Karl Case, Ray Fair, Sharon Oster (2019). Principles of Microeconomics, Global Edition (13th ed.). Pearson. ISBN: 978-1292303390.



Specifically, a change is said to be efficient when it makes some members of society better off without making other members of society worse off. An efficient, or *Pareto optimal*, system is one in which no such changes are possible. An example of a change that makes some people better off and nobody worse off is a simple voluntary exchange. I have apples and you have nuts. I like nuts and you like apples. We trade. We both gain, and no one loses. Thus, the original, pre-trade allocation of apples and nuts was not Pareto optimal.

For a definition of efficiency to have practical meaning, we must answer two questions: (1) What do we mean by "better off"? and (2) How do we account for changes that make some people better off and others worse off?

The answer to the first question is simple. People decide what "better off" and "worse off" mean. I am the only one who knows whether I am better off after a change. If you and I exchange one item for another because I like what you have and you like what I have, we both "reveal" that we are better off after the exchange because we agreed to it voluntarily. If everyone in the neighborhood wants a park and the residents all contribute to a fund to build one, they have consciously changed the allocation of resources and they all are better off for it.

The answer to the second question is more complex. Nearly every change that one can imagine leaves some people better off and some people worse off. If some gain and some lose as the result of a change, and it can be demonstrated that the value of the gains exceeds the value of the losses, then the change is said to be *potentially efficient*. In practice, however, the distinction between a *potentially* and an *actually* efficient change is often ignored and all such changes are simply called *efficient*.

## ECONOMICS IN PRACTICE

### Cutting Rice Cultivation and Water Rationing in Egypt

From ancient history to until recently, Egypt was the largest producer and exporter of grains and rice in the Middle East. This was because of the river Nile, Egypt's lifeline. However, over the last few decades Egypt has been suffering from acute water scarcity due to climate change and a rapid growth in population.

Egypt needs 90 billion cubic meters of water annually to cover the needs of its population of 100 million, but it has only 60 billion cubic meters, 55.5 billion cubic meters of which comes from the Nile, and the rest from non-renewable underground water and recycled wastewater. Owing to an annual shortage of one-third of the required volume, Egypt suffers from extreme water scarcity. To make matters worse, the completion of the Grand Ethiopian Renaissance Dam is expected to further exacerbate the problem by reducing Egypt's share of Nile water.

To mitigate this problem, the Egyptian government is reducing the area of land available for water-consuming crops, rice in particular, as it consumes more than twice the amount of water needed to grow wheat or maize. Rice cultivation has been more than halved over the last few years and rice exports have been banned.

Though the decision to cut rice production will rationalize water consumption, especially as the Grand Ethiopian Renaissance Dam nears completion, it has been highly controversial to both farmers and consumers. Egyptian farmers typically prefer to grow rice because it has proven to be a highly profitable industrial crop, yielding high revenues in domestic sales and export proceeds.

Egypt's rice consumption is estimated to be 4.3 million tons in 2018, and the decision to cut rice production to 3.3 million tons means that Egypt would need to import 1 million tons of rice. For consumers, this reduction in supply will raise the prices of rice for a population already suffering from double-digit inflation.

#### CRITICAL THINKING

1. Use a general equilibrium diagram to show the impact of the decision to move farmers from cultivating rice (product X) to other crops (product Y).

# Externalities, Public Goods, and Common Resources

16

**CHAPTER OUTLINE AND LEARNING OBJECTIVES**



In Chapters 6 through 12, we built a complete model of a perfectly competitive economy. The market economy described in those chapters does a good job at providing efficient outcomes for society. In Chapters 13 to 15, we described three different market structures that impede the achievement of efficiency. In these cases it was the absence of competition that created problems for the working of the market. In this chapter we tackle a rather different set of market failures. Here we will be looking at environmental problems, issues in providing collective goods and managing common resources. In these cases, as we will see, competitive markets do not in most circumstances lead to efficient outcomes. Here we will find an enhanced role for the government in helping the economy to achieve efficiency.

As we continue our examination of market failure, we look first at *externalities* as a source of inefficiency. When you buy a car or decide how much to drive it, how much do you consider the effects on the environment of the carbon produced by that car? For many years, manufacturing firms and power plants paid little attention to the effects of the smoke they produced on the quality of the air we breathe. In both cases, the costs of these actions are borne not entirely by the decision maker, but by others in society. As a consequence, the decisions made will in general not be optimal.

Most goods we have thus far discussed are private goods. If I buy an apple and eat it, the benefits come to me alone. Some goods, however, are consumed collectively. National parks, military defense, and public education all benefit society in general. These products are called *public goods* or *social goods,* and even when they are quite valuable to a large number of people, private markets do not typically provide them. Public goods are most commonly produced or financed by governments. The process of choosing what social goods to produce is different from the process of private choice.

We will also explore common resources in this chapter. How well does the private market manage our seas? Our large fisheries? Here too we will discover a role for governments, often at the global level.

Finally, while the existence of externalities, public goods, and common resources are examples of market failure and provide an opportunity for government action, it is not necessarily true that government involvement always improves matters. Just as markets fail, so too can governments.

**16.1 LEARNING OBJECTIVE**

Understand the market failure associated with externalities and the possible solutions to this set of issues.

