Part IV: Practical Problems With the Implementation of Benefit-Cost Analysis

In Part I it was argued that the voluntary supply and demand interactions of the market system (and its analog for public goods) will lead to perfect decisions, if we possess perfect information about tastes, technology, and prices. This would be true for decisions at a point in time and for decisions regarding projects with benefits and costs occurring over lengthy time periods. Part II emphasized that the “rosy scenario” of Part I only occurs when there are no “missing markets.” Externalities and public goods were discussed as two important cases where failure to charge prices that accurately reflect scarcity leads to the wrong relative amounts of environmental and other goods—to relatively too few environmental goods and too many ordinary goods. The Coase Theorem was seen as a reason why environmental problems are not more prevalent, but the conditions under which it is valid are restrictive. Part III examined the flawed incentives that people have to accurately reveal their preferences for public goods, further diminishing the practical significance of the Coase Theorem for both the economist and the environmentalist.

In Part IV we now turn to the study of how economists and others go about actually determining the position and shape of the marginal benefit and marginal cost curves in a world of imperfect information. Chapter 9 presents information on how the costs of environmental control policies are estimated. That there is but one chapter on costs and several on benefits reflects the greater uncertainty on the benefits side, hence the many approaches toward their estimation that require discussion. Chapter 10 provides an overview of the benefit estimation chapters, giving a sense of the types of approaches, before going into the more in-depth critiques that make up Chapters 11 through 15.

The various methods of benefit estimation embed a wide variety of underlying assumptions, assumptions that often are not only dubious, but that are also in many cases inconsistent. One approach, for example, requires that people be perfectly aware of the variation in pollution and the damages associated with pollution—as knowledgeable about these “goods” as they are of the nature of a can of tomato soup or a cup of steamed broccoli. Another approach assumes, oppositely, that those damaged by pollution have zero perception of what is causing their damages and how those damages would vary over space, for otherwise people would employ various (costly) mitigation strategies.

Each approach yields marginal damage estimates (and marginal damages are the marginal benefits of cleanup). But how are we to think about those estimates? Are they “alternative” estimates? Since the assumption about perceptions of damage differ so dramatically this would seem unlikely—they are almost certainly picking up different damages, some perceived and some not. Yet, to add the damages together might be very likely to lead to double-counting of some damages. In all cases, however, what we are seeking is an accurate measure of marginal willingness to pay for environmental benefits that can only come at the cost of foregone other goods that we also care about.
Chapter 9. Approaches to Estimating the Costs of Environmental Control Policies

As emphasized in Chapters 1 and 2, “costs” have little to do with dollars per se. Rather, the fact of scarcity—that we can't have everything we want with the resources available to us—forces us to make choices. In the environmental setting, this means that we face a trade-off between environmental goods and other goods that we would also like to have. Choosing more environmental quality inevitably (apart from so-called "no regrets" policies that are rare\(^1\)) means that we must have less of other goods—the foregone benefits from those goods are the costs of the decision to have more environmental quality.

However, analysis of the cost side of environmental decision-making is often made easier by the fact that many environmental control costs do handily come in the form of dollars which makes it easier to add them up and to compare them to benefits (assuming we meaningfully put the policy benefits in dollar terms\(^2\)).

Types of Environmental Policy Costs

There are essentially three types of control policies. The most commonly used policy in the United States and many other countries is that of required add-on controls. The catalytic converters required on all automobiles built after 1974 is but one example of this approach. The second type of cost is required input or output substitutions, with the substitution of low-sulfur

\(^1\)A policy is referred to as a “no regrets” policy if it provides benefits with zero or negative costs. For example, many people are unaware that replacing ordinary incandescent light bulbs with low wattage fluorescent bulbs would be both cheaper and provide environmental improvements (less energy generated with reduced pollution and carbon dioxide buildup). Another example might be an aluminum recycling effort that ends up being profitable.

