CHAPTER 3

Externalities: definition, significant types, and optimal-pricing conditions

The externality is in some ways a straightforward concept: yet, in others, it is extraordinarily elusive. We know how to take it into account in our analysis, and we are aware of many of its implications, but, despite a number of illuminating attempts to define the notion,[1] one is left with the feeling that we still have not captured all its ramifications. Perhaps this does not matter greatly. The definitional issue does not seem to have limited seriously our ability to analyze the problem, and so it may not be worth a great deal of effort. Certainly, we do not delude ourselves that this discussion will be the last word on the subject.

The literature has also offered distinctions among a number of different classes of externalities. Some of these distinctions have been illuminating; others (including one proposed by the authors!) have been the source of some confusion. Consequently, it is useful to explore the different kinds of externalities and their implications for Pareto-optimal pricing. In particular, we shall examine with some care Viner's distinction between technological and pecuniary externalities; although economists have generally accepted Viner's distinction and its implications, propositions that overlook this point still appear periodically and yield misleading conclusions. We will encounter such a case later in this chapter.

We shall also examine the distinction between public-goods and private-goods externalities, which has its source in the seminal work of Bator and Head.[2] Most externalities of relevance for public policy, as we shall see, are of the public-goods variety. There are instances, however, in which externalities of policy significance can possess the property of privateness. As Freeman has shown recently, this distinction, though perhaps of

[1] See, for example, F. M. Bator, "The Anatomy of Market Failure," *Quarterly Journal of Economics* LXXII (August, 1958), 351–79; J. M. Buchanan and W. C. Stubblebine, "Externality," *Economica,* as well as the classic discussion by James E. Meade in his "External Economies and Diseconomies in a Competitive Situation," *Economic Journal* LXII (March, 1952), 54–67; and in his book, *The Theory of Economic Externalities* (Geneva: Institut Universitaire de Hautes Études, 1973), especially Chapters 1 and 2.

[2] Bator, "The Anatomy of Market Failure," *Quarterly Journal of Economics;* and J. G. Head, "Public Goods and Public Policy," *Public Finance* XVII (No. 3, 1962), 197–219.

some interest in itself, does not have any fundamental implications for the pricing of externalities.[3] We shall find that the optimal pricing of externalities, be they of the public-goods or private-goods types, calls for a pricing vector that exhibits a fundamental asymmetry: It requires one level of price for the consumers (victims) of the externality and a different level of price for its producer or source. No normal market price can fulfill this asymmetry requirement, since if the buyer of a product pays p dollars for it, the seller must, by the reciprocal nature of a market transaction, receive p dollars for it. Viewed in this way, it is necessary to qualify the widespread attribution of the misallocations that stem from externalities to the failure to charge a price for the resource or service in question. What is needed is not an ordinary price but a fiscal instrument with the basic asymmetry property possessed, as we shall see, by a Pigouvian tax or subsidy.[4]

The analysis will require us to explore in some depth the treatment of the recipients or "victims" of an externality. Some authors have argued for the compensation of victims for the damages that they absorb; others have contended that in some circumstances victims must be taxed in order to induce optimal behavior.[5] We shall find that neither of these policies is, in general, compatible with economic efficiency. For the basic case, we show that victims should neither be compensated nor taxed if Pareto optimality is the objective. The level of damages itself provides precisely the correct inducement for victims to adopt the efficient levels of "defensive" activities. Any payments to, or taxation of, victims will, in general, lead to inefficient responses by the individuals affected by the externality. Where numbers are large, this proposition is valid except for the instance where the victim is in a position to transfer or "shift" the externality to some other victim. In this special case, the victim must be subject to a tax on any such shifting activities.

In this chapter, we will present and discuss these propositions rather heuristically; we postpone more rigorous derivations to the following chapter where they easily fall out of the analysis of the formal models.

1 Definition: externality

Ultimately, definitions are a matter of taste and convenience. Bator, who makes no attempt to define the externalities concept very formally, never-

[3] A. Myrick Freeman III, "Depletable Externalities and Pigouvian Taxation," *Journal of Environmental Economics and Management* XI (June, 1984), 173–9.

[4] As we shall discuss later in this chapter, under an appropriate (and feasible) definition of property rights, market transactions can provide an alternative to the Pigouvian measures.

[5] For a noted example of the latter position, see R. H. Coase, "The Problem of Social Cost," *Journal of Law and Economics* III (October, 1960), 1–44.

theless proposes to interpret the concept so broadly that it includes most major sources of what he calls "market failure."[6] He even includes in this category cases of increasing returns to scale in which "natural monopoly" may be the most efficient market form and in which marginal-cost pricing does not permit the firm to cover its costs. One can only object that this broad connotation is not what most writers have in mind when they discuss externalities. The analysis of the increasing-returns problem is ultimately quite different from that of the more conventional externalities[7] that constitute the primary threat to the environment and to the quality of life more generally. It therefore seems preferable to hold to a narrower, more conventional interpretation of the term.

Buchanan and Stubblebine do just that, though, as has been suggested elsewhere, the concept they call the "Pareto-relevant externality" corresponds to what is meant in most of the literature when the term *externality* is used without modifiers.[8] Their approach is, in general, unobjectionable as an operational concept. By and large, they define externalities not in terms of what they are but what they do. That is, they assert, in effect, that a (Pareto-relevant) externality is present when, in competitive

[6] Bator, "Anatomy of Market Failure," *Quarterly Journal of Economics.*

[7] For an alternative and illuminating approach to the concept of externalities that also distinguishes them from increasing returns, see K. J. Arrow, "The Organization of Economic Activity: Issues Pertinent to the Choice of Market Versus Nonmarket Allocation," in Congress of the United States, Joint Economic Committee, *The Analysis and Evaluation of Public Expenditures: The PPB System,* 1 (Washington, D.C.: Government Printing Office, 1969), 47–64. Arrow associates externalities with the absence of some markets for the trading of items affecting the welfare of economic agents. Thus, the absence of a market for the right to emit smoke is taken, quite correctly, as a central condition leading to a socially excessive level of smoke emissions.

