence of wars and labor strikes shows that reaching agreement can be difficult and that failing to reach agreement can be costly. The problem is often that each party tries to hold out for a better deal. For example, suppose that Dick gets a \$500 benefit from having the dog and Jane bears an \$800 cost from the barking. Although it is efficient for Jane to pay

IN THE NEWS

The Coase Theorem in Action

Whenever people come in close contact, externalities abound.

Don't Want Me to Recline My Airline Seat? You Can Pay Me

By Josh Barro

I fly a lot. When I fly, I recline. I don't feel guilty about it. And I'm going to keep doing it, unless you pay me to stop.

I bring this up because of a dispute you may have heard about: On Sunday, a United Airlines flight from Newark to Denver made an unscheduled stop in Chicago to discharge two passengers who had a dispute over seat reclining. According to The Associated Press, a man in a middle seat installed the Knee Defender, a \$21.95 device that keeps a seat upright, on the seatback in front of him.

A flight attendant asked him to remove the device. He refused. The woman seated in front of him turned around and threw water at him. The pilot landed the plane and booted both passengers off the flight.

Obviously, it's improper to throw water at another passenger on a flight, even if he deserves it. But I've seen a distressing amount of sympathy for Mr. Knee Defender, who wasn't just instigating a fight but usurping his fellow passenger's property rights. When you buy an airline ticket, one of the things you're buying is the right to use your seat's reclining function. If this passenger so badly wanted the passenger

in front of him not to recline, he should have paid her to give up that right.

I wrote an article to that effect in 2011, noting that airline seats are an excellent case study for the Coase Theorem. This is an economic theory holding that it doesn't matter very much who is initially given a property right; so long as you clearly define it and transaction costs are low, people will trade the right so that it ends up in the hands of whoever values it most. That is, I own the right to recline, and if my reclining bothers you, you can pay me to stop. We could (but don't) have an alternative system in which the passenger sitting behind me owns the reclining rights. In that circumstance, if I really care about being allowed to recline, I could pay him to let me.

Donald Marron, a former director of the Congressional Budget Office, agrees with this analysis, but with a caveat. Recline negotiations do involve some transaction costs — passengers don't like bargaining over reclining positions



with their neighbors, perhaps because that sometimes ends with water being thrown in someone's face.

Mr. Marron says we ought to allocate the initial property right to the person likely to care most about reclining, in order to reduce the number of transactions that are necessary. He further argues that it's probably the person sitting behind, as evidenced by the fact people routinely pay for extra-legroom seats.

Mr. Marron is wrong about this last point. I understand people don't like negotiating with strangers, but in hundreds of flights I have taken, I have rarely had anyone complain to me about my seat recline, and nobody has ever offered me money, or anything else of value, in exchange for sitting upright.

If sitting behind my reclined seat was such misery, if recliners like me are "monsters," as Mark Hemingway of *The Weekly Standard* puts it, why is nobody willing to pay me to stop? People talk a big game on social media about the terribleness of reclining, but then people like to complain about all sorts of things; if they really cared that much, someone would have opened his wallet and paid me by now. ■

Source: *New York Times*, April 27, 2014.

Dick to find another home for the dog, there are many prices that could lead to this outcome. Dick might demand \$750, and Jane might offer only \$550. As they haggle over the price, the inefficient outcome with the barking dog persists.

Reaching an efficient bargain is especially difficult when the number of interested parties is large, because coordinating everyone is costly. For example, consider a factory that pollutes the water of a nearby lake. The pollution confers a negative externality on the local fishermen. According to the Coase theorem, if the pollution is inefficient, then the factory and the fishermen could reach a bargain in which the fishermen pay the factory not to pollute. If there are many fishermen,

however, trying to coordinate them all to bargain with the factory may be almost impossible.

When private bargaining does not work, the government can sometimes play a role. The government is an institution designed for collective action. In this example, the government can act on behalf of the fishermen, even when it is impractical for the fishermen to act for themselves.

QuickQuiz

Give an example of a private solution to an externality. • What is the Coase theorem? • Why are private economic participants sometimes unable to solve the problems caused by an externality?