\(^2\)Some people believe that it is not only very difficult to put health and other environmental benefits in dollar terms but that it is also morally wrong to do so. But, whether morally wrong or not, such a process is inevitable; the health effects are going to occur or not occur whether we “think” about them or not. To make rational decisions requires that we compare the advantages with the disadvantages of a decision, so some “weighting” must occur. To do that unavoidable weighting in dollar terms is just a matter of convenience.
For both air and water, sources of emissions (for air) or of effluent (for water) are broken into point sources, where the pollution exits via a smokestack or pipe, and non-point sources where the origin of the pollution is less concentrated. For water, examples of non-point sources would be urban parking lot run-off of oil/detritus or agricultural run-off of fertilizer or pesticides into local streams, rivers or oceans. For air, the non-point sources are household emissions from furnaces, fireplaces and the like along with very large emissions from the transportation sector, usually sub-categorized into “mobile sources.”
Required input or output substitutions, and other “process changes,” are also quite common. This approach involves substituting a more expensive but less polluting input or output for its less expensive and more polluting counterpart. An important example would be requiring the use of Western coal, which has approximately one-third of the sulfur content of Eastern coal. The substitutions may be “complete” as, for example, the bans on DDT, CFCs, or certain types of asbestos. Or, the approach might be “partial,” with some important uses of the damaging input or output being allowed while others are not.

Illustrating, suppose that a firm has chosen an input combination that is lowest cost (to maximize profits) for the output level it is producing. The input combination chosen might not, of course, be the lowest cost from society's perspective, allowing for external costs. For example, a long-lived chlorinated hydrocarbon pesticide such as DDT might be chosen by a farmer as "least cost." But, there might be many external damages (bio-amplification of pollution concentration moving up the food chain, damages to aquifers, runoff damage, etc.) that cause the social cost of this approach to be quite high. Substituting from DDT to, say, malathion (which has a far shorter residence time in the environment, breaking down into harmless sub-components) might be far less costly when all costs are considered. Not only might the substitute product be more expensive because it is less effective, but the farmer might also need several applications rather than just one. Hence the private costs might be substantially higher, despite the lower social costs, if external damages are large.

In such cases, a required substitution might make a great deal of sense. Usually, however,

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4 In a “political world,” such required substitutions, while often very efficient, might not happen because of losses of jobs and tax revenue in regions disfavored by such regulations. If, on the other hand, the economic incentive approach is used, such substitutions become voluntary individual firm decisions and not subject to political maneuvering. The role of politics and jurisdictions will be taken up in detail later in the text.
outright bans are seldom optimal, for reasons that will be clear from the supply and demand discussion of Chapter 2. Some uses of the substance under consideration for the ban might be of very great importance (e.g. banning saccharin to a diabetic, who is unable to tolerate sugar), while other uses are less important. The “all-or-nothing” approach of banning is a very blunt instrument in many such cases. A properly set tax on such goods might discourage frivolous uses while at the same time allowing high-valued uses to continue.

As with add-on control devices, the cost of required input or output substitutions are usually fairly easy to determine, at least relative to benefits. The cost of the substitute will be higher either because more must be used or because a given quantity has a higher price, or both. To an Eastern power plant, for example, Western coal costs more because of shipping, while more of it also has to be used because it has a somewhat lower BTU rating than Eastern coal.

Finally, although either implicitly or explicitly not even allowed in most current policy, spatial or temporal relocation of pollutants sometimes offers a low-cost alternative way of reducing total damages from residuals in the environment. This approach does not reduce total emissions but moves them—at a cost—to where they do less environmental damage. A given amount of emissions into the atmosphere can have very different impacts depending on how those emissions affect air quality (which varies) and how many damage receptors there are to experience the reduction in air quality (which also varies).

Illustrations would probably be useful. Some locations, such as the South Coast Air Basin that contains Los Angeles, CA, are frequently subject to stagnant air conditions, resulting in high concentrations of ambient air pollution. Other locations, such as Chicago, have generally dependable replacement of dirty air with clean air from prevailing, relatively steady, winds from the West. So, any given amount of emissions can have very different impacts on air quality—and
it is air quality that affects utility, not emissions *per se*.

Similarly, holding constant the relationship between emissions and air quality, the relationship between air quality and “damages” (benefits of control) depends on how many people, and things people care about, are present to be damaged. To emphasize perhaps the most important case, population density is on the order of 1,000 times greater in large urban areas than in rural areas (perhaps 6,000 people per square mile versus 6 people per square mile in a rural location). This means that, other things equal, any change in air quality has 1,000 times more damage in urban areas than in rural areas.

Of course, “other things” are not always equal–we might care greatly about locations with few people (e.g. the Everglades or Grand Canyon), desiring to keep such places pristine. But, nonetheless it is clear that for one to say “I don’t want to just move pollution around, I want to eliminate it!” is in general irrational, ignoring many policies that can have benefits far greater than costs. Those proposing new power plants, by way of illustration, have been required for many years to present alternate possible locations with an eye to incorporating trade-offs between private costs and social costs in the final decision of where such plants are located. Perhaps belaboring this, merely locating a power plant downwind rather than upwind of a population center might greatly reduce local damages, while the transmission distance to customers might be similar in either location. Such site-review policies could be usefully expanded, since damages from any given amount of pollution can be orders of magnitude smaller or larger depending on where they occur.

