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. In addition, many 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 Chapter 3 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 is 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 environment 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 12.1 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 12.1 shows the inverted-U relationship. 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 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 12.2 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 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 12.2, 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 12.2 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 freer 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 façade, 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 lim-
its 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? In several recent rulings (discussed in the box 'Dolphins, Turtles, and the WTO') the WTO indicated that the environmental exception does not permit a country to limit imports based on production methods used by firms in other countries. Essentially, the WTO is unwilling to let a country use its trade policy to punish another country for having a different environmental policy toward production processes.

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.
Case Study  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, however. 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 show that the WTO (which incorporates the GATT) will not endorse efforts by one country to use trade policy to impose its environmental policies outside its borders, or to force other countries to change their environmental policies. Environmentalists are furious, because they believe that the WTO places its principles of trade policy ahead of environmental safeguards.

Within these constraints, what can the United States do if it wishes to save more dolphins? One possibility would be a tax or ban on U.S. consumption of dolphin-unsafe tuna. As a domestic measure it might pass WTO scrutiny, although affected foreign producing countries could complain that it was a disguised form of illegitimate import restriction. The major problem probably would be implementing the consumption policy: How does one identify tuna that is caught with dolphin-unsafe methods? A more fruitful 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 very 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 that fail to
protect sea turtles from deadly entrapment in nets. Four Asian countries filed a complaint with the WTO in 1997, and the WTO issued a ruling against the United States, stating the United States was not permitted to use trade policy to force other countries to adopt environmental policies, even to protect an endangered species. This negative ruling prompted the U.S. government to negotiate and reach agreements with a number of foreign countries. The foreign countries agreed to use nets with turtle-excluder devices, and the United States provided money and training in how to use the modified nets.

Many environmentalists believe that a country should be able to set minimum standards for production methods used by foreign countries, as a condition for exporting to the country. WTO rules oppose the use of trade policy by one country to coerce another country to use certain production methods. The WTO rules are consistent with the principle that an environmental standard appropriate for one country is not necessarily appropriate for another, because economic and environmental conditions differ between countries. In addition, the WTO rules prevent situations in which several countries each require that foreign production meet their standards. A potential exporting country would be unable to export to all of these countries if the various standards were inconsistent with each other.

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, plurilaterally, 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 9 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. 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 9. Social marginal cost (SMC, which includes the marginal social side cost of the pollution) exceeds private marginal cost (MC, which does not include the marginal social side 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 9, the specificity rule is a useful policy guide. The specificity rule

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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, that 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 non-smoking 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. These 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.)
sacrifices 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 benef-
cits differ from social costs and benefits.

If, for example, an industry is causing acid rain by discharging sulfur 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 sulfur 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 to be explored here represent opposing sets of 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., pollu-
  tion) 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 exter-
nality. 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 what-
ever, the specificity rule would take us on the most direct route. If the externa-
lity 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, con-
sumption, 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 12.3.
### FIGURE 12.3 Types of Externalities and Product-Market Prescriptions

<table>
<thead>
<tr>
<th>Source of External Costs (e.g., Pollution) Harming Our Nation</th>
<th>If the Whole World Had Only One Government, Its Best Product-Market Policy Would Be</th>
<th>Best Product-Market Policy for Our Nation Acting Alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just our own production</td>
<td>Tax our production</td>
<td>Tax our production (as in Figure 12.4) Tax our imports</td>
</tr>
<tr>
<td>Just foreign production</td>
<td>Tax foreign production</td>
<td>Tax our production and imports</td>
</tr>
<tr>
<td>World production</td>
<td>Tax world production (or consumption)</td>
<td>Tax our consumption</td>
</tr>
<tr>
<td>Just our own consumption</td>
<td>Tax our consumption</td>
<td>Tax our exports</td>
</tr>
<tr>
<td>Just foreign consumption</td>
<td>Tax foreign consumption</td>
<td></td>
</tr>
<tr>
<td>World consumption</td>
<td>Tax world consumption (or production)</td>
<td>Tax our consumption and exports</td>
</tr>
</tbody>
</table>

Note: The box contains "appropriate government measures." These could be taxes, environmental quotas, or outright prohibitions. Remember that only "best product-market-policy" interventions are considered here. In many cases, a more direct approach would tax inputs (specific technologies, e.g., use of high-efficiency fuel-efficient automobiles) rather than the final product (e.g., electricity from power plants or coal transportation). And in other cases, an optimal policy would induce pollution more than one product market at once.

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 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 12.3, 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.

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 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 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 12.5. 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 12.4 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 12.4 shows the additional costs imposed on the
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 social costs (MSC) of their pollution and operate along the supply curve $S_d$.

