Without working through another numerical example (see Bailey on this), it is not hard to see that the bids of potential tenants will differ from their bids under the tax scheme by precisely the amount of this lump-sum element. All prospective tenants will thus raise their bids by vs^* (relative to the Pigouvian tax), so the high bidder under the subsidy program will coincide with the high bidder under the tax regime. We thus find that the substitution of the subsidy program will have direct allocative effects that are no different from the tax scheme.[28] Note also that, like compensation, the subsidy payment under competitive conditions will accrue, in the end, not to the tenant but to the landowner. Because this does not affect the supply of the input, the payment is, once again, lump sum.

7 Concluding comment

This chapter has shown that, although there is some degree of symmetry in the effects of taxes and subsidies on the generation of externalities, the two are far from perfect substitutes. Since the opportunity cost of the failure to collect a subsidy payment is the same at the margin as a tax of equal magnitude, the effects of the two upon behavior bear some resemblance. Yet we have found that in equilibrium they can lead to striking differences in the behavioral patterns of firms and their industry. For example, we examined one pertinent model - that of perfect competition with a fixed ratio of emissions to outputs - in which the following somewhat paradoxical results emerged: (1) An emissions tax does *not* reduce the emissions of the individual firm. (2) An abatement subsidy does reduce the firm's emissions. (3) The tax reduces the aggregate emissions of the industry. (4) The subsidy increases the industry's emissions.

Only in the case analyzed by Martin J. Bailey, in which subsidies constitute solely a contribution to pure economic rent, do subsidies produce the same results as a set of optimal taxes, and then, incidentally, compensation of the victims of externalities is likewise not a source of inefficiency. We note in conclusion that the Bailey case - that in which the detrimental effects of externalities affect only particular sites - may be an extremely important one in practice.

[28] As is clear from the discussion, this assumes that all prospective tenants are assigned the same s^*. Otherwise, the lump-sum element would vary among potential tenants.

CHAPTER 15

Environmental protection and the distribution of income

At least from a reading of the newspapers, one gets the impression that environmental policies are an issue in which income class plays a significant role. The poor and the wealthy seem to assign different degrees of priority to environmental protection: the proposed construction of an oil refinery is likely to produce anguished cries from middle- and upper-income inhabitants of a potential site and yet be welcomed as a source of more remunerative jobs by residents whose earnings are low. Similarly, proposals to ban DDT have been received with somewhat less enthusiasm in underdeveloped countries than they have encountered in the wealthier nations. This should, of course, come as little surprise to an economist. Assuming environmental quality to be a normal good, we would expect that wealthier individuals would want to "buy" more of it.

In addition to these differences in the demand for environmental quality, distributive elements also enter when we consider how the costs of a policy of environmental protection are likely to be distributed among individuals with differing incomes. To reach firm conclusions on so broad a subject is difficult, because the methods that are used to finance such policies vary widely. Nevertheless, by making some reasonable assumptions and exploring the available evidence, environmental economists have made some estimates of the incidence of these costs.

Obviously, the distributive side of externalities policy is of interest in and of itself in a world in which inequality and poverty have assumed high priority among social issues. In addition, without adequate consideration of this aspect of the matter, we may not be able to design policies that can obtain the support they require for adoption. Thus, by ignoring the redistributive effects of an environmental policy, we may either unintentionally harm certain groups in society or, alternatively, undermine the program politically.

In the first section of this chapter, we consider the relation between Pareto optimality and equity in environmental programs. In particular, we will present a theorem that shows that, under certain conditions *all* users of common-property resources who impose external costs upon one another may actually be made worse off by the introduction of the Pareto-optimal tax! This suggests a possible source of conflict between objectives in the design of environmental measures.

In the next two sections, we construct two polar models describing the consumption of environmental quality; with these, we explore the extent to which individuals with differing incomes will succeed in obtaining their desired level of consumption of environmental services. From this background, we then use these models along with some statistical evidence to examine the incidence, first, of the benefits of environmental programs, and, second, of their costs.

The results suggest that strong measures to improve environmental quality may indeed have a very uneven pattern of incidence, particularly during the period of adjustment to a new composition of output and employment. Moreover, the evidence suggests that we can typically expect a somewhat regressive pattern of distribution of the benefits and costs from environmental programs; we find some basis for the contention that environmental concern "is not the poor man's game."

Yet, because there is strong evidence that health and longevity are affected substantially by pollution and by other types of environmental damage, we continue to believe that the interests of society, including those of its less-affluent members, require a relatively efficient environmental program even taking account of its distributive consequences. But the pious hope that the "distributive branch" of the fiscal authority can be trusted to compensate for the regressive effects of environmental programs carries little conviction. This suggests that programs to improve the quality of the environment should incorporate provisions specifically designed to help offset any distributive consequences; we discuss some provisions of this kind in the concluding section.

1 Efficiency and equity in the provision of environmental quality

The efficiency conditions we have derived in earlier chapters of this book are all founded on the criterion of Pareto optimality. That is, in each case, we determined a state, or set of conditions, necessary for maximization of the welfare of any one individual, selected arbitrarily, without reducing the level of welfare (also selected arbitrarily) of any other member of the community. This may appear to avoid entirely the issue of income distribution, for if the proposal harms no one, it would seem, almost by definition, to be unobjectionable to everyone.

The matter can be put another way. It is tempting to argue that, whatever the distribution of income that is desired or with which one starts, an allocation of resources that is not Pareto-optimal must be unsatisfactory. For, given any such allocation, there must exist some reshuffling of resources that benefits some individuals and harms no one. This *is* true by definition, for if no such alternative were available, the initial allocation would have satisfied the conditions of Pareto optimality. It is all too easy to conclude from this that it is irrational to oppose a policy measure necessary or, perhaps, sufficient for the achievement of Pareto optimality, for with a supplementary program capable of achieving whatever distribution is desired, the policy maker can always increase social welfare by combining the socially desired distributive measure with one that achieves a Pareto-optimal allocation of resources.

Although all this is unimpeachable at a formal level, the difficulty of implementing such policy packages in practice is well-known. Nevertheless, it is often ignored by economists who advocate concrete policies derived directly from welfare theory. This section offers a specific example that illustrates dramatically how dangerous it can be to disregard the redistributive consequences of environmental policies.