Water pollutants, called “effluent” rather than “emissions,” can similarly be located so as to minimize damages to water quality. It matters whether an “oxygen sag” (lowered oxygen content in water, with changes in the nature of viable flora and fauna) occurs where commercial
and recreational fishing is important or not. Similarly, water quality will be more important at a beach or municipal water inlet than at other locations.

The timing of emissions, whether air or water emissions, can also matter greatly. Air emissions during an inversion (where relatively cool air is trapped against the ground by higher level warm air), can result in extreme accumulations of pollution in the atmosphere. Environmental policy might well impose stricter standards, even to the point of shutting down polluters and restricting transportation mobility, at such times. Similarly, effluent into high temperature and low flow streams (as at certain times in the late summer in many locations) can do far more damage than emissions into those same rivers and streams at other times (e.g. during Spring runoff with high volume, cool waters that contain more oxygen and better dilute any pollutants present). Many such policies can have benefits greater than costs.

The spatial or temporal approaches do not, however, address global environmental problems—problems such as global warming will be unaffected by such local or regional policies. Still, once the global concerns are addressed with optimal controls, it will remain the case that relocations over space or time can yield additional benefits for mankind and the environments that we value.

**The Economic Incentive Approach**

Why have we taken the approaches to environmental policy that we have? Why, in particular, have we modeled our control policies largely on the old Soviet system of “command and control?” Just as the Soviet planners told industrial firms what and how to produce, EPA policy-makers in the U.S. tell emitters how they must produce to get a given environmental outcome (e.g. required catalytic converters to obtain a given auto-related air quality). Yet, the rest of the economic system is not that way at all, either in the U.S. or in most of the rest of the
democratic world.

The reason we have what is, almost certainly at this time, an archaic method of getting improved environmental quality is related to the fact that we were a rich country before we had much in the way of environmental “monitoring capacity.” That is, for both required emission controls (e.g. catalytic converters, scrubbers, baghouses) and for process change controls (e.g. Western coal for Eastern coal), it was much easier to observe whether the controls were met, than to observe whether they had any impact on air quality. This was because actually monitoring air quality, in the way necessary for an effective economic incentive approach, was not possible.

Suppose, for example, that bureaucrats just said to car companies in the late 1960s when controls were first implemented, “We don’t care how you do it, but we want your cars to be ten times cleaner beginning in five years than they are now.” This did not happen because monitoring how much pollution was coming out of the tailpipe of an automobile was at that time very expensive; indeed, it was completely impractical to suggest that we might be able to know how much pollution is coming out of every single car (new and old) on the road, as modern tailpipe inspections currently allow at reasonable cost. Similarly, to charge a major sulfur emitter per ton of SO$_2$ requires that we know how many tons they emit. This requires continuous monitoring, because polluters might choose to emit at night or other times when they cannot be easily observed by regulators, this being particularly so for water polluters.

So, in the early days of pollution control, it was much easier to see whether a smokestack scrubber or catalytic converter was in place than it was to have any sense of whether the air was actually getting cleaner and at reasonable cost. Indeed, neither the power plant nor the household automobile driver cared whether the pollution control device actually worked; they only cared whether they had it, meeting the letter of the law requiring it.
There are two major problems with the approach of required add-on controls and required process changes. First, requiring firms and households to take particular actions might not be the least cost way to obtain the same outcome—either might know of less expensive ways to achieve the same result. For example, requiring a SO$_2$ scrubber might be much more expensive for certain power plants than substituting low-sulfur Western coal which might achieve the same level of air quality. Second, neither the firm nor the household has any incentive to care whether the device required actually works. Once they have met the “letter of the law” they have no strong economic interest in whether we get the environmental quality that was hoped for when the legislation requiring the device or process change was imposed.

In recent years, continuous monitoring has become quite low-cost, and “emission inventories” are available for most pollutants for most major locations. The ability to monitor pollutant emissions is critical to being able to harness the forces of the market to clean up our air and water. The other critical condition for the economic incentive approach to work well is that there must be variation in costs of cleanup among polluters. If a ton of SO$_2$ pollution costs the same to eliminate regardless of industry, age of plant, and so on, there can be no substantial benefits from the economic incentive approach. How do economic incentive approaches work?

