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## >> Externalities

### Section 2: Policies Toward Pollution

 Before 1970, there were no rules governing the amount of sulfur dioxide power plants in the United States could emit—which is why acid rain got to be such a problem. After 1970, the Clean Air Act set rules about sulfur dioxide emissions—and the acidity of rainfall declined significantly. Economists argued, however, that a more flexible system of rules that exploited the effectiveness of markets could achieve lower pollution at less cost. In 1990 this theory was put into effect with a modified version of the Clean Air Act. And guess what? The economists were right!

In this section we'll look at the policies governments use to deal with pollution and at how economic analysis has been used to improve those policies.

#### Environmental Standards

 The most serious external costs in the modern world are surely those associated with actions that damage the environment—air pollution, water pollution, habitat destruction, and so on. Protection of the environment has become a major role of government in all advanced nations. In the United States, the Environmental

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Protection Agency is the principal enforcer of environmental policies at the national level, supported by the actions of state and local governments.

How does a country protect its environment? At present the main policy tools are **environmental standards**, rules that protect the environment by specifying actions by producers and consumers. A familiar example is the law that requires almost all vehicles to have catalytic converters, which reduce the emission of chemicals that can cause smog and lead to health problems. Other rules require communities to treat their sewage, factories to avoid or limit certain kinds of pollution, and so on.

Environmental standards came into widespread use in the 1960s and 1970s, and they have had considerable success in reducing pollution. For example, since the United States passed the Clean Air Act in 1970, overall emission of pollutants into the air has fallen by more than a third, even though the population has grown by a third and the size of the economy has more than doubled. Even in Los Angeles, still famous for its smog, the air has improved dramatically: in 1988 ozone levels in the South Coast Air Basin exceeded federal standards on 178 days; in 2003, on only 68 days.



Despite these successes, economists believe that when regulators can control a polluter's emissions directly, there are more efficient ways than environmental standards to deal with pollution. By using methods grounded in economic analysis, society can achieve a cleaner environment at lower cost. Most current environmental standards are inflexible and don't allow reductions in pollution to be achieved at minimum cost. For example, Plant A and Plant B might be ordered to reduce pollution by the same percentage, even if their costs of achieving that objective are very different.

How does economic theory suggest that pollution should be directly controlled? There are actually two approaches: taxes and tradable permits. As we'll see, either approach can achieve the efficient outcome at the minimum feasible cost.

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An **emissions tax** is a tax that depends on the amount of pollution a firm produces.

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## Emissions Taxes

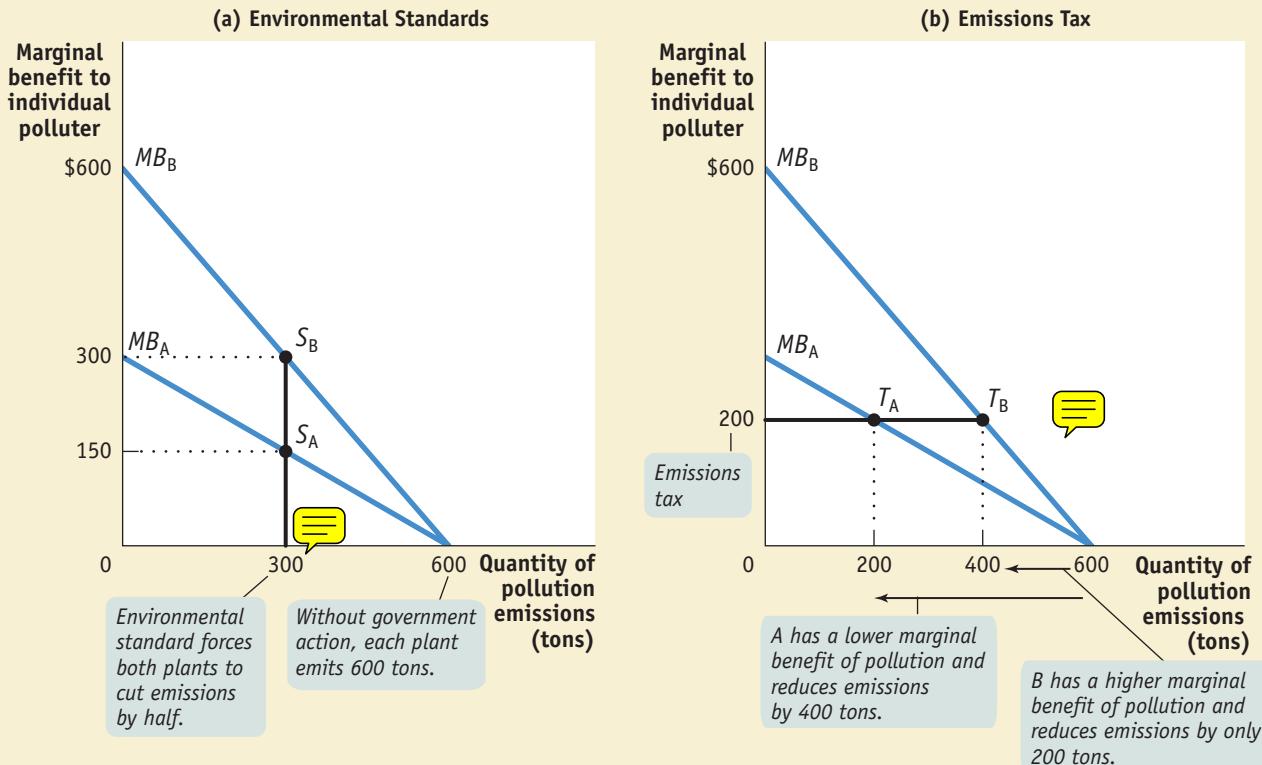
One way to deal with pollution directly is to charge polluters an **emissions tax**. Emissions taxes are taxes that depend on the amount of pollution a firm produces. For example, power plants might be charged \$200 for every ton of sulfur dioxide they emit.

