6 Public Goods and Publicly Provided Private Goods

FOCUS QUESTIONS

1 What distinguishes public goods, those goods which are typically provided by governments, from privately provided goods? What do economists mean by *pure public goods*?

2 Why will private markets undersupply pure public goods? What is the free rider problem?

3 Why do governments provide goods which are not pure public goods?

4 What determines an efficient supply of pure public goods? How is the efficient supply affected by concerns about income distribution? How is it affected by the fact that taxes required to pay for the public good typically introduce distortions in the economy?

5 In what sense is efficient government a public good?

The government supplies a wide variety of goods, from national defense to education to police and fire protection. Some of these goods, like education, are also provided privately; others, like national defense, are the exclusive province of government. What are the economic properties of such goods? How do they differ from goods such as ice cream, automobiles, and the myriad of other goods that are provided principally through private markets?

6 PUBLIC GOODS AND PUBLICLY PROVIDED PRIVATE GOODS

Earlier chapters noted the central role played by prices in market economies. Because of the price system, markets result in an efficient allocation of resources. Prices ration private goods. Those consumers who are willing and able to pay the requisite price obtain the good. This chapter asks: What is distinctive about the goods typically provided by government? What prevents them in many cases from being provided privately? And if they are provided privately, why is the private supply likely to be inadequate?

PUBLIC GOODS

To distinguish between private and public goods, economists ask two basic questions. First, does the good have the property of rival consumption? **Rival consumption** means that if a good is used by one person, it cannot be used by another. For instance, if Lynn drinks a bottle of apple juice, Fran cannot drink that same bottle of apple juice. By contrast, **non-rival consumption** refers to cases for which one person's consumption does not detract from or prevent another person's consumption.

The classic example of non-rival consumption is national defense. If the government creates a military establishment that protects the country from attack, all citizens are protected. National defense costs are essentially unaffected when an additional baby is born or an additional individual immigrates to the United States. This stands in sharp contrast to private goods. It costs additional resources to provide another bottle of apple juice so that both Lynn and Fran can have one. This is the only way for Lynn and Fran each to enjoy a bottle of apple juice. For a non-rival good, such as a lighthouse, though it would indeed cost more to build more lighthouses, there is essentially no additional cost for an additional ship to make use of an existing lighthouse.

The second question we ask to distinguish between private and public goods relates to the property of **exclusion**. Is it possible to exclude any individual from the benefits of the public good (without incurring great costs)? A ship going past a lighthouse, for instance, cannot be excluded from the benefits the lighthouse provides. Likewise, if the country is defended against attack by foreigners, then all citizens are protected; it is difficult to exclude anyone from the benefits. Clearly, if exclusion is impossible, then use of the price system is impossible, because consumers have no incentive to pay. By contrast, private goods always have the property of excludability: individuals can be excluded from enjoying the good unless they pay for it.

Generally speaking, private goods have the properties of rival consumption and excludability; public goods are characterized by non-rival consumption and non-excludability. Goods for which there is *no* rivalry in consumption and for which exclusion is *impossible* are **pure public goods.** To develop a more complete picture of public goods (and pure public goods), we now examine the properties of non-rivalry and non-exclusion in greater detail. We will see how these properties may lead to market failures, creating a rationale for the public provision of public goods.

PUBLIC GOODS AND MARKET FAILURES

In order to isolate the role of excludability and rivalrousness in consumption, we consider instances in which a good has one property but not the other. For some goods, consumption is non-rival but exclusion is possible. For instance, the marginal cost of an additional individual turning on his television and watching a show is zero; the number of times I watch *Seinfeld* does not detract from the number of times you can watch it. But exclusion is possible (though costly), through signal scramblers, as illustrated by pay-TV.

Even if exclusion were possible, when a good is non-rival, there is no impetus for exclusion from the standpoint of economic efficiency. Charging a price for a non-rival good prevents some people from enjoying the good, even though their consumption of the good would have no marginal cost. Thus, charging for a non-rival good is inefficient because it results in underconsumption. The marginal benefit is positive; the marginal cost (of the extra person watching the show) is zero. The underconsumption is a form of inefficiency.

But if there is no charge for a non-rival good, there will be no incentive for supplying the good. In this case, inefficiency takes the form of undersupply.

Thus, there are two basic forms of market failure associated with public goods: **underconsumption** and **undersupply.** In the case of non-rival goods, exclusion is undesirable because it results in underconsumption. But without exclusion, there is the problem of undersupply.

PAYING FOR PUBLIC GOODS

If exclusion is possible, even if consumption is non-rival, governments often charge fees, called **user fees,** to those who benefit from a publicly provided good or service. Toll roads are financed by user fees. The airline ticket tax can be thought of as a user fee; revenues from the ticket tax (currently 10 percent of the price of the ticket) go to finance airports and the air traffic control system. User fees are often thought of as an equitable way of raising revenues, since those who use the public facility the most (and therefore presumably benefit from it the most) pay the most. However, when consumption is non-rival, user fees introduce an inefficiency. We can use the sort of analysis introduced in Chapter 5 to measure the inefficiency.

This is illustrated in Figure 6.1 for the case of a bridge. We have drawn the demand curve for the bridge, describing the number of trips taken as a function of the toll charged. Lowering the toll results in increased demand for the bridge. The capacity of the bridge is Q_c; for any demand below Q_c there is no congestion and no marginal cost associated with use of the bridge. So long as the bridge is operating below capacity, consumption is non-rival; additional consumption by one individual does not detract from what others can enjoy. Since the marginal cost of usage is zero, efficiency requires that the price for usage be zero. But clearly, the revenue raised by the bridge will then be zero.

This is where the difference between *public provision* and private is clearest: with a single bridge, the monopoly owner would choose a toll to maximize his revenue, and would build the bridge only if those revenues equaled or exceeded the cost of the bridge. The government would face a more

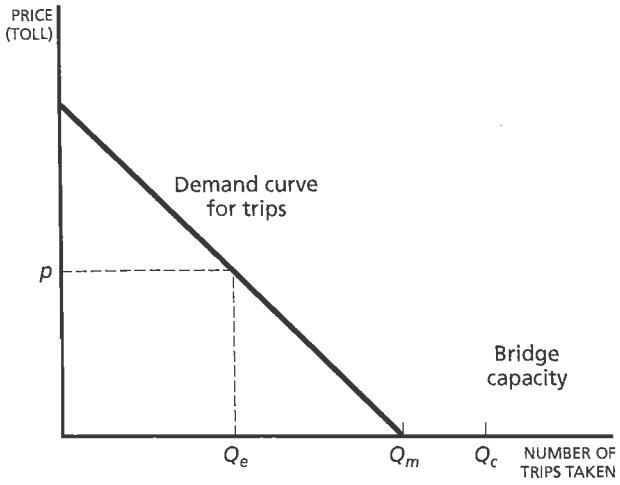

FIGURE 6.1 **Bridges: How a User Fee Can Result in Underconsumption** If the capacity is large enough, the bridge is a non-rival good. While it is possible to exclude people from using the bridge by charging a toll, p, this results in an underconsumption of the good, Q_e, below the non-toll level of consumption, Q_m.

complicated set of calculations. It might charge the toll required to just cover the costs of construction, to break even. In doing so, it would recognize that with any toll, the usage of the bridge would be reduced, and some trips whose benefits exceed the social cost (here zero) would not be undertaken. Thus, it might charge a toll less than required to break even, raising the revenue required to finance the bridge in some other way. It might not even charge any toll. In making these decisions, it would weigh equity considerations—the principle that those who benefit from the bridge should bear its costs—with efficiency considerations. The distortions arising from the underutilization of the bridge would need to be compared with the distortions associated with alternative ways of raising revenues (for example, taxes) to finance the bridge. Finally, the government might build the bridge even if the maximum revenue it could obtain from the tolls was less than the cost of the bridge, since it recognizes that there is some consumer surplus from the bridge: the amount that at least some individuals might be willing to pay for the bridge may be considerably greater than even the amount raised by the revenue-maximizing toll.