Economic incentive approaches work by encouraging those who are best at fighting pollution to do so. There are three basic types of economic incentive approaches to reducing pollution. Salable emission rights will receive the most attention here, because it is in somewhat more common use and is the likely approach to ultimately be taken in limiting world-wide CO$_2$ emissions.

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5Indeed, many households (an estimated 8-13%) substituted the then-available, and much cheaper, leaded gasoline for non-leaded gas in cars with the newly-required catalytic converters. It turns out that just a few tankfuls of leaded gas coated the catalytic converters rendering the car roughly 100 times dirtier.
What is to be established by the following simple example is that any given level of environmental quality can be achieved at least social cost (scarce labor, capital, and other resources) if those who are most efficient at fighting pollution receive incentives to do so.

Suppose our objective is to reduce sulfur dioxide, SO₂, pollutant discharges into the air from one million tons to 700,000 tons per year. Ideally, the decision of how much to lower pollution would be based on a balancing of marginal benefits and marginal costs, but this is not at all critical to the advantages of the economic incentive approach. Even if the required cut in emissions is completely arbitrarily chosen, we would still want to achieve the goal at least cost.

Consider a simple production system with five different types of firms described in Table 9.1. The first column lists the five firm types, labeled A through E. The second column

<table>
<thead>
<tr>
<th>FIRM</th>
<th>SO₂ Emitted (thousands of tons)</th>
<th>Cleanup (cost/ton, $)</th>
<th>COST Policy 1</th>
<th>COST Policy 2</th>
<th>COST Policy 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>300</td>
<td>$500</td>
<td>150x$500=$75M</td>
<td>90x$500=$45M</td>
<td>-$0-</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
<td>$400</td>
<td>50x$400=$20M</td>
<td>60x$400=$24M</td>
<td>-$0-</td>
</tr>
<tr>
<td>C</td>
<td>200</td>
<td>$300</td>
<td>50x$300=$15M</td>
<td>60x$300=$18M</td>
<td>-$0-</td>
</tr>
<tr>
<td>D</td>
<td>200</td>
<td>$200</td>
<td>50x$200=$10M</td>
<td>60x$200=$12M</td>
<td>200x$200=$40M</td>
</tr>
<tr>
<td>E</td>
<td>100</td>
<td>$100</td>
<td>-$0-</td>
<td>30x$100=$3M</td>
<td>100x$100=$10M</td>
</tr>
<tr>
<td>TOT:</td>
<td>1,000,000</td>
<td></td>
<td>=$120,000,000</td>
<td>=$102,000,000</td>
<td>=$50,000,000</td>
</tr>
</tbody>
</table>

indicates how much is emitted from each type of plant, with plant type A, for example, emitting 300,000 tons of sulfur dioxide per year. The third column provides information about the
It should perhaps be emphasized that there is no necessary relationship between the volume of pollution produced by a plant and how costly it is for the plant to cleanup. Large polluters, like Firm A, could have low costs of cleanup and small polluters, like Firm E, could have high costs of cleanup. Similarly, one would not expect that the costs of cleanup would be the same within any given plant for each ton cleaned up—rather, one would expect that each plant might have some pollution that could be eliminated cheaply and other pollution that could only be eliminated at high cost. The numbers in Table 9.1 are purely hypothetical.

The Chicago Board of Trade (CBOT) has been auctioning sulfur dioxide permits since 1993. For much more detail on the specific workings of this program, see: http://www.chicagoclimatex.com/education_ccfe/so2_background_drivers_pricing_pdf.pdf

The policies are representative of actual policies, but many other types of policies exist, for example, requiring a specific add-on control device. It should be clear from the text discussion cost savings resulting from the economic incentive approach would hold for a wide variety of specific policies—after all, a required device could always be voluntarily purchased if that turned out to be optimal for a particular firm.
It is not the least bit critical to the analysis that the firms be given seventy percent or even any rights to pollute. Each firm might be required to purchase rights to any amount of pollution from the EPA or from you for that matter. Who gets to sell the rights to the (reduced) amount of emissions is a matter of equity, but as a practical

Policy 3 is the salable emission rights policy. Under this policy, each firm is assumed to be granted the right to emit up to seventy percent of last year’s pollution. What will happen?