Look again at Figure 19-2 in “Section 1: The Economics of Pollution,” which shows that the socially optimal quantity of pollution is  $Q_{OPT}$ . At that quantity of pollution, the marginal social benefit and marginal social cost of an additional ton of emissions are equal at \$200. But in the absence of government intervention, power companies have no incentive to limit pollution to the socially optimal quantity  $Q_{OPT}$ ; instead, they will push pollution up to the quantity  $Q_{MKT}$ , at which marginal social benefit is zero.

It’s now easy to see how an emissions tax can solve the problem. If power companies are required to pay a tax of \$200 per ton of emissions, they now face a marginal cost of \$200 per ton and have an incentive to reduce emissions to  $Q_{OPT}$ , the socially optimal quantity. This illustrates a general result: an emissions tax equal to the marginal social cost at the socially optimal quantity of pollution induces polluters to internalize the externality—to take into account the true costs to society of their actions.



Why is an emissions tax an efficient way (that is, a cost-minimizing way) to reduce pollution but environmental standards are generally not? Because an emissions tax ensures that the marginal benefit of pollution is equal for all sources of pollution but an environmental standard does not. Figure 19-3 shows a hypothetical industry consisting of only two plants, Plant A and Plant B. We’ll assume that Plant A uses newer technology than plant B and so has a lower cost of reducing pollution. Reflecting this difference in costs, Plant A’s marginal benefit of pollution curve,  $MB_A$ , lies below Plant B’s marginal benefit of pollution curve,  $MB_B$ . Because it is more costly for Plant B to reduce its pollution at any output quantity, an additional ton of pollution is worth more to Plant B than to Plant A.

**Figure 19-3 Environmental Standards versus Emissions Taxes**

**Figure 19-3 Environmental Standards versus Emissions Taxes (continued)**

In both panels,  $MB_A$  shows the marginal benefit of pollution to Plant A and  $MB_B$  shows the marginal benefit of pollution to Plant B. In the absence of government intervention, each plant would emit 600 tons. However, the cost of reducing emissions is lower for Plant A, as shown by the fact that  $MB_A$  lies below  $MB_B$ . Panel (a) shows the result of an environmental standard that

requires both plants to cut emissions in half; this is inefficient, because it leaves the marginal benefit of pollution higher for Plant B than for Plant A. Panel (b) shows that an emissions tax achieves the same quantity of overall pollution efficiently: faced with an emissions tax of \$200 per ton, both plants reduce pollution to the point where its marginal benefit is \$200. >[web...](#)

In the absence of government action, we know that polluters will pollute until the marginal social benefit of an additional unit of emissions is equal to zero. Recall that the marginal social benefit of pollution is the cost savings, at the margin, to polluters of an additional unit of pollution. This means that without government intervention each plant will pollute until its own marginal benefit of pollution is equal to zero. This corresponds to an emissions quantity of 600 tons each for Plants A and B—the quantity of pollution at which  $MB_A$  and  $MB_B$  are each equal to zero. So although Plant A and Plant B value a ton of emissions differently, without government action they will each choose to emit the same amount of pollution.

Now suppose that the government decides that overall pollution from this industry should be cut in half, from 1,200 tons to 600 tons. Panel (a) of Figure 19-3 shows how this might be achieved with an environmental standard that requires each plant to cut its emissions in half, from 600 to 300 tons. The standard has the desired effect of reducing overall emissions from 1,200 to 600 tons but accomplishes it in an inefficient way. As you can see from panel (a), the environmental standard leads Plant A to produce at point  $S_A$ , where its marginal benefit of pollution is \$150, but Plant B produces at point  $S_B$ , where its marginal benefit of pollution is twice as high, \$300.

This difference in marginal benefits between the two plants tells us that the same quantity of pollution can be achieved at lower total cost by allowing Plant B to pollute more than 300 tons but inducing Plant A to pollute less. In fact, the efficient way to reduce pollution is to ensure that at the industry-wide outcome, the marginal benefit of pollution is the same for all plants. When each plant values a unit of pollution equally, there is no way to re-arrange pollution reduction among the various plants that achieves the optimal quantity of pollution at a lower total cost.