10-4 Conclusion

The invisible hand is powerful but not omnipotent. A market's equilibrium maximizes the sum of producer and consumer surplus. When the buyers and sellers in the market are the only interested parties, this outcome is efficient from the standpoint of society as a whole. But when there are external effects, such as pollution, evaluating a market outcome requires taking into account the well-being of third parties as well. In this case, the invisible hand of the marketplace may fail to allocate resources efficiently.

In some cases, people can solve the problem of externalities on their own. The Coase theorem suggests that the interested parties can bargain among themselves and agree on an efficient solution. Sometimes, however, an efficient outcome cannot be reached, perhaps because the large number of interested parties makes bargaining difficult.

When people cannot solve the problem of externalities privately, the government often steps in. Yet even with government intervention, society should not abandon market forces entirely. Rather, the government can address the problem by requiring decision makers to bear the full costs of their actions. Pollution permits and corrective taxes on emissions, for instance, are designed to internalize the externality of pollution. These are increasingly the policies of choice for those interested in protecting the environment. Market forces, properly redirected, are often the best remedy for market failure.

CHAPTER QuickQuiz

- Which of the following is an example of a positive externality?
 - Dev mows Hillary's lawn and is paid \$100 for performing the service.
 - While mowing the lawn, Dev's lawnmower spews out smoke that Hillary's neighbor Kristen has to breathe.
 - Hillary's newly cut lawn makes her neighborhood more attractive.
 - Hillary's neighbors pay her if she promises to get her lawn cut on a regular basis.
- If the production of a good yields a negative externality, then the social-cost curve lies _____ the supply curve, and the socially optimal quantity is _____ than the equilibrium quantity.
 - above, greater
 - above, less
 - below, greater
 - below, less

3. When the government levies a tax on a good equal to the external cost associated with the good's production, it _____ the price paid by consumers and makes the market outcome _____ efficient.
 - a. increases, more
 - b. increases, less
 - c. decreases, more
 - d. decreases, less
4. Which of the following statements about corrective taxes is generally NOT true?
 - a. Economists prefer them to command-and-control regulation.
 - b. They raise government revenue.
 - c. They cause deadweight losses.
 - d. They reduce the quantity sold in a market.
5. The government auctions off 500 units of pollution rights. They sell for \$50 per unit, raising total revenue of \$25,000. This policy is equivalent to a corrective tax of _____ per unit of pollution.
 - a. \$10
 - b. \$50
 - c. \$450
 - d. \$500
6. The Coase theorem does NOT apply if
 - a. there is a significant externality between two parties.
 - b. the court system vigorously enforces all contracts.
 - c. transaction costs make negotiating difficult.
 - d. both parties understand the externality fully.

SUMMARY

- When a transaction between a buyer and seller directly affects a third party, the effect is called an externality. If an activity yields negative externalities, such as pollution, the socially optimal quantity in a market is less than the equilibrium quantity. If an activity yields positive externalities, such as technology spillovers, the socially optimal quantity is greater than the equilibrium quantity.
- Governments pursue various policies to remedy the inefficiencies caused by externalities. Sometimes the government prevents socially inefficient activity by regulating behavior. Other times it internalizes an externality using corrective taxes. Another public policy is to issue permits. For example, the government could protect the environment by issuing a limited number of pollution permits. The result of this policy is similar to imposing corrective taxes on polluters.
- Those affected by externalities can sometimes solve the problem privately. For instance, when one business imposes an externality on another business, the two businesses can internalize the externality by merging. Alternatively, the interested parties can solve the problem by negotiating a contract. According to the Coase theorem, if people can bargain without cost, then they can always reach an agreement in which resources are allocated efficiently. In many cases, however, reaching a bargain among the many interested parties is difficult, so the Coase theorem does not apply.

KEY CONCEPTS

externality, p. 190

internalizing the externality, p. 193

corrective tax, p. 196

Coase theorem, p. 203

transaction costs, p. 204

QUESTIONS FOR REVIEW

1. Give an example of a negative externality and an example of a positive externality.
2. Draw a supply-and-demand diagram to explain the effect of a negative externality that occurs as a result of a firm's production process.
3. In what way does the patent system help society solve an externality problem?
4. What are corrective taxes? Why do economists prefer them to regulations as a way to protect the environment from pollution?