Public Goods

7

The city of Dhaka, Bangladesh, has a garbage problem. Every few days, residents of the various Dhaka neighborhoods bring their trash to large dumpsters in central areas or smaller dumpsters along their local streets. In theory, municipal employees then collect the garbage and cart it off for disposal. In practice, however, those employees often fail to show up, leaving the garbage to rot in the streets and residents to fume in frustration.

An economist might wonder why the residents of Dhaka don't simply scrap the current system of public trash collection and instead pay a private service to pick up their trash. In this way, the free market might solve Dhaka's problems. The trouble is that private trash collection, financed by a voluntary fee paid by neighborhood residents, faces the classic *free rider problem* introduced in Chapter 5: any resident could continue to throw his trash in the dumpsters, and then refuse to pay his share of the trash collection fee, with the hope that his neighbors would pick up the costs for him. If his neighbors cover the cost of collection, then this free-rider gets all the benefits of trash collection but pays none of the costs. Yet, if some in the neighborhood free-ride, then others will feel exploited by paying to have their non-paying neighbors' trash picked up; these residents might decide not to pay either. Eventually, the number of free-riders might grow large enough that the town would not be able to raise sufficient funds to finance the trash collection from a private company. For this reason, only about 50 of Dhaka's 1,100 neighborhoods have been able to replace the municipal trash collection with private collection financed by voluntary trash collection fees.[1]

The problems faced by the city of Dhaka illustrate the difficulties of effectively addressing the free rider problem through a private mechanism. Goods that suffer from this free rider problem are known in economics as *public goods,* and they are the focus of this chapter. We begin by defining *public goods* and determining the optimal level of their provision. We then turn to the first question of public finance and ask if the government should be involved in

[1] Pargal et al. (2000).

the provision of public goods. We show that the private sector is in fact likely to underprovide public goods due to the free rider problem. Sometimes, however, private actors successfully provide public goods, so we discuss the factors that make private provision successful.

We then discuss the public provision of public goods. In principle, the government can simply compute the optimal amount of a public good to provide, and provide that level. In practice, however, the government faces several difficulties in providing the optimal level of public goods. First, when private parties are already providing the public good, government provision may simply *crowd out* this private provision so that the total amount of the public good provided does not rise. Second, measuring the actual costs and benefits of public goods (which is required for determining optimal public goods provision) is difficult. Finally, determining the public's true preferences for public goods, and aggregating those preferences into an overall decision on whether to pursue public goods projects, raises a variety of challenges.

This chapter begins our section on public goods provision. Chapters 8 and 9 provide details on the problems of measuring the costs and benefits of public projects (*cost-benefit analysis*), and on the difficulties of effectively translating voters' preferences for public projects into public policy (*political economy*). Chapter 10 discusses the local provision of public goods and raises the important question of whether competition across localities can solve the public goods provision problems raised in Chapters 7–9. Finally, Chapter 11 focuses on one of the most important public goods provided in the United States, education.

7.1 Optimal Provision of Public Goods

Goods that are **pure public goods** are characterized by two traits. First, they are **non-rival in consumption:** that is, my consuming or making use of the good does not in any way affect your opportunity to consume the good. Second, they are **non-excludable:** even if I want to deny you the opportunity to consume or access the public good, there is no way I can do so. These are fairly strong conditions, and very few goods meet these conditions in practice. Most of the goods we think of as public goods are really **impure public goods,** which satisfy these two conditions to some extent, but not fully.

pure public goods Goods that are perfectly non-rival in consumption and non-excludable.

non-rival in consumption One individual's consumption of a good does not affect another's opportunity to consume the good.

non-excludable Individuals cannot deny each other the opportunity to consume a good.

impure public goods Goods that satisfy the two public good conditions (non-rival in consumption and non-excludable) to some extent, but not fully.

Table 7-1 shows possible combinations of public good characteristics. Goods that are both excludable and rival are pure private goods. Private goods such as ice cream are completely rival (once you eat an ice cream cone, I cannot consume that ice cream cone at all) and they are completely excludable (you can simply refuse to sell me an ice cream cone).

There are two types of impure public goods. Some goods are *excludable, but not rival.* The best example here is cable television: the use of cable TV by others in no way diminishes your enjoyment of cable, so consumption is non-rival. It is, however, possible to exclude you from consuming cable TV: the cable company can simply refuse to hook you up to the system. Other goods, such as walking on a crowded city sidewalk, are *rival but not excludable*. When you walk on a crowded city sidewalk, you reduce the enjoyment of that walking experience for other pedestrians, who must now fight against even more foot traffic. Yet it would be very difficult for any city to exclude individuals from using the sidewalk!

▪ **TABLE 7-1**

Defining Pure and Impure Public Goods

		Is the good rival in consumption? Yes	No
Is the good excludable?	Yes	Private good (ice cream)	Impure public good (cable TV)
	No	Impure public good (crowded city sidewalk)	Pure public good (national defense)

Whether a good is private or public depends on whether it is rival and excludable. Pure private goods such as ice cream are both rival and excludable. Pure public goods such as national defense are neither rival nor excludable. Goods that are rival but not excludable, and vice versa, are impure public goods.

Pure public goods are rare because there are few goods that are both not excludable and not rival. A classic example of a pure public good is national defense. National defense is not rival because if I build a house next to yours, my action in no way diminishes your national defense protection. National defense is not excludable because once an area is protected by national defense, everyone in the area is protected: there is no way the government can effectively deny me protection since my house is in a neighborhood with many other houses. Other classic examples of pure public goods include lighthouses and fireworks displays.

