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Contents

Chapter Thirteen

Trade and the Environment

Protection. For free traders, this word represents the consummate evil. For environmentalists, it is the ultimate good. Of course, for the trade community, "protection" conjures up images of Smoot and Hawley, while the environmental camp sees clear mountain streams, lush green forests, and piercing blue skies.

Daniel C. Esty, 2001

As nations interact more and more with each other, they have more and more effect on each other's natural environments. Often the international environmental effects are negative, as when activity in one nation pollutes other nations' air and water, or when it uses up natural resources on which other nations depend. These environmental concerns have become irreversibly global and are a growing source of international friction.

Inevitably, international trade has been drawn into the environmental spotlight, both as an alleged culprit in environmental damage and as a hostage to be taken in international environmental disputes. This chapter addresses the rising debate over the proper role of government policies in attacking environmental problems when the problems and policies have international effects.

IS FREE TRADE ANTI-ENVIRONMENT?

One attack on international trade is that it makes environmental problems worse. For instance, perhaps free trade simply promotes production or consumption of products that tend to cause large amounts of pollution. It is difficult to evaluate such a broad claim as this. But it is easy to find cases of the opposite, where government policies that limit or distort trade result in environmental damage. In the early 1980s, the United States forced Japan to limit its exports of autos to the United States. As a result, U.S. consumers tended to buy U.S. cars that were less fuel-efficient than the Japanese cars they could no longer buy, probably resulting in more pollution. Another well-researched

case is the environmental effects of government policies that protect domestic agriculture. The web of import limits and export and production subsidies leads to excessive use of pesticides and fertilizers as protected farmers strive to expand production. Free trade would lead to farming that is more friendly to the environment.

Some kinds of trade can help efforts to protect the environment. Freer trade in capital equipment that incorporates environmentally friendly technologies and freer trade in environmental services can be conduits for improved environmental practices, especially in developing countries.

One fear of environmentalists is that free trade permits production to be shifted to countries that have lax environmental standards. Exports from these "pollution havens" then would serve demand in countries with tighter standards, with the result that total world pollution is higher. However, research on relocation of production in response to differences in environmental standards finds that the effects are small. The costs to firms of meeting environmental protection regulations are usually small (less than 1 or 2 percent of sales revenues), even in the most stringent countries, so the incentive to relocate is usually small. Other determinants of production location, like standard comparative cost advantage, transport costs, and external scale economies, are usually more important. In addition, many multinational companies refrain from setting up high-pollution operations in lax countries because of fears of unexpected liabilities in cases of accidents, general risks to corporate reputations from appearing to cause excessive harm to the environment, and the costs of meeting more stringent regulations that are likely to be adopted in the future in these countries.

Let's turn to look at a concrete example of a recent global shift to freer international trade: the agreements reached during the Uruguay Round of trade negotiations. Does the expansion of trade resulting from these agreements harm or help the environment?

- Our analysis from Chapters 3 and 4 indicates that freer trade will alter the *composition* of what is produced and consumed in each country. As the composition of what is produced and consumed changes, the total amounts of pollution will change.
- That analysis also shows that there will be additional gains from trade. These gains could set up two different effects.
  a. The *size* of the economy is larger. The increase in production and consumption probably leads to more pollution, other things being equal.
  b. The higher *income* can lead to more pressure on governments to enact tougher environmental protection policies. For instance, stricter government policies may lead firms to clean up wastes before they are released into the environment or to switch to production methods that create less pollution per unit produced. Demand for a clean environment is a normal good.

Before examining the effects of the Uruguay Round, it's useful to look at how the size and income effects play against each other. How do rising production, consumption, and income in a country actually affect environmental quality? When income per person (our overall indicator of size and income) rises, does the environment deteriorate or improve? That is, which tends to be larger, the harm from the size effect or the environmental protection from the income effect?

There are likely to be different general patterns for this combined size–income effect, depending on what kind of environmental problem we are examining. Here are the three basic patterns:

1. *Environmental harm declines with rising income per person.* For some issues, the benefits of better environmental quality are so large that the income effect is dominant over (almost) the entire range of income per person. That is, the demand for better environmental quality as income rises is simply larger than any adverse effects from rising production scale.
2. *Environmental harm rises with rising income per person.* For some other issues, the benefits of preventing environmental harm are not considered to be large. The adverse effects from rising size dominate any modest increases in demand for better environmental quality.
3. *The relationship is an inverted U.* For yet other issues, the demand for better environmental quality is weak at first, perhaps because the focus when people are poor is on developing production to reduce the grip of material poverty. When income is low, people are willing to accept some environmental harm to increase production and income. This damage rises as economic activity rises. But, at some point at which the dire effects of poverty have been reduced enough, the demand for better environmental quality becomes more forceful. As incomes rise further, more stringent government regulation takes over. The environmental harm declines even though production and consumption are increasing.

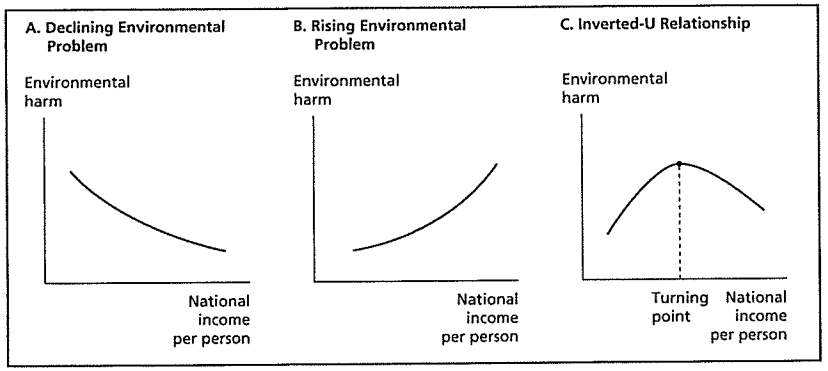
Figure 13.1 provides some examples of these patterns for different environmental issues. Some very basic environmental dangers, including airborne heavy particles and lead in water, tend to fall as income rises, as shown in panel A. Some environmental problems rise with greater income, as shown in panel B. These include emissions of carbon dioxide, which we will discuss later in this chapter. The demand to reduce this pollutant is not particularly strong even when incomes are high. The harm from global warming is rather abstract, the costs of reducing these emissions are substantial, and the problem is global, so actions by any one country would have little effect on the problem.

Panel C of Figure 13.1 shows the inverted-U relationship.[1] The pollutants that fit this pattern tend to be those that cause harm within the region or country, so regional or national efforts to abate the pollution provide benefits to the people in that locale. This pattern has been found for such air pollutants as sulfur dioxide (which causes acid rain), airborne particulates, and lead, and such water pollutants as fecal coliform (resulting from inadequate containment or treatment of human and animal wastes) and

[1] The inverted-U shape is sometimes called the environmental Kuznets curve, named after the Nobel Prize winner Simon Kuznets. His research on the effects of economic development found an inverted-U relationship between per capita income and income inequality.

We should be careful interpreting and using this inverted-U shape. It is a statistical relationship and does not guarantee that any single country is on the curve or follows it as the country develops. There are also other influences, including the type of government (democracy generally is more responsive to popular demand for pollution control than is dictatorship) and the source of growth in national production and income (growth could be biased toward or against pollution-intensive sectors of the national economy).

FIGURE 13.1 Environmental Problems by Income Level



Examples:
Concentration of heavy particles in urban air
Concentration of lead in water
Lack of dissolved oxygen in rivers
Percentage of population without safe water
Percentage of urban population without sanitation

Examples:
Carbon dioxide emissions per person
Urban waste per person

Examples (estimates of turning points):
Air pollution:
- Sulfur dioxide ($3,000 – $10,700)
- Suspended particulate matter ($3,300 – $9,600)
- Nitrogen oxides ($5,500 – $21,800)
- Carbon monoxide ($9,900 – $19,100)
- Lead from gasoline ($7,000)

Water pollution:
- Fecal coliform ($8,000)
- Arsenic ($4,900)
- Biological oxygen demand ($7,600)
- Chemical oxygen demand ($7,900)

Source of examples: Edward B. Barbier, "Introduction to the Environmental Kuznets Curve Special Issue," *Environment and Development Economics* 2, no. 4 (December 1997), pp. 369–81.

arsenic. Estimates of *turning points* (beyond which the pollution declines) often are at levels of income per person that are higher than those of most developing countries but lower than those of industrialized countries.

Now we have the tools that we need to examine the environmental effect of the Uruguay Round. Figure 13.2 shows the environmental effects that the trade changes resulting from the Uruguay Round have had on four air pollutants.

The *composition effects* tend to increase levels of all pollutants in the United States, the European Union, and Japan. With the exception of Latin America, the composition effects tend to reduce pollution in the developing countries. The reason for this pattern is Heckscher–Ohlin with a twist. As the world moves toward freer trade, production of capital- and skill-intensive products expands in the industrialized countries and shrinks in the developing countries. These products include most of the products that are environmentally "dirty," including iron and steel, the refining of other

FIGURE 13.2 Environmental Effects of the Uruguay Round (Percent Changes in Emissions for Each Type of Pollutant, in Each Place)

	Sulfur Dioxide			Suspended Particulates			Nitrogen Dioxide			Carbon Monoxide		
	Comp[1]	S & I[2]	Total[3]	Comp	S & I	Total	Comp	S & I	Total	Comp	S & I	Total
United States	0.4	−0.7	−0.3	0.2	−0.8	−0.6	0.1	0.0	0.1	0.1	−0.6	−0.5
European Union	0.3	−0.4	−0.1	0.2	−0.3	−0.1	0.1	0.2	0.3	0.2	−0.3	−0.1
Japan	2.0	−0.6	1.4	0.3	−0.5	−0.2	0.3	0.1	0.4	0.3	−1.0	−0.7
Latin America	0.5	0.7	1.2	0.4	0.6	1.0	0.6	0.9	1.5	0.2	0.8	1.0
China	−1.8	2.1	0.3	−0.9	2.0	1.1	−0.3	1.6	1.3	−0.1	1.8	1.7
East Asia	−3.1	1.8	−2.2	−3.0	1.7	−1.3	−0.1	2.0	1.9	−1.9	1.9	0.0
South Asia	−0.6	1.3	0.7	−0.4	1.4	1.0	−0.5	1.0	0.5	−0.5	1.3	0.8
Africa	−0.1	2.8	2.7	0.0	2.7	2.7	0.2	2.0	2.2	0.0	2.4	2.4
World	−0.3	0.2	−0.1	−0.1	0.1	0.0	0.1	0.5	0.6	0.0	0.1	0.1

[1]Composition effect.
[2]Combined size effect and income effect.
[3]Total change = Composition effect + Combined size effect and income effect.