## Externalities and Environmental Economics

**externality** Actions of one party impose costs or benefits on a second party.

An **externality** exists when the actions or decisions of one person or group impose a cost or bestow a benefit on second or third parties. Externalities are sometimes called *spillovers* or *neighborhood effects*. Inefficient decisions result when decision makers fail to consider social costs and benefits.

The presence of externalities is a significant phenomenon in modern life. Examples are everywhere: Air, water, land, sight, and sound pollution; traffic congestion; automobile accidents; abandoned housing; nuclear accidents; and secondhand cigarette smoke are only a few. Reports of melting ice caps have fueled worry among scientists and others across the world about global warming. Concern about air quality is a major political issue in much of the developing world. The study of externalities is a major concern of *environmental economics*.

The growth of China and India has put increased pressure on the environment. As new countries industrialize, strains on global air and water systems are inevitable. We have become increasingly aware of the global nature of externalities.

### Marginal Social Cost and Marginal Cost Pricing MyLab Economics Concept Check

In the absence of externalities, when a firm weighs price and marginal cost to decide output, it is weighing the full benefits to society of additional production against the full costs to society of that production. Those who benefit from the production of a product are the people or households who end up consuming it. The price of a product is a good measure of what an additional unit of that product is "worth" because those who value it more highly already buy it. People who value it less than the current price are not buying it. If marginal cost includes all costs—that is, all costs *to society*—of producing a marginal unit of a good, additional production will be efficient, provided $P$ is greater than $MC$. Up to the point where $P = MC$, each unit of production yields benefits in excess of cost. Figure 16.1(a) shows a firm and an industry in which no externalities exist.

Suppose, however, that the production of a firm's product imposes external costs on society as well. A firm producing detergent may dump wastewater into a local river as a by-product of its detergent production, affecting the quality of water in the river experienced by the local community. A steel firm may produce carbon emissions as well as steel, contributing both to air pollution and global warming. These are costs of producing steel or detergent just as much as is the labor or capital costs of making those goods. What would happen to the firm and industry in Figure 16.1(a) if we made the firm responsible financially for the external costs they impose? Figure 16.1(b) shows what happens graphically when we add the external costs to the financial costs of the firm. The curve labeled *MSC*, **marginal social cost**, is the sum of the marginal cost of producing the product and the correctly measured marginal external cost involved in the process of production.

**marginal social cost (*MSC*)** The total cost to society of producing an additional unit of a good or service. MSC is equal to the sum of the marginal cost of producing the product and the correctly measured marginal external cost involved in the process of production.

When we correctly include the external costs in the firm's budget by, for example, forcing the firm to pay those costs, the firm's marginal costs rise by the amount of the external costs at that output level, shifting up to the curve labeled *MSC* on the right hand side of Figure 16.1(b). The industry supply curve, which is just the sum of the marginal cost curves of the firms in the industry, also then shifts up to the curve labeled S' in the figure. A new equilibrium occurs at the intersection

In complex cases of externalities, like acid rain, governments often get involved. The United States began its regulatory work in reducing acid rain with the Clean Air Act in 1990. Since then, the United States has made substantial progress in reducing the problem of acid rain, and many acidified lakes and streams now once again support fish life. Recently, the United States has employed an innovative "cap-and-trade" program to control emissions, which we will discuss later in this chapter. For acid rain, which travels across national boundaries, agreements between Canada and the United States have also played an important role.

**Other Externalities** Clearly, the most significant and hotly debated issue of externalities is global warming. The 2007 Nobel Peace Prize was awarded to former Vice President Al Gore and the Intergovernmental Panel on Climate Change, a group of 2,500 researchers from 130 nations that issued a number of reports linking human activity to the recent rise of the average temperature on Earth. Most scientists predict that absent a change in climate policy, major adverse consequences such as dramatically rising sea levels are likely. The global nature of the problem, coupled with the fact that warming will hurt some countries—those with big coastlines and warm current temperatures—more than others makes finding a solution to this issue especially hard.

Individual actions by households can also create externalities. When I drive during rush hour, I increase congestion faced by other drivers. If I smoke, your health may be compromised. Again the key issue is weighing the costs and benefits to all parties of decisions made.

**Some Examples of Positive Externalities** Thus far we have described a series of negative externalities. But externalities can also be positive. In some cases, when other people or firms engage in an activity, there are side *benefits* from that activity. From an economics perspective, there are problems with positive externalities as well.

Ian Ayres and Steve Levitt have studied a fascinating example of a product with positive externalities, LoJack. LoJack is a device that allows police to track a car when it is stolen. When a car has a LoJack device installed, the gains to stealing that car are sharply reduced. These devices not only help recover cars but also help catch car thieves. Suppose that 90 percent of the cars in a community have LoJack installed. If all LoJack cars were identified—the way houses are that have burglar alarms—potential thieves could look for the unmarked cars. As it happens, LoJack does not come with any identifying mark. From a thief's perspective, any car has a 90 percent chance of having a LoJack installed. As a result, the benefits from stealing *any* car are reduced. With reduced benefits, fewer thefts occur. Ayres and Levitt have found that the size of these positive externalities is large; they estimate that the purchaser of a LoJack captures, as an individual, only 10 percent of the value of the device.[1]

We also see positive externalities in the case of vaccinations. The more people who are vaccinated, and thus less likely to become ill, the less likely it is that a disease will spread. But the less likely the disease, the lower the private benefits to people from getting a vaccination. With communicable diseases, health precautions taken by an individual have positive external benefits to the rest of the community.