In general terms, the issue is a simple one. Given any initial resource allocation, *A*, that is not Pareto-optimal, it is of course true that there must exist at least one other allocation, say *B*, that leaves everyone unharmed in comparison with *A* and makes some individuals better off. But now select randomly some other Pareto-optimal allocation, *C*. There is no way of knowing from this whether or not some persons will be harmed by the move from the nonoptimal point, *A*, to the optimal point, *C*. The distinction here is between a *state* of Pareto optimality and a *move* that can be described as a *Paretian improvement*. Any point on the utility-possibilities frontier obviously represents a Pareto-optimal state; no one can increase his level of welfare without reducing that of someone else. However, a *move* from some position in the interior of utility-possibilities space to a point on the frontier may not itself be Pareto optimal, for it can make someone worse off. Thus, somewhat paradoxically, a *move* to a *state* of Pareto optimality may not itself be a Paretian improvement.

Martin Weitzman and Uwe Reinhardt have independently constructed striking examples of this point with direct implications for environmental policies.[1] We describe Reinhardt's simpler, but less-formal, analysis because it is easier to follow and its rigor is sufficient for our purposes.

A standard illustration of the effects of externalities is road crowding. An additional car that enters an overcrowded highway adds to the congestion and imposes a time loss on everyone else. The driver's entry thus generates a marginal social cost that exceeds the marginal private costs.

[1] M. Weitzman, "Free Access vs. Private Ownership as Alternative Systems for Managing Common Property," *Journal of Economic Theory* VIII (June, 1974), 225–34; U. Reinhardt, "Efficiency Tolls and the Problem of Equity" (Working Draft, 1973).

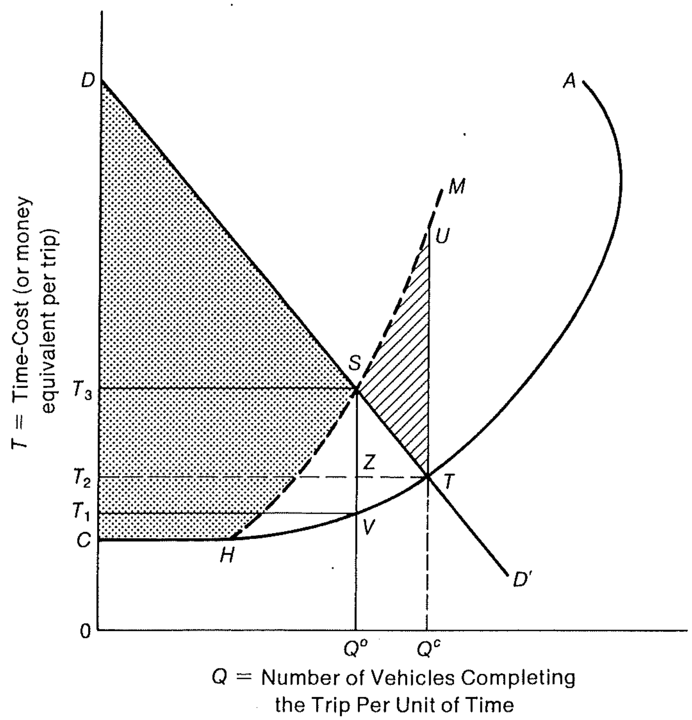

Figure 15.1

In this case, every driver is both a generator of these externalities and a victim of the same externalities produced by other drivers. The drivers constitute a self-contained group engaged in inefficient levels of driving activity. In accord with the conclusions of Chapter 4, optimality requires the imposition upon each driver of a toll equal to the marginal social damage resulting from his presence, *with no compensation to him for the damage he suffers from the presence of others.*

So far there is nothing new in our discussion. But the novel and rather startling observation offered by Weitzman and Reinhardt is that this optimal Pigouvian tax, far from benefiting some drivers without harming anyone, may, on the contrary, result in a loss in welfare to each and every one of the road users.

The proof is easily provided with the aid of a supply-demand diagram, Figure 15.1. For simplicity, we assume that there is a fixed rate of exchange between time spent on the journey and money. That is, we take

one hour to be worth some specified number of dollars to all individuals.[2] We deal with the demand for and cost of travel along some specified stretch of road. *DD'* is the analogue of the ordinary market demand curve that we interpret, subject to the usual qualifications, as an approximation to a curve of marginal social benefits.

Curve *CA* indicates the money value of the amount of time spent per vehicle on the journey (that is, it is a curve of average social time cost per vehicle trip).[3] We asume that *CA* is increasing over some range, which simply implies that the presence of additional vehicles can slow traffic.

The curve labelled *CHM* is the marginal social cost of an additional vehicle.[4] The net benefit to this group of drivers is given by the area between the marginal social cost curve, *CHM*, and the marginal benefit (demand) curve, *DD'*. This is at a maximum (dotted area) at traffic volume OQ^o. However, left to itself, traffic will settle at the "competitive" level, OQ^c, at which the demand curve crosses the average cost curve. This must be so because, at any smaller volume of traffic, marginal private benefit exceeds marginal private cost so that traffic will expand (and conversely). Relative to the optimal level of usage, OQ^o, the competitive level, OQ^c, involves a net loss to the drivers equal to the cross-hatched area, *STU*.

Our theory tells us that society can eliminate this loss by imposing a road tax, T_1T_3 equal to *VS*, the marginal social damage at the optimal level of usage, OQ^o. However, it is easy to see that this must leave every driver worse off. For as compared with the unregulated usage, the individual saves T_1T_2 in time-cost per trip, but for this saving he pays the

2 For a notion of time-price that is justified more rigorously, see Gary Becker, "A Theory of the Allocation of Time," *Economic Journal* LXXV (September, 1965), 493–517. Becker's treatment is much more complex than ours: time-price varies from individual to individual according to each person's opportunity cost. We assume here that the cost of time is the same for everyone. Weitzman's approach, incidentally, does not require this simplification.

3 The shape of *CA* may require a bit of comment. It is horizontal over the stretch *CH*, which indicates that up to some level of utilization, the road is completely uncongested so that additional vehicles do not slow anyone down. The later backward bend in the curve represents a phenomenon that has been substantiated empirically: after some point, a further increase in the number of vehicles attempting to enter the road increases the time-costs so severely that the number of vehicles able to traverse it in a given period of time is actually reduced. The analysis, however, does not depend in any way on the two properties of the average cost curve discussed in this note; it requires only that the marginal costs of congestion be increasing at least over some range.

4 Note that *CA*, not *CM*, is the curve of marginal *private* costs. Consider an individual traversing the stretch of road we are examining. If traffic is at level OQ^o, the individual who embarks on the road can anticipate a time-cost for his journey of Q^oV. That is, if the total time-cost of his day's activities would otherwise be x, the decision to add this trip to his other activities will increase his total time-cost to $(x+Q^oV)$.

additional amount T_1T_3 per trip. Because with a negatively sloping demand curve, the latter *must* be greater than the former by the amount $ZS = T_2T_3$, he will inevitably suffer a net loss in welfare.