Source: M. A. Cole, A. J. Rayner, and J. M. Bates, "Trade Liberalization and the Environment: The Case of the Uruguay Round," *World Economy* 21, no. 3 (May 1997), pp. 337–47.

metals, chemicals, petroleum refining, and pulp and paper. Production of unskilled-labor-intensive products, like textiles and apparel, shrinks in the industrialized countries and expands in the developing countries. Most less-skilled-labor-intensive products are environmentally "clean." Thus, as the composition of what is produced changes, pollution-intensive production tends to expand in the high-income industrialized countries and pollution-intensive production tends to decline in the low-income developing countries.

The gains from the Uruguay Round increase size and income. As shown in Figure 13.2, the combined *size and income effects* tend to lower pollution in the industrialized countries for sulfur dioxide, suspended particulates, and carbon monoxide because these countries are beyond the turning points in the inverted-U curves for these three pollutants. The combined size–income effects tend to increase nitrogen dioxide pollution in the European Union and Japan, because the turning point for this pollutant is estimated to be at about the U.S. level of income per person. The combined size–income effects tend to increase pollution in the developing countries because their incomes are lower than the four turning points.

What actually happens to the environment in each place as a result of the Uruguay Round is the sum of the effects. The actual effects (the sums of the composition effects and the combined size and income effects) vary by country and by pollutant. The overall effects for the world are generally small, as are the effects for most countries and pollutants. Even for countries whose pollution increases, the monetary value of the usual gains from freer trade are a large multiple of the monetary cost of any extra pollution. For instance, for the world, the costs of the extra nitrogen dioxide pollution are less than 0.3 percent of the global gains from the freer trade. If we take a slightly different perspective, the world and the individual countries could prevent the extra

pollution using only a small part of the gains that they get from the Uruguay Round agreements. In a more limited analysis, the same study that is the source of estimates shown in Figure 13.2 concludes that the Uruguay Round is likely to increase global emissions of carbon dioxide by 3.3 percent. This increase is somewhat larger than that for the other pollutants, but it is still only a small part of the global increase in carbon dioxide that has been occurring.

In summary, free trade is not inherently anti-environment. Relocation of production to avoid stringent environmental standards is small. Shifts toward freer trade cause a variety of changes, but the net effects on overall pollution usually seem to be small.

IS THE WTO ANTI-ENVIRONMENT?

Even if free trade is not itself anti-environment, environmentalists often complain that the global rules of the trading system, the rules of the World Trade Organization (WTO), prevent governments from pursuing strong environmental protection policies. There are some things that are not in doubt. Most important, a government that takes actions to control environmental damage caused by its own firms' production is *not* violating WTO rules. Beyond this, there are questions.

The main preoccupation of the WTO (and the GATT before it) is with liberalizing trade, but the rules also make special mention of environmental concerns. Article XX lists general exceptions to its free-trade approach. While Article XX begins by repeating the signing governments' fear that any exceptions are subject to abuse by protectionists, it does admit exceptional arguments for trade barriers. Two of those arguments are environmental exceptions to the case for free trade:

> Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures:
> . . . (b) necessary to protect human, animal, or plant life or health;
> . . . (g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption.

There is an obvious tension here. The signing parties conceded that environmental concerns might conceivably justify trade barriers, but they were suspicious that such concerns would be a mere facade, an excuse for protectionists to shut out foreign goods.

There are three important types of policies that may qualify for environmental exceptions. First, *consumption* of products can cause damage. WTO rulings make it clear that a country generally can impose product standards or other limits on consumption to protect the country's health, safety, or the environment, even though such a policy will limit imports. A key is that the policy applies to all consumption, not just to imports. For instance, the WTO ruled that France can prohibit consumption and production of asbestos or asbestos-containing products within its borders, including prohibiting imports of these products. Similarly, the WTO ruled that the United States

can impose a gas-guzzler tax on autos that get few miles per gallon, as long as the tax applies to all cars, both domestically produced and foreign.

At the same time, the WTO is vigilant against using environmental standards as disguised protectionism. The WTO ruled that U.S. regulations on average fuel economy of cars sold by each manufacturer violated WTO rules because they treated imports produced by foreign automakers differently from domestic autos. The WTO also ruled that U.S. policies on fuel additives violated the rules because they treated foreign-produced gasoline differently from domestically produced gasoline. The WTO ruled that a ban by Thailand on cigarette imports to promote health violated WTO rules because domestically produced cigarettes continued to be sold. In these three cases the issue was not the environmental health objective itself. Rather, it was the fact that imports were treated differently from domestically produced products without any overarching need to do so.

The WTO does also examine the basis for standards. As a result of the Uruguay Round, product standards to protect health or safety must have a scientific basis. This requirement tries to prevent a government from inventing standards that are written to limit imports. More controversially, it also may prevent a government from responding to public perceptions of risks, such as concern about genetically altered foods, if there is little scientific evidence supporting the public fears.

Second, *production in foreign countries* can cause environmental damage. Can a government limit imports of a foreign product produced using methods that violate the country's own environmental standards? As discussed in the box on "Dolphins, Turtles, and the WTO," the position of the WTO has evolved to one that permits an environmental exception for national rules that limit imports of products produced using processes that harm the environment, but with strict standards:

- The rules must demonstrably assist in pursuing a legitimate environmental goal, and they must limit trade as little as possible.
- The rules must be applied equally to domestic producers and to all foreign exporting firms.
- The country imposing the rules should be engaged in negotiations with other involved countries to establish a multilateral agreement to address the environmental issue (if such agreement does not yet exist).

Again, the objective of the WTO is to allow countries to pursue environmental protection using policies that may affect international trade, but to prevent countries from using environmental claims to create disguised protectionism.

Third, there are some environmental problems that are global in scope and that may require global solutions negotiated among many governments. Can a *multilateral environmental agreement* use controls on international trade to implement the agreement, or sanctions on a country's trade to enforce the agreement? Two important multilateral agreements discussed later in this chapter—the Convention on International Trade in Endangered Species and the Montreal Protocol—use trade bans, even for trade with countries that have not signed the agreements. The WTO has not been asked to rule on these agreements. The WTO seems to be comfortable with this multilateral approach to well-defined environmental problems, but it has not actually issued any rulings endorsing them.

Global Governance Dolphins, Turtles, and the WTO

Dolphins have long had a special appeal to humans because of their intelligence and seeming playfulness. The sympathy for dolphins, like the sympathy for all large animals, grows with income. It was inevitable that any threat to dolphins, even though they are not an endangered species, would mobilize a strong defense in the industrialized countries.

Most tuna are caught by methods that do not harm dolphins. But, for unknown reasons, large schools of tuna choose to swim beneath herds of dolphins in the Eastern Tropical Pacific Ocean. Before 1960, this posed no threat to dolphins. Fishing crews used hooks to catch tuna, and dolphins' sonar allowed them to avoid the hooks. However, the 1960s brought a new method for catching tuna, purse-seine fishing, in which speedboats and helicopters effectively herd the dolphins and tuna into limited areas, where vast nets encircle large schools of tuna. As the nets draw tight underwater, the dolphins, being mammals, drown. Six million dolphins have died this way since 1960.

The United States tried to stop this purse-seine netting with the Marine Mammals Protection Act of 1972, but with limited effect. The law can prohibit use of this method in U.S. waters, out to the 200-mile limit, and use of this method by U.S. ships anywhere in the world. Fishing fleets responded to the 1972 law by reflagging as ships registered outside the United States. Between 1978 and 1990, the share of U.S. boats in the Eastern Pacific tuna fleet dropped from 62 percent to less than 10 percent.

The United States still had some economic weapons at its disposal. The government pressured the three main tuna-packing and tuna-retailing firms (StarKist, Bumble Bee, and Chicken of the Sea) to refuse to buy tuna taken with dolphin-unsafe methods. While there have been charges that at least one of the firms packed dolphin-unsafe tuna under its dolphin-safe label, the dolphin-safe scheme does appear to have had some success. Through this and other forms of pressure, the estimated dolphin mortality in tuna fishing dropped from 130,000 in 1986 to 25,000 in 1991.

The United States did not let the matter rest there. In 1991, the U.S. government banned tuna imports from Mexico and four other countries. Mexico immediately protested to the GATT, where a dispute resolution panel handed down a preliminary ruling that the U.S. import ban was an unfair trade practice, a protectionist act against Mexico. The GATT panel ruled that the United States cannot restrict imports based on production methods used by firms in other countries. The EU also challenged the U.S. legislation as a violation of the GATT, because it included a "secondary boycott" against tuna imports from any country importing dolphin-unsafe tuna from countries like Mexico that use this fishing method. In 1994, a GATT panel again ruled against the United States.

These rulings suggested that international trade rules would not endorse efforts by one country to use trade policy to impose its environmental policies outside of its borders, or to force other countries to change their environmental policies. Environmentalists were furious, because they believe that principles of trade policy were placed ahead of environmental safeguards.

Within these constraints, what can the United States do if it wishes to save more dolphins? One possibility is to negotiate with other countries to get them to alter the methods they use to catch tuna, perhaps by offering other benefits in exchange. In 1995, six countries (including Mexico) agreed to adopt dolphin-friendly fishing. However, some fishing fleets could just reflag to yet other countries, so the best solution probably would be a global multilateral agreement on tuna fishing.

Sea turtles, a species threatened with extinction, present a similar case. Some shrimp are caught with nets that trap and kill sea turtles. A U.S. law passed in 1989 requires shrimpers in U.S. waters to alter their nets with turtle-excluder devices, and it prohibits shrimp imports from countries whose rules do not require such devices to protect sea turtles.

The U.S. government initially applied the U.S. law to 14 Caribbean and Latin American countries, negotiated with them, and allowed them three years to implement changes in their fishing methods. Following a U.S. court ruling, the U.S. government extended the application of the law to other countries unilaterally and with only a four month phase-in.

Four Asian countries filed a complaint with the WTO in 1997. In the ruling on the case, the WTO decided that:

- Protection of sea turtles was a legitimate environmental purpose.
- The actual U.S. policies violated WTO rules because they did not apply equally to all foreign exporting countries.
- The actual U.S. policies were unacceptable because they required specific actions by the foreign countries (enacting laws and using turtle-excluder devices) and did not recognize alternative ways to protect sea turtles.
- The actual U.S. approach was also unacceptable because the U.S. did not undertake negotiations with the exporting countries affected by the extension of application of the law.

In response to the ruling, the U.S. government removed the discriminatory terms, recognized other turtle-protection methods, and began negotiations with the countries affected by the extension of the law. In 2001 the WTO ruled that, with these changes in place, the United States was in compliance with WTO rules, so that it could restrict imports of shrimp caught in ways that harm sea turtles. The WTO also ruled that good-faith negotiations toward a multilateral agreement were adequate—reaching an actual agreement was not a prerequisite for the U.S. to apply its law. At about the same time as the WTO rulings, the United States did reach agreements with a number of foreign countries to adopt rules to protect sea turtles.