The problem with positive externalities should now be clear. For this type of externality, the individuals in charge have too little incentive to engage in the activity. Too few LoJacks are bought; too few people wash their hands often; too few people would vaccinate their children unless forced to do so by school systems.

## Costs and Benefits of Pollution MyLab Economics Concept Check

If you look back at Figure 16.1, you will see that the optimum amount of output for the pollution-emitting firm analyzed in the figure is positive. This tells us that at the optimum this firm is producing emissions, with some cost to the environment. In general, we will find that at the optimum the level of emissions of most pollutants is not zero. This may surprise you but is an important application of economics to a serious world issue.

[1] Ian Ayres and Steven D. Levitt, "Measuring Positive Externalities from Unobservable Victim Precautions: An Empirical Analysis of Lojack," *Quarterly Journal of Economics* 108, (1), 1998.

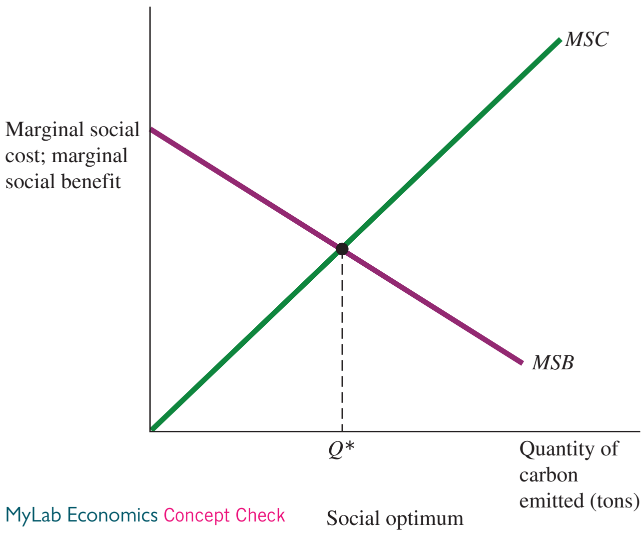
Note that the title of this subsection has both "costs" and "benefits" in it. The social costs of pollution are likely clear to you. They might include health problems from smog or loss of fish species from water pollution. But what are the social benefits of pollution? The social benefits of pollution are the costs we avoid by not eliminating the pollution while still being able to enjoy the goods that create the pollution in the first place. You could eliminate the carbon you emit by not driving, but that would have a cost to you. Or you could turn in your gas-powered car and buy a hybrid, which would cost money. Not doing those things is a benefit to you, one that we want to weigh against the costs to society of having you drive. Similarly, a steel plant gets a benefit from pollution both from the profits it earns selling steel and from avoiding costs of refitting the steel plant. The **marginal social benefit of pollution** is the incremental benefit to society from producing one more unit of pollution. The benefit is the cost saved from continuing to pollute rather than eliminate pollution either by not producing the polluting product or by altering the way the firm produces it.

**marginal social benefit of pollution** The incremental benefit to society from producing one more unit of pollution.

We can use this idea to determine the optimum amount of pollution in a society. The goal is to use the absorptive capacity of our environment as efficiently as possible. The principle we will apply should be familiar to you from other contexts. Each unit of pollution that is emitted has a marginal social cost, borne by society, perhaps in the form of health losses or lost recreational opportunities from polluted waterways. Continuing to produce that unit of pollution also has a benefit, represented by the marginal social benefit of pollution. Again, the benefit comes from resources saved in not having to eliminate the externality. We compare the two. If an incremental unit of pollution has a marginal social benefit in excess of its marginal social cost, we produce it; otherwise we do not. In other words, if on the margin society benefits more from controlling the emission than it costs to do that control, then the emission is controlled. Otherwise it is not. At the optimum, the marginal social cost of pollution emitted will exactly equal the marginal social benefit from emissions.

Figure 16.2 presents this analysis graphically. Along the horizontal axis we measure the level of pollution; here we have used tons of carbon emitted. On the vertical axis we represent the marginal social cost of experiencing carbon emissions (green line) and the marginal social benefit from pollution (purple line). It is interesting to think about the slopes of these two curves. As we increase emissions levels, the MSC increases; the *MSC* curve slopes up. This tells us that as we increase emissions the added cost of one more unit of emissions goes up. For many pollutants the environment can absorb low levels reasonably well, so marginal costs at low levels are low. As we dump more pollutants into the environment, however, the harm to nature generally increases. Adding a little bit of smoke to a clear sky may have little effect as it dissipates; adding that same smoke to an already hazy sky may have serious health consequences. Figure 16.2 presents the MSC as a straight line, but that will often not be the case. For example, the slope of the MSC curve may increase quite dramatically as the environment approaches a saturation point. The marginal social benefit curve shown in the figure has, by contrast, a downward slope. At high levels of emissions (on the right in the graph), there are often cheap ways to eliminate some

**FIGURE 16.2 Socially Optimal Polution Level**
At the optimum, $Q^*$, marginal social benefit equals marginal social cost.