THE FREE RIDER PROBLEM

Many of the most important publicly provided goods—such as public health programs and national defense—have the property of non-excludability, making rationing by the price system unfeasible. For instance, the interna-

tional vaccine program against smallpox virtually wiped out the disease, to the benefit of all, whether they contributed to supporting the program or not. While national defense has the property of non-excludability and zero marginal cost, there are a few goods which have the property of at least high costs of exclusion, even though the marginal cost of using the good is positive. Congested urban streets are an example: under current technology, it is expensive to charge for the use of the street (someone could collect tolls at each corner, but the cost would be extremely high); but the throughput of the street may be limited, so if one more person uses it, another is displaced—indeed, in some cases, as more people attempt to use the street, the total throughput of the street may even be decreased, as gridlock sets in.

The infeasibility of rationing by the price system implies that the competitive market will not generate a Pareto efficient amount of the public good. Assume that everyone valued national defense, but the government did not provide for it. Could a private firm enter to fill this gap? To do so, it would have to charge for the services it provided. But since every individual would believe that he would benefit from the services provided regardless of whether he contributed to the service, he would have no incentive to pay for the services *voluntarily*. That is why individuals must be forced to support these goods through taxation. The reluctance of individuals to contribute voluntarily to the support of public goods is referred to as the **free rider problem.**

An example will help to illustrate the nature of this problem. In many communities, fire departments are supported voluntarily. Some individuals refuse to contribute to the fire department, yet, in an area where buildings are close together, the fire department will usually put out a fire in a noncontributor's building because of the threat it poses to adjacent contributors' structures. Knowing that they will be protected even if they do not pay induces some people to be free riders.

Clearly, if it is not possible to use price to ration a particular good, the good is not likely to be provided privately. If it is to be provided at all, government will have to take responsibility.

There are a few cases where non-excludable public goods are provided privately. Usually this is because there is a single, large consumer whose direct benefits are so large that it pays him to provide it for himself. He knows that there are free riders benefiting from his actions, but in deciding how much to supply, he looks only at his own direct benefit, not at the benefits that accrue to others. For instance, a large shipowner might find it worthwhile to install a lighthouse and light buoys, even if others cannot be excluded from enjoying the benefits. But in deciding how many lighthouses and buoys to construct, he looks only at the benefits which accrue to his own ships. The total benefit of an additional buoy—including the benefits both to his own ships and to others, for instance—might be considerable, even though the direct benefit to his own ships might not warrant the additional cost. In that case he would not put the additional buoy into place. Thus, even if there is *some* private provision of public goods, there will be an undersupply.

ECONOMISTS AND THE FREE RIDER PROBLEM

The free rider problem is just a reflection of an important incentive problem that arises in the case of public goods: If the good is going to be provided anyway, why should I pay? What I would contribute would be negligible, and hardly alter the aggregate supply. To be sure, if everyone reasoned the same way, the good would not be supplied. That is one of the arguments for government's providing these goods, because government has the power to compel people to contribute (through taxes).

But there are many instances of public goods being supported voluntarily: volunteer fire departments, local charities, hospitals, public TV, and many others. How do we explain these? Perhaps

PURE AND IMPURE PUBLIC GOODS

A pure public good is a public good where the marginal costs of providing it to an additional person are strictly zero and where it is impossible to exclude people from receiving the good. National defense is one of the few examples of a pure public good. Many public goods that government provides are not *pure* public goods in this sense. The cost of an additional person using an uncrowded interstate highway is very, very small, but not zero, and it is possible, though relatively expensive, to exclude people from (or charge people for) using the highway.

Figure 6.2 compares examples of goods that are often publicly provided with the strict definition of a *pure* public good. It shows the ease of exclusion along the horizontal axis and the (marginal) cost of an additional individual's using the good along the vertical axis. The lower left-hand corner represents a pure public good. Of the major public expenditures, only national defense comes close to being a pure public good. The upper right-hand cor-

PUBLIC GOODS

Pure public goods have the properties of perfectly non-rival consumption and non-excludability.

With non-rival consumption, it is not desirable to exclude anyone from the benefits. With private provision, there will be underconsumption and/or undersupply.

With non-excludability, it is not feasible to exclude anyone from the benefits of the good. There will be a free rider problem. Such goods typically cannot be provided by the market, and when they are privately provided, they will be undersupplied.

economists have overemphasized the "selfish" nature of man? Several recent studies in experimental economics have suggested that this might be the case. These experimental situations are designed to make individuals face situations where they could free ride if they wanted to; alternatively, they could cooperate in providing for a public good. Systematically, more cooperative behavior and less free riding is observed than economists' analysis of selfish incentives would suggest. Interestingly, when economists participate in these experiments, their behavior systematically comes much closer in accord with the predictions of their theory.

ner represents a good (ordinary health services) where the cost of exclusion is low and the marginal cost of an additional individual using the good is high. It is easy to charge each patient for health services, and it costs a doctor twice as much to see two patients as to see one—there are significant marginal costs of providing health services to additional individuals.

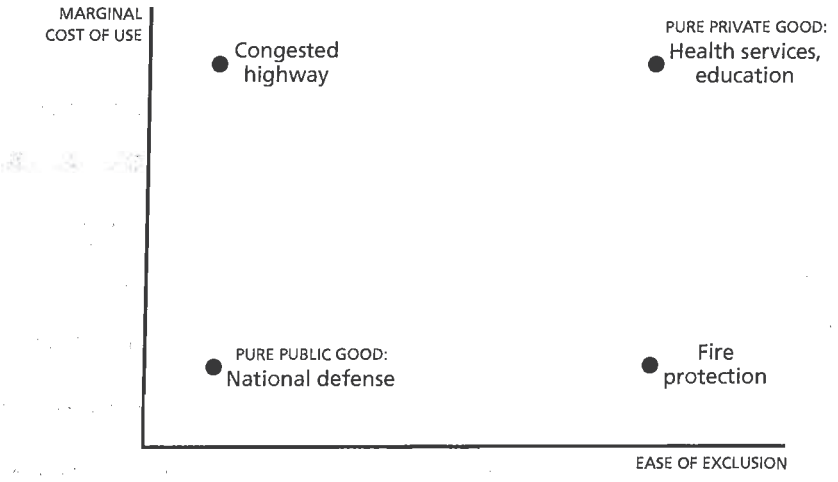

FIGURE 6.2 **Publicly Provided Goods** Pure public goods are characterized by non-rival consumption (the marginal cost of an additional individual's enjoying the good is zero) and non-excludability (the cost of excluding an individual from enjoying the good is prohibitively high). Goods provided by the public sector differ in the extent to which they have these two properties.

PROPERTY RIGHTS, EXCLUDABILITY, AND EXTERNALITIES

Some problems of excludability arise not from the *feasibility* of exclusion, but from imperfections in the legal structure which make exclusion difficult. Some economists, such as Nobel Prize–winning economist Ronald Coase, have argued that many public-good and externality problems would be resolved if property rights, which allow exclusion, were established.

Consider a crowded room. The air in the room is a public good: all persons in the room breathe essentially the same air. When any individual smokes, he creates an externality on others. In the absence of property rights, he would fail to take that into account in his decision to smoke. But if property rights were assigned, the problem would (so the argument goes) be resolved. Assume the "rights" to the air were given to a particular individual. (Coase argues that, apart from distribution, to whom it is given makes no difference.) He would then conduct an auction: he would ask the smokers how much they would be willing to pay to allow smoking, and he would ask the nonsmokers how much they would be willing to pay to prohibit

Many goods are not pure public goods but have one or the other property (non-rivalrousness or non-excludability) to some degree. Fire protection is like a private good in that exclusion is relatively easy—individuals who refuse to contribute to the fire department could simply not be helped in the event of a fire. But fire protection is like a public good in that the marginal cost of covering an additional person is low. Most of the time, firefighters are not engaged in fighting fires but are waiting for calls. Protecting an additional individual has little extra cost. Only in that rare event when two fires break out simultaneously will there be a significant cost to extending fire protection to an additional person. But even here, matters are more complicated: if we want to protect the building next door which has paid for fire protection, it may be necessary to put out the fire in the building which has not paid for protection—exclusion may not really be feasible. Similarly, while the main beneficiary of a vaccination may be the individual protected, and there is a significant marginal cost of vaccinating an additional individual, the public health benefits from universal vaccination—the reduced incidence of the disease, possibly its eradication—are benefits from which no one can be excluded.