It is helpful to think about a public good as one with a large positive externality. If I set off fireworks high into the sky, it benefits many more people beyond myself, because many people will be able to see the display. I am not compensated for other people's enjoyment, however: I can't exclude others from seeing the fireworks, so I can't charge them for their enjoyment.

Optimal Provision of Private Goods

Before we model how to determine the optimal quantity of public goods to provide, let's review the conditions for optimal provision of private goods. Imagine that there are two individuals, Ben and Jerry, who are deciding between consuming cookies and ice cream, two pure private goods. For simplicity, suppose that the price of cookies is $1.

Quick Hint A convenient modeling tool in economics is the **numeraire good,** a good for which the price is set at $1. This tool is convenient because all choice models are technically written about the choice between goods, not the choice of a particular good. As a result, what matters for modeling the demand for any good (such as ice cream) is its price relative to other goods (such as cookies), not the absolute level of its price. By setting the price of cookies to $1, we make the analysis easier by making the absolute and relative price of ice cream equal.

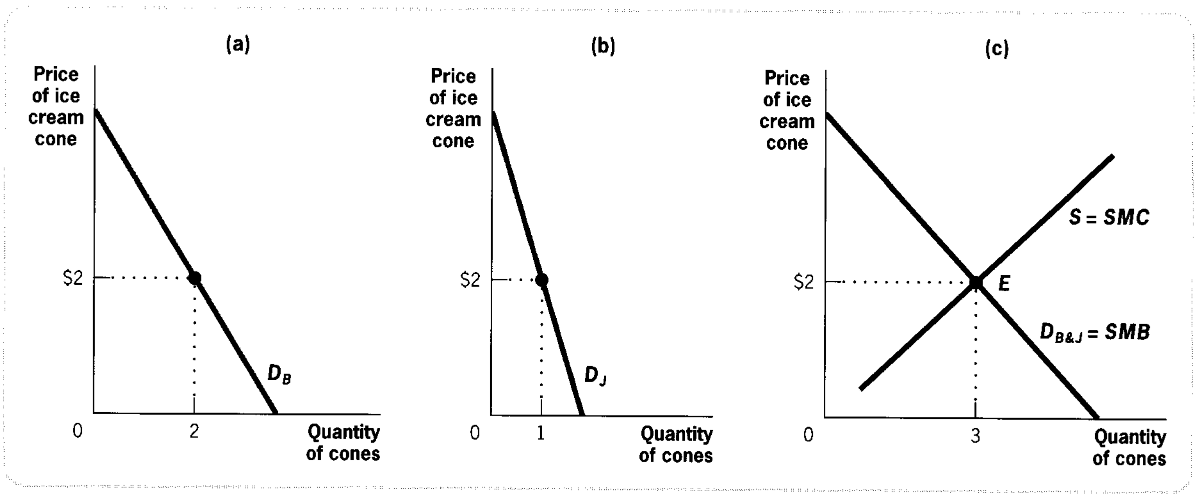
numeraire good A good for which the price is set at $1 in order to model choice between goods, which depends on relative, not absolute, prices.

Figure 7-1 shows the analysis of the market for ice cream cones. Panels (a) and (b) show Ben's and Jerry's individual demand curves for ice cream cones; that is, the number of ice cream cones that each man would demand at each price. Panel (c) shows the market demand curve, the horizontal sum of the two individual demands: for every price of ice cream cones, we compute Ben's demand and Jerry's demand, and then add them to produce a total market demand. At \$2, Ben would like two ice cream cones, and Jerry would like one, for a total market demand of three cones. As we learned in Chapter 5, the demand curve in the final panel of Figure 7-1 also represents the *Social Marginal Benefit (SMB)* of ice cream consumption, the value to society from the consumption of that cone.

The market supply curve for ice cream represents the marginal cost of producing ice cream cones for a firm. As discussed in Chapter 5, in a market with no failures, this curve also represents the *Social Marginal Cost (SMC)* of ice cream production, the cost to society from the production of that cone. In a private market, then, equilibrium occurs where the *SMB* = *SMC,* the point at which supply and demand intersect. In Figure 7-1, equilibrium is at point *E:* at a price of \$2, the market demands three ice cream cones, which are supplied by the firm.

A key feature of the private market equilibrium is that *consumers demand different quantities of the good at the same market price.* Ben and Jerry have different tastes for ice cream, relative to cookies. The market respects those different tastes by adding up the demands and meeting them with an aggregate supply. In this way, Ben and Jerry can consume according to their tastes. Since Ben likes ice cream more than Jerry, he gets two of the three cones that are produced.

■ **FIGURE 7-1**



Horizontal Summation in Private Goods Markets • In private goods markets, we horizontally sum the demands of Ben and Jerry to get market demand for ice cream cones. If Ben demands 2 ice cream cones at \$2, and Jerry demands 1 ice cream cone at \$2, then at a market price of \$2 the quantity demanded in the market is 3 ice cream cones.