If the world price is $1.10, then the country exports 0.7 billion reams of paper. In comparison with no trade, the country may be worse off, as it is here (gain of the shaded triangle at the top of the figure, but loss of the shaded rectangle at the bottom).

The country can also export the wrong product. 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 MSC, made domestic producers operate along the supply curve $S_d = S_t$, which refocuses all social costs.
country by the pollution that results from production of paper in the country. We keep track of this negative externality using the marginal social side costs (MSSC) of the pollution. (This figure is the analog of Figure 9.2, 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.

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 12.4, 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, a social side 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 social side cost of pollution, we can read the effects of trade on the country from the top half of Figure 12.4, 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.)

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*a 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!*)
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 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 new issues for government policies toward pollution.

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 12.5 shows how we can determine the “right” amount of pollution, the amount that brings the greatest net gain to the world as a whole. 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 12.5.

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3 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.
FIGURE 12.5
A Classic Case of International Pollution With an Ideal Policy Solution

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 D. 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. In fact, if Figure 12.5 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.  

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 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.

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6 At point B, allowing 80 million tons of pollution (instead of none) brings the world a net gain of area $BCD$, or $(1/2) \times (720 - 80) \times 80 = 264,000$ billion euros per year.
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.²

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 sides often would not reach that efficient solution. Instead, negotiations would break down and each side would do as it pleased in its own territory. The result could be costly rampart 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 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). The decline in German paper exports reduces German paper production, and 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

² 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 the Ukraine will struggle over the headwaters of the Don. (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.
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 (see again the box “Dolphins, Turtles, and the WTO”). 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 11, and it remains important 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 luxury 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. 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 there, and the millions of people attracted by the jobs available, became too obvious. U.S. critics 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 from Tijuana to the mouth of the Rio Grande. 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 a bank to fund cleanup projects using billions of dollars obtained with governmental backing. Mexico also promised to enforce its environmental standards more effectively. With these additional provisions, environmental lobbying groups were actually divided about the final version of NAFTA. The Sierra Club and Friends of the Earth strongly opposed NAFTA on environmental grounds, while the Audubon Society, the Environmental Defense Fund, the National Wildlife Federation, and the Natural Resources Defense Council gave qualified support to NAFTA with the added environmental provisions.

However, even with these provisions in NAFTA and the general spirit of cooperation it has engendered, progress has been very slow. 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 has lent little, in part because the interest rates it charges are too high for the Mexican local governments. So far the environmental problems along the Mexico–U.S. border show how difficult it can be to address transborder pollution, especially when the two countries do not share the same views about the importance of environmental quality.

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 11, 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 is a natural process. 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 158 member countries by 2002, 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, gray 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 26,000 species because free trade could lead to the threat of extinction.

No species with a trade ban has become extinct. 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 naturally 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. The drastic reduction in demand, especially demand from the affluent countries, caused ivory prices to plummet, from $100 per kilogram to only $3 or $4 per kilogram. Poaching decreased (mostly a movement down the poachers’ supply curve) and elephant populations stabilized or even increased.

The bans on trade in African elephants and their ivory appear to be successful. Especially in eastern Africa, it has greatly reduced poaching. However, by itself it may not be a long-run solution. Africa’s human population growth will bring more crop cultivation, and cultivation is simply inconsistent with a roaming elephant population. Where crops come, the elephant will go. Even in dry southern Africa, irrigation will eventually bring crops.

Fortunately, there have been further developments. In 1997, Zimbabwe, Botswana, and Namibia (joined later by South Africa and Zambia) asked CITES to end the bans for their elephants. They argued that elephants were not endangered in their countries—in fact, they had too many elephants. They argued that they needed some economic use of elephants to justify the costs of managing the herds. Based on the principle of “sustainable use” that it had previously adopted in 1992, CITES permitted limited hunting of elephants for these three countries. By adopting a role for sustainable use, CITES recognizes that the profit of commercial trade can deter other pressures toward extinction. But CITES now must face the challenge of evaluating claims of sustainable use, rather than simply using its precautionary bans. For many species the ultimate success of CITES probably depends less on its 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, by up to $54 billion per year. 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. 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 12.3 through 12.5. 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 economic and environmental effect it was supposed to have. By 2002, manufacture of chlorofluorocarbons had almost ended. Concentrations of chlorine-containing compounds in the stratosphere peaked and began to decline in 2000. Yet, because of the slow chemical

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6 The signatories were 18 industrial OECD nations, Argentina, Brazil, Mexico, Egypt, Kenya, South Africa, Zaire, Malaysia, Thailand, the former Soviet Union, Bulgaria, former Czechoslovakia, Hungary, and 25 other developing countries. By 2002, the number of signatories had risen to 183 countries.
process of recovery, the ozone holes will remain for a long time; ozone concentrations in the stratosphere will not return to normal levels until the middle of the 21st century.