Sometimes the marginal cost of using a good to which access is easy (a good that possesses the property of non-excludability) will be high. When an uncongested highway turns congested, the costs of using it rise dramatically, not only in terms of wear and tear on the road but in terms of the time lost by drivers using the road. It is costly to exclude by charging for road use—as a practical matter, this can only be done on toll roads, and, ironi-

smoking. He would then offer the air for sale to those for whom the value was highest. This would be efficient.*

But this "solution" ignores the free rider problem: individual smokers have an incentive not to reveal the full value of the right to smoke (if they might actually have to pay that amount); and similarly individual nonsmokers have an incentive not to reveal the full value of clean air.

While there are some important cases where assigning property rights would reduce or eliminate externalities or public good problems, in some of the most important cases, assigning property rights is either impracticable or would not resolve the underlying problems.

*The resource allocation would be Pareto efficient, *given the assignment of the property right of the air to a single individual.* But, of course, if the smokers bid more than the nonsmokers, the smoker who winds up having to pay for the right to smoke is worse off relative to the initial situation where he could smoke without paying anything. Though in this example, the smokers could have compensated the nonsmokers, such compensation may well not be made.

cally, the tollbooths often contribute to the congestion. New technologies, which automatically bill regular users of the road, have radically reduced these costs.

COSTS OF EXCLUSION For many goods, the issue is not so much the feasibility of rationing, but the cost. Thus, TV and radio provided over the airwaves has one of the two properties of a public good: consumption is non-rival. But it may be feasible to exclude some consumers, as in the use of TV scramblers for pay-TV, even though it is costly to do so. In the case of pay-TV, though there is a cost to exclusion, there is no benefit to society from doing so. In other cases, such as a slightly crowded highway, there is a cost to exclusion (the cost of collecting tolls), and some benefit (less congestion).

There are, of course, costs associated with exclusion for private goods as well as for public goods. Economists call these **transactions costs.** For example, the salaries of checkout clerks at grocery stores and collectors of tolls along toll highways and at toll bridges are transactions costs, part of the administrative costs associated with operating a price mechanism. But while the costs of exclusion are relatively small for most private goods, they may be large (prohibitive) for some publicly provided goods.

EXTERNALITIES AS IMPURE PUBLIC GOODS Pure public goods have the property that if one individual purchases more of it, all individuals' consumption of that good increases by the same amount. (Individuals may, of course, differ

in how they value the increased consumption.) Pure private goods have the property that if one individual purchases more of it, others are (at least directly) unaffected. Goods for which there are externalities in consumption have the property that others are affected, but not necessarily in the same amount. Externalities can thus be viewed as a form of impure public goods (or perhaps better stated, public goods can be viewed as an extreme form of externalities).[1]

PUBLICLY PROVIDED PRIVATE GOODS

Publicly provided goods for which there is a large marginal cost associated with supplying additional individuals are referred to as **publicly provided private goods.** Though the costs of running a market provide one of the rationales for the public supply of some of these goods, it is not the only or even the most important rationale. Education is a publicly provided private good in the sense defined above—if the number of students enrolled doubles, costs will roughly double (assuming that quality, as reflected in class size, expenditures on teachers and textbooks, and so on, are kept roughly the same). One of the usual explanations given for public provision of education is concerned with distributive considerations; many feel that the opportunities of the young should not depend on the wealth of their parents.

Sometimes when the government provides a private good publicly (like water), it simply allows individuals to consume as much as they want without charge. Remember, for these goods, there is a marginal cost associated with each unit consumed. It costs money to purify water and to deliver it from the source to the individual's home. If a private good is freely provided, there is likely to be overconsumption of the good. Since the individual does not have to pay for the good, he will demand it until the point where the marginal benefit he receives from the good is zero, in spite of the fact that there is a positive marginal cost associated with providing it. In some cases, such as water, satiation may be quickly reached, so that the distortion from overconsumption may not be too large (Figure 6.3A). In other cases, such as the demand for certain types of medical services, the distortion may be very large (Figure 6.3B). The welfare loss can be measured by the difference between what the individual is willing to pay for the increase in output from Q_e (where price equals marginal cost) to Q_m (where price equals zero) and the costs of increasing production from Q_e to Q_m. This is the area of the shaded triangles in Figure 6.3.

[1] This is sometimes expressed by saying that for private goods, J's individual utility depends only on his own purchases, X^J. For a pure public good, J's utility depends on the *sum* of the purchases of all individuals: $X^1 + X^2 + \ldots + X^J + \ldots$. When there is an externality, J's utility may depend more heavily on his own purchases, but it may also depend on others' more weakly; for instance, it might depend on $aX^1 + aX^2 + \ldots + X^J + \ldots aX^n$, where a is a small number.

PUBLICLY PROVIDED PRIVATE GOODS

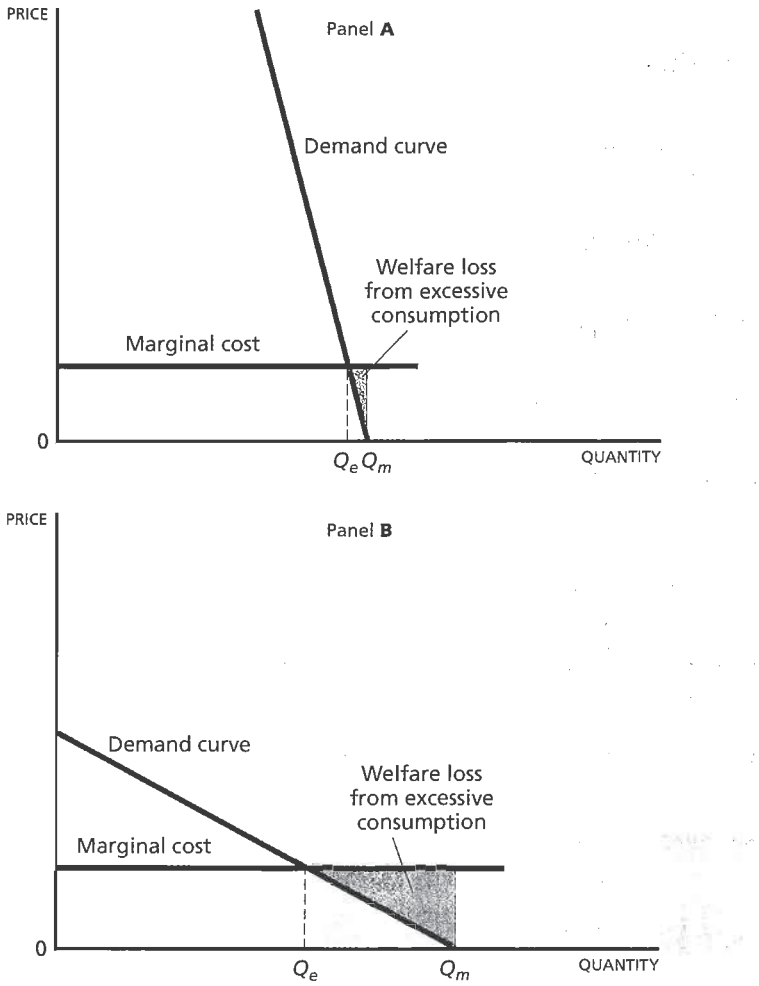

FIGURE 6.3 **Distortions Associated with Supplying Goods Freely** (A) For some goods, such as water, supplying the good freely rather than at marginal costs results in relatively little additional consumption. (B) For other goods, such as certain medical services, supplying the good freely rather than at marginal costs results in extensive overconsumption.