We can see from panel (b) how an emissions tax achieves exactly that result. Suppose both Plant A and Plant B pay an emissions tax of \$200 per ton, so that the marginal cost of an additional ton of emissions to each plant is now \$200 rather than zero. As a result, Plant A produces at  $T_A$  and Plant B produces at  $T_B$ . So Plant A reduces its pollution more than it would under an inflexible environmental standard, cutting its emissions from 600 to 200 tons; meanwhile, Plant B reduces its pollution less, going from 600 to 400 tons. In the end, total pollution—600 tons—is the same as under the environmental standard, but total surplus is higher. That’s because the reduction in pollution has been achieved efficiently, allocating most of the reduction to Plant A, the plant that can reduce emissions at lower cost.

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Taxes designed to reduce external costs are known as **Pigouvian taxes**.

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The term *emissions tax* may convey the misleading impression that taxes are a solution to only one kind of external cost, pollution. In fact, taxes can be used to discourage any activity that generates negative externalities, such as driving during rush hour or operating a noisy bar in a residential area. In general, taxes designed to reduce external costs are known as **Pigouvian taxes**, after the economist A. C. Pigou, who emphasized their usefulness in a classic 1920 book, *The Economics of Welfare*. In our example, the optimal Pigouvian tax is \$200; as you can see from Figure 19-2 in “Section 1: The Economics of Pollution,” this corresponds to the marginal social cost of pollution at the optimal output quantity,  $Q_{OPT}$ .

Are there any problems with emissions taxes? The main concern is that in practice government officials usually aren’t sure how high the tax should be set. If they set the



tax too low, there will be too little improvement in the environment; if they set it too high, emissions will be reduced by more than is efficient. This uncertainty cannot be eliminated, but the nature of the risks can be changed by using an alternative strategy, issuing emissions permits.

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**Tradable emissions permits** are licenses to emit limited quantities of pollutants that can be bought and sold by polluters.

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## Tradable Emissions Permits

**Tradable emissions permits** are licenses to emit limited quantities of pollutants that can be bought and sold by polluters. They are usually issued to polluting firms according to some formula reflecting their history. For example, each power plant might be issued permits equal to 50 percent of its emissions before the system went into effect. The more important point, however, is that these permits are *tradable*. Firms with differing costs of reducing pollution can now engage in mutually beneficial transactions: those that find it easier to reduce pollution will sell some of their permits to those that find it more difficult. In other words, firms will use transactions in permits to re-allocate pollution reduction among themselves, so that in the end those with the lowest cost will reduce their pollution the most, while those with the highest cost will reduce their pollution the least. Using our original example, this means that Plant A will find it profitable to sell 100 of its 300 government-issued licenses to Plant B. The effect of a tradable permit system is to create a market in rights to pollute.

Just like emissions taxes, tradable permits provide polluters with an incentive to take the marginal social cost of pollution into account. To see why, suppose that the market price of a permit to emit one ton of sulfur dioxide is \$200. Then every plant has an incentive to limit its emissions of sulfur dioxide to the point where the marginal benefit of emissions is \$200. This is obvious for plants that buy rights to pollute: if a plant must pay \$200 for the right to emit an additional ton of sulfur dioxide, it faces the same incentives as a plant facing an emissions tax of \$200 per ton. But it's equally true



for plants that have more permits than they plan to use: by *not* emitting a ton of sulfur dioxide, a plant frees up a permit that it can sell for \$200, so the opportunity cost of a ton of emissions to the plant's owner is \$200.

In short, tradable emissions permits have the same cost-minimizing advantage as emissions taxes over environmental standards: either system ensures that those who can reduce pollution most cheaply are the ones who do so. The socially optimal quantity of pollution shown in Figure 19-2 in “Section 1: The Economics of Pollution” could be efficiently achieved either way: by imposing an emissions tax of \$200 per ton of pollution or by issuing tradable permits to emit  $Q_{OPT}$  tons of pollution. If regulators choose to issue  $Q_{OPT}$  permits, where one permit allows the release of one ton of emissions, then the equilibrium market price of a permit among polluters will indeed be \$200. Why? You can see from Figure 19-2 that at  $Q_{OPT}$ , only polluters with a marginal benefit of pollution of \$200 or more will buy a permit. And the last polluter who buys—who has a marginal benefit of exactly \$200—sets the market price.

It's important to realize that emissions taxes and tradable permits do more than induce polluting industries to reduce their output. They also provide incentives to create and use less-polluting technology. In fact, the main effect of the permit system for sulfur dioxide has been to change *how* electricity is produced rather than to reduce the nation's electricity output. For example, power companies have shifted to the use of alternative fuels such as low-sulfur coal and natural gas; they have also installed scrubbers that take much of the sulfur dioxide out of a power plant's emissions.

The main problem with tradable emissions permits is the flip-side of the problem with emissions taxes: because it is difficult to determine the optimal quantity of pollution, governments can find themselves either issuing too many permits—that is, they don't reduce pollution enough, or issuing too few—that is, they reduce pollution too much.

In practice, after first relying on rigid environmental standards, the U.S. government has turned to a system of tradable emissions permits to control acid rain, and current proposals would extend that system to other major sources of pollution. The Economics in Action that follows describes how the system has worked in practice. ■