Many environmentalists seem to believe incorrectly that WTO rules always favor free trade and so prevent a country from using trade-related measures as part of its efforts to protect the environment. The truth is more nuanced. The WTO is certainly vigilant against environmental policies and rules that unnecessarily limit trade or discriminate between foreign suppliers. Still, the WTO cannot force a member country to change its policies if the country does not want to. More important, the WTO generally accepts the legitimacy of protecting the environment and setting minimum environmental standards through negotiations between countries. The appellate body in the sea turtle case said in its report:

> We have not decided that protection and preservation of the environment is of no significance to the members of the WTO. Clearly it is. We have not decided that the sovereign states that are members of the WTO cannot adopt effective measures to protect endangered species, such as sea turtles. Clearly, they can and they should. And we have not decided that sovereign states should not act together bilaterally, pluri-laterally, or multilaterally, either within the WTO or in other international fora, to protect endangered species or to otherwise protect the environment. Clearly, they should and do.

THE SPECIFICITY RULE AGAIN

To get a better grip on the links between trade and the environment, we must first revisit some key points of microeconomics. Environmental effects such as pollution call for special policies or institutional changes if, and only if, they are what economists call externalities. Recall from Chapter 10 that externalities are spillovers. An **externality** exists when somebody's activity brings direct costs or benefits to anybody who is not part of the marketplace decision to undertake the activity.[2] If your activity imposes a direct cost on somebody who has no impact on your buying or selling, they bear an external cost. If your activity brings them a direct benefit without their participation, they receive an external benefit.

Also recall that whenever an externality exists, there is a distortion, caused by a gap between private and social costs or benefits. Where there are distortions, a competitive market, in the absence of government policy, results in either too much or too little of the activity, because people see only the private costs and benefits of their actions, not the full social costs and benefits.

Pollution is an externality that imposes an external cost on people who do not have any say over the pollution. That is, the social costs of production or consumption of the product are larger than the private costs that are recognized by the people in the market who make the decisions about producing and consuming. We can see the effects of this distortion using the terminology introduced in Chapter 10. Social marginal cost (*SMC,* which includes the marginal external cost of the pollution) exceeds private marginal cost (*MC,* which does not include the marginal external cost). In the competitive market, price (*P*) equals private marginal cost and private marginal benefit (*MB*). If there are no external benefits, then private marginal benefit is the same as social marginal benefit (*SMB*). The distortion is that $SMC > MC = P = MB = SMB$. Because some social costs are ignored by market decision-makers, too much of the activity (production and/or consumption) occurs. For the last unit, the social cost of this unit exceeds the social benefit ($SMC > SMB$). This last unit is inefficient, and any other units for which *SMC* exceeds *SMB* are also inefficient. By adding more to social cost than they add to social benefit, these last units lower well-being for the society.

Because an externality leads to sub-par performance of a market, there is a role for government policies to enhance the efficiency of the market. As we saw in Chapter 10, the specificity rule is a useful policy guide. The **specificity rule** says to intervene at the source of the problem. It is usually more efficient to use the policy tool that is specific to the distortion that makes private costs and benefits differ from social costs and benefits.

[2] The definition refers only to "direct" effects on others so as to exclude effects transmitted through prices. If people decide to smoke fewer cigarettes, their not polluting the public air reduces an *externality*—the external cost to those whose pleasure and health might be hurt by the smoke. But if the switch to nonsmoking drops the price of cigarettes, we will not call the implications of that price drop *externalities.* So externalities do not include the income losses to tobacco companies, the possibly lower wages for tobacco workers, the lower land values in tobacco-raising areas, and so on. Those are just market-price effects, not (direct) externalities. (We stick to this definition even though Alfred Marshall tried to confuse us by calling such market-price effects *pecuniary externalities.*)

If, for example, an industry is causing acid rain by discharging sulfurous compounds into the air, the best approach is a policy that restrains the discharge of the sulfur compounds themselves. That is usually better than, say, taxing electrical power, because this latter approach would not send the electric companies the signal that the problem is their emissions of sulfurous compounds. Even worse would be more indirect measures like cutting down on all economic growth or all population growth to reduce the emissions.

There are several ways for a government to attack the externality directly. The two leading strategies represent different beliefs about the proper role of government in our lives:

- Use of *government taxes and subsidies.* The government could tax private parties to make them recognize the external costs that their actions (e.g., pollution) impose on others. (Correspondingly, it could pay them subsidies to get them to recognize the external benefits their actions give to others.)
- Changing *property rights* so that all relevant resources are somebody's private property. If somebody owns a resource, including even the right to pollute it, then what they decide to do with it depends on what others offer for that resource. If they choose to pollute (or to deplete the resource), it is because they were not offered enough by others to avoid pollution (or depletion). There is a new market for the private property, a market whose absence caused the externality in the first place.

Different as these two approaches are, they are both valid ways to attack an externality. Sometimes one is more practical, sometimes the other. In our discussions, we will often use the tax-and-subsidy approach, but we should keep in mind that the same efficiency-enhancing outcome could sometimes be achieved using the property-rights approach.

A PREVIEW OF POLICY PRESCRIPTIONS

Following the specificity rule, we can develop general guidelines for solutions to international externalities. If we could choose any kind of policy measure whatsoever, the specificity rule would take us on the most direct route: If the externality is pollution in some place, make the pollution itself more expensive; if resource depletion is excessive, make the depletor pay more. Often, though, we cannot hit the exact target, the externality itself. Often the only workable choices are policies toward some economic flow near the target, such as production, consumption, or trade in products related to the externality. What then?

When we have to choose between doing nothing and intervening in product markets *related to* externalities, as a substitute for controlling the externalities directly, we should follow guidelines like those summarized in Figure 13.3.

The table contains two sets of best-feasible prescriptions: one for the whole world acting as one government, and one for a single nation unable to get cooperation from other governments. These represent the two extremes in international negotiations over issues like pollution or natural-resource depletion: The greater the scope for international cooperation, the more relevant is the column of prescriptions for a world

FIGURE 13.3 Types of Externalities and Product-Market Prescriptions

Source of External Costs (e.g., Pollution) Harming Our Nation	Examples	If the Whole World Had Only One Government, Its Best Product-Market Policy Would Be	Best Product-Market Policy for Our Nation Acting Alone
Just our own production	Chemicals	Tax our production	Tax our production (as in Figure 13.4)
Just foreign production	Acid rain across borders; tuna and dolphins; ivory	Tax foreign production	Tax our imports
World production	CO_2 buildup from fossil fuels; CFCs	Tax world production (or consumption)	Tax our production and imports
Just our own consumption	Fossil fuels, tobacco, narcotics	Tax our consumption	Tax our consumption
Just foreign consumption	Fossil fuels	Tax foreign consumption	Tax our exports
World consumption	Fossil fuels	Tax world consumption (or production)	Tax our consumption and exports

Note: *Tax* here means "impose government restrictions." These could be taxes, quantitative limits, or outright prohibitions. Remember that only "best product-market policy" interventions are considered here. In many cases, a more direct approach would tax an input or specific technology (e.g., use of high-sulfur coal or fuel-inefficient automobiles) rather than the final product (e.g., electricity from power plants or road transportation). And in other cases, an optimal policy might manipulate more than one product market at once.

with a single government. The more hopeless it is to gain cooperation, the more we must settle on the single-nation prescriptions in the right column.

If nations cooperate, as if they formed a single world government, there would be essentially no role for international trade policy. In the best of worlds, government would devise a way to tax the activity of pollution itself, to translate its concern about pollution into direct incentives. In the one-world-government column of Figure 13.3, the recommended policies are one step away from taxing pollution itself, taking the form of taxes on production or consumption. They are not taxes on exports or imports. This is because pollution and other externalities seldom arise from trade as such. The specificity rule accordingly calls for taxes near the source of the pollution, and taxes on production or consumption are closer to that target than taxes on international trade are.[3]

If one nation must act alone, trade barriers could be an appropriate second-best solution. That would happen if our nation suffered from transborder pollution, either from foreign production (e.g., foreign producers of our imported steel causing acid rain in our country) or from foreign consumption (e.g., foreign cars burning our exported gasoline upwind from our nation). In this situation, the only way in which our nation can discourage the foreign pollution is by taxing imports of the products

[3] It may seem suspicious that Figure 13.3 mentions raising taxes but not lowering them or giving out subsidies. The reason is simply that the cases listed here are all cases of negative externalities, the kind that do harm and must be reduced by taxing the polluting activities. If Figure 13.3 had dealt with the mirror-image cases, in which there are external benefits rather than costs, it would have recommended lower taxes or subsidies.

made by a polluting process (e.g., foreign steel) or by taxing exports of products that generate pollution when consumed (e.g., gasoline).

The rest of the chapter takes up discussion of each of three types of sources of external costs noted in Figure 13.3. First we look at issues when the external costs are ones we impose on ourselves—domestic pollution and similar national externalities. Then we analyze cases in which the activity of another country imposes an external cost on our country—transborder pollution and similar cross-country externalities. Finally, we examine the challenges of global external costs—global pollution and similar worldwide externalities.

TRADE AND DOMESTIC POLLUTION

Economic activities sometimes produce significant amounts of *domestic pollution* (or similar environmental degradation). That is, the costs of the pollution fall only (or almost completely) on people within the country. *If there are no policies that force market decision-makers to internalize* these external costs, then we reach two surprising conclusions about trade with domestic pollution. First, *free trade can reduce the well-being of the country.* Second, *the country can end up exporting the wrong products;* it exports products that it should import, for instance.

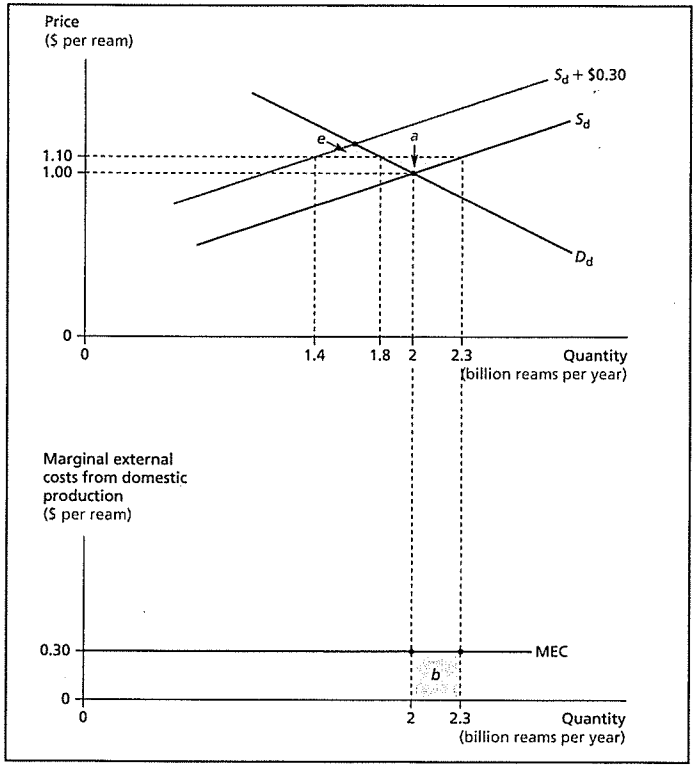
To see this, consider the case of an industry whose production activity creates substantial pollution in the local rivers, lakes, and groundwater. For instance, consider the paper-making industry in a country like Canada. It is very convenient for paper companies to dump their chemical wastes into the local lakes, and the firms view this as a free activity (if the Canadian government has no policy limiting this kind of pollution). The Canadian companies are happy that the lakes are there, and the firms' operations thrive, producing profits, good incomes for their workers, and good products for their customers at reasonable prices.