MyLab Economics Concept Check

emissions. Cutting back a ton of carbon emissions at this level may be quite cheap. Thus, the benefits from being able to pollute are small. In the driving example, it is easy to think of some trips you could avoid taking at all with little detriment. As we cut back emissions, however, moving to the left on the graph, technology for reductions may reach a limit and eliminating the last little bit of pollution may in fact be possible only by eliminating production altogether. If you had to give up driving altogether that lost benefit might be high indeed.

We see the optimum emissions level in Figure 16.2 is $Q^*$, found at the intersection of the *MSC* and *MSB* curves. At this point, society is using its environment most efficiently, weighing the reduction in costs from experiencing pollution against the lost benefits from changing consumption or investing resources in mitigation.

Drawing the marginal curves as we have done and identifying the optimal level of pollution is a relatively straightforward application of the principles of marginalism that we have covered often in this text. It is a more difficult challenge to empirically measure these curves. The *MSC* of emissions ranges from health costs, to aesthetics, to loss of species diversity, or even to increases in risks to populations from rising sea levels. Many of these risks are uncertain and some occur only in the future. Environmental economists working with natural scientists have spent considerable time trying to provide reasonable estimates of what these costs might be. It is not easy to estimate the marginal social benefit curves, which requires us to assess the costs of technological solutions to emissions problems.

We have explored externalities and, focusing on pollution, have seen the characteristics of an optimal solution to the externality problem. But how do we move to the optimal level? Here there is much debate, both about how much progress can be made by private action and about the right type of government policy instruments to use.

## Internalizing Externalities MyLab Economics Concept Check

A number of mechanisms are available to provide decision makers with incentives to weigh the external costs and benefits of their decisions, a process called *internalization*. In some cases, externalities are internalized through bargaining and negotiation without government involvement. In other cases, private bargains fail and the only alternative may be government action of some kind.

Four approaches have been taken to solving the problem of externalities: (1) private bargaining and negotiation, (2) environmental standards, (3) government-imposed taxes and subsidies, and (4) sale or auctioning of rights to impose externalities. Although each is best suited for a different set of circumstances, all provide decision makers with an incentive to weigh the external effects of their decisions.

**Private Bargaining and Negotiation** Many of you probably live in dormitories. Now and again you may have found yourself with a neighbor who is much noisier than you would like. For you the noise is an externality, one that prevents you from either sleeping or studying. For the neighbor, the noise has its benefits, likely produced by a party. How do you handle this externality? For most people in this situation, the first step is obvious: Knock on the neighbor's door and ask him or her to be quieter. In fact, good manners are a societal reaction to incipient externalities. As societies increase in population density, more and more activities fall under the category of "not done in public." Consider what has happened over time to the social acceptability of smoking, for example. Even fashion can create externalities. In 2010, in anticipation of its Expo, the Chinese government cracked down on the tendency of its citizens in Shanghai to wear their pajamas outside the home, believing that this attire has negative externalities for their international guests.

Even when there are no social norms against an activity, private bargains and negotiation can often solve an externality problem. The first formal model of how private negotiations might work in this setting was described by Ronald Coase in 1960.[2] The **Coase theorem**, which is a staple topic in both law and economics classes, tells us that under certain conditions, private bargaining can solve the externality problem without government action.

**Coase theorem** Under certain conditions, when externalities are present, private parties can arrive at the efficient solution without government involvement.

[2]See Ronald Coase, "The Problem of Social Cost," *Journal of Law and Economics*, 1960. Coase won the 1991 Nobel Prize in Economics.

the externality have different marginal costs of reducing their pollution, it is also difficult to find the right standard to set. In these circumstances, when methods to reduce emissions are varied, and polluters differ widely in their ability to control emissions, most economists favor managing externalities by turning to a type of price system, using either taxes or a tradable permits market.

**Taxes and Subsidies** When private negotiations fail, economists have traditionally advocated marginal taxes and subsidies as a direct way of forcing firms to consider external costs or benefits. When a firm imposes an external social cost, the reasoning goes, a per-unit tax should be imposed equal to the damages of each successive unit of output produced by the firm—the tax should be *exactly equal* to marginal external costs.[3]

Return to look at Figure 16.1(b). We saw in this figure how a firm would do the right thing in terms of emissions if only it faced the right marginal cost curve, the *MSC*. We can use the tax system to do exactly this! Suppose we impose a tax on this firm exactly equal to the marginal external cost it imposes on society. The firm now faces a marginal cost curve that is the same as the marginal social cost curve—its marginal cost curve is now *MSC*. It experiences the externality cost as a financial cost; it pays the government taxes to "use" the environment, just as it pays workers to use their labor. Remember that the industry supply curve is the sum of the marginal cost curves of the individual firms. This means that as a result of the tax, the industry supply curve shifts to the left, driving output down to the optimal level and the price up. The new price to consumers covers the resource costs of producing the product *and* the external costs created by the pollution that result from these goods being produced because a profit-maximizing firm equates price with marginal cost. The consumer decision process is once again efficient at the margin because marginal social benefit as reflected in market price is equal to the full social marginal cost of the product.