RATIONING DEVICES FOR PUBLICLY PROVIDED PRIVATE GOODS

When there is a marginal cost associated with each individual using a good, if the costs of running the price system are very high, it may be more efficient simply to provide the good publicly and to finance the good through general taxation, even though providing the good publicly causes a distortion. We illustrate this in Figure 6.4, where we have depicted a good with constant marginal costs of production, c. (It costs the firm c dollars to pro-

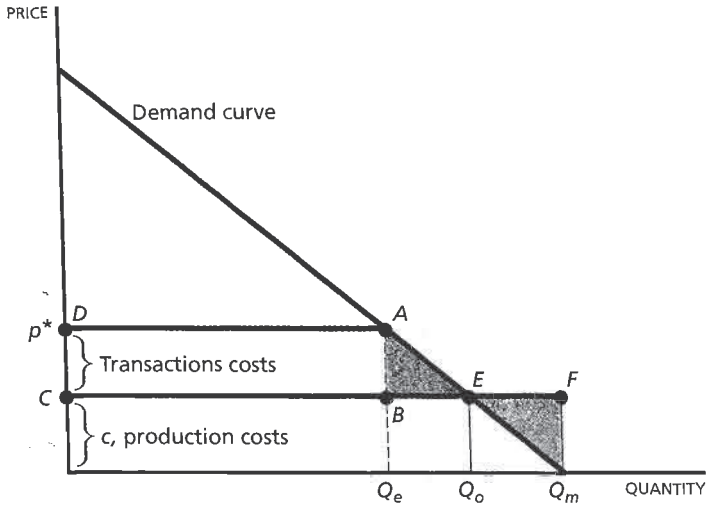

FIGURE 6.4 **Transactions Costs** When transactions costs are sufficiently high, it may be more efficient to supply the good publicly than to have the good supplied by private markets.

duce each unit of the good.)[2] However, to sell the good entails transactions costs, which raise the price to p^*. Assume now the government supplies the good freely. This eliminates the transactions costs, and the entire lightly shaded area *ABCD* is saved. There is a further gain as consumption increases from Q_e to Q_o, since individuals' marginal valuations exceed the marginal costs of production. The heavily shaded area *ABE* measures the gain. On the other hand, if individuals consume the good until the marginal value is zero, in expanding consumption from Q_o to Q_m, the marginal willingness to pay is less than the cost of production. This is obviously inefficient. To decide whether the good should be provided publicly, we must compare the savings in transactions costs plus the gain from increasing consumption from Q_e to Q_o with (1) the loss from the excessive consumption of the good (the shaded area EFQ_m in Figure 6.4), plus (2) the loss from the distortions created by any taxes required to finance the provision of the good publicly.

The high costs of private markets' providing insurance has been used as one of the arguments for the public provision of insurance. For many kinds of insurance, the administrative costs (including the selling costs) associated with providing the insurance privately are more than 20 percent of the benefits paid out, in contrast with the administrative costs associated with public insurance, which (ignoring the distortions associated with the taxes re-

[2] We assume, moreover, that the demand curve does not shift significantly as we raise taxes.

quired to finance the administrative costs of the social insurance programs) are usually less than 10 percent of the value of the benefits.

Given the inefficiencies arising from overconsumption when no charges are imposed for publicly provided private goods, governments often try to find some way of limiting consumption. Any method restricting consumption of a good is called a **rationing system.** Prices provide one rationing system. We have already discussed how user fees may be employed to limit demand. A second commonly employed way of rationing publicly provided goods is **uniform provision:** supplying the same quantity of the good to everyone. Thus, we typically provide a uniform level of free education to all individuals, even though some individuals would like to have more and some less. (Those who would like to purchase more may be able to purchase supplemental educational services on the private market, such as tutoring.) This, then, is the major disadvantage of the public provision of goods; it does not allow for adaptation to differences in individuals' needs and desires as does the private market.

This is illustrated in Figure 6.5, where the demand curves for two different individuals are drawn. If the good was privately provided, Individual 1, the high demander, would consume Q_1, while Individual 2, the low demander, would consume the much smaller quantity Q_2. The government chooses to supply each individual with a quantity that is somewhere in between, Q^*. At this level of consumption, the high demander is consuming less than he would like; his marginal willingness to pay exceeds the marginal cost of production. On the other hand, the low demander is consuming more than the efficient level; his marginal willingness to pay is less than the marginal cost. (But since he does not have to pay anything for it, and still values the good positively, he, of course, consumes up to Q^*.)

For certain types of insurance (say, social security for retirement), the government provides a basic, uniform level. Again, those who wish to purchase more can do so, but those who wish to purchase less cannot. The dis-

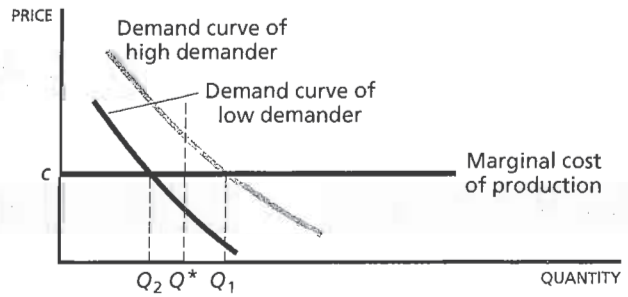

FIGURE 6.5 **Distortions Associated with Uniform Provision** When the publicly provided private good is supplied in equal amounts to all individuals, some get more than the efficient level and some get less.

tortion here may not, however, be very great; if the uniform level provided is sufficiently low, then relatively few individuals will be induced to consume more than they would otherwise, and the savings in administrative costs that we referred to earlier may more than offset the slight distortion associated with the uniform provision of the basic level of insurance. On the other hand, the system of combining public and private provision may increase total transactions (administrative) costs over what they would be if only the public sector or private sector took responsibility.

A third method of rationing that is commonly employed by the government is **queuing:** rather than charging individuals money for access to the publicly provided goods or services, the government requires that they pay a cost in waiting time. This allows some adaptability of the level of supply to the needs of the individual. Those whose demand for medical services is stronger are more willing to wait in the doctor's office. It is claimed that money is an undesirable basis upon which to ration medical services: Why should the wealthy have a greater right to good health than the poor? Queues, it is argued, may be an effective device for discriminating between the truly needy (who are willing to wait in line) and those who are less needy of medical care. But queues are a far from perfect way of determining who is deserving of medical care, since those who are unemployed or re-

THREE METHODS OF RATIONING PUBLICLY PROVIDED GOODS

1 User charges

Advantage: Those who benefit bear the costs.

Disadvantages: Results in underconsumption.
Administering pricing system adds transactions costs.

2 Uniform provision

Advantage: Saves on transactions costs.

Disadvantages: Leads some to underconsume, others to overconsume.
High demanders may supplement public consumption, increasing total transactions costs.

3 Queuing

Advantage: Goods (like health care) allocated not necessarily on basis of who is wealthiest.

Disadvantages: Alternative basis of allocation (who has time to spare) may be undesirable.
Time is wasted.

tired, but are not so needy of medical care, may be more willing to wait than either the busy corporate executive or the low-paid worker holding down two jobs. In effect, willingness to pay has been replaced as a criterion for allocating medical services by willingness to wait in the doctor's office. There is, in addition, a real social cost to using queuing as a rationing device—the waste of time spent queuing; this is a cost that could be avoided if prices were used as a rationing device.

EFFICIENCY CONDITIONS FOR PUBLIC GOODS

A central concern is how large the supply of public goods should be. What does it mean to say that the government is supplying too little or too much of a public good? Chapter 3 provided a criterion that enables us to answer this question: a resource allocation is Pareto efficient if no one can be made better off without someone else's becoming worse off. There we established that Pareto efficiency in private markets requires, among other criteria, that the individual's marginal rate of substitution is equal to the marginal rate of transformation.

In this section of the chapter, we characterize what is required for Pareto efficiency in the supply of pure public goods, and in particular, goods for which the marginal cost of an additional individual enjoying them is zero. *Pure public goods are efficiently supplied when the sum of the marginal rates of substitution (over all individuals) is equal to the marginal rate of transformation.* The *marginal rate of substitution* of private goods for public goods tells how much of the private good each individual is willing to give up to get one more unit of the public good. The sum of the marginal rates of substitution thus tells us how much of the private good all the members of society, together, are willing to give up to get one more unit of the public good (which will be jointly consumed by all). The *marginal rate of transformation* tells us how much of the private good must be given up to get one more unit of the public good. Efficiency requires, then, that the total amount individuals are willing to give up—the sum of the marginal rates of substitution—must equal the amount that they have to give up—the marginal rate of transformation.