Other Canadians have a different view, of course. Having the lakes turn brown with chemical waste spoils the scenery, the swimming, the fishing, and other services that they get from their lakes. The dumping of wastes into the lakes imposes an external cost on other users of the lakes.

The top half of Figure 13.4 shows the Canadian market for paper, with the domestic supply curve reflecting the private marginal cost of production and the domestic demand curve reflecting the private marginal benefits of paper consumption (which are also the social marginal benefits if there are no external benefits). The bottom half of Figure 13.4 shows the additional costs imposed on the country by the pollution that results from production of paper in the country. We keep track of this negative externality using the marginal external costs (MEC) of the pollution. (This figure is the analog of Figure 10.2, which showed the case of external benefits.) To keep the analysis simple, we assume that the external cost of the pollution is constant at $0.30 per ream of paper.

With no international trade (and no government policies limiting pollution), the paper market clears at a price of $1 per ream, with 2 billion reams produced and consumed per year. Because there is no recognition in the market of the cost of the pollution, this is overproduction of paper.

FIGURE 13.4 When Domestic Production Causes Domestic Pollution



When domestic production causes pollution that imposes an external cost on the country, we find several surprising results about trade. If the government has no policy limiting this pollution, then domestic firms ignore the marginal external costs (MEC) of their pollution, and operate along the supply curve S_d. If the world price is \$1.10, then the country exports 0.5 billion reams of paper. In comparison with no trade, the country may be worse off, as it is here (gain of the shaded triangle *a* in the top of the figure, but loss of the shaded rectangle *b* in the bottom).

The country may also export the wrong products. Here it would be best if the country actually imported 0.4 billion reams. That would happen if a \$0.30 tax, equal to the MEC, made domestic producers operate along the supply curve S_d + \$0.30, which reflects all social costs.

Consider the shift to free trade, with an international price of \$1.10 per ream (and still no government policies limiting pollution). Domestic production expands to 2.3 billion reams, domestic consumption declines to 1.8 billion, and 0.5 billion reams are exported. For the case shown in Figure 13.4, free trade unfortunately makes the country worse off. The usual gain from trade is shown by the shaded triangle *a* in the upper graph, a gain of \$25 million. But the extra production brings pollution that has an extra cost of the shaded area *b* in the lower graph, an external cost of \$90 million (\$0.30 per ream on the additional 300 million reams produced). Free trade reduces the well-being of the country by \$65 million.

The country's government could avoid this loss by prohibiting exports of paper. But we know from the specificity rule that this is not the best government policy. The best policy attacks pollution directly, for instance by placing a tax on pollution from paper production. If there is no way to reduce pollution per ream produced, then the tax should add \$0.30 per ream to the firms' cost of production. The tax forces the firms to recognize the cost of pollution, and it alters their behavior. The domestic supply shifts up by the amount of the tax, to S_d + \$0.30. This new supply curve now reflects all social costs, both the private production costs and the external pollution costs.

If this government policy is in place, what happens with free trade? Domestic consumers still buy 1.8 billion reams of paper, but now domestic producers supply only 1.4 billion reams. As shown, it is actually best for the country to import paper, not export it. Because the new supply curve (with the \$0.30 tax) includes the external cost of pollution, we can read the effects of trade on the country from the top half of Figure 13.4, without referring to the bottom half. We find the usual triangle of gains from importing, the shaded triangle *e*.

From this example we see that pollution that imposes costs only on the local economy can still have a major impact on how we think about international trade. *With no government policy limiting pollution,* the country can end up worse off with free trade, and the trade pattern can be wrong. In the case of pollution caused by production that we examined, the country exported a product that it should instead import. (If, instead, the pollution cost is not so high, then the problem is that the country exports too much.)[4]

The country can correct this type of distortion by using a policy that forces polluters to recognize the external cost of their pollution. In our paper example, the government used a pollution tax, but instead it could establish property rights. For instance, people could be given the right to the water. Polluting firms then must pay the owners for the right to pollute. Or a limited number of rights to pollute could be created by the government, so that firms need to buy these rights if they want to pollute.

If domestic firms must pay the pollution tax (or pay for the right to pollute), they probably will not be happy. The pollution tax raises their production costs, and they produce and sell less. In addition, they face competition from imports at the world price of \$1.10. Even if they accept the reason for the pollution tax, they may still complain about the imports. If other countries do not impose a similar pollution

[4] What can happen if pollution is caused by consumption, not production? In this case the country tends to consume too much of the product, so the country could import a product that it should instead export (or, at least, it imports too much of the product).

tax on their producers, then the domestic firms often complain that the imports are unfair. They claim that the lack of foreign pollution controls is a form of implicit subsidy, or that the foreign firms are engaged in "eco-dumping" based on lax foreign government policies.

What are we to make of these complaints? Should the country impose countervailing duties on imports from a country with different pollution policies? From the national perspective of the importing country, the answer is generally no. Foreign production may create pollution in the foreign country, but this has no impact on the importing country if the costs of this foreign pollution affect only foreigners. As with many other complaints about unfair exports, the best policy for the importing country is simply to enjoy the low-price imports. Indeed, under the rules of the World Trade Organization, lax foreign pollution policies are not a legitimate reason for imposing countervailing duties.

From the perspective of the whole world, it depends on why the foreign pollution policies are different from those of the importing country. It may be efficient for the foreign country to have different, and perhaps more lax, pollution policies. The pollution caused by foreign production may not be so costly, because the foreign production itself creates less pollution, because the foreign environment is not so badly affected, or because foreigners place less value on the environment. In our paper example, the production process or the raw materials used in foreign production may create less pollution. Or the foreign country may have larger water resources or rainfall, in which case the pollution is not so damaging because the foreign environment has a larger "assimilative capacity." Or the foreign country may assign a high value to producing income to purchase basic goods because its people are poor and are therefore willing to accept some extra pollution more readily.

On the other hand, the foreign country may simply have policies that are too lax. From the point of view of the foreign country and the world, it would be better if it had tougher pollution policies. As a type of second-best approach, import limits by other countries could improve things. But these limits will not make the importing country better off, even though they might raise world well-being.

TRANSBORDER POLLUTION

In the previous section we considered pollution that had costs only to the country doing the pollution. While we reached some surprising conclusions about free trade in the absence of government policies limiting pollution, we also had a ready solution. The government should implement some form of policy addressing pollution that is occurring in its country. If each country's government addresses its own local pollution problems, then each can enhance its own national well-being. In the process, world well-being is also raised.

However, many types of pollution have transborder effects—effects not just on the country doing the pollution but also on other countries. Examples include air pollution like particulates and sulfur dioxide that drifts across national borders and water pollution when the body of water (river or lake) is in two or more countries. **Transborder pollution** raises major issues for government policies toward pollution.

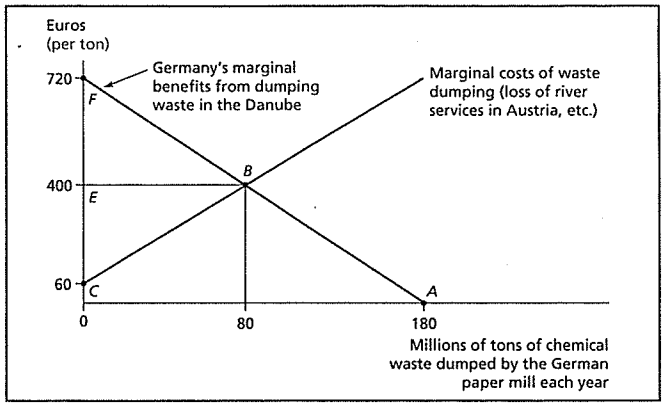


FIGURE 13.5 A Classic Case of International Pollution with an Ideal Policy Solution

If there are no limits on pollution, then the German firm dumps 180 million tons. If the countries could negotiate the best solution, the pollution would be limited to 80 million tons.

Suppose that a German paper company builds a new paper mill on the Danube River, just to the west of where the river flows into Austria. It is very convenient for the paper company to dump its chemical wastes into the river, and it views this as a free activity (if the German government has no policy limiting this kind of pollution). Austrians have a different view. The dumping of wastes into the German Danube imposes an external cost on the Austrians and others (Slovaks, Hungarians, Serbs, Romanians, and Bulgarians) downstream.

The Right Solution

Figure 13.5 shows how we can determine the "right" amount of pollution, the amount that brings the greatest net gain to the world as a whole.[5] The figure focuses directly on pollution, without also showing the supply and demand for paper. It portrays Germany's benefits and Austria's costs from different rates of dumping waste into the Danube by the German paper mill. If left to itself, the German mill dumps as much as it wants into the Danube, ignoring the costs to Austria (and other nations). It will pollute until there is no more that it wants to dump at zero cost. That will be at point *A*, with the paper company dumping 180 million tons of waste per year. Point *A* is a disaster in Austria, where the river damage rises along the marginal cost curve in Figure 13.5.

[5] Here, as in other chapters, the interest of the "world as a whole" is the sum of net gains to all parties, with each dollar (or euro) of gain or loss worth the same regardless of whose gain or loss it is. That is, we continue to follow the one-dollar, one-vote metric introduced in Chapter 2. To reject it, we would have to have another set of welfare weights, considering a dollar or euro of gain to the German firm to have a different value from the same value of gain or loss to Austrians.

Point *A* is also inefficient from a world perspective. Any pollution beyond 80 million tons is inefficient—it does more damage than it benefits the paper company. In the figure any waste dumping above 80 million tons has marginal costs that are above the marginal benefits. For instance, while the last few tons dumped bring the German firm almost no extra benefits (perhaps because these would be easy to avoid or clean up), these last few tons cost the Austrians about 700 euros per ton.

But, looking at it from the other side, we see that a total ban on dumping into the Danube would also be a mistake in this situation. The total ban, if effectively enforced, would force the paper mill to point *F*. Downstream users would be delighted, of course, to have the river clean. But the complete cleanup costs more than it is worth. That is, allowing the first ton of pollution each year would be worth 720 euros to the paper company (perhaps because it is very costly to capture the last small amounts of waste for alternative disposal). Yet downstream users lose only 60 euros of extra enjoyment and income (at point *C*). The downstream cost of the first ton of pollution is not that high, probably because the river can assimilate this small amount of pollution without much damage. From a world viewpoint, the first ton of pollution should be allowed.