![Figure 9.1 The Demand and Supply of SO\textsubscript{2} Emission Rights](image)

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\textsuperscript{9}It is not the least bit critical to the analysis that the firms be given seventy percent or even any rights to pollute. Each firm might be required to purchase rights to any amount of pollution from the EPA or from you for that matter. Who gets to sell the rights to the (reduced) amount of emissions is a matter of equity, but as a practical
Firms having a high cost of eliminating SO$_2$ will want to buy the rights to emit if they can buy those rights for less than the cost of cleanup. Similarly, low cost of cleanup emitters of SO$_2$ will want to sell the rights to emit if they can receive more than their cost of cleanup for those pollution rights. The case is as depicted in Figure 9.1.

Since Firm A would be willing to pay as much as $500 to emit, the demand for the first 300,000 rights to emit is $500. Firm B would only be willing to pay up to $400 to continue emitting the 200,000 tons it emits, and so on. In the absence of a limit on emissions rights, the firms would collectively emit 1,000,000 tons of pollution.

However, the supply of rights to emit is now only seventy percent of last year’s pollution, which will result in high cost of cleanup firms (such as Firm A) wanting to buy the rights to pollute from low cost of cleanup firms (such as Firm E). Because of the somewhat peculiar “step-function” form of the demand curve in this case, the equilibrium price is not specific but will end up somewhere between $200/ton and $300/ton; assume for simplicity that it is $250/ton.

It is easy to see the incentives that are created by this emissions rights market. Firm A will want to buy the rights to emit 90,000 tons of pollution, because it has the right to emit 210,000 (seventy percent of last year’s emissions). This will cost the firm $$22.5 million dollars, but note that a -$0- is entered in the cost column for Policy 3 in Table 9.1. This is because the dollars are mere transfers–Firm A is not changing its production in any way, hence has the same real cost as before. It is using neither more nor less of society’s scarce resources. We will look

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10The odd shape stems from the simplifying assumption that each firm as a constant cost of cleanup for each ton emitted. This is unlikely to be the case in practice, since each of the firms will have some pollution that can be cleaned up more cheaply than other pollution. This would “smooth” the demand curve. Moreover, the more firms there are in the market, the greater the number of “steps” in Figure 9.1–for a very large number of firms the demand curve would also take on the normal downward-sloping appearance of the demand curves in Chapter 2.
at the financial transfers a bit more at the close of this example, but for now recognize that only Firms D and E will be changing their behavior.

It is in the interests of Firms B and C to also buy rights to pollute rather than clean up, because their cleanup costs are $400/ton and $300/ton respectively, and they can buy the right to pollute for $250/ton, less than their cleanup costs. Each of these firms will purchase 60,000 tons of emission rights (since they already have the rights to emit 140,000 tons, seventy percent of last year’s pollution), paying 60,000($250/ton) or $15,000,000 each.

Total payments for the right to pollute then are the $22.5 million from Firm A, plus the $30 million from Firms B and C. This dollar amounts are received by Firms D and E, who are the sellers of emission rights. Firm D is better off by $50/ton of pollution for every ton it cleans up because this firm can clean up for $200/ton while selling the rights to a ton of emissions for $250. So Firm D will sell all 140,000 rights to pollute that it was assigned. Similarly, Firm E will sell its entire allotment of 70,000 rights to emit, because this firm can clean up for $100 and sell the rights to pollute for $250.

A total of 210,000 rights to pollute are exchanged at the $250/ton price, with the dollar costs to buyers being transferred to sellers, hence “washing out” from society’s perspective. But, note that the salable emissions rights approach, Policy 3, results in less than half the cost in terms of society’s real scarce resources when compared to the traditional “command approaches” of Policies 1 and 2. These results, while stemming from a purely hypothetical example, are in fact quite “real world,” with of the market incentive approach typically costing 20-50% of traditional approaches. This is because Firms D and E, the firms that are relatively good at fighting pollution, are encouraged to do so under the market incentive approach.

There are many additional benefits associated with the economic incentive approaches.
First, since environmental quality is less expensive with these approaches, ordinary downward-sloping demand curves would suggest that we would want to “buy” greater amounts of environmental improvement at its lower price. Additionally, environmental groups could advertise intentions to buy rights to pollute, without exercising them.\footnote{This approach would not eliminate the free rider problem but it might well be more effective than appeals that involve competing with “deep-pocket” polluters in efforts to pass pro-environment legislation.}

Another major advantage of the economic incentive approach is that it encourages economic growth \textit{without} environmental degradation. Suppose the demand for the output of the firms in Table 9.1 goes up and they wish to produce more output, which would normally result in greater emissions of sulfur dioxide. Since they have no more rights to pollute than before the increase in demand, they must enter the emissions rights markets with greater demands. This might drive the price of emissions up to $350/ton or so, at which point Firm C would begin cleaning up and selling its rights to pollute.