Let's apply this efficiency condition to national defense. Assume that when we increase production of guns (national defense) by one, we must reduce production of butter (basic consumer products) by one pound (the marginal rate of transformation is unity). Guns used for national defense are a public good. We consider a simple economy with two individuals: Crusoe and Friday. Crusoe is willing to give up one-third of a pound of butter for an extra gun. But his one-third pound alone does not buy the gun. Friday is willing to give up two-thirds of a pound of butter for an extra gun. The total amount of butter that this small society would be willing to give up, were the government to buy one more gun, is $1/3 + 2/3 = 1$.

The total amount they would *have to* give up to get one more gun is also one. Thus, the sum of the marginal rates of substitution equals the marginal

rate of transformation; their government has provided an efficient level of national defense. If the sum of the marginal rates of substitution exceeded unity, then, collectively, individuals would be willing to give up more than they had to; we could ask each of them to give up an amount slightly less than the amount that would make them indifferent, and it would still be possible to increase the production of guns by one unit. Thus they could all be made better off by increasing the production of the public good (guns) by one.

DEMAND CURVES FOR PUBLIC GOODS

Individuals do not buy public goods. We can, however, ask how much they would demand if they had to pay a given amount for each extra unit of the public good. This is not a completely hypothetical question, for as expenditures on public goods increase, so do individuals' taxes. We call the extra payment that an individual has to make for each extra unit of the public good his **tax price.** In the following discussion, we shall assume the government has the discretion to charge different individuals different tax prices.

Assume that the individual's tax price is p, that is, for each unit of the public good, he must pay p. Then, the total amount the individual can spend, his *budget constraint*, is:

$$C + pG = Y,$$

where C is his consumption of private goods, G is the total amount of public goods provided, and Y is his income. The budget constraint shows the combinations of goods (here, public and private goods) that the individual can purchase, given his income and his tax price. The budget constraint is represented in Figure 6.6A by the line BB. Along the budget constraint, if government expenditures are lower, consumption of private goods is obviously higher. The individual wishes to obtain the highest level of utility he can, consistent with his budget constraint. Figure 6.6A also shows the individual's indifference curves between public and private goods. The individual is willing to give up some private goods if he gets more public goods. The quantity of private goods he is willing to give up to get one more unit of public goods is his marginal rate of substitution. As he gets more public goods (and has fewer private goods), the amount of private goods he is willing to give up to get an extra unit of public goods becomes smaller—that is, he has a diminishing marginal rate of substitution. Graphically, the marginal rate of substitution is the slope of the indifference curve. Thus as the individual consumes more public goods and fewer private goods, the indifference curve becomes flatter.

The individual's highest level of utility is attained at the point of tangency between the indifference curve and the budget constraint, point E in panel A. At this point, the slope of the budget constraint and the slope of the indifference curve are identical. The slope of the budget constraint tells us how much in private goods the individual must give up to get one more unit of public goods; it is equal to the individual's tax price. The slope of

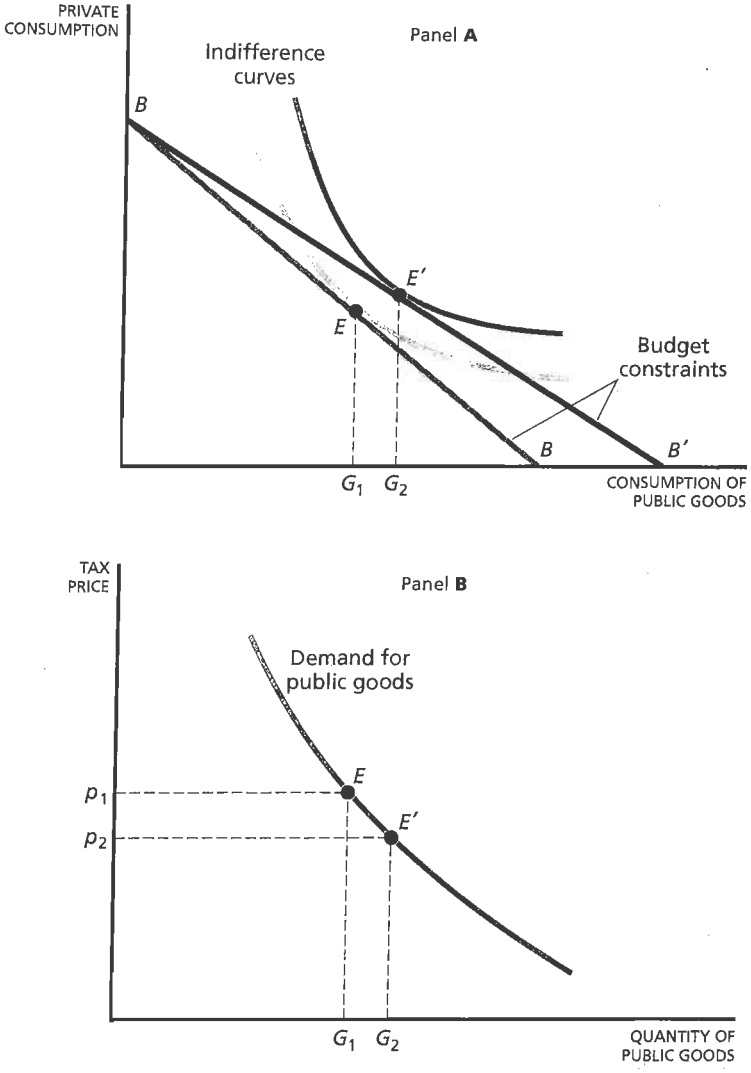

FIGURE 6.6 **Individual Demand Curve for Public Goods** The individual's most preferred level of expenditure is the point of tangency between the indifference curve and the budget constraint. As the tax price decreases (the budget constraint shifts from *BB* to *BB'*), the individual's most preferred level of public expenditure increases, generating the demand curve of panel B.

the indifference curve tells us how much in private goods the individual is willing to give up to get one more unit of public goods. Thus at the individual's most preferred point, the amount that he is *willing* to give up to get an additional unit of public goods is just equal to the amount he *must* give up to get one more unit of the public good. As we lower the tax price, the bud-

get constraint shifts out (from BB to BB'), and the individual's most preferred point moves to point E'. The individual's demand for public goods will normally increase.

By raising and lowering the tax price, we can trace out a demand curve for public goods, in the same way that we trace out demand curves for private goods. Figure 6.6B plots the demand curve corresponding to panel A. Points E and E', from panel A, show the quantity of public goods demanded at tax prices p_1 and p_2. We could trace more points for panel B by shifting the budget constraint further in panel A.

We can use this approach to trace out the demand curves for public goods of Crusoe and Friday. Then we can add them *vertically* to derive the **collective demand curve** in Figure 6.7. Vertical summation is appropriate because a pure public good is necessarily provided in the same amount to all individuals. Rationing is infeasible and is also undesirable, since one individual's usage of the public good does not detract from any other individual's enjoyment of it. Therefore, for a given quantity we add up everyone's willingness to pay to calculate the total willingness to pay; by

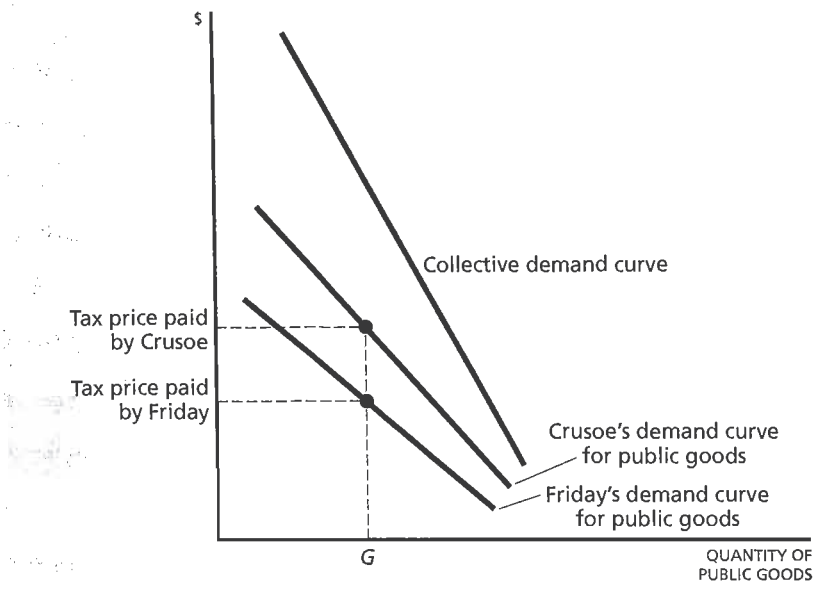

FIGURE 6.7 **Collective Demand for Public Goods** Since at each point on the demand curve the price is equal to the marginal rate of substitution, by adding the demand curves vertically we obtain the sum of the marginal rates of substitution, the total amount of private goods that the individuals in society are willing to give up to get one more unit of the public good. The vertical sum thus can be thought of as generating the collective demand curve for the public good.