Way 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 producers 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 daunting environmental problem of all. Human activity, especially the burning of fossil fuels, is raising the concentration of carbon dioxide (CO₂) in the earth's atmosphere. Most climate scientists believe that the rise of CO₂ 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 when it has melted much of the polar ice caps. 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 CO₂ 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 CO₂ have risen by about a third since 1800 and are still rising. Human activity, especially the burning of fossil fuels, is the main source of the buildup, though the magnitudes are still being debated. The effects of the CO₂ 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 (1.1° F) in the past
half century, mostly since 1980. Most forecasts are that temperatures will rise by
anywhere from 1.4° C to 3.8° C during the 21st century, with the median forecast
being 2.5° 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 CO₂ buildup is the main reason, the climatic changes and economic effects
cannot be predicted with any certainty. Some countries would gain from the
warming, some would lose, and we are unsure about the magnitudes and about
which countries to list in the gaining and losing columns.

This scientific uncertainty argues for a middle policy path that we could call
an “insurance” path. Given the risks, it would be foolish to do nothing. It would
also be foolish to risk wrecking the world economy with radical changes. Better
to start leaning in the direction of cutting greenhouse-gas emissions while knowl-
edge accumulates.

Second, it must be understood that three relatively palatable policy changes
will fall far short of stopping the CO₂ 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, only 10 to 11
percent of the emissions, and the net global buildup of CO₂ would continue.

2. A second option would be to take CO₂ out of the atmosphere with afforesta-
tion, that is, by stopping deforestation and reforesting previously cleared land.
Unfortunately, the popular press has overrated and misdirected this solution. The
overrating has taken the form of undue emphasis on mature forests, especially in
the tropics. Contrary to widespread belief, a mature forest does not absorb CO₂
from the atmosphere. It has achieved an equilibrium in which the absorption of
atmospheric CO₂ by plant growth is approximately canceled by the release of CO₂
from decaying plant matter. Only growth of new forests absorbs CO₂ in significant
degree. It would take perpetual growth of new forests equal in area to all current
U.S. forests to cut the CO₂ 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
CO₂ 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. Even as we have
been burning fossil fuels, known reserves have been increasing faster. Earth con-
tains so much oil and other fossil fuels, and our exploration for them has been so
incomplete, 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, sheer scientific uncertainty urges a gradual “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 CO₂ buildup. Finally, trying to cut emissions by cutting international trade leaves too many options for substituting home fuel use for traded fuel.

We are left to consider the direct approach: tax consumption or production of fossil fuels on a near-global scale. What effects would such a global tax have on world income? Many economists have tried to estimate the effects of greenhouse gas abatement. Figure 12.6 shows the gist of most studies, drawing on estimates by John Whalley and Randall Wigs. In this case, the tax is levied on each unit of carbon content, to aim as directly as possible at greenhouse gas emissions. Presuming that we learn that global warming is a serious problem that requires a fairly aggressive approach, the tax is set at a dollar rate that aims to cut emissions in half from 1990 to 2030. The tax of $44.8 per ton of carbon is a tax of about $54.00 per barrel of crude oil or $1.34 per gallon of gas ($0.34 per liter).

Any variant of the global carbon tax would cut world income (world GDP) by something over 4 percent by the year 2030, according to the first row of numbers in Figure 12.6. That is a significant price to pay for better climate, though it is limited by economies’ (estimated) ability to conserve on fossil fuels in response to the tax.

When we look at how the cost is distributed across the major economic regions of the world, we see big differences that would surely spark a heated debate in any world conference over such a tax. In the first column, the tax is levied on fuel producers and the tax revenues are rebated by their governments to the populations of those fuel-producing countries. That brings a 4.5 percent windfall gain to the oil-exporting countries, from a system that taxes the rest of the world heavily.

Alternatively, suppose that the tax is collected on fuel consumption by governments where the fuel is consumed. While that might seem a greater hardship on fuel consumers than the production tax, it is not. On the contrary, if the tax is global and uniform, the share of it that is paid by fuel consumers (as opposed to producers) is the same whether the tax falls directly on consumers or directly on producers. Regardless of who directly pays the tax, the slopes of the demand and supply curves will dictate how the tax burden is split between consumers and producers. Actually, having the tax collected in the consuming countries is a boon to them inasmuch as the revenue is collected and domestically rebated by
FIGURE 12.6  Welfare Effects of Carbon Taxes on Various Regions of the World