Increasing returns were, at one point, considered to be an externalities problem in the conventional sense, because A's purchase of such an item may make it cheaper for B to obtain. This led to a long and confusing controversy that was only settled when J. Viner, in his "Cost Curves and Supply Curves," *Zeitschrift für Nationalökonomie,* III (1931–1), 23–46, showed that what was involved was just a pecuniary externality. For a review of the literature see H. S. Ellis and W. Fellner, "External Economies and Diseconomies," *American Economic Review,* XXXIII (September, 1943), 493–511. Of course, increasing returns do give rise to a number of analytic and policy problems: the unsustainability of competition (if the increasing returns are not produced by external economies), the losses resulting from marginal cost pricing in these circumstances, and the danger of breakdown of the second-order maximum conditions. None of these is, however, an externalities problem in the conventional sense, and each has given rise to a distinct body of literature. For a review of the discussion of increasing returns and monopoly, see Alfred E. Kahn, *The Economics of Regulation* (Wiley: New York, 1970), especially Volume II, Chapter 4. On the literature on marginal cost pricing and decreasing costs, see W. Baumol and D. Bradford, "Optimal Departures from Marginal Cost Pricing," *American Economic Review,* LX (June, 1970), 265–83.

[8] "Externality," *Economica.*

equilibrium, the (marginal) conditions of optimal resource allocation are violated. Perhaps this is all that need be said. However, it is not fully satisfying. One is tempted to look for a definition that starts earlier in the process, one that identifies the economic phenomenon leading to the postulated violation of the optimality conditions. Somehow, one is happier if the violation of these requirements can be *deduced* from the economic conditions that one takes as a definition, rather than just assuming that the violation occurs in some unspecified way.

Let us then attempt to provide an alternative definition of our own.[9]

Condition 1. An externality is present whenever some individual's (say A's) *utility* or *production* relationships include real (that is, nonmonetary) variables, whose values are chosen by others (persons, corporations, governments) without particular attention to the effects on A's welfare.[10]

This definition should not be misunderstood to be a simple equation of externalities with economic interdependence. When I rely on farmers for my food, no externality need be involved, for they do not decide for me how many zucchini I will consume, nor does my consumption enter directly into their utility functions.[11] Note also that the definition rules out cases in which someone *deliberately* does something to affect A's welfare, a requirement Mishan has emphasized.[12] If I purposely maneuver my car to splatter mud on a pedestrian whom I happen to dislike, he is given no choice in the amount of mud he "consumes," but one would not normally regard this as an externality.

It has also been suggested that for a relationship to qualify as an externality it must satisfy a second requirement:

Condition 2. The decision maker, whose activity affects others' utility levels or enters their production functions, does not receive (pay) in

[9] This definition is, of course, very similar in spirit to many others found in the literature. See, for example, E. J. Mishan, "The Postwar Literature on Externalities, An Interpretive Essay," *Journal of Economic Literature,* IX (March, 1971), 2–3.

[10] The reason the definition has been confined to effects operating through utility or production functions will become clear in a later section. We should also append to this definition the condition that the relationship holds in the absence of regulatory pressures for the control of the activity. One might argue that the threat or presence of government intervention can force the polluter to concern himself with the effects of his emissions on those whom he harms, but we would not want to say that his newly awakened concerns disqualify his emissions as an externality.

[11] Of course, my *payment* to him does affect his utility. This already brings in the distinction between pecuniary and technological externalities that will be discussed later in this chapter.

[12] E. J. Mishan, pp. 342–3 of his "The Relationship between Joint Products, Collective Goods and External Effects," *Journal of Political Economy* LXXVII (May/June, 1969), 329–48.

compensation for this activity an amount equal in value to the resulting benefits (or costs) to others.

This second proviso is required if the externality is to have all of the unpleasant consequences, including inefficiencies and resource misallocation, that are associated with the concept. It has long been recognized that, at least in some cases, proper pricing or tax-subsidy arrangements will eliminate the misallocations, though, as we will see later in this chapter, matters here are not as simple as has sometimes been supposed.[13]

Nevertheless, as was suggested to us by Professor Dorfman, one may prefer to define an externality to be present whenever condition 1 holds, whether or not such payments occur. If optimal taxes are levied, smoke generation by factories will no doubt be reduced, but it will not be reduced to zero. In that case, it seems more natural to say that the externality has been reduced to an appropriate level, rather than asserting that it has been eliminated altogether. Perhaps more important, the use of condition 1 alone as our definition has the advantage that, instead of postulating in advance the pricing arrangements that yield efficiency and Pareto optimality,[14] we can *deduce* from it what prices and taxes are compatible with these goals and which are not. These calculations will, as a matter of fact, be carried out in this and the following chapters. At any rate, we will say that an externality is present if the activity satisfies condition 1.

2 Public versus private externalities

In his classic paper, "The Anatomy of Market Failure," Bator pointed out that many externalities partake of the character of public goods. If the air in a city is polluted, it deteriorates simultaneously for every resident of the area, not just for any one individual. An increase in the number of people in the area will not reduce the level of atmospheric pollution. Air pollution, then, is clearly a public "bad." Similarly, landscaping of a garden that can be seen by all those passing by is a public good; it

[13] Thus, condition 1 may be taken to correspond roughly to what Buchanan and Stubblebine, in "Externality," *Economica,* have called *an externality* and conditions 1 and 2 together constitute what they call "a Pareto-relevant externality" (that is, an externality that prevents the necessary conditions for Pareto optimality from being satisfied). On the role of condition 2 in previous discussions of the definition of *externality,* see Mishan, "Relationship between Joint Products, Collective Goods and External Effects," *Journal of Political Economy,* p. 342.

[14] In this volume, we will define a vector of outputs to be *efficient* if it involves the largest *output* of some arbitrarily chosen good that can be attained without reducing the output of any other good. A vector of output values, *and its distribution among consumers,* is as usual, defined to be *Pareto-optimal* if it yields the largest value of some one consumer's *utility* that can be obtained without a reduction in the utility of any other consumer.

yields an externality which (at least up to some number of beneficiaries sufficiently large to cause congestion) confers benefits on all viewers of the garden. It is now commonplace that where a public good (or bad) is involved, the ordinary price system is unable to provide an efficient outcome. The basic source of the problem is (as we called it in the first edition of this book) the "undepletable" nature of public goods: the fact that an increase in the consumption of the good by one individual does not reduce its availability to others.[15] My breathing of polluted city air, for example, does not alter the quality of air inhaled by others. Likewise, my viewing of a local garden does not (if there is no congestion) detract from the pleasure to other onlookers.