calculating this amount at every quantity, we trace out the collective demand curve.[3]

The demand curve can be thought of as a "marginal willingness to pay" curve. That is, at each level of output of the public good, it says how much the individual would be willing to pay for an extra unit of the public good. (Remember, the tax price for the public good faced by the individual is set equal to his marginal rate of substitution, which simply gives how much of the private good he is willing to give up for one more unit of the public good.) Thus, the vertical sum of the demand curves is just the sum of their marginal willingnesses to pay, that is, it is the total amount that all individuals together are willing to pay for an extra unit of the public good. Equivalently, since each point on the demand curve of an individual represents his marginal rate of substitution at that level of government expenditure, by adding the demand curves vertically we simply obtain the sum of the marginal rates of substitution (the total marginal benefit from producing an extra unit). The result is the collective demand curve shown in Figure 6.7.

We can draw a supply curve just as we did for private goods; for each level of output, the price represents how much of the other goods have to be forgone to produce one more unit of public goods; this is the marginal cost, or the marginal rate of transformation. At the output level where the collective demand is equal to the supply (Figure 6.8), the sum of the marginal willingnesses to pay (the sum of the marginal rates of substitution) is just equal to the marginal cost of production or the marginal rate of transformation. Since at this point, the marginal benefit from producing an extra unit of the public good equals the marginal cost, or the sum of the marginal rates of substitution equals the marginal rate of transformation, the output level described by the intersection of the collective demand curve and the supply curve for public goods is Pareto efficient.

Though we constructed each individual's demand curve for public goods in a manner analogous to the manner in which we could construct his demand curve for private goods, there are some important distinctions between the two. In particular, while market *equilibrium* occurs at the intersection of the demand and supply curves, we have not provided any explanation for why the equilibrium supply of public goods should occur at the intersection of the demand curve we have constructed and the supply curve. We have only established that if it did, the level of production of the public good would be Pareto efficient. Decisions about the level of public goods are made publicly, by governments, and not by individuals; hence, whether

[3] The collective demand curve is also sometimes referred to as the *aggregate demand curve* (not to be confused with the same term used in macroeconomics), and is the analog to the market demand curve for private goods. When constructing the market demand curve for private goods, we add up the quantities demanded for a given price, because all individuals face the same price but may consume different amounts. The *market demand curve* is thus derived by adding up the individual demand curves horizontally.

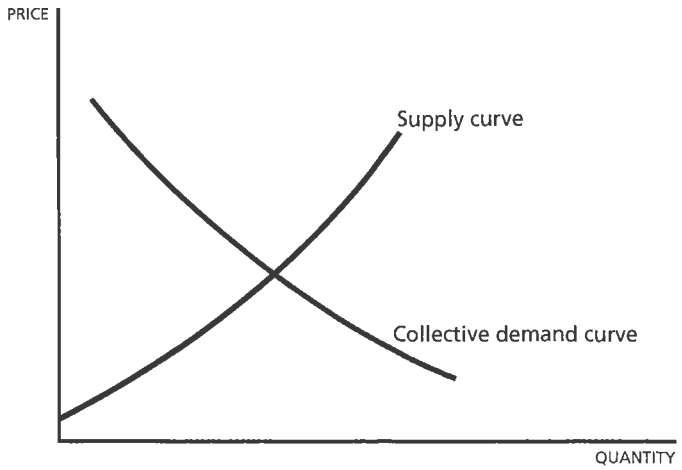

FIGURE 6.8 **Efficient Production of Public Goods** An efficient supply of public goods occurs at the point of intersection of the demand curve and the supply curve. The collective demand curve gives the sum of what all individuals are willing to give up, at the margin, to have one more unit of public goods (one more gun), while the supply curve gives the amount of other goods that have to be given up to obtain one more unit of the public good.

production occurs at this point depends on the nature of the political process, a subject discussed at length in the next chapter.

Moreover, while in a competitive market for private goods all individuals face the same prices but consume different quantities (reflecting differences in tastes), a pure public good must be provided in the same amount to all affected individuals, and we have hypothesized that the government could charge different tax prices for the public good. One way of thinking about these prices is to suppose that each individual is told beforehand the

EFFICIENCY CONDITION FOR PURE PUBLIC GOODS

Efficient production requires that the sum of the marginal rates of substitution equal the marginal rate of transformation.

Efficient production occurs at the intersection of the collective demand curve, formed by vertically adding the demand curves for each individual, with the supply curve.

share of public expenditures that he will have to bear. If some individual has to bear 1 percent of the cost of public expenditures, then an item that costs the government $1.00 costs him 1 cent, while if an individual has to bear 3 percent of the cost of public expenditures, then an increase in public expenditures by $1.00 costs that individual 3 cents.

Finally, we should emphasize that we have characterized the Pareto efficient level of expenditure on public goods corresponding to a particular distribution of income. As we shall see in the next section, the efficient level of expenditure on public goods generally depends on the distribution of income.

PARETO EFFICIENCY AND INCOME DISTRIBUTION

Recall from our discussion of Chapters 3 and 5 that there are many Pareto efficient resource allocations; any point on the utility possibilities schedule is Pareto efficient. The market equilibrium in the absence of market failures corresponds to just one of those points. By the same token, there is not a unique Pareto optimal supply of public goods. The intersection of the demand and supply curves in Figure 6.8 is one of these Pareto efficient levels of supply, but there are others as well, with different distributional implications.

To see how the efficient level of public goods depends on the distribution of income, assume the government transferred a dollar of income from Crusoe to Friday. This would normally shift Crusoe's demand for public goods (at any price) down and Friday's up. In general, there is no reason why these changes should exactly offset each other, so that the aggregate level of demand will normally change. With this new distribution of income, there is a new efficient level of public goods. But efficiency is still characterized by the sum of the marginal rates of substitution equaling the marginal rate of transformation. To put it another way, each point on the utility possibilities schedule may be characterized by a different level of public goods, but at each point the sum of the marginal rates of substitution equals the marginal rate of transformation.

The fact that the efficient level of public goods depends, in general, on the distribution of income has one important implication: one cannot separate out efficiency considerations in the supply of public goods from distributional considerations. Any change in the distribution of income, say, brought about by a change in the income tax structure, will thus be accompanied by corresponding changes in the efficient levels of public-goods production.[4]

[4] Some economists have suggested that decisions concerning the efficient level of public-goods production and distribution of income can be separated; for instance, there is a view that concerns about the distribution of income should be reflected in tax schedules and welfare programs, but that decisions concerning the supply of public goods can and should be made quite independently of such considerations. There are some cases where the decisions can be separated (see Atkinson and Stiglitz, *Lectures in Public Economics* [New York: McGraw-Hill, 1980] or L. J. Lau, E. Sheshinski, and J. E. Stiglitz, "Efficiency in the Optimum Supply of Public Goods," *Econometrica* 46 [1978]: 269–84), but these are indeed special.

LIMITATIONS ON INCOME REDISTRIBUTION AND THE EFFICIENT SUPPLY OF PUBLIC GOODS

Governments, in evaluating the benefits of a public program, often seem to be particularly concerned with the question of *who* benefits from the program. They seem to weight benefits that accrue to the poor more heavily than benefits that accrue to the rich. Yet the previous analysis suggested that one should simply add up the marginal rates of substitution, the amounts that each individual is willing to pay at the margin for an increase in the public good, treating the rich and the poor equally. How can these approaches be reconciled?