We argued previously that standards sometimes created problems when there are multiple ways to reduce emissions and when firms differ in the marginal benefits they received from polluting (or thought of another way, their marginal costs of cleaning up). Emission taxes will work much better in this regard. Suppose in drawing the marginal social benefit curve in Figure 16.2 we were combining information from two different polluters. One firm, A, finds it easy to avoid polluting. Perhaps it is a new plant, easily able to switch to a different type of fuel. For A, the marginal benefit of polluting is relatively low because avoiding that pollution is easy. A second firm, B, is old and can stop polluting only at great expense. Ideally, if we want to reduce as much pollution as possible per dollar, we should have the firm that can reduce pollution cheaply do more of it. That is exactly what a tax will do. If the government sets a tax at $10 per ton of carbon emitted, both firms will take actions that reduce carbon as long as those actions cost them less than $10 per ton. For Firm A, there may be many such actions, so it will cut back a lot before it becomes too expensive to do any more. For Firm B, perhaps little reduction will occur. Both firms will look across technological solutions to find the ones that reduce emissions at the lowest costs. In the end, the key policy goal is to make sure the right amount of total reduction occurs, and taxes will accomplish this at lower costs than will a standard.

Figure 16.3 shows us how a tax would work for Firms A and B. Before we impose a tax, each firm is polluting at its maximum level, thinking of pollution as free. *Each* firm produces $Q_0$ worth of emissions. Total industry emissions are thus $2Q_0$. Suppose now the government, based on information about both firms and about the *MSCs* of emissions, wants to cut emissions in half to $Q_0$. Looking at the information it has gathered, it sets the tax at T*. Every unit of emissions produced by the firm costs it T*, so you can think of T* as the per-unit price of emissions.

Look first at Firm A. At its original level of emissions, $Q_0$, the tax per unit is quite a bit higher than the marginal benefit it gets from polluting. So it starts to cut back using whatever technological opportunities it has. As long as the price of the emission is more than the benefit to the firm of not cleaning up, the firm reduces its emissions. For firm A, emissions fall all the way to $Q_A$. At that point, it is too expensive to cut back any further. Firm B, with much higher benefits

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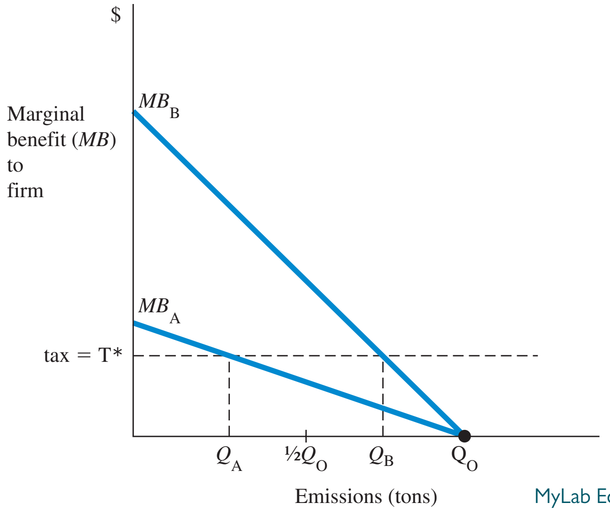
[3]As we discuss later in this chapter, damage costs are difficult to measure. It is often assumed that they are proportional to the volume of pollutants discharged into the air or water. Instead of taxes, governments often impose *effluent charges*, which make the cost to polluters proportional to the amount of pollution caused. We will use *tax* to refer to both taxes and effluent charges.




MyLab Economics Concept Check

**FIGURE 16.3 Optimal Emissions Taxes for Firms with Different Marginal Benefit Curves**
If a per-unit tax exactly equal to marginal external costs is imposed on a firm, the firm will weigh the tax against its marginal benefits from polluting and choose an optimal emissions level. Here two firms differ in their marginal benefits and thus choose different levels. In equilibrium each firm chooses a level so that the *MSB* = the tax. The result is that the optimal pollution level is achieved at the lowest costs.

from polluting, ends up producing $Q_B$ emissions. If the tax has been set right, the sum of $Q_A$ and $Q_B$ will be $Q_0$, or one half the original emission level of $2Q_0$. The tax has accomplished its task of reducing emission levels.

Suppose we had instead used standards to achieve the emissions reduction, requiring each firm to produce ½$Q_0$ rather than allowing firms to choose emissions based on their costs. Firm B is now producing more emissions than the standards would have required and would need to reduce further. We can see from the marginal benefit curve of Firm B how much it would lose by having to cut back its emissions further. Firm A's emissions under the tax system are lower than ½$Q_0$, the standard allowance, so Firm A could increase its emissions. So a common standard benefits Firm A and costs Firm B. Notice, Firm A gains *less* from the ability to have higher emissions than Firm B loses in having to reduce its emissions. Therefore, on net, using a standard to achieve the desired emissions level gives us higher costs. The emissions tax has not only reduced emissions as firms face the true price of those emissions, but it has also done so at minimum cost by encouraging firms with the lower benefits from polluting to do less of it relative to other firms.

The control of carbon emissions is one area in which many economists have argued strongly for the use of a tax, though we have not yet seen one at the federal level. Carbon emissions come from many different industries and consumers, with different marginal social benefit curves. Automobiles and airplanes create considerable emissions; power plants also emit considerable carbon. Moreover, each of these actors has multiple ways to reduce emissions, from fuel choice to filters to technology choice. As we have seen, with big differences in marginal benefit curves taxes can achieve the same results as standards but at lower costs. The *Economics in Practice* box on the next page describes the Paris Agreement, which requires countries to pledge their commitment to improve their environmental impact.