As is well known, it is inefficient to charge for the consumption of such public goods, because the consumption of the good by one individual does not influence the level of satisfaction of anyone else. A positive price may inhibit an individual's consumption, thereby reducing his or her satisfaction without increasing that of other persons.[16]

[15] In his classic discussion of public goods, Head ("Public Goods and Public Policy," *Public Finance*) lists *two* attributes of such goods: "jointness of supply" and the inability to exclude potential consumers. Here, we concern ourselves with the first of these attributes, jointness of supply, for which we use the term "undepletability." An undepletable externality is thus one for which consumption by one individual does not reduce the consumption of anyone else. As Head shows, the two properties of public goods need not accompany one another (although they may). Exclusion may be possible even though the good is undepletable (e.g., a fence with a gate may exclude potential viewers of a garden). Similarly, depletion does not imply exclusion. The standard case here is one in which several petroleum suppliers have wells that draw on the same oil field; no supplier is excluded from the field, yet every barrel of oil removed by one supplier is no longer available to the others. We prefer to use the adjective "undepletable" rather than "public" because it focuses attention on the attribute that is pertinent here.

[16] This result, however, assumes the absence of a budget-balancing condition for the financing of the public goods. As Baumol and Ordover show, where a public good has to be financed by taxation (and where the amount in question is sufficiently large to distort decisions and cannot be raised by lump-sum measures), optimality requires *all* prices, P_i, in the economy to depart from marginal cost, MC_i, in accord with the well-known Ramsey formula, $P_i - MC_i = k(MR_i - MC_i)$, where MR_i is the marginal revenue of good i, and k is a constant that is identical for all goods, individuals, and firms in the economy. Thus, every commodity in the economy, and not just public goods, would have to experience a divergence between price and marginal cost, all thereby contributing to the financing of our public good j. However, since additional consumption of j adds nothing to social cost by its undepletability property, for that good the Ramsey rule simplifies to $P_j = k(MR_j)$. We note also that where the economy's production function is characterized by locally constant returns to scale at the equilibrium point, $k = 0$ so that the standard public good price $P_j = 0$ is then also the Ramsey price. See W. J. Baumol and J. A. Ordover, "On the Optimality of Public Goods Pricing with Exclusion Devices," *Kyklos* XXX (Fasc. 1, 1977), 5–21. All this is related to the issues raised by Common, to which we shall return in Chapter 4.

It is easy to think of many examples of environmental externalities that exhibit the property of undepletability: polluted air and water, noise, neighborhood slums, etc. We refer the reader to the list of externalities problems at the end of Chapter 2.

We turn now to the private (or as we will call it) the "depletable" case. For reasons that will soon become apparent, it is not so easy to provide a convincing example of a depletable externality. To get a clear illustration that may also begin to suggest the nature of the difficulty, we go back into economic history. Following World War II, there was a severe shortage of fuel, and it was reported that in several areas in Europe many people spent a good part of their time walking along railroad tracks looking for coal that had been dropped by passing trains. It is clear that this is a depletable externality, because for every additional bit of coal found by one gatherer, that much less was available to others.

The reason that the coal was left along the tracks was undoubtedly that the railroad companies did not find it profitable to gather the loose coal and then sell it. In principle, if there were enough money to be made, the railroad might even have hired the self-employed gatherers and put them to work collecting the coal for sale. We know very well that business firms are prepared to spend significant amounts on the accumulation of bits of material when they are precious enough (for example, in the working of gold and platinum). In such cases, then, either the externality must be insignificant or the cost of collecting an appropriate fee must be very high. Otherwise, private enterprise will find it profitable to take the measures necessary to eliminate the externality. Thus, it is hardly an accident that Bator found few depletable externalities that constitute important policy issues.

To take another example, consider the case of trash disposal by individual A. If A dumps trash on B's (unguarded) property, then this trash is not available to be deposited on C's land. In this instance, we have an external *bad*. But note that the externality is, in this case, divisible among the victims: Whatever trash is dumped on one victim's property cannot become a source of disutility for someone else. (Trash dumped on streets or in other public areas is obviously another matter.) Unlike the case of polluted air, our trash example involves a depletable externality in that it is divisible among the victims (i.e., one victim's consumption of the externality reduces that of others). The important allocative issue here is for the trash to be disposed of in the least costly way to society.

In summary, externalities can take either of two forms: a public (undepletable) form or a private (depletable) form. The issue of primary interest is how to adapt the set of incentives facing the parties to an externality so as to induce socially optimal behavior. We turn next to this important

matter. We will find in this regard that the basic policy prescription is the same for the undepletable and depletable cases. However, as we will discuss in a later section, there is a subclass of depletable externalities for which some supplementary measures may be needed.

3 Pareto-optimal pricing of externalities

In the first edition of this book, we contended that the distinction between depletable and undepletable externalities was of fundamental importance, because the appropriate policy measure for correcting the resulting allocative distortion differed in the two cases. However, as Freeman showed subsequently ("Depletable Externalities and Pigouvian Taxation"), this is not correct. Aside from the special case to be discussed later, the basic policy prescription is the same for both the depletable and undepletable cases. It is instructive, we believe, to explore this matter in more detail.

Let us consider first the undepletable case, which is, from all evidence, the more important one for environmental policy. We return, for purposes of illustration, to the familiar case of the smoky factory that pollutes the atmosphere over an entire area. All residents of the area suffer from the pollution; moreover, one individual's consumption of smoky air does not reduce that of any other. The allocative problem here involves two decisions: the adoption of the efficient level of smoke emissions by the factory, and the choice of the efficient level of "defensive" activities by the victims. The first of these decisions is self-explanatory: the factory owners must select the proper level of abatement measures to reduce emissions to their efficient levels. The response of victims is a bit more subtle. Victims may have available to them a range of activities through which they can protect themselves from the detrimental effects of the externality. In our case of the smoky factory, for example, nearby residents may invest in air-cleansing devices, or, alternatively, may choose to move to a new location more distant from the factory. Such responses we shall call "defensive activities." Note that such defensive activities have no effects on the consumption of smoke by any other victims; they are *purely private* in nature. (This is important, as we shall see shortly.)