Similarly, suppose a new polluting firm opens up in the area of the five firms in Table 9.1. This firm, since it has no history of emissions, receives no initial emissions rights, hence must buy those from existing firms. This will again increase the price of emission rights, encouraging all existing firms to engage in greater cleanup efforts. Thus, even with economic growth the level of pollution does not go up; indeed, at higher per capita income levels, it is likely that we would desire a smaller supply of emissions rights.

What about alternative approaches involving economic incentives? Consideration of Figure 9.1 should make clear that if authorities were to charge a pollution tax of $250/ton, exactly the same outcome would occur. Firms A, B, and C would merely pay the tax, while Firms D and E would cleanup rather than pay the tax. Note, however, that having to pay a tax is
It should be noted that a subsidy can achieve the identical short-run outcome as a tax (or salable emissions rights). Paying firms $250/ton to eliminate pollution, rather than taxing them, creates the same incentive to eliminate pollution—firms D and E would accept the subsidy and eliminate pollution. But, subsidies make the polluting industries more profitable rather than less profitable vis-a-vis taxes and salable emissions rights. Hence subsidies result in a non-optimally large polluting sector in the long run. 

One of the reasons many economists and environmentalists prefer salable emissions rights to pollution taxes is that under the salable emissions rights approach, the environmental outcome is certain, and what is uncertain is the sales price of the allowed emissions rights. Under the tax approach, it is the tax that is certain, while the environmental outcome is uncertain.

Reiterating the goal of this chapter, we are seeking information on accurately-measured costs of environmental policies to compare to our best guesses at the environmental benefits associated with those policies. Clearly, costs have been higher historically than necessary because of the historical approaches of command and control, rather than reliance on the economic incentive approaches that have had such success in the market system as a whole. The economic incentive approaches result in pollution being cleaned up by those who are best at cleaning up, in much the same way that any other market good is produced, in equilibrium, by those who are best at producing it.

Hence, a major source of upward-bias in estimation of the costs of environmental policies is associated with failure to use economic incentive approaches which would be expected to lower costs. Another source of upward bias stems from “technology forcing,” which occurs when an environmental policy (say, salable emission rights) sets in motion entrepreneurs who

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12 It should be noted that a subsidy can achieve the identical short-run outcome as a tax (or salable emissions rights). Paying firms $250/ton to eliminate pollution, rather than taxing them, creates the same incentive to eliminate pollution—firms D and E would accept the subsidy and eliminate pollution. But, subsidies make the polluting industries more profitable rather than less profitable vis-a-vis taxes and salable emissions rights. Hence subsidies result in a non-optimally large polluting sector in the long run.
Questions for Discussion:

1) Most of the examples of this chapter related to production by firms. Can you think of some examples of required add-on devices, input or output substitutions, or spatial/temporal changes that apply to the household sector? [Hint: these are more common than you might think, both in the home and on the road.]

2) Can you think of how the costs of various environmental policies that you know about fit into the taxonomy introduced at the beginning of this chapter?

3) In the text, a “ban” on some polluting activity or good was referred to as a “blunt instrument.” Thinking in terms of the supply and demand diagrams of Chapter 2, why was this assertion made?

4) Can you think of some examples of policies that might have benefits greater than costs that shift the location or timing of pollution emissions of various sorts?

5) Why were the purchases of the emission rights not considered to be “costs” in the discussion

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13 It is certainly the case that costs are often understated for many projects (e.g. airports, dams) undertaken by government. The politics of such cases is rather different, though, with powerful interests wanting to get paid to create the project. If anything, such forces would be reversed for environmental projects, that often have powerful political enemies.
of salable emission rights?

6) Imagine a sixth firm, like one of the other five firms in Table 9.1, comes into existence. What happens to Figure 9.1? The equilibrium price of emission rights? The level of pollution?

7) It is sometimes argued that costs of various projects are *understated* rather than overstated (a rough “rule of thumb” one hears is that actual costs will be twice what the costs were estimated *a priori* to be). Why is this less likely to be the case for environmental projects?

8) Why does a tax of $250/ton emitted result in the *same amount* of short-run pollution as does a subsidy of $250/ton for each ton not emitted?

9) Rank taxes, subsidies, and salable emission rights according to which would lead to the smallest size of the polluting sector in the long run.