The result seems paradoxical, for here we have a move to a Pareto optimum that appears to be detrimental to *everyone* involved. But this is, of course, not so. Assuming that the level of employment remains the same, *some* members of the economy must gain in the process. The taxes must either finance the supply of additional public goods or, by decreasing prices or taxes paid by others, it must add to the private-goods consumption of other persons. The point is that, so long as the users of the road do not share in the proceeds made possible by the additional public revenues,[5] they will actually suffer a loss in welfare from the imposition of the "optimal" tax.[6] There is thus a net gain to the community, but it is associated with a loss to drivers on the taxed road.

Although we have used the case of highway congestion to illustrate the theorem, it should be clear that this proposition also applies to at least some other sorts of envirionmental usage. More specifically, the argument shows that, wherever a common-property resource is subject to rising costs of congestion, the imposition of the optimal Pigouvian tax will reduce the welfare of the users of that resource so long as they are excluded from the benefits accruing from the tax revenues. We may see here why opposition to "optimal" taxes is to be expected, unless special provisions are made to assist the losers.

2 The demand for environmental quality by income class

In later sections of this chapter, we will offer some empirical evidence and tentative conclusions on the probable pattern of incidence of the benefits and costs of programs to enhance the quality of the environment. However, to examine the issue theoretically, it is necessary first to consider in this and the next two sections how the demand for environmental quality is likely to vary with income and how these variations in demand can, to some extent, be accommodated through the individual's choice of location.

[5] Because compensation of the victims was shown, in Chapter 4, to be incompatible with Pareto optimality, the road users *cannot* share in the proceeds of an optimal tax program if that share depends to any extent on their own use of the road.

[6] This suggests, incidentally, that the argument will not hold if every member of the community uses the road. In this case, the welfare gain arising from the move to a Pareto-optimal pattern of resource use must get back to (at least some of) the road users. Indeed, as the preceding footnote argues, in this case, no tax program may even be able to achieve Pareto optimality. However, if the real tax proceeds are channeled back in a manner that is sufficiently indirect, they may not cause significant deviations from Pareto optimality.

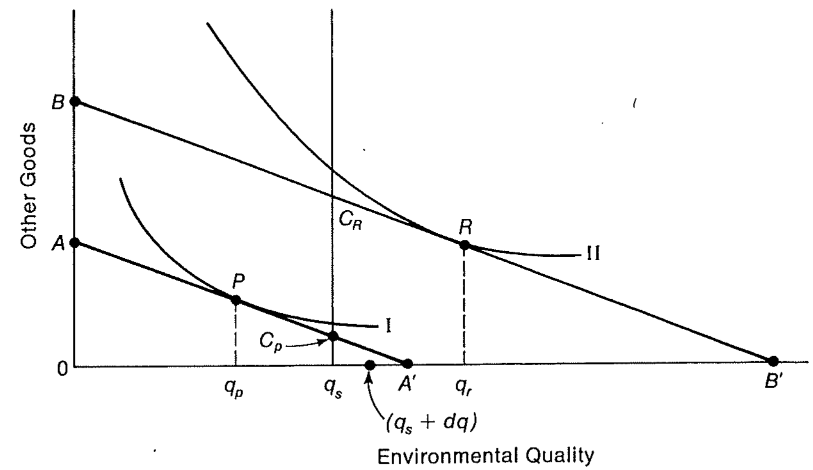

Figure 15.2

As suggested earlier, there is good reason to believe that the demand for environmental quality will rise with income. Such a case is illustrated in Figure 15.2, where we see that a rise in the individual's budget constraint from AA' to BB' leads to an increase in his desired level of environmental quality from q_p to q_r. We might therefore expect higher-income groups to have a greater demand than poorer individuals for such things as clean air and water.

This conclusion depends upon three assumptions implicit in Figure 15.2. The first is that, for a typical individual, environmental quality is a normal good, so that his desired degree of, say, air cleanliness rises with income, an assumption that seems quite reasonable. Second, this proposition assumes at least roughly similar preference *functions* for rich and poor; or, more accurately, it presumes that lower-income groups do not possess systematically stronger preferences for environmental quality than the more wealthy. Otherwise, the poor, because of their more intense preferences for clean air, might, in spite of their lower incomes, still be willing to pay more than the rich for a given level of environmental quality. This second assumption also seems to us a valid one. In fact, if preferences themselves diverge significantly among income groups, it would be our guess that the stronger predilection for environmental protection is to be found among those with higher incomes. The dangers, both in health and aesthetic terms, of environmental deterioration are frequently complex and sometimes apparently remote and so are more likely to be

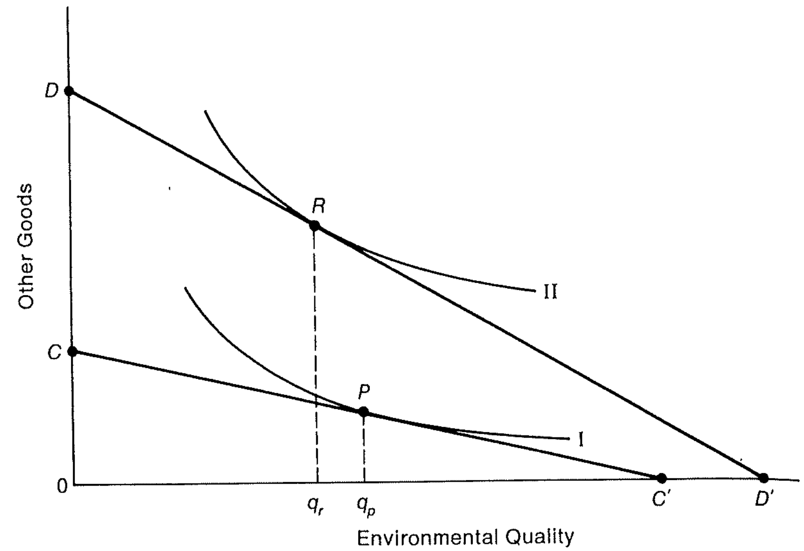

Figure 15.3

recognized by those reached regularly by the media that offer extensive discussions of the issues. Some have actually characterized the growing concern with environmental protection as an "upper-class" movement.[7]