Our problem is thus to find a set of conditions that characterize behavior consistent with a social optimum on the part of factory owners and victims and to determine a set of incentives that will induce profit-maximizing firms and utility-maximizing individuals to satisfy these conditions. We will undertake this exercise formally in the next chapter. The formal analysis confirms that in a competitive setting the solution to our problem requires only a single policy measure: a Pigouvian tax (or effluent fee) on emitters equal to marginal social damage. More precisely, the

environmental authority should levy a fee per unit of smoke emissions equal to the marginal damages accruing to all victims (residents and other firms).

As is generally recognized, the Pigouvian tax serves to internalize the external costs that the emitting factory imposes on others. Consequently, the factory owners will take into consideration not only their usual costs of production but also the other forms of social cost that their activities entail. In contrast, there is no need for any supplementary incentives for victims. As we shall demonstrate in Chapter 4, the damages that victims suffer from the detrimental externality provide precisely the correct incentives to induce them to undertake the efficient levels of defensive activities.

Let us next consider the case of a depletable externality. Instead of smoke, suppose that the local factory emits a depletable waste (like trash). There are two subcases of interest here. First, assume that the factory has no control over where the wastes are deposited. For technical reasons (e.g., geography or weather), the wastes always end up in a particular place irrespective of any disposal actions by the factory. The victim in this case is the individual who occupies the disposal site. A little reflection suggests that this case is, in principle, little different in its essentials from the public or undepletable case. The only difference is that we have but one victim. Hence, the marginal social damages are equal to the marginal damages to that individual alone. But the policy prescription remains the same as that in the undepletable case: a Pigouvian tax on the source of the externality and no supplementary incentives for the victim.[17]

Suppose, however, that the factory owners have some choice as to where they dump their wastes. An important aspect of the allocative problem now becomes the choice of the most efficient disposal site. For this case, the factory owners must face a schedule of fees that reflects the varying damages associated with the dumping of the trash at alternative sites. Confronted by such a schedule of fees, a profit-maximizing firm can be counted on to choose the site that minimizes the damages. So, once again, we find that a Pigouvian charge equal to marginal social damage leads

[17] In the previous edition of this book, we claimed, mistakenly, that the depletable case has fundamentally different implications for optimal pricing than does the undepletable case. As we indicated earlier, our error was first discovered and corrected by Freeman, to whom we are grateful. The effects of the depletable externality discussed in the text need not, of course, be limited to a single victim. In our trash example, the disposal operation can result in a division of the trash among several sites with a consequent multiplicity of victims. Since the externality is depletable, it would remain true by definition that whatever trash is deposited on one site cannot be deposited elsewhere. In this instance, the generator of the externality should pay a Pigouvian unit tax equal to the sum of the marginal damages over the various sites.

to an efficient result. Moreover, as before, victims, responding solely to the damages, can be expected to select the efficient levels of defensive activities.

In sum, irrespective of whether the externality is of the depletable or undepletable variety, the proper corrective device is a Pigouvian tax equal to marginal social damage levied on the generator of the externality with no supplementary incentives for victims. The latter part of this prescription needs some further discussion, to which we turn next.

4 Should the victims of externalities be taxed or compensated?

The efficient treatment of victims of externalities has been the source of varied prescriptions and considerable confusion in the literature. Some have argued that victims should be compensated for the damages they suffer, and others (like Coase) have argued that in some circumstances, victims should be taxed. As we indicated in the preceding section and will show formally in the next chapter, *so long as the number of victims is large,* the efficient treatment of victims prohibits compensation – whether the externality is of the depletable or undepletable variety. Moreover, taxation of victims is equally inappropriate (except for a special case whose rationale is somewhat different from that proposed by Coase).[18]

The discussion in the preceding section indicates that the victim of a detrimental externality should face a zero charge: The victim should neither be taxed nor compensated for the damages absorbed. Thus, in our case of the smoky factory, the discussion suggests that residents in the neighborhood of the factory should not receive compensation for smoke damages from the owners of the factory. What sort of allocative distortion would result were such compensation to be paid to nearby residents? Professor Coase has provided the basis on which this question can be answered. In this case, the socially optimal solution is likely to involve some degree of spatial separation between the factory and local residences. But if all the neighbors of factories were paid amounts sufficient to compensate them fully for all damages, including increased laundry bills, injuries to health, aesthetic insults, etc., obviously no one would have any motivation to locate away from the factory. Too many people would choose to live in smoky conditions, for they would, in effect, have been offered an economic incentive to accept the ill effects of the smoke

[18] This, of course, is not to deny that it is desirable to pass on to someone the real resources corresponding to the taxes collected from the generators of externalities. However, in the absence of any lump-sum subsidy mechanism, this should, in principle, be done through Ramsey reductions in all prices as described in note 16 – not through compensation to the victims of the externality based on the amount of damage they sustain.

with no offsetting benefits to anyone. The resulting inefficiency should be clear enough.

The point here is that victims typically have available to them a variety of responses to reduce the damages they suffer. For example, a victim can install insulation to reduce the amount of noise experienced from a nearby construction activity, or, as mentioned earlier, move farther away from the smoky factory. And, as we have just seen, compensation of victims is not economically efficient because it weakens or destroys entirely the incentive to engage in the appropriate levels of such defensive activities. As Olson and Zeckhauser have put it, "... the commonplace suggestion that those who generate external diseconomies ought to have to compensate their victims for any losses they suffer, can work against Pareto optimality. When such a suggestion is adopted, those injured by the diseconomy have no incentive to protect themselves from it, even if this should be more economical than requiring adjustment on the part of those who generate the diseconomy."[19]

In addition to the moral hazard problem, compensation of victims leads to other economic inefficiencies. As we shall see in the next chapter, it tends to produce excessive entry into the "victim activity" – too many laundries will open for business in the vicinity of the smoky electricity plant. Moreover, since compensation is a form of subsidy payment to the victim, it will serve to reduce the price of the victim's product and lead to socially excessive levels of its consumption. Because purchasers of laundry services do not pay the full marginal social cost of these services (since the laundry is compensated for the costs attributable to pollution), a socially excessive amount of laundry activity will be elicited by consumer demand.