It is also useful to represent this equilibrium outcome mathematically. Recall from Chapter 2 that an individual's optimal choice is found at the tangency between the indifference curve and the budget constraint. This is the point at which the *marginal rate of substitution* between ice cream cones and cookies (the rate at which consumers are willing to trade ice cream cones for cookies) equals the *ratio of the prices* of ice cream cones and cookies. That is, Ben and Jerry each consume ice cream cones and cookies until their relative marginal utilities from the consumption of these products equal the relative prices of the goods. The *optimality* condition for the consumption of private goods is written as

(1) $$MU^B_{ic}/MU^B_c = MRS^B_{ic,c} = MRS^J_{ic,c} = P_{ic}/P_c$$

where MU is marginal utility, MRS is the marginal rate of substitution, the superscripts denote Ben (B) or Jerry (J), and the subscripts denote ice cream cones (ic) or cookies (c). Given that the price of cookies is \$1, and the price of an ice cream cone is \$2, then the price ratio is 2. This means that, in equilibrium, each individual must be indifferent between trading two cookies to get one ice cream cone. Ben, who likes ice cream more, is willing to make this trade when he is having two ice creams cones. But Jerry, who likes ice cream less, is only willing to make this two cookies for one ice cream cone trade at his first cone; after this, he isn't willing to give away two more cookies to get one more ice cream cone.

On the supply side, ice cream cones are produced until the marginal cost of doing so is equal to the marginal benefit of doing so, which, in this competitive market, is equal to the price. Thus, equilibrium on the supply side requires

(2) $$MC_{ic} = P_{ic}$$

Recall that we have set P_c = \$1. Thus, we have from equation (1) that $MRS = P_{ic}$, and we have from equation (2) that $MC = P_{ic}$. In equilibrium, therefore, $MRS = MC$.

The private market equilibrium is also the social-efficiency-maximizing choice (the point that maximizes social surplus). This is because when there are no market failures, the MRS for any quantity of ice cream cones equals the social marginal benefit of that quantity; the marginal value to society is equal to the marginal value to any individual in the perfectly competitive market. Similarly, when there are no market failures, the MC for any quantity of ice cream cones equals the social marginal cost of that quantity; the marginal cost to society is equal to the marginal cost to producers in a perfectly competitive market. Thus, at the private market equilibrium $SMB = SMC$, which is the condition for efficiency we derived in Chapter 5 for efficiency maximization: the efficiency-maximizing point is the one where the marginal value of consuming the next unit to any consumer is equal to the marginal cost of producing that additional unit.

Optimal Provision of Public Goods

Now, imagine that Ben and Jerry are choosing not between ice cream cones and cookies but between missiles, a public good, and cookies. Once again, the price of cookies is set equal to $1. A difference between missiles and ice cream cones is that individuals cannot tailor their own specific consumption of missiles. Because missiles are a public good, whatever amount is provided must be consumed equally by all. This characteristic of the market for public goods turns the private market analysis on its head, as shown in Figure 7-2. Each person is now forced to choose a common quantity of the public good. Because Ben and Jerry have different tastes for missiles and cookies, they will be willing to pay different prices for this common quantity. Ben has a very flat demand for missiles; he is willing to pay only $2 for the first missile and $1 for the fifth missile (panel (a)). Jerry has a steeper demand, and is willing to pay $4 for the first missile and $2 for the fifth missile (panel (b)).

Whatever number of missiles is chosen applies to Ben and Jerry equally, since missiles are a public good. To arrive at the market demand for missiles, we do not sum horizontally, as with private goods (where we sum the individual quantities demanded at the given market price). Instead, we sum *vertically* by adding the prices that each individual is willing to pay for the fixed market quantity. Ben and Jerry are together willing to pay $6 for the first missile, but their willingness to pay declines as the number of missiles increases, so they are only willing to pay $3 for the fifth missile. This vertically summed demand curve is shown in panel (c) of Figure 7-2.

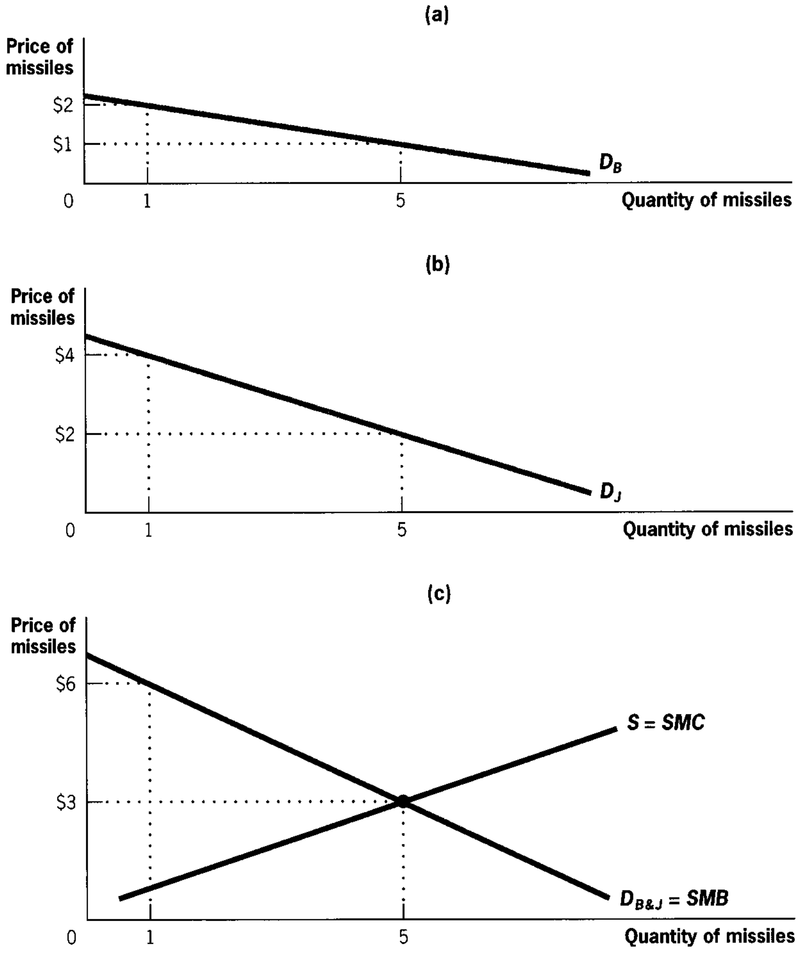
Panel (c) also shows a supply curve for missiles, which equals their marginal cost of production. The socially optimal level of production is the intersection of this supply with the vertically summed demand. That is, given that any missiles that are provided protect both Ben and Jerry, the producer should consider the *sum* of their valuations (their willingness to pay) in making its production decision. The resulting socially optimal level of production is five missiles.