If Figure 13.5 correctly portrays the marginal benefits and costs, pollution up to 80 million tons adds to world well-being because the benefit to Germany from using the Danube for its waste is greater than the costs imposed on Austria. The paper company should be allowed to dump waste up to 80 tons per year, but no more than that. At point *B*, the benefits of using the river as a drain for wastes stop exceeding the costs of doing that. However offensive the idea may be to those who love clean water and don't buy much paper, the economist insists that 80 million tons, not zero tons (or 180 million tons), is the "optimal amount of pollution" in this situation.[6]

To get the right solution, something must be done to make the German paper company recognize the costs of its pollution, and this something cannot be too drastic. The specificity rule indicates that the best government policy is one that acts directly on the problem. A government could use the tax/subsidy approach to guide the use of the Danube to the optimal point *B*, if the government has good estimates of the marginal costs and benefits of the pollution. For instance, the government could tax the paper company 400 euros for every ton it dumps into the river. The company will respond by dumping 80 million tons a year (at point *B*), since up to that 80 millionth ton the company's gain from putting each extra ton of waste in the river exceeds the 400-euro tax. An efficient balance would be struck between the competing uses of the river.

A pollution tax like the one just described might well happen if "the government" were the Austrian government. But here the problem becomes international. Austria has no direct tax power over a paper mill in Germany, except to the extent that the mill happens to do business in Austria. More likely, the tax/subsidy option is in the hands of the German government since the paper mill is on the German side of the border. Germany might not tax the paper mill at all. Dumping 180 tons a year (at point *A* again) brings greater national gains to Germany than the world-efficient pollution tax at point *B*.

The likelihood that one country would decide to go on imposing an external cost on the rest of the world is a setback for the economist seeking global efficiency. To the

[6] At point *B*, allowing 80 million tons of pollution (instead of none) brings the world a net gain of area *BCF*, or (1/2) × (720 − 60) × 80 = 26.4 billion euros per year.

efficiency-minded economist, it would not matter how we got to point *B* as long as we got there. But the German government has no incentive to tax the German company for its pollution.

We can imagine another way, assigning property rights, to try to get the efficient solution. A World Court could rule that the Danube is the property of the German paper company (or the German government), and Austria must pay the German company to reduce its pollution. Or the World Court could rule that the Danube belongs to Austria, and the German company must buy the right to pollute for each ton it dumps. The Nobel Prize–winning economist Ronald Coase pointed out that *either* court ruling could result in the same amount of pollution, as long as the property rights can be enforced. If the German company owned the river, the Austrian users would be willing to pay 400 euros per ton to reduce pollution to 80 million tons, and the German firm would agree to reduce its pollution to this level. If Austria owned the river, the German firm would be willing to pay 400 euros per ton for the right to dump 80 million tons, and the Austrians would accept this offer. Who gets the money depends on who owns the river, but in either case the same amount of pollution results.

This private-property approach has a major problem, however, when it comes to international disputes. There is no supreme world court that can enforce a property claim of one country's residents in another country. Austrians have no real legal recourse if the German paper mill insists on discharging all its wastes into the Danube. The Austrian government could threaten to take retaliatory actions against Germany. But it is unlikely that Austria would hold the right kind of power to force Germany to cooperate on the specific issue of the paper mill and the Danube if the Germans did not want to cooperate. The result is likely to be inefficient.[7]

We therefore get the same striking results for either the tax/subsidy approach or the property-rights approach. The good news is that any of several arrangements *could* give us the efficient compromise solution to the transborder pollution problem (at point *B*). The bad news is that the two countries often would not reach that efficient solution. Instead, negotiations would break down and each country would do as it pleased in its own territory. The result could be costly rampant pollution, as at point *A*, if the polluting firms can do as they please.

A Next-Best Solution

If international negotiations fail, the Austrian government must still consider what it can do on its own. If an international agreement is not possible, what can the government of the country that is being harmed by the other country's pollution do? It cannot

[7] As it happens, the German–Austrian case is relatively benign in real life because Germany does care greatly about good relations with Austria, and both are members of the European Union. Yet the question "Whose river is it, anyway?" is destined to arise more and more often. Here are some examples: (1) Turkey has upstream control of the Euphrates, a vital resource for Syria and Iraq. (2) Now that they are separate nations, Russia, Belarus, and Ukraine will struggle over the headwaters of the Dnieper. (3) If the eight upstream nations use the Nile more intensively, there will be consequences for Egypt. (4) The Zambezi River will be the focus of disputes as Zambia, Angola, Botswana, Zimbabwe, and Mozambique construct dams to support irrigation projects. (5) Several drought-prone nations, most notably Mali and Niger, compete for the waters of the Niger River upstream from Nigeria.

tax or restrict the pollution-creating activity in the other country directly. But it may be able to have some influence by adopting policies toward international trade.

In our example, let's say that Austria imports paper from Germany, and that Austrian paper production does not create much pollution (or this pollution is controlled by appropriate Austrian government policies). The Austrian government could attempt to reduce the dumping of waste into the Danube by limiting its imports from Germany (or, if possible, from the specific firm whose factory is responsible for the pollution). If the decline in German paper exports reduces German paper production, then this also reduces the amount of waste that is dumped into the Danube. Austria gives up some of the gains from importing paper—that is, Austria suffers the usual deadweight losses from restricting imports. But Austria can still be better off if the gain from reducing the costs of the river pollution exceeds these usual deadweight costs. If instead Austria exports paper to Germany, then the Austrian government should consider subsidizing paper exports to Germany. The increase in Austrian exports can reduce German import-competing paper production, again leading to less dumping of waste.

There is a major problem with this indirect approach to addressing transborder pollution. The rules of the WTO generally prohibit the Austrian government from increasing its import tariffs or subsidizing its exports. Although, as we have seen, the rules also offer exceptions for measures intended to protect the environment, the WTO interprets this exception narrowly. So the WTO probably would not permit Austrian use of trade policy in response to lax German environmental policies.

NAFTA and the Environment

Environmental problems along the Mexico–U.S. border provide a real case of the challenges of transborder pollution. This issue was prominent in the fight over approving the North American Free Trade Agreement (NAFTA), adding to the concerns already discussed in Chapter 12, and it remains contentious in evaluations of the effects of NAFTA.

Mexico has a strong set of environmental protection laws and regulations on the books, comparable to those of the United States. But Mexican enforcement of these is weak. Weak enforcement is not surprising, and it is not only the result of limited administrative resources. Popular demand for clean air and water is a normal good. Nations feel they can afford to control many pollutants only when GDP per capita has reached high enough levels. Mexico has sacrificed air and water quality for economic development. Mexico City's smog is as bad as any in the world.

For the United States, a major concern is the pollution emanating from the Mexican side of the Mexico–U.S. border. The environmental problems in the border region arose well before NAFTA. In the 1960s, the governments of Mexico and the United States encouraged growth of industry just south of the border, where businesses could assemble goods for reentry into the United States without the usual tariffs and quotas. The arid border is not a forgiving place for a large industrial population. The absence of infrastructure for the several thousand *maquiladora* firms producing on the Mexican side, and the millions of people attracted by the jobs available, became (and remain) all too obvious. U.S. critics can point to unmanaged hazardous wastes, soil erosion, air pollution, raw sewage and other water pollution, lack of organized rubbish disposal, and lack of clean drinking water. While the pollution is most severe on the Mexican side

of the border, major damage also affects the American side. Coal-fired power plants in northern Mexico cause serious air pollution in Texas, and Mexican water pollution is fouling the Rio Grande, a prime source of water for many U.S. towns.

Critics of NAFTA argued that freer trade would yield more environmental damage in the trade-oriented *maquiladora* zone, and they recommended rejecting NAFTA. In response to these criticisms, a side agreement on environmental issues was attached to NAFTA. It established a commission to investigate complaints about failure to enforce national environmental laws. It set up the North American Development Bank, owned by the U.S. and Mexican governments, to fund cleanup projects. Mexico also promised to enforce its environmental standards more effectively. With these additional provisions, environmental lobbying groups were actually divided about approving the final version of NAFTA.

What have been the effects since NAFTA began in 1994? NAFTA has not led to a decline in environmental standards in the United States, and it has not made Mexico a "pollution haven" for dirty industries, as some opponents had feared. But the institutions set up by the side agreement have had limited effects. The commission can investigate, but it has no power to mandate enforcement. It appears to have had little impact on Mexican enforcement of its environmental laws, which remains weak. The bank got off to a slow start, with few projects during its first five years. Since 1999 it has become more active, so that by March 2008 it had approved total funding (both loans and grants) of close to $1 billion, although only about 60 percent is to projects in Mexico, where the major problems exist. The projects supported have prevented conditions from deteriorating further, especially as population and business activities in the border area continue to grow. But, as Hufbauer and Schott (2006, p. 62) observe, the bank's project funding "still remains far below levels that would perceptibly improve border environmental conditions."

NAFTA has engendered a spirit of cooperation between the U.S. and Mexican governments, but the two countries still do not share the same views about the importance of ameliorating environmental damage. The environmental problems along the Mexico–U.S. border show how difficult it can be to address transborder pollution.

GLOBAL ENVIRONMENTAL CHALLENGES

Our discussion of transborder pollution focused on cases in which one country's activities impose external costs on another country. Things become even more controversial when the whole world's economic activities impose external costs on the whole world. Two important global environmental challenges are depletion of the ozone layer and global warming resulting from the buildup of greenhouse gases. Other challenges also have a global dimension, especially those that involve extinction of species or depletion of common resources such as fish stocks. We begin with an overview of important concepts and then examine specific applications.

Global Problems Need Global Solutions

Consider a global environmental problem like the depletion of the ozone layer caused by human release of chemicals. As we will see when we look at this in more detail,

many types of activities release these chemicals, and the total of the global release causes the depletion. The harm of ozone depletion has global effects, with some countries more affected than others.

What would each country do if it set its own policy toward this problem? From the purely national viewpoint, each country would recognize that chemical releases have some negative effect on its people, and it might use a policy to limit releases if it thought the national harm was large enough. But, for the whole world, total releases would be much too large. Each country would ignore the harm that its own releases did to other countries, so it would not be sufficiently stringent with its own environmental policy.

To get closer to the best global policy, the countries would need to find some way to cooperate. Each would need to tighten its standards compared to what it would do on its own. If each country does this, the whole world is better off. Many, but perhaps not all, of the countries will also each be better off. Each country incurs some costs in tightening its standards, but each also derives benefits from the reduction of the environmental damage.