Coase, however, has pushed this point harder. He argues that not only should we avoid compensation of victims, but we should tax them for the

[19] M. Olson, Jr. and R. Zeckhauser, "The Efficient Production of External Economies," *American Economic Review* LX (June, 1970), 512–17. The allocative problems that can be produced by full compensation are well known in other contexts. Full payment by an insurance company for all losses from theft removes any incentive for precautions against robbery; it makes for an inadequate allocation of resources to burglary prevention devices. Or to bring the matter out more sharply with the aid of a rather grizzly example, suppose workers, *on the average,* were known to feel fully compensated for the loss of a finger by the payment of one million dollars. Imagine the horror that might result if industrial insurance were to offer this compensation to anyone suffering from such a loss! In each of these cases, the *absence* of full coverage is essential for the prevention of what may conservatively be described as great economic waste.

Of course, it may nevertheless be decided to undertake some compensation of victims on grounds of fairness. But then there must be a trade-off between fairness and efficiency. On this, see W. J. Baumol, *Superfairness: Applications and Theory* (Cambridge, Mass.: M.I.T. Press, 1986), Chapter 5.

costs that their decisions impose on the factory owners. Coase's contention is that when residents select a home in the vicinity of the factory, they impose an "external" cost on the generator of the externality, the owners of the factory. This cost takes the form of a higher Pigouvian fee to the owners reflecting the increase in damages from the factory's smoke emissions associated with the rise in the number of victims. This argument, however, is incorrect (for the case where the number of victims is large – the case that is *not* the subject of Coase's analysis). As we shall see later, the increase in the effluent fee to the firm is not a true externality in the sense that we have defined the term. To provide the proper incentives to victims for defensive activities, neither compensation nor a tax is appropriate.

5 A qualification: the special case of shiftable externalities

As we have seen, the general Pigouvian prescription entails no supplementary incentives, either compensation or taxation, for victims of detrimental externalities. However, as Bird has pointed out recently, there exists a special set of circumstances in which it may be necessary to subject victims to taxation.[20] We will treat this special case as a qualification to the general rule for the treatment of victims, but, as will become clear, this case really does not constitute an exception to the Pigouvian results. Rather, it entails an extension of the Pigouvian measure to encompass external effects associated with responses by victims. It is clearly Pigouvian in spirit.

This case involves what we shall call a "shiftable externality." In such instances, the victim has the opportunity to "shift" the externality to a third party.[21] Returning to our trash example, the victim may respond to the dumping of the rubbish on his or her own property by removal and dumping of the wastes onto someone else's land. In short, the victim avoids the detrimental effects of the externality by shifting it to another party. For such cases, we obviously need some sort of incentive

[20] Peter J. W. N. Bird, "The Transferability and Depletability of Externalities," *Journal of Environmental Economics and Management* XIV (March, 1987), 54–57.

[21] We choose the term *shiftable* here because of the close analogy with its use in the field of taxation. In particular, a tax is said to be shifted when the entity on which the tax is levied is able to alter its behavior in such a way as to place the burden of the tax on others. Similarly, we will call an externality shiftable if the recipient has the ability (as in our trash example) to push the externality along to other parties. We note that shiftable externalities are a subclass of depletable externalities. If the externality is undepletable, it must by definition be unshiftable, since one person's consumption of the externality leaves others unaffected. The property of depletability is a necessary, but not a sufficient, condition for an externality to be shiftable.

to induce efficient behavior by victims as well as by the generator of the externality.

The required incentive in this instance takes the form of a tax on the victim applicable to any shifting activities. More precisely, victims must be subject to a unit tax equal to the marginal social damage accruing to the parties to whom the victim shifts the externality. In our trash example, the initial victim should face a schedule of Pigouvian taxes equal to the marginal social damages corresponding to the various shifting alternatives available to him. It is easy to see why this leads to an efficient outcome. The socially optimal result involves the depositing of the wastes where they do the least net damage (net of shifting costs). Suppose that an initial victim finds that the tax he must pay to place the trash elsewhere exceeds the value of the damages he absorbs if he simply serves as the trash receptor. In this case, he will choose not to shift the externality, and this is obviously the optimal social outcome, since it is clear that the damage to the initial victim is less than that to any alternative victim. In contrast, if the initial victim finds an alternative victim that is willing to absorb the wastes for less than the former is willing to pay, then shifting will occur and will obviously be socially efficient.

In sum, in the special case of a shiftable externality, victims must themselves be subject to a tax equal to the marginal social damages caused by their shifting activities. As should be clear, such a tax is Pigouvian in spirit – it represents an extension of the Pigouvian prescription to encompass any externality-generating activities which are undertaken by victims in the course of protecting themselves from other externalities. The basic principle remains unmodified – all generators of externalities, whatever other roles they may play, must be charged for the (marginal) damage that they impose on others. But in the role of victim *per se,* efficiency requires that no one either be taxed or compensated. Only if one person happens to be both victim and generator of externalities simultaneously should he be subject to a tax, but only for assuming the latter role.

6 Externalities and property rights

The source of an externality is typically to be found in the absence of fully defined property rights.[22] And this implies that in some instances

[22] There is now a large literature on the relationship between externalities and property rights. The seminal piece is the Coase paper that we have so often cited. Among the paper's many insights is the now famous "theorem" that where there is costless bargaining between the generator and the victim of an externality, the optimal outcome will emerge so long as *either* party holds the pertinent property right – it does not matter which one. For other important contributions, see Harold Demsetz, "The Exchange and Enforcement of Property Rights," *Journal of Law and Economics* VII (October, 1964), 11–26; and J. H. Dales, *Pollution, Property, and Prices* (Toronto: University of Toronto Press, 1968).