Once again, a mathematical exposition helps clarify the mechanism underlying this result. The marginal missile is worth $MRS^B{}_{m,c}$ to Ben and $MRS^J{}_{m,c}$ to Jerry, so its total value to society is $MRS^B{}_{m,c} + MRS^J{}_{m,c}$. The social marginal benefit (*SMB*) of the next missile is the sum of Ben and Jerry's marginal rates of substitution, which represent their valuation of that missile. The social marginal cost (*SMC*) is the same as earlier: the marginal cost of producing a missile. Thus, the social-efficiency-maximizing condition for the public good is

$$MRS^B{}_{m,c} + MRS^J{}_{m,c} = MC \tag{3}$$

Social efficiency is maximized when the marginal cost is set equal to the *sum of the MRSs, rather than being set equal to each individual's MRS.* For private goods, it is optimal for firms to produce until the marginal cost equals the benefit to the marginal consumer, and that is the private competitive market outcome. For public goods, however, it is socially optimal for firms to produce until the marginal cost equals the benefit to *all* consumers combined. This is because the private good is rival: once it is consumed by any one consumer, it is gone. The public good is non-rival: since it can be consumed jointly by all consumers, society would like the producer to take into account the sum of all consumers' preferences.

■ **FIGURE 7-2**



Vertical Summation in Public Goods Markets • For public goods, we vertically sum the demands of Ben and Jerry to get the social value of the public good. If Ben is willing to pay $1 for the fifth missile, and Jerry is willing to pay $2 for the fifth missile, then society values that fifth missile at $3. Given the private supply curve for missiles, the optimal number of missiles to produce is five, where social marginal benefit ($3) equals social marginal cost ($3).

7.2 Private Provision of Public Goods

We have now developed the conditions for the optimal provision of public goods: public goods should be produced until the marginal cost for producers equals the sum of marginal rates of substitution for all consumers. With this finding in mind, the first question to ask (as always) is: Does the private sector get it right? If the private sector provides the optimal quantity of goods at the market price, then there is no market failure, and there is no potential role for the government in terms of improving efficiency.

free rider problem When an investment has a personal cost but a common benefit, individuals will underinvest.

Private-sector Underprovision

In general, the private sector in fact *underprovides public goods* because of the **free rider problem** discussed in Chapter 5: since my enjoyment of public goods is not solely dependent on my contribution to them, I will contribute less to their provision than is socially optimal.

Let's consider this problem in the context of an example. Suppose Ben and Jerry live by themselves far away from others. It is July Fourth, and they want to have a celebration. For this celebration, they care about only two consumption goods: ice cream cones and fireworks. The price of each of these goods is \$1, so for every firework they buy, they forgo a serving of ice cream. Ice cream is a private good here, but fireworks are a pure public good: fireworks are non-rival since both Ben and Jerry can enjoy them without impinging on the other's enjoyment, and fireworks are non-excludable since they explode high in the sky for both Ben and Jerry to see. Neither Ben nor Jerry cares about who sends up the firework, as long as it's up in the sky for them to see. Both Ben and Jerry benefit equally from a firework sent up by either of them; what matters to them is the *total amount of fireworks*. To further simplify the example, suppose that Ben and Jerry have identical preferences over different combinations of fireworks and ice cream.

If left to their own devices, Ben and Jerry will choose to consume combinations of fireworks and ice cream cones identified by the points at which their indifference curves are tangent to their budget constraints. The slope of the budget constraints is 1, since fireworks and ice cream cones are each \$1 per unit. The slope of the indifference curves is the *MRS*, or the ratio of marginal utilities. So, for both Ben and Jerry, they will set $MU_F / MU_{ic} = 1$, or $MU_{ic} = MU_F$. This equivalence will determine the quantities of fireworks and ice cream cones consumed.

The optimality condition for public goods is that the marginal cost of the good should be set equal to the *sum* of marginal rates of substitution. Optimal consumption of fireworks would therefore occur at the point at which $MU^B{}_F/MU^B{}_{ic} + MU^J{}_F/MU^J{}_{ic} = 1$. Since Ben and Jerry's preferences are identical, this is equivalent to saying that $2 \times (MU_F / MU_{ic}) = 1$, or $MU_F = \frac{1}{2} \times MU_{ic}$.

Recall that marginal utilities diminish with increasing consumption of a good. In a private market equilibrium, fireworks are consumed until their marginal utility equals the marginal utility of ice cream. But, in the optimal public goods equilibrium, fireworks are consumed until their marginal utility is *half* the marginal utility of ice cream; that is, more fireworks are consumed in the optimal public goods outcome than in the private outcome.

This result is exactly what we would expect from the free rider problem. Ben and Jerry each have to forgo a serving of ice cream to provide a firework, but both Ben and Jerry benefit from each firework that is provided. There is a clear strong positive externality here: Ben's or Jerry's provision of the firework greatly benefits the other person. As we saw with positive externalities earlier, this situation leads naturally to underproduction. Thus, the free rider problem leads to a potential role for government intervention. (The appendix to this chapter works out a formal mathematical example of the free rider problem, illustrating how the private market underprovides the public good.)