The third, and most problematic, of the conditions implicit in Figure 15.2 is that there is a fixed price for environmental quality, a price that is invariant with respect to income. It is certainly conceivable that, with a progressive tax system, the price of environmental programs will be higher for the rich than for the poor. In fact, we can even have a situation like that illustrated in Figure 15.3, where the effect of the price differential outweighs that of income, so that the poorer individual actually demands a higher level of environmental quality (q_p) than that (q_r) desired by the wealthier person. We will have more to say about this later, when we examine the various ways in which individuals can "buy" varying degrees of environmental quality. Let us say here that we frankly doubt that the situation depicted in Figure 15.3 is plausible as a typical

[7] See, for example, J. Harry, R. Gale, and J. Hendee, "Conservation: An Upper Class Social Movement," *Journal of Leisure Research* I (Summer, 1969), 246. This, of course, does not prove that there exist systematic disparities in the preference maps of rich and poor for environmental quality; the apparently greater concern of the wealthy for environmental protection may result simply from a positive income effect like that illustrated in Figure 15.2. Our point here is simply that there seems to be no persuasive evidence that the poor exhibit stronger preferences for environmental quality than do the rich.

case. For one thing, what is relevant here is not the progressivity of the initial tax structure, but rather that of the *incremental* taxes needed to finance increased outlays on environmental protection. Progressivity of current taxes by no means implies that the tax-price of a given *increase* in environmental protection need be greater to the rich than to the poor. Moreover, as we shall see shortly, the evidence suggests that private-sector costs of pollution control are distributed in a regressive manner. Outcomes like that depicted in Figure 15.3 seem very unlikely.

3 A public-good model of the provision of environmental quality

In this section and the next, we want to consider two polar cases of the consumption of environmental quality. In this first model, we take environmental quality to be a pure, Samuelsonian public good; this is a world in which all individuals in society consume exactly the same quality of air, water, and other environmental goods. Returning to Figure 15.2, let indifference curve I and budget constraint AA' represent the situation of our typical poor individual, while curve II and budget constraint BB' are associated with a rich person. As noted earlier, the wealthier individual will, in this case, demand a level of environmental quality, q_r, higher than q_p, the amount desired by his poorer counterpart. If, however, environmental quality is a pure public good, all persons must, by definition, consume the same set of environmental services. This means that a single level of environmental quality (or vector of environmental characteristics) must be settled upon by society. If this decision is made through democratic processes, let us say by simple majority rule, we might expect to obtain (roughly) the level of environmental quality most preferred by Duncan Black's median voter.[8] The point here is that a likely outcome is a compromise in which the quality of the environment will be less than that desired by the wealthy and more than that preferred by the poor, say q_s in Figure 15.2. To the extent, therefore, that environmental quality is a relatively pure public good, we should find upper-income groups pushing for greater outlays on environmental programs in opposition to the wishes of the poor, who want more income to devote to the consumption of other goods. We will return to this point later.

4 The model of perfect adaptation by choice of location

As many writers have pointed out, environmental quality is, at least under most circumstances, far from a pure public good. The quality of air,

[8] D. Black, "On the Rationale of Group Decision Making," *Journal of Political Economy* LVI (February, 1948), 23–34.

for example, varies substantially even within the confines of a single metropolitan area. This means that an individual does have some choice as to his environment: he can determine to some extent his environmental surroundings by his selection of location.[9] We can envision, at the opposite pole from our pure public-good case, a Tiebout type of world in which a continuum of environmental quality is available at differing points in space.[10] Individuals choose, in accordance with their demands, a location that provides the most desired quality of the environment. Locations offering superior environmental quality obviously rent for a higher price and thus command an economic rent. Moreover, in line with our earlier discussion, we can expect higher-income groups to satisfy their relatively high demands for environmental quality by selecting sites with comparatively little air pollution, noise, and so on. In contrast, the poor can be expected to occupy the less-attractive parts of the metropolitan area in exchange for lower rents. In fact, if differentials in environmental quality are perfectly capitalized into differentials in property values and rents, we can visualize a locational pattern that is economically efficient in that the marginal rate of substitution (MRS) between environmental quality and other goods of each individual would, in equilibrium, equal the opportunity cost of a "unit" of environmental quality; equality of MRSs among individuals would then hold. Although poorer individuals would consume an inferior quality of environment (as depicted in Figure 15.2), their marginal valuation, as measured by their willingness to sacrifice other goods for another unit of environmental quality, would be identical with that of wealthier persons if the (marginal) costs of environmental improvement were the same for everyone.

Although the Tiebout polar case, like that of pure public good, is surely an oversimplification, it contains more than a little truth. Empirical studies have verified that, within metropolitan areas, property values do indeed reflect differences in environmental quality. In one such study (and there are others with similar results), Ridker and Henning found, in the St. Louis metropolitan area, that property values displayed a significant inverse relationship with a measure of the extent of air pollution (specifically, a measure of atmospheric sulfation levels).[11] Moreover, Freeman, in a study of three metropolitan areas, determined that exposure to air pollution varies inversely with income; he concludes that, "Air quality is distributed in a pro-rich manner."[12] It is thus clear that geographical location has, to some degree, permitted individuals to purchase different environmental qualities in accord with the differences in their effective demands and, as is to be expected, this bears a strong relationship to income. The poor live in the most heavily polluted sections of metropolitan areas, while the wealthier seek out the more attractive sites.

Reality, of course, lies somewhere between the two worlds that we have dealt with: the community in which public goods are supplied to everyone in equal quality and the range of geographic areas offering a wide variety of levels of public outputs. The rich and the poor cannot afford to live too far apart; the latter offer jobs to the poor, and the former offer services to the rich. Geographic separation imposes heavy time and money costs of commuting on one or both parties. For this and other reasons, one often finds slum neighborhoods cheek by jowl with the homes of the wealthy. If the air is foul, neither of them escapes it completely, and purification of the atmosphere affects both neighborhoods directly. Most environmental programs thus have strong elements of "publicness."

5 The distribution of benefits of environmental programs

We turn now to the issue of central concern: the incidence by income class of the costs and benefits of environmental programs. We will consider, first, the distribution of the benefits from these programs, and, second, the pattern of incidence of their costs. At the outset, we stress that it is difficult to reach firm conclusions on these matters; in some cases, a single program has both pro-poor and pro-rich elements. Nevertheless, the available evidence on these programs, along with some reasonable conjectures, suggest to us (as it has to others) that, without specific redistributive measures as part of an environmental policy, we can expect programs of environmental improvement to be typically pro-rich in their redistributive effects.

Let us first consider the distribution of benefits of a program of environmental improvement in the pure public-goods case; we will then reexamine the issue in the model of geographic specialization. Suppose, for example, that the public authority undertakes to reduce the level of air pollution in a metropolitan area. Where the improvement is a pure public good, it must, by definition, be available to everyone on equal terms. Thus, it will not be provided preponderantly either to the rich or to the

[9] Even in the same locality within a particular city, environmental quality may vary. The rich, for instance, can insulate themselves from such annoyances as noise and the discomforts of hot and dirty air through the purchase of appropriately constructed apartments, air conditioners, and so on.