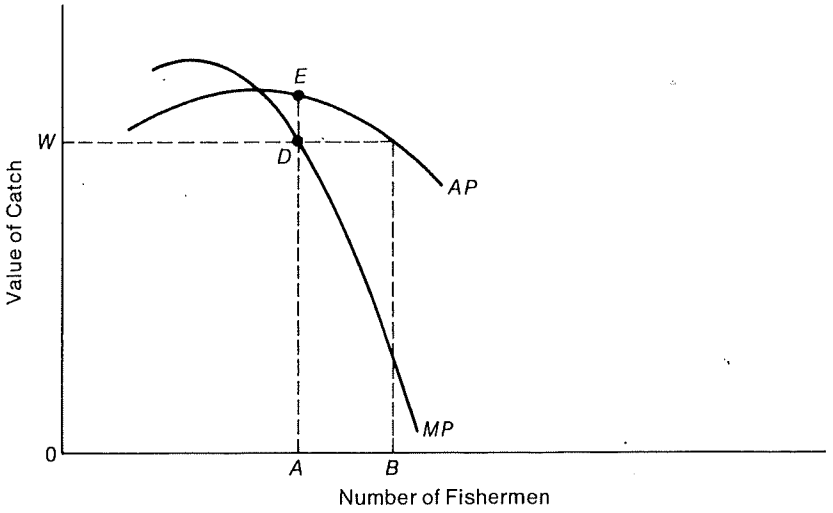

Figure 3.1

the distortions resulting from an externality can be eliminated through an appropriate redefinition of such rights of ownership. Once again, the general point is best made clear through an example. Consider a lake to which all fishermen have free access. The haul of one fisherman reduces the expected catch of the others, so a detrimental externality is present. The result of individual maximizing behavior in this setting will be an excessive level of fishing activity. This is easily seen with the aid of Figure 3.1. If W in the figure represents the wage (and marginal product) in alternative employments, the number of fishermen in equilibrium will be OB, where the average product (in money terms) of a fisherman equals the wage that he can obtain elsewhere. This is obviously too large a number of fishermen, because an individual's fishing activity imposes costs on others and thereby generates a marginal social yield lower than the value of marginal product in other activities. Following the discussion in the preceding sections, one can correct this distortion by introducing an appropriate charge for admission to the lake, a charge that effectively internalizes the external costs that a fisherman imposes on his compatriots. In Figure 3.1, such a charge is equal to DE; this effectively reduces the

net return to the marginal fisherman to equality with his marginal social product and leads to a reduction in the number of fishermen to the efficient level, OA.

There is, however, another approach to the correction of the distortion associated with this free-access equilibrium. Suppose that, instead of introducing an entry fee, the lake were transferred from public to private ownership, perhaps through some sort of auction. Suppose, moreover, that the new owner seeks to maximize profits from fishing activities on the newly acquired lake. He thus hires fishermen to whom he pays a wage of W and from whom he receives the catch in return. Note that the profit-maximizing solution implies that the lake owner will hire OA fishermen; he will take on fishermen to the point at which the value of the marginal product equals the wage, W, that he must pay. Thus, the private-ownership outcome will be socially efficient.[23]

A redefinition of property rights may thus in some instances represent an alternative means (and sometimes even a preferable one) for dealing with an externality. By establishing ownership rights where none existed before, we may effectively eliminate the externality. However, this is not always easy to do. Establishing rights in "clean air," for example, is not a simple matter. There may, moreover, be other reasons for desiring free access to certain socially held resources. But, as we shall see in later chapters, there may be ways of establishing certain kinds of rights that can facilitate the regulation of various sorts of pollution. For now, we simply want to make clear the significant connection between externalities and property rights and the policy alternative that this relationship suggests.

[23] The inefficiencies associated with the free-access equilibrium have long been recognized. The issue is nicely described in a book that appeared early in the nineteenth century:

> Suppose that the earth yielded spontaneously all that is now produced by cultivation; still without the institution of property it could not be enjoyed; the fruit would be gathered before it was ripe, animals killed before they came to maturity; for who would protect what was not his own; or who would economize when all the stores of nature were open to him? . . .
>
> In this country, for instance, where the only common property consists in hedge-nuts and blackberries, how seldom are they allowed to ripen . . .

From Mrs. J. H. Marcet, *Conversations in Political Economy,* 3rd ed. (London, 1819), 60–1. This book, written by a friend of David Ricardo, was one of the first textbooks in economics. It takes the form of a dialogue between a Mrs. B and her young friend, Caroline, who quickly succumbs to her mentor's economic arguments. A more recent nontechnical and influential treatment of this issue is Garrett Hardin's "The Tragedy of the Commons," *Science* 162 (December 13, 1968), 1243–48. For a more rigorous analysis, see, for example, H. Scott Gordon, "The Economic Theory of a Common-Property Resource: The Fishery," *Journal of Political Economy* VXII (April, 1954), 124–42.

7 Summary: pricing and external effects

It has often been said that externalities introduce distortions in resource use because they are cases in which society fails to charge a price (positive or negative) for a good (or a bad). We see now that the issue is somewhat more complex. The real problem is that no normal price can do the job. The trouble in this case is that economic efficiency requires a pricing asymmetry: a nonzero price to the "supplier" of the externality (positive price for an external benefit and a negative price or tax for a detrimental externality), and a zero price for the consumption of the externality. However, an ordinary price is, by its nature, symmetrical between supplier and consumer; it cannot assume the asymmetrical form required to induce efficient behavior. But a Pigouvian tax (subsidy) can. The tax or subsidy provides the proper incentive for the supplier of the externality while leaving its consumer with a zero price, as efficiency dictates.

8 Technological and pecuniary externalities

In a paper that is now one of the classics of economic literature, Jacob Viner showed that not all relationships that appear to involve externalities will produce resource misallocation.[24] There is a category of pseudo-externalities, the *pecuniary externalities,* in which one individual's activity level affects the financial circumstances of another, but which need not produce a misallocation of resources in a world of pure competition. Viner brought the distinction to our attention to clear up an error in Pigou. The nature of the error is now largely a matter of doctrinal history and does not particularly concern us here. However (despite some recent assertions to the contrary), the distinction remains of great relevance for current discussions of externalities.

Pecuniary externalities result from a change in the prices of some inputs or outputs in the economy. An increase in the number of shoes demanded raises the price of leather and hence affects the welfare of the purchasers of handbags. But unlike a true externality (Viner called it a *technological externality*), it does not generate a *shift* in the handbag production function.

It should be emphasized that, whether an externality is pecuniary or technological, the ultimate comparative static effects are likely to involve changes both in prices *and* in the values of the relevant real variables. In the case of technological externalities (for example, the increased real

[24] Viner, "Cost Curves and Supply Curves," *Zeitschrift für Nationalökonomie.*

resource cost of laundry output resulting from an enlarged volume of smoke), prices will almost certainly be affected (laundry prices will rise) and even input prices may well be altered as their usage is changed. Similarly, in the pecuniary case, say in the case of a rise in the price of leather produced by an increased demand for shoes, the handbag manufacturers may well modify their manufacturing processes by, for example, the substitution of labor for leather through more careful cutting of the raw materials.