▶ APPLICATION

The Free Rider Problem in Practice[2]

The free rider problem is one of the most powerful concepts in all of economics, and it applies to everything from your everyday interactions to global politics. Some everyday examples, and interesting solutions, include the following:

- WNYC, the public radio station in New York, has an estimated listening audience of about 1 million people, but only 75,000 (7.5%) of their listeners send in money to support the station. Contributions account for only 35% of WNYC's budget. To avoid such a free rider problem in the United Kingdom, the national television station BBC charges an annual licensing fee (currently around $200) to anyone who owns and operates a TV! The law is enforced by keeping a database of addresses recorded when TV purchases are made, and periodically a fleet of BBC vans scours the country with TV detection devices that can sense the "local oscillator" that operates when a TV is being used. If you're caught without a license, the fine can run up to $1,500.
- A 2000 study of the file-sharing software Gnutella showed that 70% of users download files only from others, and never contribute their own files via upload. The top 1% of Gnutella users contribute 40% of the total files shared, and the top 20% of users provide 98% of all files traded. The file-sharing software Kazaa now assigns users ratings based on their ratio of uploads to downloads and then gives download priority to users according to their ratings, thus discouraging free riders.
- In 1994, the town of Cambridge, England, tried to provide a public good in the form of 350 free green bicycles scattered throughout the city. Users were expected to return each bicycle to one of 15 stands after its use. Unfortunately, within four days of the scheme's launch, not a single bicycle could be found, most having been likely stolen and repainted a different color. The scheme ultimately cost the city about $20,000, thus posing the ultimate in literal "free rider" problems. ◀

[2] Public radio data comes from Arik Hesseldahl's "Public Radio Goes Begging," a March 30, 2001, article in Forbes. The Gnutella study is described in Patti Hartigan's "Free Riders Who Don't Share in the Digital Community," an August 25, 2000, article for the *Boston Globe*. The British bicycle caper is reported in the *London Times'* April 20, 1994, article "Thieves Put Spoke in Freewheeling Dream."

Can Private Providers Overcome the Free Rider Problem?

The free rider problem does not lead to a complete absence of private provision of public goods. Many of us grew up in towns where there were privately financed fireworks displays, parks, even garbage collection. Indeed, one of the most famous counterarguments to the necessity of public provision of private goods was made for the case of lighthouses. Lighthouses seem to fit the definition of a pure public good: one ship's use of the light does not affect another's, and ships cannot be excluded from seeing the light when they are at sea. Indeed, for many generations, economists pointed to lighthouses as a classic example of a public good that would be underprovided by the private sector. John Stuart Mill was the first to argue that government should build lighthouses because "it is impossible that the ships at sea which are benefited by a lighthouse should be made to pay a toll on the occasion of its use." The great economist Paul Samuelson, in his classic text *Economics,* agreed that lighthouse building was "government activity justifiable because of external effects."[3]

Nonetheless, in a famous 1974 article, Ronald Coase (of Coase's theorem) conducted historical research showing that British lighthouses had been successfully provided by private interests long before the government ever took over the task. Private individuals, sensing a profitable opportunity, obtained permission from the government to build lighthouses and then levy tolls at the ports where the ships anchored. These individuals would determine how many lighthouses the ship had passed on its route and then charge them accordingly. Thus lighthouses were successfully provided by the private market until 1842, by which point the British government had purchased all private lighthouses in order to publicly provide this particular good.[4]

Thus, it appears that the private sector can in some cases combat the free rider problem to provide public goods. The previous example of file-sharing software shows one approach to doing so: charging user fees that are proportional to their valuation of the public good. The following policy application shows another example of privately financing public goods through such user fees—and the problems that such an approach can face.

▶ APPLICATION

Business Improvement Districts

The quality of city streets is another example of a public good. Residents all want clean, safe spaces in which to walk, but it is infeasible to charge pedestrians a fee for using the streets. For this reason, cities use tax revenues to publicly provide police departments for safety, sanitation departments for cleanliness, and public works departments to decorate the public spaces. Unfortunately,

[3] These quotations come from Coase (1974), described next.

[4] According to Coase (1974), the reason put forth by the government was that government ownership would actually lower prices by preventing private owners from inflating prices. Coase then argues that the government takeover did not, in fact, lower prices.

public provision of these services does not always work effectively. Take, for example, New York City's Times Square, an area of midtown Manhattan that by 1980 was infested with muggers, pickpockets, heroin dealers, prostitutes, and stores selling pornography and various kinds of weapons. The city government spent ten years attempting to clean up Times Square, but eventually gave up on the area once described as "dirty, dangerous, decrepit and increasingly derelict."[5]

Then, in 1992, a group of local businessmen decided to start a Business Improvement District (BID), a legal entity that privately provides local security and sanitation services, and funds these services with fees charged to local businesses. In theory, BIDs should fail because of the free rider problem: each business will simply hope that other area businesses will pay for the services from which they all will benefit. The New York law, however, is structured so that if the BID organizers can get over 60% of the local business community to agree to join, then the BID can levy fees on all local businesses. In the Times Square case, 84% of local businesses agreed to pay fees in order to fund the BID's services.