Still, it may be very difficult to reach this global agreement. One problem is that there may be disagreement about the costs of the environmental damage or the costs of tightening standards. Science is unlikely to provide a definitive accounting, and countries differ in their willingness to take environmental risks. Even if this problem is not so large, others are likely to arise. Countries that suffer net losses from tightening may be unwilling to take part, unless they receive some other kind of compensation. Even countries that gain from the global agreement have a perverse incentive. A country can gain even more by free-riding. That is, it can gain most of the benefits if other countries abide by the agreement to tighten standards, even if this country does not, and it avoids the costs of tightening its own standards.

Because of the free-rider problem, a global agreement needs some method of enforcement, to get "reluctant" countries to agree in the first place, and to assure that they abide by the agreement after it is established. There is no global organization that can provide these enforcement services. Countries can establish an enforcement mechanism as part of the global agreement, but it is not clear what it should be. It is generally not possible to impose fines directly. One possible penalty is some kind of trade sanctions, to reduce the offending country's gains from trade. As we saw in Chapter 12, such sanctions also have costs for the countries imposing the sanctions, and in any case they often do not work.

This is a sobering analysis. When an environmental problem causes only domestic costs, it is up to the government of the country to address it. When the problem is transborder but regional among a small number of countries, it is more difficult but still may be solvable by negotiations. When the problem is global, a global (or nearly global) multilateral agreement is needed, but negotiating and enforcing this agreement may prove to be very difficult or impossible. To gain more insight, let's turn to four global problems. We begin with a fairly effective global agreement to use trade policy to prevent the extinction of endangered species. Next we depict depletion of ocean fishing stocks and the lack of any effective solutions to this global inefficiency. Then we portray a successful, nearly global agreement to reverse ozone depletion. We conclude with the most daunting of global environmental issues: greenhouse gases and global warming.

Extinction of Species

Extinction of species can be a natural process outside of human influence. Still, within the past half century the specific role of human activity in causing extinction has become recognized and controversial. It is reckoned that human activities eliminated only 8 mammal and 24 bird species in the 18th century, then 29 mammals and 61 birds in the 19th century, and 52 mammals and 70 birds from 1900 to 1987. There is a general belief that there is a loss when a species becomes extinct, perhaps because there may be future uses for the species (for instance, as a source of medicinal products). Thus, a global effort to prevent extinction of species can be economically sensible.

Human activities contributing to extinction include destruction of habitat, introduction of predators, and pollution. In addition, excessive hunting and harvesting can also cause extinction. The specificity rule indicates that the best global policy to preserve species would be a policy that promotes the species through such direct means as protected parks and wild areas; ranching, cultivation, and similar management intended to earn profits from the ongoing existence of the species; and zoos and gardens to maintain species in captivity. While there is no global agreement specifically to promote these best solutions, there is a global agreement that attempts to control the pressure of international demand as a source of incentives for excessive hunting and harvesting.

In 1973, over 100 nations signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora **(CITES)**. With 173 member countries by 2008, CITES establishes international cooperation to prevent international trade from endangering the survival of species. An international scientific authority decides which species are endangered. Commercial trade is usually banned for species threatened with extinction—about 900 species, including elephants, grey whales, and sea turtles. To export these products for noncommercial purposes, a nation must obtain an export permit from the central authority, and it must have a copy of an import permit from a suitable buyer in a country that signed CITES. Commercial trade is limited for an additional 33,000 species because free trade could lead to the threat of extinction.

No CITES-listed species has become extinct as a result of international trade. Some, including the rhino and the tiger, continue to decline, but CITES has probably slowed the declines. Generally, CITES seems to be fairly effective. This is impressive in that most member countries have incomplete national legislation, poor enforcement, and weak penalties for violating the trade bans or controls.

Much of the conflict over endangered species centers on Africa, with its unique biodiversity and its fragile ecosystems. The biggest fight so far has been over the fate of the African elephant, which is hunted for its ivory tusks.

The human slaughter of elephants accelerated at an alarming rate in the 1970s and 1980s. The African elephant population was cut in half within a span of only eight years in the 1980s. The problem was most severe in eastern Africa, north of the Zambezi River. The governments of Kenya, Tanzania, and Zambia, while ostensibly committed to protecting elephants, were not preventing killing by poachers. The threat to elephants was weaker in southern Africa, south of the Zambezi, for three reasons: The governments of Zimbabwe, Botswana, and Namibia enforced conservation more aggressively, agriculture was less of a threat to the wild animal population, and some elephants of Botswana and Zimbabwe had tusks of poor commercial quality.

In 1977, the African elephant was placed on the list of species with controlled trade. Public pressure from affluent countries to save the elephants became intense by the late 1980s. Although the African elephant did not fully meet the official definition, in 1989 it was moved to the list of endangered species. Also in 1989, most of the CITES countries signed a complete ban on exporting or importing ivory. Education and information on the plight of the elephant reduced demand for ivory, especially demand in affluent countries, and ivory prices plummeted from $100 per kilogram to $3 or $4 per kilogram in the 1990s. Poaching decreased (mostly a movement down the poachers' supply curve) and the elephant populations stabilized or increased. However, demand for ivory rose in the 2000s, especially increased Asian buying as incomes expanded there, and ivory prices rose close to $900 per kilogram by 2008. Poaching has increased in some parts of Africa, and illegal trade has increased.

Elephant numbers rose in the 1990s in the countries of southern Africa to such an extent that these countries argued that they had too many elephants. In 1997 these countries asked CITES to end bans for their elephants. They argued that they needed some economic use of elephants to justify the costs of managing the herds. In 1992 CITES had adopted the principle of "sustainable use," but CITES has moved very cautiously. For the countries of southern Africa, CITES has permitted limited hunting and a few sales of ivory.

CITES has generally been reasonably effective, but the situation of the elephant in the 2000s shows the challenges facing CITES. First, a ban on exporting by itself restricts legal supply, so it raises the world price and encourages poaching and illegal trade. The ban works well only if it is coupled with a demand shift away from the animal. For a while demand for elephants' ivory did decrease, but demand has returned. Second, a ban adversely affects the people and the governments where the animal lives. To preserve the animal, it helps to make the animal valuable to the people who have other uses for the land. Africa's human population growth will bring more crop cultivation, and cultivation is simply incompatible with a roaming elephant population. Economic incentives to keep the animals in the wild can arise from tourism and from hunting and harvesting. If tourism is not enough, then the long-run solution probably is based on commercial hunting and trade that are consistent with sustainable use. For many species the ultimate success of CITES depends less on its precautionary bans and, paradoxically, more on its ability to encourage economic management for commercial uses.

Overfishing

The oceans, along with fish and other marine life, are one of the great global resources. However, major problems can develop because no one actually owns these resources. The world's fish catch peaked in 1988 (ignoring data from China, whose catches seem to be seriously overstated). About a quarter of the earth's 200 main fish stocks are overfished; sustainable catches could be larger if the stocks were better managed. For most fish species, overfishing does not pose a threat of extinction, but it does mean that populations are becoming smaller than they should be. Why are we squandering this resource? What can we do?

We have here an example of the "tragedy of the commons." With open access to fishing and no ownership, the incentive of each fishing firm is to catch as many fish

as possible. There is no incentive to conserve. Even if one fishing firm did restrain its catch to maintain the fish stock, others would simply increase their catch. So all fish too much, and the fish stock declines. Rather than limiting their fishing industries, governments often make matters worse by subsidizing them. The result is severe overcapacity of fishing boats, perhaps twice as much ship tonnage as would be needed for a sustainable fish catch.

With good management of fishing stocks, the world catch of fish could be 10 to 20 percent larger than it is now. But even single nations have trouble managing their fishing activities. The fishing industry, with its overcapacity, pushes for lesser limits, even if this is helpful only in the short run. Global or multilateral agreements could enhance global fishing. But given the difficulty of negotiating and enforcing such agreements, effective ones are rare. We pay a global cost, in the form of less fish at a higher price.

CFCs and Ozone

The 1940s brought new technologies for using chlorofluorocarbon compounds (CFCs) in several industries. About 30 percent of CFCs came to be used in refrigeration, air conditioning, and heat pumps; about 28 percent in foam blowing; about 27 percent in aerosol propellants; and about 15 percent in dry cleaning and other industrial cleaning and degreasing. By the early 1970s, evidence had accumulated showing that CFCs and the halons used in fire extinguishers, while not directly toxic, were depleting ozone in the upper atmosphere. The chemical process is slow and complex. It takes 7 to 10 years for released CFCs to drift to the stratosphere, where their chlorine compounds interact with different climatic conditions to remove ozone. By 1985, the now-famous ozone holes were clearly detected in the stratosphere near the North and South Poles. Stratospheric ozone is an important absorber of ultraviolet rays from the sun, and its removal raises dangers of skin cancer, reduced farm yields, and climatic change.

In 1987, over 50 nations signed the **Montreal Protocol** on Substances that Deplete the Ozone Layer, and by 2008 the number of signatories had risen to 191 countries. The signing parties agreed to ban exports and imports of CFCs and halons. After more scientific evidence accumulated, most signatory nations agreed in 1990 to phase out their own production of these chemicals by 2000, with later deadlines and interim production limits for developing countries.

Note that the protocol called for outright bans and other quantitative limits, not a pollution tax or polluting-product tax like those discussed in Figures 13.3 through 13.5. The reason is that the scientific evidence suggested a steeply rising social-cost curve for CFC emissions into the atmosphere. With the cost curve so vertical, it did not make sense to use tax rates on a trial-and-error basis in the hope of achieving the large cut in pollution. It was better to legislate the bans and limits from the start, without waiting several years to see if some tax schedule had the right effects.

The Montreal Protocol is achieving much of the intended economic and environmental effects. Concentrations of chlorine-containing compounds in the stratosphere peaked and began to decline in 2000. Yet, because of the slow chemical process of recovery, the ozone holes will remain for a long time; ozone concentrations in the stratosphere will not return to normal levels until about 2070.

Why the success in this case? Why didn't nations try to free-ride by refusing to comply while demanding that others do so, as so often happens? Experts point to several factors that eased the signing and enforcement of the Montreal Protocol:

- The scientific evidence was clearer about CFCs and ozone than it is about other possible human threats to the atmospheric balance.
- A small group of products was involved, for which substitutes appeared to be technologically feasible with limited cost increases.
- Production of CFCs was concentrated in the United States and the EU, and in a few large publicity-conscious firms (mainly DuPont) so that agreement could be easily reached and enforced.
- The same higher-income countries that dominated production and use of these chemicals are also closer to the North and South Pole, so they expected to suffer most of the environmental damage themselves.