***Measuring Social Costs*** To use taxes and subsidies, social costs from externalities must be estimated in financial terms. For the detergent plant polluting the nearby river to be properly taxed, the government must evaluate the costs of the damage done to residents downstream in monetary terms. This evaluation is difficult but not impossible. When legal remedies are pursued, judges are forced to make such estimates as they decide on compensation to be paid. Surveys of "willingness to pay," studies of property values in affected versus unaffected areas, and sometimes the market value of recreational activities can provide basic data.[4]

In the case of some externalities, social costs involve health problems or loss of life. Here, monetary costs are more difficult to estimate. Nevertheless, in many settings policy makers make judgments that implicitly set values on life and health. In making choices about traffic safety or occupational hazards, government agencies routinely put a dollar value on lives. As individuals, when we decide the risks to take, we too are implicitly valuing our health and lives.

[4]Kenneth Arrow et al., "Report of the NOAA Panel on Contingent Valuations," January 1993.

***Subsidizing External Benefits*** Sometimes activities or decisions generate external benefits instead of costs, as in the LoJack example. Investors who revitalize a downtown area—an old theater district in a big city, for example—provide benefits to many people, both in the city and in surrounding areas.

Activities that provide such external social benefits may be subsidized at the margin to give decision makers an incentive to consider them. Just as ignoring social costs can lead to inefficient decisions, so too can ignoring social benefits. Government subsidies for housing and other development, either directly through specific expenditure programs or indirectly through tax exemptions, have been justified on such grounds.

**Tradeable Emissions Permits: Selling or Auctioning Pollution Rights** As we have seen, the right to impose environmental externalities is beneficial to the parties causing the external costs. In a sense, the right to dump in a river or to pollute the air or the ocean is a valuable resource as it permits a firm to produce its goods and avoid any costs of cleanup. Thinking of the privilege to dump in this way suggests an alternative mechanism for controlling pollution: selling or auctioning the pollution rights to the highest bidder. The Clean Air Act of 1990 takes this cap-and-trade approach to controlling the emissions from our nation's power plants. Emissions of sulphur dioxide and nitrogen oxide, both of which contribute to acid rain, are capped at the plant level, that is, emissions from each plant are limited to a specified amount. The lower the

## ECONOMICS IN PRACTICE

### The Cost of Emissions

With rising concerns about climate change and pollution across the world, it is generally agreed that governments and businesses need to cooperate to limit global warming to 1.5 to 2 degrees Celsius above pre-industrial levels. In 2015, representatives of 196 nations, intragovernmental agencies, and business organizations came together the Paris Agreement to draw long-term goals for adaptation and agreed to adopt a set of policies to mitigate the impact of climate change.

Under the Paris Agreement, governments will prepare nationally determined contributions (NDCs). NDCs outline a country's targets to reduce national emissions to limit global temperature rise to 2 degrees Celsius and the steps it has taken to address climate change. As of mid-2018, 18 countries have submitted their NDCs, accounting for 56 percent of global GHG emissions.

Business organizations use their own internal carbon prices to incentivize behaviors that reduce GHG emissions. For example, creating a finance bias against projects with high emissions encourages proposing projects with low emissions. Carbon pricing initiatives have been implemented in 45 nations and 25 subnational jurisdictions. These initiatives increased from 29 in 2015 to 51 in 2018. Carbon pricing initiatives comprise of 25 emission trading systems (ETSs) and 26 national carbon taxes. These carbon pricing initiatives—that were implemented or scheduled for implementation—accounted for 11 gigatons of carbon dioxide emissions or about 20 percent of global greenhouse gas emissions. The aggregate value of the ETSs and carbon taxes in 2018 reached $82 billion.[1]

Between 2017 and 2018, carbon pricing increased by 56 percent, mostly in Latin America and Asia. But these initiatives still fall short of the 2020 temperature reduction target. To reduce greenhouse gas emissions, the EU has implemented reforms that raised the price of carbon allowances from €4.38 per ton in May 2017 to €13.82 per ton in 2018. In order to achieve the target of limiting global warming to 1.5 to 2 degrees Celsius, carbon allowances have to be priced at €25–€30 per ton by 2020–2021 and to quadruple by 2030.[2]

But these initiatives will not suffice because there are many nations and jurisdictions round the world that are lagging behind. These countries can adopt indirect policies such as imposing fuel taxes, the removal of fossil fuel subsidies, and regulations that may incorporate a "social cost of carbon."

#### CRITICAL THINKING

1. What does the "social cost of carbon" mean? How can it reduce GHG emissions?

[1]Climate Disclosure Project, 2017. "Putting a price on carbon Integrating climate risk into business planning," CDP, October.
[2]The World Bank Group, 2018. *State and Trends of Carbon Pricing -2018*, May, The World Bank, Washington D.C.

level specified, the more air quality will improve. The plant is issued a permit allowing it to emit only at that level. This permit can be used or can be traded to another firm in what has developed into a large auction market. For a firm with low costs of abating pollution, it is often in the firm's best interest to cut back below its permit levels and sell its unused permits to a firm with higher abatement costs. In this way, the given level of emissions chosen by the government will be achieved at the lowest possible costs as a result of market trades. Environmentalists can also buy up permits and leave them unused, resulting in improvements in air quality beyond what the government mandated. These cap-and-trade programs are being used around the world in an attempt to reduce greenhouse gases responsible for global warming.