<table>
<thead>
<tr>
<th>A Tax on the Carbon Content of Fossil Fuel Production, Collected by the Producers' Governments</th>
<th>A Tax on the Carbon Content of Fossil Fuel Consumption, Collected by the Consumers' Governments</th>
<th>A Tax on the Carbon Content of Either Consumption or Production, Rebated on a Global per Capita Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average tax rate ($/ton of carbon)</td>
<td>$448</td>
<td>$448</td>
</tr>
<tr>
<td>Welfare Change by 2030 (% of GDP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole world</td>
<td>-4.4%</td>
<td>-4.4%</td>
</tr>
<tr>
<td>European Union</td>
<td>-4.0</td>
<td>-1.0</td>
</tr>
<tr>
<td>U.S. and Canada</td>
<td>-4.3</td>
<td>-3.6</td>
</tr>
<tr>
<td>Japan</td>
<td>-3.7</td>
<td>+0.5</td>
</tr>
<tr>
<td>Other industrial market economies</td>
<td>-2.3</td>
<td>-2.1</td>
</tr>
<tr>
<td>Oil exporters</td>
<td>+4.5</td>
<td>-18.7</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>-7.1</td>
<td>-6.8</td>
</tr>
</tbody>
</table>

Source: Anderson and Blackhurst (1992), p. 103, using Whalley and Wigner. For further detailed estimates, see the chapters by Winters and by Figueres, Whalley, and Wigner in Anderson and Blackhurst.

their own governments, as in the middle column of estimates in Figure 12.6. In this case, the industrial countries suffer much less than with the production tax (Japan actually gains on the deal), and the oil-exporting countries take a beating from the loss of world demand.

Finally, if the tax on either fuel production or fuel consumption is distributed around the world so that everybody gets the same tax-revenue rebate per person, the effects would be distributed according to the right-hand column in Figure 12.6. Poor countries, represented by the "rest of the world" category, would receive a net gain because their tax receipts exceed the cost of fuel scarcity. To the extent that the global policy intends to equalize incomes around the world, this approach would have appeal. The larger point, though, is that the differences in how the tax revenues are distributed have such huge consequences for well-being that any world negotiations over the carbon tax would surely be acrimonious.

Actual world negotiations over global warming have indeed been difficult. Industrial countries committed in Rio de Janeiro in 1992 to keep their CO₂ emissions at 1990 levels, but they have not done so. For instance, U.S. emissions were over 12 percent larger in 2000 than in 1990.

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 6 to 8 percent below their 1990 levels by the years 2008-2012 and then to continue reductions. Developing countries refused to make any commitments, however. They argued that they are poor and should not have to slow their economic growth.
The Kyoto Protocol includes some trading among countries of credits for emission reductions. This approach is conceptually attractive—creating a market for the right to emit—and it could be the basis for expanding the agreement in the future. It encourages emission reductions where they can be achieved at lowest cost, so it enhances economic efficiency. (A carbon tax would do this as well, by encouraging reductions to avoid paying the tax.) In addition, the initial allocations of rights could be used to induce developing countries to become part of an expanded agreement in the future, by giving them more than their current share of global emissions.

However, the Kyoto Protocol itself is not likely to meet its objectives. The role of the United States, which is the source of about a fifth of the world’s total greenhouse-gas emissions, is a key issue. With no actions by the U.S. government to reduce U.S. emissions, they will be 40 percent above the U.S. target for 2008. In March 2001, President George W. Bush pulled the United States out of the Kyoto process, stating that it was unacceptable because developing countries made no commitments and achieving the emissions target would be too costly for the United States. Nonetheless, the other 178 countries completed the final version of the Kyoto Protocol in late 2001, adding some credits for reforestation and improved agricultural practices that absorb CO₂. As of July 2002 the final version had not yet entered into force, but it will if Russia and one or two other industrialized countries formally ratify it. However, without U.S. participation, the Kyoto Protocol cannot accomplish much. We remain well short of 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 the possibility of environmental exceptions to its free-trade thrust. But the WTO has usually ruled against 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 to view trade limits that are part of multilateral environmental agreements more favorably.

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 11, 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 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 CO₂ and other greenhouse gases is the most daunting global environmental problem. Science does not provide clear 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. Most developing countries prefer to pursue growth and rising incomes and are not willing to constrain their development by taking actions to reduce their emissions. More important, the United States has indicated that it will not abide by the Kyoto Protocol.
Suggested Reading


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 restricts imports of goods produced using production methods that would violate the 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 coast.

6. Consider the example of domestic pollution shown in Figure 12.4. Suppose that the marginal social side cost of the pollution is $0.05 per ream produced (instead of $0.30).

a. With this different MSSC, 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 20 years?

a. Eliminating all subsidies to energy use.

b. Restoring the original tropical rain forest.

c. A tax of $448 per ton of emitted carbon, 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 emission of CO₂? What differences between the two cases explain the difference in outcome?