Greenhouse Gases and Global Warming

Finally, we turn to the most challenging environmental problem of all. Human activity, especially the burning of fossil fuels, is raising the concentration of carbon dioxide (CO_2) in the earth's atmosphere. Most climate scientists believe that the rise of CO_2 is causing a pronounced warming of the earth's climate through a "greenhouse effect." The warming could bring desertification of vast areas, and could flood major coastal cities and farm areas as it melts glacier ice and warms ocean water. It is hard to imagine a solution as clean and workable as the Montreal Protocol's phaseout of chlorofluorocarbons. The activities that release carbon dioxide, methane, and other greenhouse gases into the atmosphere are harder to do without than were CFC refrigerants and sprays. In addition, the damage from adverse climatic change would be spread around the globe unpredictably and unevenly.

To see the available options, we should first clear the air, so to speak, by noting some limits on the choices available. Three main points must be made at the outset: (1) The scientific facts are not fully established, (2) three palatable solutions will fall short of arresting the CO_2 buildup, and (3) international trade is not the cause or the cure.

First, the scientific facts about the greenhouse effect are less certain than the facts about CFCs and stratospheric ozone. We do know that atmospheric concentrations of CO_2 have risen by about a third since 1800. The atmospheric concentrations continue to rise, and a reasonable estimate is that they will double during the 21st century if we do nothing to limit emissions. Human activity, especially the burning of fossil fuels, is the main source of the buildup.

The effects of the CO_2 buildup cannot be predicted precisely. We do know that there is a greenhouse effect—in fact, it is crucial to keeping the earth's surface and lower atmosphere warm. The earth's average surface temperature has increased about 0.6° C (1° F) in the past half century, mostly since 1980. Most forecasts are that temperatures will rise by anywhere from 1.8° C to 4.0° C during the 21st century, with an average forecast of 2.8° C. Swings in average temperatures are normal in earth's history, but changes of this size in so short a time are not.

Even if the earth is getting warmer and CO_2 buildup is the main reason, the climatic changes and economic effects cannot be predicted with certainty. Nonetheless, the

best available climate forecasts indicate that countries closer to the equator are likely to experience more adverse climate change, with potentially large economic losses for developing countries in Africa, South and Southeast Asia, and Latin America. Smaller relative economic losses, or even possible gains, are expected for most industrialized countries, China, Central and Eastern Europe, and Russia. Two areas that face a risk of catastrophic losses are India (if there is major change in monsoon patterns) and Europe (if the warming Atlantic current changes direction).

Scientific uncertainties do not justify doing nothing. The risks are real and indicate that a path of taking out "insurance" makes sense. We do not need radical actions that risk wrecking the world economy. We should move in the direction of cutting greenhouse-gas emissions, with adjustments in the future as scientific knowledge improves.

Second, it must be understood that three relatively palatable policy changes will fall far short of stopping the CO_2 buildup:

1. One desirable option is known as the "no-regrets" option. Let's just remove all those unwarranted *subsidies* to energy use that should have been removed anyway. Removing bad energy subsidies would reduce, at most, no more than 10 percent of the emissions, and the net global buildup of CO_2 would continue.

2. A second option would be to take CO_2 out of the atmosphere with afforestation, that is, by stopping deforestation and reforesting previously cleared land. Unfortunately, a mature forest does not absorb CO_2 from the atmosphere. It has achieved an equilibrium in which the absorption of atmospheric CO_2 by plant growth is approximately canceled by the release of CO_2 from decaying plant matter. Only growth of new forests absorbs CO_2 in significant degree. It would take perpetual growth of new forests equal in area to all current U.S. forests to cut the CO_2 buildup by 20 to 25 percent. Forests play much less role in the greenhouse-gas balance than does the burning of fossil fuels.

3. A third option that doesn't work is to wait for depletion of the earth's fossil fuels to push up the price of energy to a point where we stop raising the global CO_2 levels. Finite as planet Earth may be, there is no prospect of exhaustion, or even severe scarcity, of fossil fuels in the next few decades. Earth contains so much oil, coal, and other fossil fuels that our current fuel habits may exhaust our good air long before they exhaust our cheap fuel supplies. To clean up the air, we must artificially raise the price of fuel long before geology will do the job for us.

A third initial point is that international trade policy cannot be the best tool. If we are to attack greenhouse-gas emissions near their source, we must attack either total consumption or total production of fossil fuels, the main human source of greenhouse-gas emissions. International trade in fuels is large, but well below half the total fuel consumption. If we were to tax international trade as such, there would still be too much substitution of one source for another to achieve a large global reduction in emissions. If we relied on taxing international trade in fuels, fuel-importing countries like the United States would substitute home supplies for imports, and fuel-exporting countries like Mexico would divert their fuel from exports to home use.

Thus far, we have limited the search for solutions in three ways. First, scientific uncertainty urges an "insurance" approach, somewhere in between doing nothing and taking radical steps. Second, some hopes—the easy "no-regrets" reforms, afforestation, and naturally rising fuel scarcity—fall short as cures for the CO_2 buildup. Finally, trying to cut emissions by cutting international trade leaves too many options for substituting home fuel use for traded fuel.

Kyoto Protocol

What progress have we made in finding a more comprehensive way to address global warming? Actual world agreements so far have not been effective. Industrial countries committed in Rio de Janeiro in 1992 to keep their CO_2 emissions at 1990 levels, but they failed to do so.

A new agreement, the **Kyoto Protocol**, was reached in late 1997. Industrial nations, which account for about half of global greenhouse-gas emissions, agreed to cut their emissions of greenhouse gases to an average of about 5 percent below their 1990 levels by the years 2008–2012. Developing countries refused to make any commitments, however. They argued that they are poor and should not have to slow their economic growth. The Protocol came into effect in 2005, but the United States and Australia decided against ratifying it. (Australia subsequently signed on in late 2007, after an election changed the party in power.)

Each country with a required 2008–2012 emission level must decide how to meet its target. The European Union has taken the lead in using tradable rights to emit carbon dioxide. This approach is a variation on the idea mentioned earlier in the chapter that property rights can be used to address pollution problems, in this case using property rights to pollute (rather than property rights to clean air). Each country allocates a limited number of rights to its individual firms that are the major sources of emissions. Then the firms can trade among themselves, as some firms lower emissions and have rights to sell, while other firms find that their emissions exceed their initial allocations and must buy additional rights. The market for the rights sets the price of emitting the pollutant, in this case CO_2. Trading in carbon emission permits, mostly through the EU's Emission Trading Scheme, reached $59 billion in 2007.

Unfortunately, the Kyoto Protocol will have only a small impact on overall global greenhouse-gas emissions. Here are some of the issues.

First, it is going to be difficult for some industrial countries to meet their targets for emission reductions. As of 2004 Canada's emissions had increased about 27 percent from the 1990 base, but it is committed to reducing emissions (averaged during 2008–2012) to 6 percent below the 1990 level. For Japan its emissions in 2004 were about 6 percent above the 1990 level and its commitment is 6 percent below. Both countries can acquire emission reduction credits from other countries, by buying them through the market for such credits and by gaining credits by supporting projects in developing countries that reduce emissions there. Still, it appears that it will be difficult for these two countries to meet their commitments.

Second, the United States, which accounts for about a quarter of the world's greenhouse-gas emissions, is not taking part. In March 2001 President George W. Bush indicated that the science was too uncertain for taking on such a costly process to reduce U.S. emissions. He also stated that it was unacceptable that developing

countries, especially China, had made no commitments. He indicated that the U.S. government instead was urging voluntary actions by U.S. firms, but so far these generally have had little effect. Instead, by 2012 it appears that U.S. emissions will be about 30 percent above what had been its Kyoto target.

Third, greenhouse-gas emissions have continued to increase in many developing countries. Most important, emissions from China and India almost doubled from 1990 to 2004.

A Global Approach

There is much discussion of what policies toward greenhouse-gas emissions will replace the Kyoto Protocol when it expires in 2012. Can we imagine a better policy? What would it accomplish, and how expensive would it be?

Global problems require global solutions, and long-term problems usually require long-term solutions. The solution to excessive global warming should include the following elements:

- Economic incentives are used to encourage emission reductions.
- All countries are involved.
- The policy extends over decades.

Economic incentives are created by establishing a price for greenhouse-gas emissions, to reflect their external costs. Pricing emissions encourages reductions in two ways. First, with a cost now attached to emissions, the price of emission-intensive products increases, and consumers react by buying less. Second, producers have the incentive to look for technologies that generate fewer emissions per unit of product. Through both of these effects, the policy spurs emission reductions at low cost. Pricing of emissions can be achieved by a tax on emissions or by tradable rights to pollute such as those used by the European Union to meet its obligations in the Kyoto Protocol.

All countries should be involved, for both effectiveness and efficiency. With no policies restricting emissions (often called "business as usual"), emissions will grow quickly in developing countries, so that by 2040 they would be the source of about 70 percent of the world's emissions. There is no way to stabilize greenhouse gasses in the atmosphere at reasonable levels without the participation of developing countries. Furthermore, the marginal costs of reducing emissions are generally lower in developing countries, because they often do not make use of the most energy-efficient technologies, and because they often rely heavily on coal to generate electricity. To achieve reductions in global emissions at low cost, much of the reduction should occur in developing countries.

The policies should be in place for a long time span, because they should affect decisions about investments in long-lived capital equipment and decisions about research and development of new technologies that can lower future emissions. The price of emissions in the future is a key input into these investment and research decisions.

A number of researchers have examined global, long-term policies toward greenhouse-gas emissions. Let's consider the results of one study, reported by the

FIGURE 13.6 Carbon Tax to Stabilize Atmospheric Carbon Dioxide

	Annual CO_2 Emissions* (gigatons)			Real Annual National Income (U.S. $ trillions)		
		2040			2040	
Country or Region	**2010**	**Baseline**	**With CO_2 Tax**	**2010**	**Baseline**	**With CO_2 Tax**
United States	6.2	11.0	3.5	12.0	25.7	25.1
Western Europe	3.7	5.4	4.4	10.5	20.9	20.4
Other industrialized countries	2.3	3.8	2.6	6.1	11.2	10.9
Russia and Eastern Europe	3.0	4.8	3.8	3.9	8.6	8.3
OPEC countries	1.4	3.6	0.8	1.0	2.9	2.3
Other developing countries	8.7	35.4	8.7	8.0	32.4	31.3
World	25.3	64.0	23.9	41.5	101.6	98.2

*From burning of fossil fuels.

Source: International Monetary Fund, *World Economic Outlook*, April 2008, Chapter 4. The author is grateful for data provided by Natalia Tamirisa.

International Monetary Fund in its April 2008 *World Economic Outlook*. The study examines several alternative policies, and we here will look at the imposition of a tax on carbon dioxide emissions at the same rate in all countries.[8]

The global CO_2 tax begins in 2013, at a rate of $3 per ton of CO_2 emissions, and rises by about $3 per year, to a level of $86 per ton in 2040, and then rises somewhat more slowly to a level of $168 per ton in 2100. (To get a feel for what this means for consumer prices, a tax of $86 per ton would result in an increase of about $0.80 in the price of gallon of gasoline.) The rising CO_2 tax is chosen for two reasons. First, it avoids large, unnecessary disruptions in the early years. Second, it is calibrated to achieve eventual stabilization of greenhouse gas concentrations in the atmosphere at about 550 parts per million, a level that is expected to result in a manageable rise in average global temperatures. The policy results in annual emissions in 2100 that are only 40 percent of current levels.