[10] See the classic article by Charles Tiebout, "A Pure Theory of Local Expenditures," *Journal of Political Economy* LXIV (October, 1956), 416–24.

[11] Ronald Ridker and John Henning, "The Determinants of Residential Property Values with Special Reference to Air Pollution," *Review of Economics and Statistics* XLIX (May, 1967), 246–57. This is a multiple-regression study that attempts to hold constant the other determinants of property values.

[12] A. Myrick Freeman, "The Distribution of Environmental Quality," in A. Kneese and B. Bower, Eds., *Environmental Quality Analysis: Theory and Method in the Social Sciences* (Baltimore: The Johns Hopkins Press, 1972), p. 264.

poor. Nevertheless, the public-goods model suggests that the dollar value placed on these *benefits* will be greater among higher-income recipients. We recall that our public-goods solution (q_s in Figure 15.2) was one in which the marginal valuation of a unit of environmental quality is higher for a rich man than for a poor man. This implies that an incremental increase in the quality of the environment will be worth more (as measured by willingness to pay) to those with higher incomes than to the poorer members of the community. In this model, therefore, an environmental program must be more favorable to the rich than to the poor providing there is no offsetting differential in the apportionment of the cost burden.[13]

However, in a Tiebout world we can reach no such simple and categorical conclusion. Because there the poor and the rich inhabit separate areas, it is possible to devise (a) programs whose benefits flow to both parties, (b) programs that exclusively, or at least primarily, affect the poor alone or (c) programs directed mainly to localities inhabited by the wealthy.

In fact, one encounters each of these three types of measures in practice. A general tax on emissions, for example, is likely to improve air and water quality everywhere to some extent and thus is a measure of type (a). A set of minimum standards for air and water quality (for example, a regulation limiting emissions in different communities sufficiently to achieve an acceptable level of sulphur dioxide in the atmosphere in all localities) may have its primary impact on poorer neighborhoods, because the wealthy may inhabit areas in which the standards were already met prior to the adoption of the regulation. Finally, a program designed to protect the more unspoiled areas, and so to preserve "sanctuaries of cleanliness," is likely to focus on the areas inhabited by the wealthy rather than the localities in which the poor live and in which deterioration may be well under way. We want to consider next somewhat more systematically the effects of each of these three types of policies. Because in our Tiebout world pollution is likely to be most serious in poorer neighborhoods, we might suppose that a program of type (a) that improves environmental quality (for example, reduces levels of air pollution) in all localities generates benefits of more critical importance to the poor than to the rich.

However, this conclusion requires several important qualifications. First, although such programs may bring greater improvement *measured in physical terms* to areas of poorer residents, it cannot be stated unequivocally

[13] Note that we cannot say that the program is strictly regressive. Although the marginal benefits to the rich are greater than those to the poor, it still remains possible that the incremental benefits would be larger *as a proportion of income* for the poor than for the rich.

that the *value* of these increases in environmental quality will be greater to the poor than to the rich. Depending on the geographical pattern of the improvements, the income elasticity of demand for environmental quality, and current income differentials, the value *in money terms* of a lesser increase in, say, air quality may still be greater in rich, than in poor, areas. Our formal analysis is consistent with this conclusion.

As Figure 15.2 suggests, in a Tiebout equilibrium there *need not* be a significant difference in the rich and poor individual's MRS between environmental quality and private goods, even though this quality is far more abundantly supplied to the former. True, the equal MRSs displayed in the figure depend on the highly questionable premise that the marginal cost of environmental improvements are the same in the two types of area. However, there seems to be no clear presumption that the relative costs will differ systematically in such a way that the relative marginal value of a given improvement will tend to be higher for the poor than it is for the rich.

Second, suppose that our cleansing of the atmosphere effected a dramatic improvement in, say, the air quality in what has been a low-income area. In our Tiebout world, this should make these sites more attractive, and thereby lead to a bidding up of rents in the area. To the extent that they are renters, the poor may well find that much of the benefit of living in a cleaner environment is largely offset by the higher rents they must pay. The force of this argument at a practical level is difficult to evaluate. As Freeman points out, the sunk investment in housing and other neighborhood configurations generally make changes in local land-use patterns a relatively slow process.[14] It *may* thus be a long period before the improvements in environmental quality become capitalized into higher rents. However, over the longer run, alterations in locational patterns and levels of rents may reduce significantly the net benefits realized by the poor.

Programs of type (b), requiring, for example, the attainment of certain minimum environmental standards in all localities, obviously have the greatest potential for a pro-poor incidence of benefits. Even here, however, the extent of this pro-poor pattern of benefits may be eroded by one response noted above: the bidding up of rents in areas inhabited by the poor as a result of the improvement in environmental quality in these neighborhoods.

We turn finally to the apparently pro-rich [type (c)] environmental programs. Because of the heavy costs of maintaining high levels of environmental quality in all areas, the environmental authority may decide to

[14] "Distribution of Environmental Quality," pp. 268–69.

confine polluting activities to specific locations so as to preserve other localities from environmental degradation.[15] Such a result can be obtained in a rather inefficient manner by zoning devices, or more efficiently by some variety of tax measure (for example, one in which taxes on emissions of fumes vary *directly* with the initial purity of the atmosphere in the area).

There is, clearly, a strong presumption that such an environmental policy will work counter to the interests of the poor in a Tiebout economy.[16] Because they may be assumed to inhabit the dirty areas to begin with, the imposition of these policies is likely to make their communities dirtier still, as polluting activities are driven there from the protected areas. Moreover, rents in the unprotected regions may be expected to increase as well, as more polluters are induced to locate there![17] Thus the poor

[15] As we saw in Chapter 8, this may be an optimal strategy in the presence of nonconvexities caused by the presence of externalities. For then there may be virtue in a corner solution in which polluting activities are segregated.

[16] The Samuleson model is not relevant to this case, which requires, as one of its premises, differentiation in the environmental quality of different communities.

[17] Actually, this is not inevitable. For example, a tax that varies directly with initial air cleanliness will to some extent discourage pollution in *both* areas. If the tax on the *relatively* unprotected area is still not too far below that in the other, it may offset the resulting migration of polluting activities from the more protected areas.