In Chapter 5, we saw how we could trace out the utility possibilities schedule simply by taking away resources from one individual and giving them to another. Recall our parable of the Robinson Crusoe economy, where in the process of transferring oranges from Crusoe to Friday some of the oranges are lost. In the U.S. economy, we use primarily the tax system and welfare system to redistribute resources. Not only are the administrative costs of running these systems large, but they have important incentive effects—for instance, on individuals' savings and work decisions. The fact that redistributing resources through the tax and welfare systems is costly implies that the government may look for alternative ways to achieve its redistributive goals; one way is to incorporate redistributive considerations into its evaluation of public projects.

DISTORTIONARY TAXATION AND THE EFFICIENT SUPPLY OF PUBLIC GOODS

The fact that the revenue raised to finance public goods is raised through distortionary taxes, such as the income tax, has some important implications for the efficient supply of public goods. The amount of private goods that individuals must give up to get one more unit of public goods is greater than it would be if the government could raise revenue in a way that did not entail distortionary incentive effects and that was not costly to administer.

We can define a **feasibility curve,** giving the maximum level of private-goods consumption consistent with each level of public goods, for our given tax system. The tax system introduces inefficiencies, so this feasibility curve lies inside the production possibilities schedule, as in Figure 6.9.

The amount of private goods we have to give up to obtain one more unit of public goods, taking into account these extra costs, is called the **marginal economic rate of transformation,** as opposed to the **marginal physical rate of transformation** we employed in our earlier analysis. The latter is completely determined by *technology*, while the marginal economic rate of transformation takes into account the costs associated with the taxes required to finance increased public expenditure. Thus we replace the earlier condition that the marginal physical rate of transformation must equal the sum of the marginal rates of substitution with a new condition, that the marginal economic rate of transformation must equal the sum of the marginal rates of substitution.

Since it becomes more costly to obtain public goods when taxation imposes distortions, normally this will imply that the efficient level of public goods is smaller than it would have been with nondistortionary taxation.

Indeed, it appears that much of the debate about the desirable level of public goods provision centers around this issue. Some believe that the dis-

EFFICIENT GOVERNMENT AS A PUBLIC GOOD

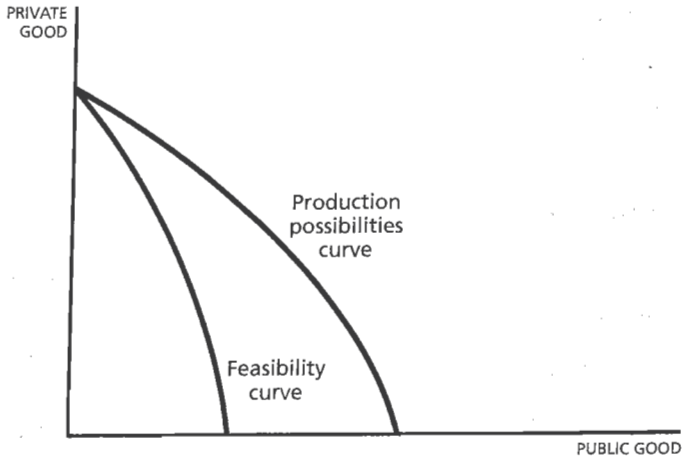

FIGURE 6.9 **The Feasibility Curve** The feasibility curve gives the maximum output (consumption) of private goods for any level of public goods, taking into account the inefficiencies that arise from the taxes that must be imposed to raise the requisite revenue. The feasibility curve lies below the production possibilities schedule.

tortions associated with the tax system are not very great, while others contend that the cost of attempting to raise additional revenues for public goods is great. They *may* agree on the magnitude of the social benefits that may accrue from additional government expenditures, but disagree on the costs.

EFFICIENT GOVERNMENT AS A PUBLIC GOOD

One of the most important public goods is the management of the government: we all benefit from a better, more efficient, more responsive government. Indeed, "good government" possesses both of the properties of public goods we noted earlier: it is difficult and undesirable to exclude any individual from the benefits of a better government.

If the government is able to become more efficient and reduce taxes without reducing the level of government services, everyone benefits. The politician who succeeds in doing this may get some return, but this return is only a fraction of the benefits that accrue to others. In particular, those who voted against the politician who succeeds in doing this gain as much as those who worked for his election, and the individual who did not vote, who attempted to free ride on the political activities of others, benefits as much as either.

REVIEW AND PRACTICE

SUMMARY

1 This chapter has defined an important class of goods, pure public goods. They have two critical properties:

- **a** It is impossible to exclude individuals from enjoying the benefits of the goods (non-excludability).
- **b** The marginal cost of an additional individual enjoying the good is zero (non-rival consumption). It is undesirable to exclude individuals from enjoying the benefits of the goods, since their enjoyment of these goods does not detract from the enjoyment of others.

2 While there are a few examples of pure public goods, such as national defense, for many publicly provided goods exclusion is possible, although frequently costly. Charging for use may result in the underutilization of public facilities. For many publicly provided goods, there is *some* marginal cost of an individual enjoying the good. While the marginal cost of an individual using a completely uncongested road may be negligible, if there is some congestion, the marginal cost may be more significant.

3 Private markets either will not supply or will provide an inadequate supply of pure public goods.

4 The problem with voluntary arrangements for providing public goods arises from individuals trying to be *free riders* and enjoying the benefits of the public goods paid for by others.

5 For many publicly provided goods, consumption is rivalrous; consumption by one individual reduces that of another; or the marginal cost of supplying an extra individual may be significant, equal to, or even greater than, the average cost. These are called publicly provided private goods. If they are supplied freely, there will be overconsumption.

6 For publicly provided private goods, some method of rationing other than the price system may be used; sometimes queuing is used, while at other times the good is simply provided in fixed quantities to all individuals. Both of these entail inefficiencies.

7 Pareto efficiency requires that a public good be supplied up to the point where the sum of the marginal rates of substitution equals the marginal rate of transformation. Different Pareto efficient levels of consumption of the public good will be associated with different distributions of income.

8 The basic rule for the efficient level of supply of public goods must be modified when there are costs (distortions) associated with raising revenue and redistributing income.

9 Efficient management of the government is a public good in itself.

KEY CONCEPTS

Exclusion
Pure public goods
User fees
Free rider problem
Transactions costs
Publicly provided private goods
Rationing system
Tax price
Collective demand curve
Feasibility curve
Marginal economic rate of transformation
Marginal physical rate of transformation

QUESTIONS AND PROBLEMS

1 Where should each of the following goods lie in Figure 6.2? Explain why each is or is not a pure public good. Where applicable, note instances where the good is both publicly and privately provided:

a College education
b A local park
c Yosemite National Park
d Sewage collection
e Water
f Electricity
g Telephone service
h Retirement insurance
i Medicine
j Police protection
k TV
l Basic research
m Applied research

2 What happens to the efficient allocation between public and private goods as an economy becomes wealthier? Can you think of examples of public goods, the consumption of which would increase more than proportionately to the increase in income? Less than proportionately to the increase in income?

3 The government rations a variety of publicly provided private goods and impure public goods (in which there is congestion) in a variety of ways. Discuss how each of these is rationed, and consider the effect of alternative rationing systems:

a Public higher education
b Health services in the United Kingdom
c Yellowstone National Park

What happens to a publicly provided good in which congestion can occur (such as a highway or swimming pool on a hot, sunny day), but in which no direct rationing system is employed?

4 To what extent do you think differences in views between advocates of less spending on public goods and advocates of more spending can be attributed to different assessments of the marginal cost of public goods,

including the increased distortions associated with the additional taxes required to finance public goods? What are other sources of disagreement?

5 What implications might the fact that efficient government is a public good have for the efficiency with which governments function?

6 Discuss the issue of vaccination from the perspective of public goods/externalities. Why might individuals not voluntarily consent to be vaccinated?

7 There has been increasing concern about increased atmospheric concentrations of greenhouse gases, such as carbon dioxide, which are likely to lead to global warming. Discuss the world's atmosphere as an "international" public good. What are some of the problems of ensuring that individuals and countries take actions to reduce emissions of greenhouse gases?

8 Discuss how changes in income, technology, or other changes in the economic environment may lead to changes in the balance between public and private provision. Illustrate, for instance, by a discussion of the role of public parks.

APPENDIX A THE LEFTOVER CURVE

In this appendix we provide an alternative, diagrammatic exposition for the basic efficiency condition for public goods:

Sum of marginal rates of substitution = Marginal rate of transformation.