How expensive is this policy approach? That is, how much does it reduce conventional measures of national income? The IMF study focuses on the effects in 2040, a year that is within our lifetimes. Figure 13.6 summarizes what the IMF study sees for both emissions and national incomes, contrasting starting values in the year 2010 (just before the CO_2 tax is enacted), the baseline values for the year 2040 (if no emissions policies are adopted—"business as usual") and the values for 2040 with the global CO_2 tax policy.

Here are some key points that we can take from the information in Figure 13.6. First, in the absence of an emissions policy (the baseline), CO_2 emissions in 2040 are about 2.5 times the 2010 emissions, and much of the increase occurs in developing countries. Second, the CO_2 tax succeeds in restraining emissions, so that global emissions levels would be somewhat lower in 2040 than they are in 2010. Much of

[8] The study also examines different types of global schemes that use tradable rights to emit. For the same path of reduction of global emissions, the global costs in terms of income loss are similar under a carbon tax and the different emission-rights schemes. The choice of scheme does matter for the effects on different countries' national incomes.

the effect of the tax is achieved by eliminating the growth of emissions in developing countries (other than Russia and Eastern Europe), with reductions in China being especially large. There is also a substantial reduction of emissions by the United States. Third, the emissions reduction is achieved at what seems to be a reasonable cost. With no policies (the baseline), world income would be 2.45 times as large in 2040 as it was in 2010. With the emission tax, world income is 2.37 times as large. Each country or region suffers some loss in national income, but, with the exception of the larger loss in the OPEC countries, it is equivalent to a reduction of only about 0.1 percentage point per year in the average annual economic growth rate.

The IMF study and others like it show that we can address the problem of global warming without imposing heavy damages on the global economy or on most if not all individual countries, if we can harness long-term economic incentives to achieve emissions reductions at low cost, and if we can achieve participation by all countries (or, at least, all of the large emitter countries). The economics are promising. Still, it will be challenging to gain agreement from enough countries to negotiate and implement such a global approach to global warming.

Summary

International trade is not inherently anti-environment, and the best solution to environmental problems is seldom one that involves trade policy. The rules of the WTO are generally consistent with this application of the **specificity rule.** They permit countries to impose environmental standards on domestic production activities and on domestic consumption activities (including environment-based product standards). The WTO also offers limited environmental exceptions to its free-trade thrust. The WTO places strict requirements on a single country that attempts to use trade policy to punish what the country views as environmentally damaging production activities in other countries. The WTO seems willing to accept trade limits that are part of multilateral environmental agreements.

Because environmental problems like pollution involve an **externality,** government policies are usually needed to get markets to be efficient. In fact, if a country's government fails to implement a policy to limit pollution, free trade may make a country worse off and the country may end up exporting the wrong products.

Transborder pollution is an example of an international externality, in which production (or consumption) activities in one country impose external costs on other countries. As with all external costs, the best solution is one that addresses the pollution directly, by imposing a tax on the pollution, or by establishing property rights (to water or whatever is being polluted, or as limited rights to pollute). However, it is often challenging for the government of the country hurt by the pollution to gain the cooperation of the government of the country doing the pollution. For instance, little progress has been made in reducing environmental problems along the Mexico–U.S. border, even though a side agreement to NAFTA established a commission and a bank for this purpose.

In some cases the environmental problem is global: Global production or consumption is imposing a worldwide external cost. The best approach to a global environmental problem is a global cooperative agreement, but achieving one is usually difficult. Often, there are differences of opinion about the size of the external costs or the

appropriate policies to adopt. Countries that suffer little or no harm have little incentive to cooperate and impose costs on themselves. More generally, countries have an incentive to free-ride on the efforts of others. Often an agreement has no real enforcement mechanism. Trade sanctions provide a possible threat against countries that do not abide by an agreement, but, as we saw in Chapter 12, sanctions often do not work.

The chapter concluded with four examples of global environmental problems. Two have been addressed by successful global agreements. An agreement **(CITES)** on using trade limits and trade bans to prevent the extinction of species has been fairly effective. But the ultimate solution may well involve creating economic incentives for "sustainable use" (the propagation and economic management of the previously endangered species), as the discussion of elephants and ivory suggested. The global agreement on CFCs (the **Montreal Protocol**) has also been effective and should reverse the ozone damage over time. Success here seems to be based on clear scientific evidence, the rather small number of CFC producers, the availability of substitutes at reasonable cost, and the fact that the major producing countries were also those likely to suffer the most damage.

Two problems have not been addressed successfully. Because no one owns the oceans and their resources, *overfishing* has led to declines in fish stocks. The large number of fishing firms and their political activity to resist limits have prevented effective global agreements. *Global warming* as a result of the atmospheric buildup of CO_2 and other greenhouse gases is the most daunting global environmental problem. Science does not provide full guidance on the magnitude of the problem and its likely effects on different countries. All countries contribute to global emissions of greenhouse gases. The **Kyoto Protocol** is an attempt to address the problem, but it probably will have little effect. A better economic approach to managing global warming would include the pricing of emissions to provide economic incentives for achieving emission reductions at low cost, the involvement of all countries in the effort to reduce emissions, and the extension of the policy over decades to encourage and to guide long-term investments and research.

Key Terms

Externality, *292*
Specificity rule, *292*
Transborder pollution, *298*
CITES, *305*
Montreal Protocol, *307*
Kyoto Protocol, *310*

Suggested Reading

Esty (1994), Uimonen and Whalley (1997), and Copeland and Taylor (2004) provide excellent surveys of trade and environment issues. Esty (2001), Neumayer (2000), and Irwin (2002) present critical analyses of the controversies. Brunnermeier and Levinson (2004) survey research on the pollution-haven hypothesis. Kelly (2003) examines WTO dispute settlement rulings on environmental and health issues. For appraisals of global environmental problems, see the series of reports, *World Resources,* from the World Resources Institute.

Numerous works provide individual case studies. On CFCs, see the chapter by Enders and Porges in Anderson and Blackhurst (1992). On NAFTA and the environment, see Hufbauer and Schott (2005, Chapter 3); On greenhouse gases, see Chapter 4 of the International Monetary Fund's April 2008 *World Economic Report,* Ekins and Barker (2001), and the special symposium in the Fall 1993 issue of *The Journal of Economic Perspectives.*

Questions and Problems

✦ 1. Does a rise in national production and income per capita tend to worsen or improve air pollution, water pollution, and sanitation? Explain.

2. "One of the benefits of free trade is that it corrects the distortion caused by pollution." Do you agree or disagree? Why?

✦ 3. Which of the following probably violate the rules of the WTO?

   a. A country's government places a tax on domestic production to reduce pollution caused by this production.

   b. A country's government prohibits imports of foreign goods produced using production methods that would violate this importing country's environmental protection laws.

   c. A country's government places a tax on domestic consumption of goods (both imported and domestically produced) to reduce pollution caused by this consumption.

   d. A country's government restricts imports of a good to reduce pollution caused by consumption of this good.

4. Mining of metallic ores often causes harm to the environment in the area around the mines. Some countries impose strict policies to limit the environmental damage caused by this mining, but others do not. The mining companies in the strict countries complain that this is unfair, and ask for limits on imports of ores and metals from the lax countries. As a government official interested in advancing the national interest in a strict country, how would you evaluate the request of your mining companies?

✦ 5. Oil spills from oceangoing tankers are rare but bring huge damages to coastlines when they occur within 200 miles of shore. Unfortunately, most tanker spills do occur on or near coasts. Rank the following alternatives according to how efficient they are in responding to the threat of oil spills. Explain your ranking.

   a. Each nation with an endangered coastline should impose a tax on all imported oil, a tax that raises enough revenue to compensate for any oil-spill damages.

   b. Each coastal nation should impose a tax on all domestically purchased oil, a tax that raises enough revenue to compensate for any oil-spill damages.

   c. Oil-carrying companies should be legally liable for all damages, in the courts of the countries whose national waters are polluted by the spills.

   d. Each coastal nation should intercept all oil tankers in national waters and charge them a fee that will cover the estimated costs of future oil spills.

   e. We might as well save ourselves the expense of trying to prevent spills. They are just accidents beyond the control of the shipping companies; they are part of the cost of having coasts.

6. Consider the example of domestic pollution shown in Figure 13.4. Suppose that the marginal external cost of the pollution is $0.05 per ream produced (instead of $0.30).

a. With this different MEC, does free trade make the country better off or worse off?
b. To gain the most from trade, should the country export or import paper? How much?

✦ 7. Which of the following would do most to cut the global buildup of carbon dioxide over the next 30 years?
   a. Eliminating all subsidies to energy use.
   b. Restoring the original tropical rain forest.
   c. A tax that rises to $86 per ton of emitted carbon dioxide, as described in this chapter.
   d. The trend toward rising fuel scarcity, caused by exhausting the world's reserves of fossil fuels.

8. Assume that the production of cement also produces a substantial amount of air pollution and that a technology is available that can lower the pollution but with somewhat higher production costs for the cement. Because of the availability of raw materials in Lindertania, it produces large amounts of cement, and its exports supply most demand in Pugelovia. But the air pollution from Lindertania's production blows into Pugelovia, causing a noticeable deterioration in Pugelovia's air quality. Although Lindertania suffers some harm itself from this air pollution, it does not now have any policy to reduce the pollution. The Pugelovian government wants to address this air pollution problem.
   a. If the two countries' governments cooperate, what is the best solution to address the problem? Explain.
   b. If Pugelovia must come up with a solution on its own, what should the Pugelovian government do? Explain.

✦ 9. Use your no. 2 pencil to write down your views on this trade-and-environment debate:

   According to the Rainforest Action Network (RAN), a rain-forest wood called jelutong is being logged at a dangerous rate in Indonesia. The reason is that pencil makers recently shifted about 15 percent of their production from the more expensive cedar wood to jelutong, saving $1 on every dozen pencils. The Incense Cedar Institute, which represents three major companies growing cedar in the United States, echoes the concerns of RAN about the threat to tropical rain forests. Speaking for the pencil makers, executives of Dixon Ticonderoga explain that the jelutong wood in Indonesia is not gathered from rain forests, but is planted and harvested on plantations.

   What should be done about the use of jelutong wood in making pencils? Should the government of Indonesia block the export of jelutong wood? Should the government of the United States tax or prohibit jelutong imports? Defend your view. If you feel you need more information than is given here, what extra information would be decisive?

10. Why did the Montreal Protocol succeed in limiting global emissions of chlorofluorocarbons (CFCs), whereas the world has found it difficult to limit the emissions of CO_2? What differences between the two cases explain the difference in outcome?