To show this, assume that a firm produces in two areas: A, which is unprotected, and B, which is protected, and let x_a and x_b be its outputs in the two locations, which are produced at respective costs $c_a(x_a)$ and $c_b(x_b)$; its total revenue is $r(x_a+x_b)$; and assume that the tax rates on polluting production in the two locations are, respectively, kt and t where $0 \leq k < 1$. Then if the firm's objective is to maximize profits, its problem is to

$$\text{Max}\ \pi = r(x_a+x_b) - c_a(x_a) - c_b(x_b) - ktx_a - tx_b,$$

yielding the first-order conditions

$$r' - c_a' - kt = 0$$

$$r' - c_b' - t = 0.$$

Differentiating totally with respect to t, x_a, and x_b, we obtain

$$(r'' - c_a'')\,dx_a + r''dx_b = k\,dt$$

$$r''\,dx_a + (r'' - c_b'')\,dx_b = dt.$$

Solving and letting D represent the determinant of the system (where $D>0$ by the second-order conditions), we have

$$\frac{dx_a}{dt} = [k(r'' - c_b'') - r'']/D.$$

Thus, if as we might expect, $r''<0$ and $c''>0$, then dx_a/dt will be negative if k is sufficiently close to unity (that is, if the tax differential is not great enough, x_a, the firm's output in the unprotected area may actually be reduced by the tax), and so its demand for land there may fall, with rents following suit. A very similar argument holds for a competitive *industry*.

will find themselves living in less-attractive areas and receiving less of a rent advantage relative to the cleaner areas than they would in the absence of the program.

So far, we have largely followed our intention of dealing exclusively with the distribution of the benefits of an environmental program. But in the Tiebout model, this procedure forces us to ignore a particularly critical issue. Suppose that the programs we have been considering require the individual communities to pay the bulk of the costs of their environmental improvements. Then, from the point of view of the members of each individual locality, its own environmental program is, *on net*, detrimental to their interests. For in the pure Tiebout case, everyone will have achieved precisely the level of environmental quality that he desires, given the cost of improvement. Consequently, any measure that forces further improvement on a community must impose on its inhabitants something they do not want. In terms of our figures, it forces them to the right of their preferred positions.

Thus in this case, programs of type (b) (the setting of uniform standards), rather than benefiting the poor, will be disadvantageous to them and to them alone, and programs of type (a) that affect the environment in every type of community will be somewhat less anti-poor because they will be disadvantageous to rich and poor alike![18]

When we bring the analysis to a lower level of abstraction, the pro-rich orientation of the benefits from environmental programs seems even more likely. For example, substantial funds have been directed into the provision of outdoor recreation facilities: national parks, the preservation of surface waters for recreational purposes, and so on. We might guess that the use of such facilities would be related directly to income, particularly in view of their significant distance from densely populated areas. Empirical studies confirm this. In a comprehensive study of the economics of outdoor recreation, Cicchetti, Seneca, and Davidson have found (using multiple-regression analysis) that level of income was a significant determinant of the probability and frequency of usage by an individual of a wide variety of outdoor recreational activities.[19] Expenditures on such facilities thus appear to have a pro-rich orientation. This result is of particular significance since it has been estimated that "70

[18] To the extent that community environmental programs have beneficial external effects on environmental quality in other jurisdictions, they may of course benefit everyone if all communities undertake measures, say, to achieve certain standards of environmental quality. In a Tiebout world, the case for additional incentives to communities for environmental improvement appears to rest primarily on such external effects.

[19] C. J. Cicchetti, J. J. Seneca, and P. Davidson, *The Demand and Supply of Outdoor Recreation* (Washington, D.C.: U.S. Department of the Interior, 1969).

percent of the benefits of improved water quality will be in the nature of improved recreational opportunities."[20]

For air quality, the distribution of the benefits of pollution control by income class seems somewhat uncertain. Gianessi, Peskin, and Wolff, in a study of the U.S. Clean Air Act, find striking locational differentials in benefits; not surprisingly, most of the benefits from efforts to improve air quality are concentrated in the heavily industrialized cities of the East.[21] The benefits (and costs) accrue primarily to urban rather than rural residents. Within urban areas, they find that the benefits may be slightly pro-poor in their pattern of incidence, but this is, in all likelihood, more than offset by a regressive pattern of costs (as we shall see shortly).

6 The distribution of transitional costs

In our public-goods model, we used the simplifying assumption that the cost per unit of environmental quality was the same for rich and poor. This is admittedly rather unlikely: the incidence of the costs of an environmental program will obviously depend on the means adopted to implement the program, be they effluent charges, government subsidies, or direct controls that, in turn, influence the structure of prices. In examining this issue, we will consider two kinds of costs: the *transitional* costs involved in a program of improving the environment and the *continuing* costs of maintaining a given state of environmental quality. By transitional costs, we mean the costs of the process of adjustment from one state of environmental quality to another; continuing costs then become the costs of maintaining, over time, the newly achieved quality of the environment.

The most striking feature of the transitional costs of environmental programs is the likelihood of a highly uneven pattern of incidence. Whether the improvement of the environment (involving, say, reduced emissions into the atmosphere and waterways) is achieved by effluent charges or by direct regulation, the effects will hit some industries much harder than others. Heavy polluters, such as those chemical and paper plants that are located in populous areas, may be forced to curtail their operations significantly and perhaps even to stop them completely. This suggests, as testified to by frequent opposition in industrial towns, that one of the

[20] Henry M. Peskin, "Environmental Policy and the Distribution of Benefits and Costs," in Paul R. Portney, Ed., *Current Issues in U.S. Environmental Policy* (Baltimore: Johns Hopkins University Press, 1978), 163.

[21] Leonard P. Gianessi, Henry M. Peskin, and Edward Wolff, "The Distributional Effects of Uniform Air Pollution Policy in the United States," *Quarterly Journal of Economics* XCIII (May, 1979), 281–301.

most significant transitional costs of environmental programs will be a loss of jobs.

The employment-restricting effects of environmental measures may be increased by the fact that such policies are not instituted in all regions simultaneously. The area that imposes them unilaterally or in concert with only a few other jurisdictions will find itself at a competitive disadvantage in the production of the polluting items. Whether or not this will reduce the level of employment in the region as a whole, it will certainly make for a decrease in the demand for labor in the industries directly affected.

There are some obvious automatic offsets to these employment effects and some that are optional. Measures that penalize the emission of pollutants will stimulate the manufacture of recycling and purification equipment. Moreover, appropriate monetary and fiscal programs can be used to minimize any loss in employment entailed in an environmental protection policy. However, it is difficult, as we have learned, for conventional stabilization policy to cope effectively and promptly with highly localized unemployment resulting from cutbacks in particular lines of activity. The short-run costs for the newly unemployed are thus likely to be heavy.