A simple example will help illustrate the potential gains from a cap-and-trade system, picking up from the two firm examples we discussed previously, we will add a bit of arithmetic. Table 16.1 shows the situation facing the two polluting firms. Assume that each firm emits five units of pollution per period and the government wants to reduce the total amount of pollution from the current level of 10 to four. To do this, the government caps each firm's allowed pollution level at two. Thus, each firm must pay to cut its pollution levels by three units. The process of reducing pollution is sometimes called *pollution abatement*. The table shows the marginal cost of abatement for each firm and the total costs. (In our language, the marginal cost of abatement is just the marginal benefit to the firm of not abating). For Firm A, for example, the first unit of pollution reduced or abated costs only $5. So the marginal benefit from being allowed to pollute is $5. As the firm tries to abate more pollution, doing so becomes more costly; the marginal costs of reducing pollution rise. If Firm A wants to reduce its pollution levels from five units to two, as the government requires, it must spend $21, $5 for the first unit, $7 for the second unit, and $9 for the third unit. Firm B finds reducing pollution to be more expensive. If it tries to reduce pollution by three units, it will have costs of $45. A cap-and-trade policy gives each of these firms two permits and allows them to trade permits if they so choose. What will the firms want to do?

Firm A can reduce its emissions from two units to one unit by spending $12 more on abatement. It would then have a permit to sell to Firm B. How much would Firm B be willing to pay for this permit? At the moment, the firm is abating three units, and the marginal cost of that third unit is $23. This tells us that Firm B would be willing to pay up to $23 to buy a permit to allow it to continue polluting up to a level of three. So there is room for a deal. Indeed, the permit price will be somewhere between the $12 demanded by Firm A and the $23 that Firm B is willing to spend. Firm A's marginal costs of abatement are lower than Firm B's, so we expect Firm A to do more abatement and sell its extra permit to B. You should be able to see from the numbers that Firm A will not sell its last permit to B. To abate another unit, Firm A would have marginal costs of $17. To avoid abatement, however, Firm B would pay only $14. There is no room for a deal. Once the trade of one permit by A to B has occurred, there are still only four units of pollution, but now Firm A is emitting one unit and Firm B is emitting three units. What are the total costs of this pollution reduction? When both firms were reducing their emission levels equally, the total costs were $21 for Firm A and $45 for Firm B, for a total of $66. Now costs are $33 for A and $22 for B, for a total of $55. (Of course, A will also be receiving a payment for the permit.)

Europe implemented the world's first mandatory trading scheme for carbon dioxide emissions in 2005 in response to its concern for global warming. Carbon dioxide emissions are a major source of global warming. The first phase of the plan, which was over at the end of 2007,

**TABLE 16.1 Permit Trading**

| Firm A | Firm A | Firm A | Firm B | Firm B | Firm B |
|---|---|---|---|---|---|
| Reduction of pollution by Firm A (in units of pollution) | *MC* of reducing pollution for Firm A | *TC* of reducing pollution for Firm A | Reduction of pollution by Firm B (in units of pollution) | *MC* of reducing pollution for Firm B | *TC* of reducing pollution for Firm B |
| 1 | $ 5 | $ 5 | 1 | $ 8 | $ 8 |
| 2 | 7 | 12 | 2 | 14 | 22 |
| 3 | 9 | 21 | 3 | 23 | 45 |
| 4 | 12 | 33 | 4 | 35 | 80 |
| 5 | 17 | 50 | 5 | 50 | 130 |

## ECONOMICS IN PRACTICE

### Emissions and Electricity Prices

The cap-and-trade program introduced in Europe and described in the text effectively resulted in a price for carbon in Europe, thus increasing the costs for carbon-producing firms. Electricity firms are among the largest of the carbon producers, and one might therefore expect increases in electricity prices to be a result. A recent study with Spanish data provides some evidence on this.

We can use the supply and demand analysis we have already learned to look at this question from a theoretical perspective. The carbon tax increases the marginal costs of electricity producers. Thus, the supply curve for the electricity market is shifted upward to the left. With stable demand, we would expect prices to rise for electricity. The question is by how much. We already know the answer to that as well: It depends on the elasticity of supply and demand!

Fortunately, our researchers were able to use excellent data from Spain to estimate quite precisely the marginal costs for the electricity market. They also know a good deal about the structure of the Spanish market, so that the firm interactions in this oligopoly market could also be modeled well. In this market, Fabra and Mar found almost a complete pass through: for a one Euro cost increase, electricity prices rose by 0.86 Euros. This is a high pass through and likely comes from two features of this market: quite inelastic aggregate demand for electricity and the fact that all firms faced similar cost increases, so that the firms had little incentive to compete by altering markups.

#### CRITICAL THINKING

1. What do you think would have happened to pass through if the largest of the electricity providers had been heavily invested in solar power, which does not produce carbon?

Based on Natalia Fabra and Mar Reguant, "Pass-Through of Emissions Costs in Electricity Markets," *American Economic Review*, September 2014, 2872–2899.

involved around 12,000 factories and other facilities. The participating firms were oil refineries; power generation facilities; and glass, steel, ceramics, lime, paper, and chemical factories. These 12,000 plants represented 45 percent of total European Union (EU) emissions. The EU set an absolute cap on carbon dioxide emissions and then allocated allowances to governments. The nations in turn distributed the allowances to the separate plants. In the second phase from 2008 through 2012, a number of large sectors were added, including agriculture and petrochemicals.