The Times Square BID has been a resounding success. Now with a budget over $5 million, the BID has 120 employees, half of whom do sanitation duties like sweeping, emptying trash cans, and removing graffiti, while the other half work as unarmed "public safety officers" in conjunction with the police. Crime has dropped significantly, the area is cleaner and more attractive, and as a result of these improvements business and tourism are once again booming. As the head of the BID describes it, "What BIDs are able to do is to devote an intense effort to a small place that the city itself could never afford. It's a way of localizing much of the functions of government and concentrating your community effort." The BID's power to levy fees on local businesses allows seemingly public goods (safety and cleanliness) to be provided through private channels.

Whether a BID works well depends strongly on the form of the law allowing BIDs to form in the first place. In Massachusetts, for example, BID laws allow local businesses to opt out of paying the required fees within 30 days of approval of the BID by the local government. The opt-out approach discourages businesses from pursuing plans for BIDs because of a fear that, after all the groundwork for the plans has been laid, businesses will withdraw from the program at the last minute rather than pay their fee for BID costs. As a result of the provision, only 2 BIDs have successfully formed in Massachusetts; the rest of the nation has 1,500 scattered throughout the states.[6] ◀

When Is Private Provision Likely to Overcome the Free Rider Problem?

While the free rider problem clearly exists, there are also examples where the private market is able to overcome this problem to some extent. Under what

[5] For more on the Times Square BID, see McDonald (2001).

[6] Kindleberger (1999).

circumstances are private market forces likely to solve the free rider problem, and under what circumstances are they not? In this section, we review three factors that are likely to determine the success of private provision: differences among individuals in their demand for the public good, altruism among potential donors to the public good, and utility from one's own contribution to the public good.

Some Individuals Care More than Others Private provision is particularly likely to surmount the free rider problem when individuals are not identical, and when some individuals have especially high demand for the public good. For example, let's assume that Ben has more income than Jerry, but total income between the two is constant, so that the social optimum for fireworks is the same as when their incomes are equal. As we show mathematically in the appendix, in this case Ben would provide more fireworks than Jerry: if the income differential is large enough, the total number of privately provided fireworks rises toward the socially optimal number of fireworks. We obtain a similar outcome if Ben and Jerry have the same income, but Ben gets more enjoyment from fireworks; even though they are a public good, Ben will still provide more of them.

The key intuition here is that the decision of how many fireworks to provide for any individual is a function of the enjoyment that the individual gets from total fireworks, net of their cost. If a person gets a lot of enjoyment, or has a lot of money to finance the fireworks, he will choose to purchase more fireworks, even though he is sharing the benefits with others: as enjoyment net of costs gets very large for any one individual, the provision of the public good starts to approximate private good provision.

Consider, for example, a driveway that is shared by a mansion and a rundown shack. In principle, there is a free rider problem in plowing the driveway, since the costs of plowing are borne by one party but both residences benefit from a clean driveway. Despite this, the mansion owner may nevertheless plow the driveway, allowing the owner of the shack to free ride, because the mansion owner has more money and perhaps cares more about having a clear driveway.

A classic example of this principle is provided by Olson and Zeckhauser (1966), who studied the financing of the North Atlantic Treaty Organization (NATO). At the time of their study, NATO was a voluntary organization that provided common military resources for defending the Americas and Western Europe. Thus, support for NATO suffered from the typical free rider problem: all countries were protected by NATO no matter which contributed, so each country had an incentive to free ride on the contributions of others. Despite this fact, NATO was well financed, with the largest nations (such as the United States) providing a disproportionate share of the financing. Olson and Zeckhauser conclude that this reflects the larger benefits perceived by the largest nations in having an organization such as NATO in existence.

Higher incomes or stronger tastes for the public goods can mitigate the free rider problem to some extent, but they are not likely to solve the problem. Even when one individual provides all of a public good, the individual still does not take into account the benefit to other individuals, and so the public good is usually still underproduced (as in the appendix's example). Thus, while the owner of the mansion may end up plowing the driveway, he may not bother to plow as well near the shack as the shack's owner would like. And while Olson and Zeckhauser highlighted the strong support for NATO by the largest nations, they also concluded that NATO is underfinanced overall due to free riding by small nations on the largest nations' contributions.

altruistic When individuals value the benefits and costs to others in making their consumption choices.

Altruism Another reason that private agents may provide more of a public good than our model would predict is that the model assumes purely selfish utility-maximizing agents. In fact, there is much evidence that individuals are **altruistic**—that is, they care about the outcomes of others as well as themselves. If individuals are altruistic, then they may be willing to contribute to a public good even if the free rider problem suggests they should not. In terms of our model, this would be equivalent to Ben caring not only about the costs of fireworks to himself, but the cost to Jerry as well, so that he is willing to contribute more in order to lower Jerry's burden.

Evidence for altruism comes from *laboratory experiments* of the kind that are typically employed in other fields, such as psychology, but that are gaining popularity as a means of resolving difficult economic issues. The typical public goods experiment proceeds as follows: five college undergraduates are placed in a room to play ten rounds of a simple game. In each round, the students are given \$1, and they have the option of keeping that \$1, or placing it in a "public" fund. After all students decide whether to contribute, the amount in the pubic fund is then doubled (by the economist running the experiment) and divided up evenly among all five students, *regardless of whether or not they contributed*. Thus, if all choose to contribute \$1 to the fund, they each receive \$2 in return. If only 2 contribute to the fund, each of the contributors receives \$0.80 (2 × \$2 / 5 students), while the noncontributors retain their full \$1 *and* get the 80¢ from the public fund, for a total of \$1.80. In this case, the contributors lose money and the noncontributors make money. There is thus a very clear incentive to free ride off the contributions of others, so that economists predict theoretically that no one should ever contribute to the public fund. If we start from a point of no contributors, any particular individual loses money by voluntarily becoming a contributor, so no one should do so.