In principle, this burden need not inevitably fall more heavily on the poor. A new refining plant, for example, may offer an unusually high proportion of jobs to executives and technicians. The pattern of transitional costs by income class will thus depend on the relative change in demand for high- and low-income employees. It is difficult to generalize on the matter; however, where environmental protection does restrict job opportunities, it is our conjecture that the costs are likely to fall most heavily on those in the lowest-income stratum. Professional personnel frequently have a greater occupational and geographical mobility than lower-wage employees; as a result, lower-income workers may well have more to lose than higher-salaried employees. This at least appears to be how workers themselves view the matter. When one reads newspaper accounts of local opposition to the curtailing of activities of some plant, the invariable rallying cry of its proponents (who are usually reported to be drawn largely from the community's lower-income groups) is that restriction of the enterprise will mean a loss of jobs that are "badly needed."[22]

This discussion has a direct bearing on the diagrammatic analysis of earlier sections. It suggests that, at least in the eyes of the poor themselves,

[22] Even if employment is not hurt by environmental protection measures, real output, conventionally measured, will tend to be reduced because a given set of inputs will yield a smaller bundle of outputs than before. In many cases, this cost, too, will probably fall most heavily on the poor. If a ban on DDT undermines the "green revolution" with its spectacular contribution to grain outputs in less-developed areas, can there be any serious doubt about the income group that will suffer the resulting malnutrition or starvation?

and, very likely, in fact as well, the transitional costs of environmental measures may be much higher for the poor than they are for the wealthy. The slope of the price line in Figure 15.3, interpreted as a curve of total real cost per unit of environmental quality, rather than being less steep for the poor, may actually be steeper for those whose jobs are jeopardized by programs for environmental improvement. In such cases, income as well as transitional "price" effects will make environmental measures more attractive to higher- than to lower-income groups.

7 The distribution of continuing costs

The continuing costs of programs to sustain a given level of environmental quality relate more to the change in the structure of prices of goods and services. If we assume that, following a transitional period of temporarily unemployed resources, full (or approximately full) employment is reestablished, the incidence of the steady-state environmental programs becomes a matter of the equilibrium set of prices (including levels of wages). Our expectation here is that there will be a rise in the relative price of those goods whose production involves substantial external costs (at least where techniques of production that reduce destructive emissions are significantly more costly than "free" dumping of wastes into the atmosphere or local waterways).

Suppose, for example, that we were to impose a set of effluent charges on emissions of the sort discussed in Chapter 11; the level of charges would be adjusted to achieve desired targets of environmental quality. What can we say about the pattern of incidence of such a set of charges? In principle, the approach to this problem is a straightforward one. Effluent fees simply amount to excise taxes on certain activities of the industry; the problem thus becomes one of determining, first, the effect of the tax on the cost and price of each commodity (including inputs) and, second, of establishing the incidence of the price changes by income class. Although all this may be straightforward in principle, the empirical evaluation of such general-equilibrium consequences is a very complex undertaking.

Although there are no studies that perform this kind of exercise for a system of effluent charges, there have been some attempts to estimate the incidence of the costs of existing pollution-control programs. Using various assumptions, these studies estimate how the costs of pollution abatement have affected the prices of various classes of products and how, in turn, these price increases have influenced the real incomes of different income classes. Some of the early studies of this type found the pattern of costs to be regressive. Gianessi, Peskin, and Wolff, for example, examined the distributive pattern of the costs of the Clean Air Act and found that lower-income groups bear costs that constitute a larger fraction of their incomes than do higher-income classes.[23] In a more recent study, H. David Robison has examined the distribution of the costs of industrial pollution abatement in a full general-equilibrium model.[24] Using a highly disaggregated input-output model, Robison assumed that the control costs in each industry were passed forward in the form of higher prices. He was then able to trace these price increases through a general-equilibrium system to determine their effect on the pattern of consumer prices. Robison's model divides individuals into twenty income classes, and for each class he has data describing the pattern of consumption. With this information, he is able to estimate for each of his income classes the increase in the costs of the items that they purchase. He finds that the pattern of incidence of control costs is quite regressive. Costs as a fraction of income fall over the entire range of his income classes, and they range from 0.76 percent of income for his lowest-income class to 0.16 percent of income for the highest-income classes. All these studies thus suggest that the costs of current programs are regressive in their incidence. This, we conjecture, would also be true for a system of effluent fees.

8 Distributive considerations in environmental policy

In sum, our models and the available evidence lend support to the view that, on balance, programs for environmental improvement promote the interests of higher-income groups more than those of the poor; they may well increase the degree of inequality in the distribution of real income. Low-income families are more likely to feel that basic needs, such as better food and housing, constitute more pressing concerns than cleaner air and water. Moreover, where new environmental programs threaten jobs, including higher-paying as well as lower-wage work, redistributive effects may weigh particularly heavily on certain individuals.

In fact, the rich and the poor seem often to have realized instinctively the difference in what they stand to gain from environmental programs.

[23] "The Distributional Effects of Uniform Air Pollution Policy in the United States." For other studies with similar findings, see Nancy Dorfman and Arthur Snow, "Who Will Pay for Pollution Control?" *National Tax Journal* XXVIII (March, 1975), 101–15; and Leonard P. Gianessi and Henry M. Peskin, "The Distribution of the Costs of Federal Water Pollution Control Policy," *Land Economics* LVI (February, 1980), 85–102.

[24] "Who Pays for Industrial Pollution Abatement?" *Review of Economics and Statistics* LXVII (November, 1985), 702–6.

In a case study in California, Perry Shapiro examined voting patterns in a referendum in Santa Barbara Country.[25]

> At issue was the development of a large ranch (El Capitan) fronting on the sea in the rural part of the county. The voters were to decide whether or not a private developer should be allowed a zoning variance to develop homesites in an established agricultural open space area. The project promised to generate an increase in local economic activity at the expense of environmental quality. The issue, as related in pre-election press reports, was one of environmental quality versus income, and there is good reason to believe this was the alternative between which voters chose in the polling booth.[26]

Using probit analysis to study the election results by wealthier and poorer districts, Shapiro found a clear, direct relationship between mean income and the proportion of voters opposing the project; only in the lowest income class was there substantial support for the grant of a variance for increased housing density.

In a similar kind of study, William Fischel examined voting behavior in eight New Hampshire towns in a local referendum on the proposed construction of a new wood-processing pulp mill.[27] Here again, the issue clearly involved a choice between new jobs and avoidance of detrimental environmental effects such as air and water pollution as well as congestion. From a statistical analysis of data from interviews with 359 voters, Fischel found (much like Shapiro) that the probability of a resident voting in favor of the pulp mill was significantly increased if the individual was in a "blue collar" occupation and was reduced if he or she was a "professional," had a relatively high income, or had a college degree. These and other studies indicate that higher-income groups give higher priority to programs for improved environmental quality than do those with lower incomes.