In Figure 6.10A we have superimposed Crusoe's indifference curve on the production possibilities schedule. If the government provides a level of public goods G, and wishes, at the same time, to ensure that Crusoe attains the level of utility associated with the indifference curve U_1 drawn in the figure, then the amount of private good that is "left over" for Friday is the vertical distance between the production possibilities schedule and the indifference curve. Accordingly, we call the (vertical) difference between the two the **leftover curve.** This curve is plotted in Figure 6.10B. We now superimpose on Figure 6.10B Friday's indifference curves. The highest level of utility he can attain, consistent with the production possibilities schedule, and consistent with the prespecified level of utility of Crusoe, is at the point of tangency between his indifference curve and the leftover curve.

There is a simple way to express this tangency condition. Since the leftover curve represents the difference between the production possibilities schedule for the economy and the first individual's indifference curve, the

APPENDIX A
THE LEFTOVER CURVE

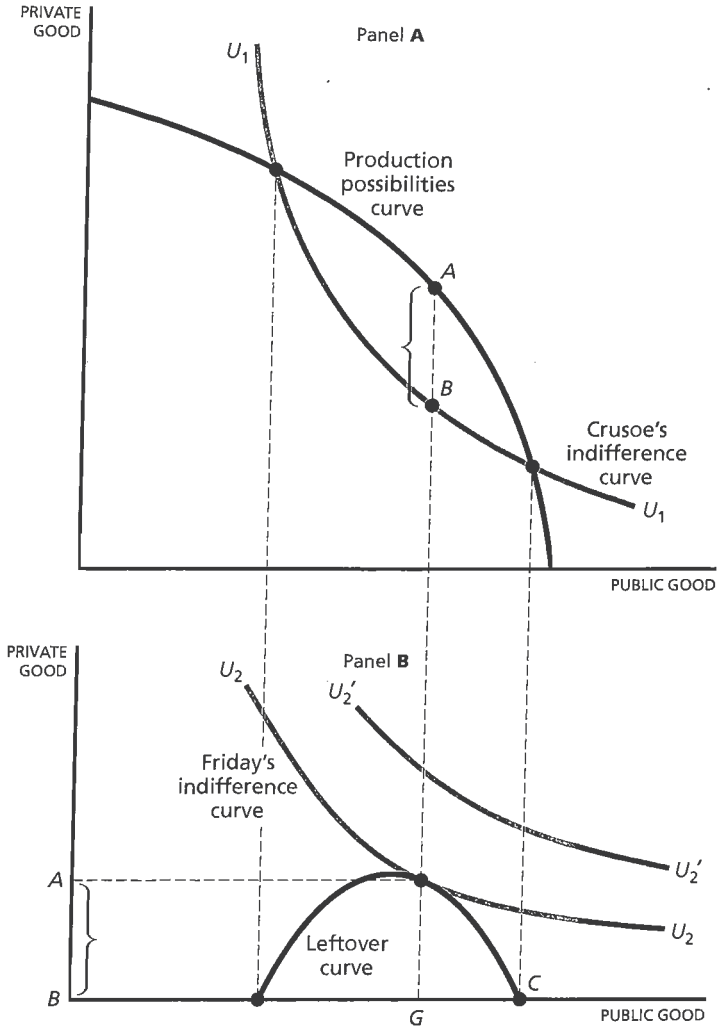

FIGURE 6.10 **Determination of the Efficient Level of Production of Public Goods** (A) If the level of public goods is G, and the first individual is to get level of utility U_1, then the distance AB represents the amount of private goods left over for the second individual. (B) The second individual's welfare is maximized at the point of tangency of his indifference curve and the "leftover" curve.

slope of the leftover curve is the difference between the slope of the production possibilities schedule and the slope of the first individual's indifference curve. The slope of the production possibilities schedule is, as we just saw, the marginal rate of transformation, while the slope of the first individual's indifference curve is his marginal rate of substitution. If G is the optimal

level of public goods, the leftover curve must be tangent to the second individual's indifference curve. Hence Pareto efficiency of the economy requires that the slope of the leftover curve be equal to the slope of the second individual's indifference curve—that is,

$$MRT - MRS^1 = MRS^2$$

or

$$MRT = MRS^1 + MRS^2,$$

where MRT stands for the marginal rate of transformation and MRS^1 stands for the first individual's marginal rate of substitution, MRS^2 for the second individual's. The marginal rate of transformation must equal the sum of the marginal rates of substitution.

It should be clear that if we chose a different (say, higher) initial level of utility for Crusoe, the leftover curve would be shifted (down), and there would be a new point of tangency of Friday's indifference curve with the new leftover curve. At the new point of tangency, the level of expenditure on public goods may be higher, lower, or the same as in the initial situation. This illustrates the point made in the text: There is not necessarily a single "efficient" level of expenditure on public goods; there are many Pareto efficient levels of expenditures, depending on the distribution of income (welfare). Issues of distribution and allocation cannot, in general, be separated.

APPENDIX B MEASURING THE WELFARE COST OF USER FEES

We can measure the cost of user fees, say, for the use of a bridge, using the techniques introduced in Chapter 5.

The loss in welfare is given by the shaded triangle in Figure 6.11. This is referred to as the **deadweight loss.** To see this, we recall that the points on the demand curve measure the individual's marginal willingness to pay for an extra trip at different quantities. Assume a price, p, was charged for the use of the bridge. The number of trips taken would then be Q_e. The welfare loss from not taking the trip is the difference between what he is willing to pay (his marginal benefit) and the marginal cost. The willingness to pay at Q_e is p, and the cost of providing an extra trip is zero; thus the welfare loss is just p. At slightly higher levels of usage, the loss is still the marginal willingness to pay, but this is now smaller. To find the total welfare loss, we simply add up the welfare loss associated with each of the trips *not* taken as a result of charging the toll. At a zero price, Q_m trips are taken. At a price of p, Q_e trips are taken. Hence, the toll results in $(Q_m - Q_e)$ trips not being taken. The loss in welfare from the first trip not taken is p; the loss in welfare from

APPENDIX B
MEASURING THE WELFARE COST OF USER FEES

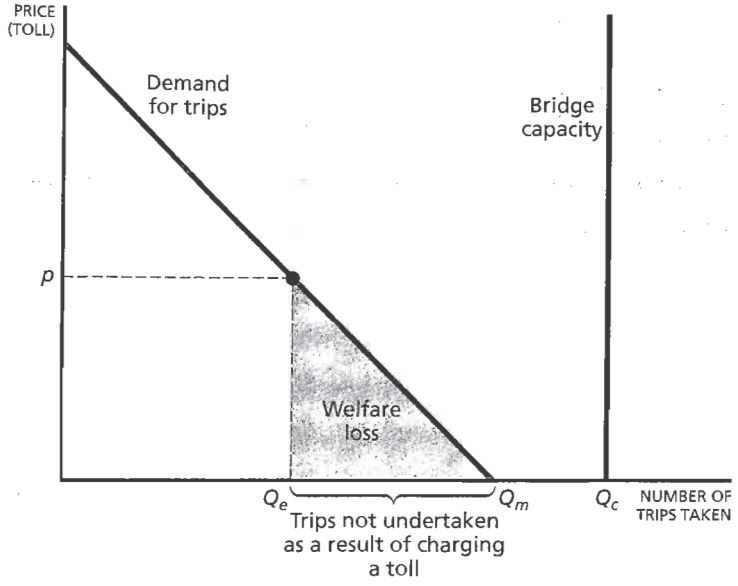

FIGURE 6.11 **Bridges: How a User Fee Can Result in Welfare Loss** As a result of a toll, p, some trips across the bridge are not taken even though they would be beneficial to society as a whole. The total welfare loss created by the toll is represented by the shaded region.

the last trip not taken is zero (his willingness to pay for one additional trip at Q_m is zero). The *average* welfare loss from each trip not taken is thus $p/2$; and the total welfare loss is $p(Q_m - Q_e)/2$, the area of the shaded triangle in Figure 6.11.[5]

[5] Recall from Chapter 5 that this is only an approximation for the deadweight loss. The correct calculation entails using the *compensated* demand schedule, not the ordinary demand schedule. However, if the fraction of income spent on traveling across the bridge is small, the two demand curves differ by very little.