The essence of the distinction then is *not* that a pecuniary externality affects only the values of monetary, rather than real, variables. The point is that the introduction of a technological externality produces a *shift* in the functions relating quantities of resources as independent variables and output quantities or utility levels of consumers as dependent variables. Consequently, it means – comparing two otherwise identical states in which there is a technological externality in one, but not in the other – that a given vector of real inputs allocated identically in both cases will *not* leave all members of the economy indifferent between the two states. In contrast, the introduction of a pecuniary externality permits all members of the economy to remain at their initial utility levels *if all inputs are used as before* and if there is an appropriate redistribution of income to compensate for the income effects of the price changes that are the instrument of that externality.

The smoke that increases the soap and labor costs of the laundry means that, if one were to employ the same quantities of inputs as would be used in the absence of the externality, either fewer clothes must be laundered or the clothes cannot come out as clean. But with the enhanced demand for shoes, it need take no more leather than before to produce a handbag. The higher price of handbags represents, in effect, only a transfer of income from purchasers of handbags or from handbag manufacturers to the suppliers of leather, or perhaps, in the long-run competitive equilibrium, from handbag purchasers to the owners of land for cattle grazing. But the initial collection of inputs will still be capable of producing the initial bundle of outputs and, hence, of leaving everyone as well off as he would have been in the absence of the increased demand for shoes.

This immediately indicates why pecuniary externalities need produce no resource misallocation under conditions of pure competition. For they do not constitute any change in the real efficiency of the productive process viewed as a means to transform inputs into utility levels of the members of the economy. Indeed, the price effects that constitute the pecuniary externalities are merely the normal competitive mechanism for the reallocation of resources in response to changes in demands or factor supplies.

Viewed another way, our increased demand for shoes, for example, may well induce a rise in the production (and in the relative cost) of shoes compared to pencils. However, this takes the form of a movement along the production-possibility frontier; it does not shift the frontier itself, as would a change in the output of smoke by our illustrative factory, that is, it causes no divergence between the slope (social marginal rate of transformation) and the private *MRT* at any point on this frontier. Similarly, because a pecuniary externality enters no utility function, it will produce no divergence between any social and private *MRS*.

This suggests the irrelevance of pecuniary externalities for the optimality of the market equilibrium of the competitive system. Equilibrium conditions for the competitive system consist (where the relevant functions are twice differentiable) of a set of equalities and inequalities involving only *private* marginal rates of substitution and transformation (that is, those of the decision maker to whose decision variables the marginal rates apply). Optimality of resource allocation, however, requires the satisfaction of precisely the same equalities and inequalities but this time involving the *social* marginal rates of substitution and transformation. Because pecuniary externalities produce no divergences between private and social marginal rates of substitution and transformation, they do not create any differences between the optimality conditions and those characterizing a competitive equilibrium. Consequently, despite the presense of pecuniary externalities, the competitive equilibrium will produce an optimal allocation of resources, provided, of course, that all of the other necessary conditions (existence, the appropriate convexity-concavity requirements, and so on) are fulfilled.

9 Variations in Pigouvian taxes as pecuniary externalities

The analysis of the preceding section can shed some light on the optimality of the Pigouvian tax measures. It has been argued recently that the imposition of such a tax can itself introduce a set of externalities, for those who are protected by the tax can, by their own decisions, affect the magnitude of the payment. If a household moves near a smoke-generating factory or undertakes to do more laundry in its vicinity, the social damage caused by the smoke will be increased and this, in turn, will lead to an increase in the tax rate that will harm the factory owner; this rise in tax rate constitutes an externality caused by the decision of the household just as surely as the smoke produced by the factory. In the words of Professor Coase,

> An increase in the number of people living or of business operating in the vicinity of the smoke-emitting factory will increase the amount of harm produced

by a given emission of smoke. The tax that would be imposed would therefore increase with an increase in the number of those in the vicinity. This will tend to lead to a decrease in the value of production of the factors employed by the factory, either because a reduction in production due to the tax will result in factors being used elsewhere in ways which are less valuable, or because factors will be diverted to produce means for reducing the amount of smoke emitted. But people deciding to establish themselves in the vicinity of the factory will not take into account this fall in the value of production which results from their presence. This failure to take into account costs imposed on others is comparable to the action of a factory-owner in not taking into account the harm resulting from his emission of smoke.[25]

This rising tax relationship that Professor Coase described is equivalent, analytically, to a *pecuniary,* not a *technological,* externality. In the case where the number of victims is large (the case with which Coase was *not* dealing), it will produce no misallocation of resources. Again, this is not difficult to show. The generation of smoke increases the real resource cost of laundry production and perhaps influences the marginal utility of various types of consumption as well. However, the increase in the tax has no such effects. It merely changes the marginal *pecuniary* return to the activities of the factory. An increase in laundry activity that increases the tax rate is precisely analogous to an increase in shoe production that increases the cost of leather to handbag manufacturers. In each case, a resource (in one case, leather, in the other, clean air) has become more valuable and the price of the resource has increased commensurately, as proper resource allocation requires.

It is true that the rise in tax rates has some real effects and not just pecuniary consequences: it leads "...to a decrease in the value of production of the factors employed by the factory," but exactly the same is true in the handbag example. People formerly employed in handbag production may, because of higher leather prices, find themselves "being used elsewhere in ways which are [or, rather, formerly were] less valuable." But this is, of course, a common property of pecuniary externalities, one that has already been emphasized. Price changes do have real effects on the equilibrium values of various economic variables but need not result in resource misallocation.

10 A note on the small-numbers case

As we stressed in Chapter 2, our emphasis in this volume is on the large-numbers case, which we consider the more important case for purposes

[25] R. H. Coase, "Problem of Social Cost," *Journal of Law and Economics,* Section IX, p. 42.