The experimental evidence shows an outcome that is very different from that predicted by economic theory. As reviewed in Ledyard (1995), nearly every such public goods experiment results in 30–70% of the participants contributing to the public fund. Interestingly, in experiments with multiple rounds, such as the one just described, contributions tend to decline as the rounds progress, but rarely, if ever, reach zero. Thus, altruism appears to trump the purely selfish prediction that underlies the theory of the free rider problem.

Laboratory experiments, however, suffer from some limitations as a source of information about real-world behavior. Individuals may behave differently in a laboratory setting, where the stakes are often small, than they do in actual markets, where the stakes can be higher. Moreover, most of the experimental evidence used in economics comes from laboratory work with college undergraduates, which may not provide a representative answer for the entire population of interest.

Nevertheless, some real-world evidence is also consistent with altruism in private support of public goods. For example, Brunner (1998) noted that the traditional theory of public goods suggests that as the numbers of users of a good increases, the tendency for individuals to contribute to the financing of that good should decrease as they feel that their contribution has less and less of an impact (with only one user, there is no free rider possibility, but as the number of users grows, each individual's contribution benefits that person less and less and others more and more). Brunner therefore studied public radio stations across the country, examining listeners' contributions in relation to the total size of a given station's audience. Surprisingly, Brunner found that the number of listeners contributing decreases only modestly as the number of listeners increases, and that, among contributors, the amount of the contribution is unchanged. This seems to suggest that there is a subset of public goods contributors who get utility simply out of giving what they feel is their appropriate share.

What determines altruism? This is a very difficult question and has given rise to an entire field of study of **social capital,** the value of altruistic and communal behavior in society. A central finding of this field is that individuals are likely to be more altruistic when they are more "trusting" of others. For example, Anderson et al. (2003) ran a typical public goods experiment of the type described, and paired the results across individuals with both attitudinal measures of trust (do you agree with statements like "most people can be trusted") and behavioral measures of trust (do you loan money to friends and strangers? have you ever been a crime victim? do you purposefully leave your doors unlocked? and so on). They found that most of the attitudinal and behavioral measures of trust were positively correlated with high contributions to the public good. In the Bangladeshi trash collection example that opened this chapter, the few communities that were successful in setting up private trash collection were those neighborhoods that tended to exhibit higher levels of "reciprocity" (do you help neighbors after a householder dies? do you and your neighbors help take each other for visits to the hospital or doctor?) and "sharing" (do you send your neighbors food during festivals or other happy occasions? do you and your neighbors share fruits/vegetables grown on your own premises?).

social capital The value of altruistic and communal behavior in society.

warm glow model Model of public good provision in which individuals care about both the total amount of the public good and their particular contributions as well.

Warm Glow A final reason that private individuals might provide more of the public good than suggested by our model is that individuals might care about their own contributions per se. Under the **warm glow model,** individuals care about both the total amount of the public good and their particular contributions as well. Perhaps they get a plaque with their name on it from making contributions, or maybe their contributions are known publicly so that their friends praise them for their generosity, or maybe they get a psychological benefit from knowing they helped a worthy cause. If individuals get utility from their particular contributions for any reason, then the public good becomes like a private good, and individuals will contribute more than predicted by our original model (in which they care only about the total public good quantity). Warm glow does not fully solve the underprovision problem, however, since individuals still do not account for the positive benefits to others of their public goods provision.

7.3 Public Provision of Public Goods

The discussion in section 7.2 highlights that the private sector will generally underprovide public goods, so that government can potentially improve efficiency by intervening. In principle, the government could solve the optimal public goods provision problem previously presented and then either provide that amount of the good or mandate private actors to provide that amount.

In practice, however, governments face some significant barriers when they attempt to solve the free rider problem in the provision of public goods. In this section, we review three of those barriers: private responses to public provision, or "crowd-out"; the difficulty of measuring the costs and benefits of public goods; and the difficulty of determining the public's preferences for public goods.

Private Responses to Public Provision: The Problem of Crowd-Out

In some instances, public goods will not be provided at all by those in the private sector unless the government tells them they must provide the good. In other cases, as we noted, the private sector is already providing the public good to some extent before the government intervenes, and this private provision will react to government intervention. In particular, public provision will to some extent **crowd out** private provision: as the government provides more of the public good, the private sector will provide less. This decrease in private provision will offset the net gain in public provision from government intervention.

The extent of such crowd-out depends on the preferences of the private individuals providing the public good. Let's continue to explore the fireworks example and make three assumptions:

1. Ben and Jerry care only about the total amount of fireworks provided: there is no warm glow from giving.
2. The government provision of fireworks will be financed by charging Ben and Jerry equal amounts.
3. The government provides fewer fireworks than Ben and Jerry were providing beforehand.

crowd-out As the government provides more of a public good, the private sector will provide less.

In this case, as we show mathematically in the appendix, *each dollar of public provision will crowd out private provision one for one.* That is, the government's intervention will have no *net effect* on the quantity of fireworks provided.

This outcome illustrates the fundamental *robustness of economic equilibria:* if a person starts from his or her individual optimum, and the market environment changes, and if the person can undo this change to get back to that optimum, he or she will do so. The private equilibrium is the preferred outcome for Ben and Jerry. If they can undo any government intervention to get back to that preferred outcome, they will do so; what was optimal before the government intervened remains optimal after government intervention given our three earlier assumptions.