There are two obvious polar reactions to these observations. An oversimplification of the reaction of the pure economist might assert that resource allocation and income distribution are two separate issues and that one should not be permitted to interfere with a rational resolution of the

[25] Perry Shapiro, "Voting and the Incidence of Public Policy: An Operations Model and an Example of an Environment Referendum," Working Paper in Economics #8, University of California at Santa Barbara (May, 1972). In several subsequent studies of voting patterns on other environmental issues, Professor Shapiro and his colleagues have obtained very similar results. See, for example, Robert Deacon and Perry Shapiro, "Private Preference for Collective Goods Revealed Through Voting on Referenda," *American Economic Review* LXV (December 1975), 943–55.

[26] *Ibid.*, pp. 1–2.

[27] "Determinants of Voting on Environmental Quality: A Study of a New Hampshire Pulp Mill Referendum," *Journal of Environmental Economics and Management* VI (June, 1979), 107–18.

other. No matter what their distributive implications, one should seek to institute policies that make for efficiency in resource utilization, leaving it to some other (unclearly identified) branch of government to take the steps required to achieve a more just distribution of income.

The other extreme view, again one that is probably rarely held in its strongest form, asserts that the elimination of poverty is a matter of much higher priority than the (primarily aesthetic) issue of environmental protection. If the latter interferes with the former, so much the worse for it; it is a luxury whose attainment must at the very least be postponed until the more pressing problem of inequality is reduced to reasonable proportions.

We find neither of these views acceptable. The past performance of redistributive policy does not make us confident that the undesired redistributive consequences of environmental programs will somehow be offset. Moreover, at a more pragmatic level, the failure to redress at least the most glaring redistributive insults will generate strong opposition to the adoption of appropriate environmental programs.

On the other hand, postponement of environmental measures is not an appealing option. If these are vital matters of public health and perhaps ultimately of survival, even the poorest citizen may not have much reason to thank the legislator who resists effective action, even if it apparently is resisted for his sake. The issues of allocation raised by the literature on externalities cannot be brushed aside lightly on distributive grounds.

What this suggests to us is the need to incorporate sensible redistributive provisions into environmental programs, both as a matter of justice and as a means to enhance their political feasibility. We should not, however, lose sight of the fact *that the primary purpose of environmental programs is allocative:* their basic rationale is the direction of resource use to achieve desired levels of environmental quality.[28] We are inclined to agree with Freeman's contention that environmental programs are generally not very well suited to the achievement of distributional objectives.[29]

The goal should rather be to neutralize the more serious of the objectionable redistributive consequences of our environmental policies. Two promising lines of strategy have been suggested. First, as we noted earlier, the most drastic redistributive effects are likely to occur during periods of transition with individuals displaced from jobs in badly located,

[28] This is admittedly a tricky issue. As Henry Aaron and Martin McGuire show at a formal level, the appropriate level of provision of a public good can, under certain circumstances, become, largely, an ethical decision. See their "Efficiency and Equity in the Optimal Supply of a Public Good," *Review of Economics and Statistics* LI (February, 1969), 31–39.

[29] Freeman, "Distribution of Environmental Quality," pp. 274–78.

heavily polluting plants. Such transition problems can be met, at least in part, by the use of *adjustment assistance,* outlays common under legislation to reduce tariffs; such provisions typically offer unemployment compensation, retraining programs, and relocation assistance to minimize the costs to those displaced by the altered patterns of output and employment resulting from the legislation. Adjustment assistance can be an important component that would spread the transition costs of the program more evenly across society.

Second, we have suggested that the continuing costs of environmental measures are likely to have a somewhat regressive pattern of incidence. Two kinds of measures can be employed to offset this. First, as Gianessi, Peskin, and Wolff suggest, subsidies rather than taxes can be employed to reduce somewhat the increases in costs in polluting industries.[30] Although this has some appeal on distributive grounds, it is a proposal that must be considered cautiously, for (as we saw in Chapter 14) subsidies to firms that reduce their emissions can lead to allocative distortions and can actually result in increased pollution by inducing the entry of new polluting firms. The use of subsidies instead of taxes requires compelling evidence that the subsidy payments will not have such undesirable consequences. Second, the finance of public environmental projects is likely to be less regressive if the funds come from federal, rather than state and local, revenues. Since the federal tax system is more progressive than most state and local taxes, this would serve to distribute the burden of this part of the cost of environmental programs in a way that is less regressive. As we mentioned earlier, it is the progressiveness of incremental revenue collections that is important here; we may expect, however, that at the margin (as well as on average) federal revenues are likely to be collected in a more progressive manner than state and local funds.

30 "The Distributional Effects of Uniform Air Pollution Policy in the United States."

CHAPTER 16

International environmental issues

Almost invariably, public discussion of programs for the protection of the environment has emphasized their international implications. Two central issues have emerged from the debates. First, questions have been raised about the effects upon the competitive position in international trade of the country undertaking the program. It has been suggested, particularly by representatives of industries likely to bear the costs, that the proposed measures would impose on exporters a severe handicap in world markets that is certain to have an adverse effect on the nation's balance of payments, its employment levels, and its GNP. This problem has proved particularly frightening to the less-affluent nations, but even in wealthy countries it has been a persistent concern.

The second issue in this area is quite a different matter; it involves the transportation across national boundaries, not of commodities desired by the recipient nation, but of pollutants whose influx it seems powerless to prevent. Although there is a good deal of talk of international cooperation in the control of transnational pollution, joint programs like those we have already discussed will undoubtedly prove difficult to institute. Therefore, it is important to consider whether the victim nation can do anything to protect itself in the absence of something better in the form of effective collective measures. Obviously, where international cooperation *can* be achieved, the theoretical analysis that has been described in earlier chapters applies equally to international and domestic policy. It is only in the absence of joint action that an analysis of special measures for an effective international policy is required.

International trade theory offers some illumination on both these issues. Accordingly, this chapter is divided into two largely unrelated parts. The first examines the effects of a domestic pollution-control program on the initiating country's balance of payments and on international patterns of specialization; the second part concerns itself with transnational pollution issues. To avoid unnecessary complications, we will assume

Much of this chapter is taken from the 1971 Wicksell Lectures, W. Baumol, "Environmental Protection, Spillovers and International Trade" (Stockholm: Almqvist and Wiksell, 1971).