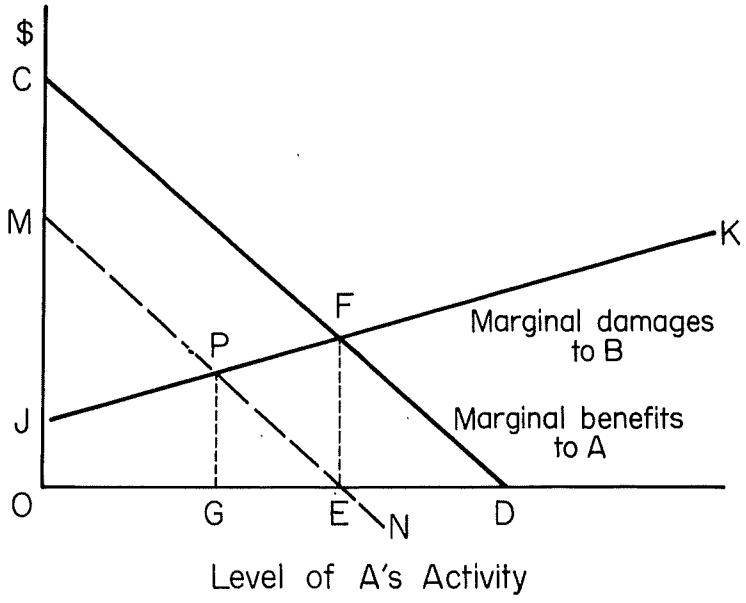

Figure 3.2

of environmental policy. However, there are a few points that are worth noting here. Coase has shown that where voluntary bargains that exhaust the potential gains from trade are struck among the parties to an externality, an efficient outcome will be reached.[26] The setting for such bargaining requires, in general, a small number of participants on both sides of the activity: one or few generators and one or few victims. In such a setting, Coasian behavior may indeed eliminate any distortions in resource use. Obviously, there would be no need for a Pigouvian tax or subsidy under such circumstances. In fact, as Coase argued and Turvey later emphasized, a Pigouvian tax in the Coase setting will itself become a source of misallocation of resources. This is easily seen in terms of an adaptation of a useful diagram introduced by Turvey.[27]

In Figure 3.2, the horizontal axis depicts the level of some activity by individual *A* that has associated with it external damages to some other party, *B*. The curve *CD* indicates the marginal benefits to *A* from this activity, and the curve *JK* reflects the marginal damages that *B* absorbs

[26] R. H. Coase, "The Problem of Social Cost," *Journal of Law and Economics.*

[27] Ralph Turvey, "On Divergences between Social Cost and Private Cost," *Economica* XXX (August, 1963), 309–13.

as an external cost of A's doings. In the absence of any extraordinary incentives, utility-maximizing behavior by A will lead to a level of the activity, OD, at which point marginal benefits become zero. Marginal benefits to society, however, become zero at OE, the point at which the marginal benefits to A are precisely offset by the marginal damages to B. Hence, OE is the Pareto-optimal outcome. Note that in a Coasian world of bargaining, individual B would be prepared to pay A to cut back on the activity to OE. For any unit of the activity to the right of OE, the marginal damages to B exceed the marginal gains to A; there are thus potential gains from trade to be realized. The Coasian equilibrium is OE, the socially correct outcome.

Suppose, however, that a public agency, behaving like a good Pigouvian, levies a tax on A equal to marginal social damage at the efficient level of output OE. The tax would be a levy of EF per unit of the activity. The effect of this tax would be to shift A's marginal benefit curve down to the dashed line MN; MN depicts the marginal gains to A net of the tax. In the absence of any bargaining, this would clearly lead A to the socially efficient outcome OE. But suppose that Coasian bargaining takes place in the presence of the tax. Realization of the gains from trade will now lead the parties to point P and the associated level of activity OG. A's activity will now be below the efficient level. We thus find that in a Coasian world, Pigouvian taxes are not just superfluous; they themselves become the source of distortions in resource allocation.

The small-numbers case can undermine the optimality of the Pigouvian solution in yet another way. A tax (positive or negative) upon generators of an externality always invites strategic behavior by victims that is deliberately designed to change the magnitude of the tax in a way that benefits the victims at the expense of society. Victims of detrimental externalities will aim for further (and socially excessive) restriction of the quantity of externality generated, whereas those who enjoy the consequences of beneficial externalities will seek to elicit socially excessive externality outputs. An example will make the mechanism clear. Imagine a laundry with two plants: plant A located near a smoky electricity-generating station, and plant B, located farther away. Suppose also that plant B is free of smoke damage but that its operation incurs heavy transport cost. Then the laundry firm may find it profitable to assign more of its operation to plant A than it would have otherwise, because the greater the level of activity at plant A, the larger the marginal damage of a puff of smoke and, hence, the larger the tax upon the electricity generator will be. The net effect will then clearly be an inappropriately low level of electricity output from the viewpoint of social welfare. The laundry will benefit by reduced transport costs and reduced pollution damage at plant A through

socially excessive use of that plant. Of course, none of this can happen if every victim is too small to be able to affect significantly the magnitude of the tax upon the polluter.

This discussion also helps to explain why Coase suggests that a tax on victims may be necessary for optimality, along with the Pigouvian tax on the generator of the externality. For if the victim's strategy involves deliberate and excessive self-subjection to damage from the externality in order to raise the tax on the generator, then a tax on the victim will be needed to discourage such antisocial strategic behavior. Thus, in the small-numbers case where there are incentives for strategic behavior, a tax on victims that accompanies a Pigouvian tax on generators may, indeed, make sense, at least in theory.

Perhaps more to the point, where both the number of generators and victims are small, the Pigouvian tax approach may well be impractical (imagine a tax rule devised for just a handful of people!). For such a case the Coasian property-rights approach may well be the most sensible way to control the externality.

The moral of the story is clear. In a small-numbers setting where Coasian bargains are likely, we should be wary of the introduction of Pigouvian measures. At the same time, we must reiterate our contention in Chapter 2 that the most widespread and serious of our environmental problems involve the large-number case for which Coasian sorts of negotiations are not to be expected. Moreover, even in the small-numbers case, there may be serious impediments to efficient bargains in the form of strategic behavior by the parties.[28]

[28] In fact, under certain forms of strategic behavior, Pigouvian taxes can yield optimal outcomes, even in the small-numbers case. On this, see Donald Wittman, "Pigovian Taxes Which Work in the Small-Number Case," *Journal of Environmental Economics and Management* XII (June, 1985), 144–54.