In both the United States and Europe, the allowances are given out to the selected plants free of charge even though the allowances will trade at a high price once they are distributed. Many are now questioning whether the government should sell them in the market or collect a fee from the firms. As it is, many of the firms that receive the allocations get a huge windfall. During the second phase in Europe, the governments are allowed to auction more than 10 percent of the allowances issued.

Another example of selling externality rights comes from Singapore, where the right to buy a car is auctioned each year through a certificate of entitlement. Despite high taxes and the need for permits to drive in downtown areas, the roads in Singapore have become congested. The government decided to limit the number of new cars on the road because the external costs associated with them (congestion and pollution) were becoming high. With these limits imposed, the decision was made to distribute car ownership rights to those who place the highest value on them. In some years the price of the entitlement has exceeded the price of the average car. It seems likely that taxi drivers, trucking companies, bus lines, and traveling salespeople will buy the licenses; families who drive for convenience instead of taking public transportation will find the licenses too expensive. Congestion and pollution are not the only externalities that Singapore takes seriously. In 2012, the fine for littering was as high as $1,000; for failing to flush

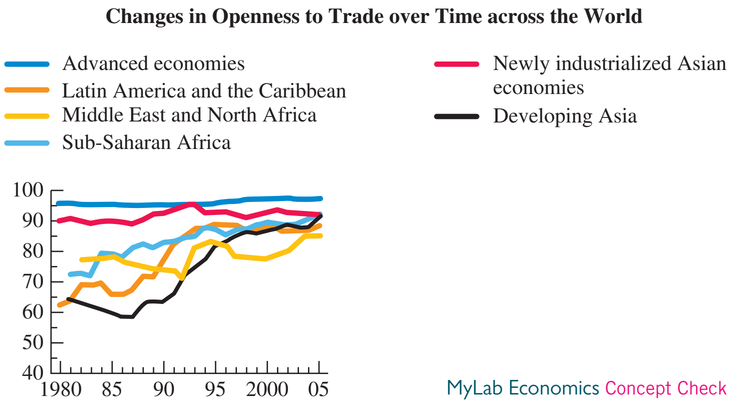
Nevertheless, the concern with global climate change has stimulated new thinking in this area. A study by the Tyndall Centre for Climate Change Research in Britain found that in 2004, 23 percent of the greenhouse gas emissions produced by China were created in the production of exports. In other words, these emissions come not as a result of goods that China's population is enjoying as its income rises, but as a consequence of the consumption of the United States and Europe, where most of these goods are going. In a world in which the effects of carbon emissions are global and all countries are not willing to sign binding global agreements to control emissions, trade with China may be a way for developed nations to avoid their commitments to pollution reduction. Some have argued that penalties could be imposed on high-polluting products produced in countries that have not signed international climate control treaties as a way to ensure that the prices of goods imported this way reflect the harm that those products cause the environment.[3] Implementing these policies is, however, likely to be complex, and some have argued that it is a mistake to bundle trade and environmental issues. As with other areas covered in this book, there is still disagreement among economists as to the right answer.

**Protection Safeguards Infant Industries** Young industries in a given country may have a difficult time competing with established industries in other countries. In a dynamic world, a protected **infant industry** might mature into a strong industry worldwide because of an acquired, but real, comparative advantage. If such an industry is undercut and driven out of world markets at the beginning of its life, that comparative advantage might never develop.

**infant industry** A young industry that may need temporary protection from competition from the established industries of other countries to develop an acquired comparative advantage.

Yet efforts to protect infant industries can backfire. In July 1991, the U.S. government imposed a 62.67 percent tariff on imports of active-matrix liquid crystal display screens (also referred to as "flat-panel displays" used primarily for laptop computers) from Japan. The Commerce Department and the International Trade Commission agreed that Japanese producers were selling their screens in the U.S. market at a price below cost and that this dumping threatened the survival of domestic laptop screen producers. The tariff was meant to protect the infant U.S. industry until it could compete head-on with the Japanese.

Unfortunately for U.S. producers of laptop computers and for consumers who purchase them, the tariff had an unintended (although predictable) effect on the industry. Because U.S. laptop screens were generally recognized to be of lower quality than their Japanese counterparts, imposition of the tariff left U.S. computer manufacturers with three options: (1) They could use the screens available from U.S. producers and watch sales of their final product decline in the face of *higher-quality* competition from abroad, (2) they could pay the tariff for the higher-quality screens and watch sales of their final product decline in the face of *lower-priced* competition from abroad, or (3) they could do what was most profitable for them to do—move their production facilities abroad to avoid the tariff completely. The last option is what Apple and IBM did. In the end, not only were the laptop industry and its consumers hurt by the imposition of the tariff (due to higher costs of production and to higher laptop computer prices), but the U.S. screen industry was hurt as well (due to its loss of buyers for its product) by a policy specifically designed to help it.




MyLab Economics Concept Check

▲ **FIGURE 20.5 Trade Openness across the World (Index is 100 minus the average effective tariff rate in the region.)**

[3]Judith Chevalier, "A Carbon Cap That Starts in Washington," *New York Times*, December 16, 2007.