For example, suppose that in the pregovernment optimum Ben and Jerry were each providing 10 fireworks, at a cost of $10 for each person. The total private provision is therefore 20 fireworks, but let's say the social optimum is 30 fireworks. To reach the social optimum, the government decides to take $5 each from Ben and from Jerry, and use the $10 raised to buy 10 more fireworks. Ben and Jerry each have $5 less, and they observe the government providing 10 fireworks. They simply cut their spending on fireworks by $5 each, so that they spend the same ($5 on fireworks, $5 to the government), and see the same total fireworks (20). So they are exactly where they originally wanted to be, and the government intervention has done nothing. This is a case of full crowd-out.

Crowd-out is a classic example of the unintended consequences of government action that we first discussed in Chapter 1. The government intended to do the right thing by increasing fireworks to the social optimum. But, in fact, it ended up having no effect, because its actions were totally offset by changes in individual actions.

Full crowd-out is rare. Partial crowd-out is much more common and it can occur in two different cases: when noncontributors to the public good are taxed to finance provision of the good, and when individuals derive utility from their own contribution as well as from the total amount of public good.

Contributors vs. Noncontributors Suppose that some people contribute more for public goods than others, either because they are richer or because they have a stronger preference for the public good. In the extreme case, suppose that Ben contributes $20 to buy 20 fireworks, and Jerry contributes nothing, because Ben likes fireworks more than Jerry or because he is richer than Jerry. This is still below the social optimum of 30 fireworks, however.

Now, suppose that the government charges Ben and Jerry each $5 for firework contributions and then provides 10 fireworks in an attempt to bring the number of fireworks to the socially optimal level of 30. Jerry now spends $5 more on fireworks, since he was providing nothing before. Ben, on the other hand, will not reduce his firework consumption by the full $10 (to offset government provision). Ben has effectively been made better off: there are 10 more fireworks that only cost him $5 in government-mandated contributions, rather than the $10 he would have spent if he'd bought those 10 fireworks.

This increase in Ben's effective wealth (value of fireworks plus value of other goods he can purchase) has a positive income effect on Ben's purchase of fireworks, so government intervention will not fully crowd out his spending. The total number of fireworks will rise above 20. By forcing Jerry to become a contributor, the government has increased total public goods provision.

Warm Glow Alternatively, there may not be full crowd-out if I care about my own contributions per se, as in the warm glow model. If I get utility from my particular contributions for any reason, then an increase in government contributions will not fully crowd out my giving. For example, consider the extreme case where *all* I care about is how much I give, and I don't care about gifts from others. If the government increases contributions from others, these contributions have no offsetting effects on my giving because my giving is, from my perspective, a private good. In this extreme case, there may be *no* crowd-out of my contributions by government intervention. As long as there is some warm glow from my own contributions, then crowd-out will be less than one for one, since part of my contribution is a private good.

Evidence on Crowd-Out How important a problem is crowd-out in reality? Unfortunately, the existing evidence on crowd-out is quite mixed. On the one hand, studies assessing how individual contributions respond to government spending suggest very small crowd-out. As the Empirical Evidence box reviews, however, these studies suffer from many of the bias problems discussed in Chapter 3. On the other hand, evidence from laboratory experiments suggest that crowd-out is large, but less than full. Thus, while there is no evidence for full crowd-out, there is also no consensus on the size of this important individual response to government intervention.

Measuring the Costs and Benefits of Public Goods

In the previous theoretical analysis, we assumed that the government could measure both the benefits and costs of providing public goods. In practice, this is quite difficult. Consider the example of improving a highway in order to reduce traffic slowdowns and improve safety. There is a clear free rider problem in relying on the private sector for this improvement. The benefits of highway improvement are fairly small for any one driver, although they may be quite large for the total set of drivers using the highway. Thus, no one driver will invest the necessary resources to improve the highway.

Should the government undertake these highway improvements? That depends on whether the costs of doing so exceed the sum of the benefits to all drivers who use the highway, but measuring these costs and benefits can be complicated. Consider the costs of the labor needed to repair the highway. The budgetary cost of this labor is the wage payments made by the government for this labor, but the economic costs can be different. What if, without this highway project, half of the workers on the project would be unemployed? How can the government take into account that it is not only paying wages but also providing a new job opportunity for these workers?

EMPIRICAL EVIDENCE

MEASURING CROWD-OUT

There are a large number of studies that consider how private spending on public goods responds to public spending on the same public goods. A classic example is Kingma's (1989) study of public radio. Public radio is supported partly by contributions from its listeners and partly by government contributions. Kingma collected data on how much governments contribute to public radio stations in different cities around the country. He then gathered data on how much individuals contribute to their public radio stations in those same cities. He found that for every $1 increase in government funding, private contributions fell by 13.5¢, for only a very partial crowd-out. Other studies in this vein typically also find that crowd-out is fairly small.[7]

This is an interesting finding, but it potentially suffers from the bias problems discussed in Chapter 3: there may be reasons why areas with different government contributions to public radio might also have different tastes for private giving. For example, suppose that governments are more able to support public radio in high-income areas than in low-income areas (since the government raises more tax revenues in the high income areas), and that individuals contribute more to charitable causes (like public radio) in high-income areas than in low-income areas. Then high-income and low-income areas are not good treatment and control groups to use for measuring the effect of government spending on individual giving. Such comparisons will be biased by the fact that high-income areas would have given more even in the absence of government intervention. In principle, regression analysis using controls for income can correct this bias, but in practice, as discussed in Chapter 3, controls are typically unable to fully correct this type of problem.

The other type of evidence that has been used in this area comes from laboratory experiments. The classic study using this approach is Andreoni (1993). He set up an experiment in which individuals contributed to a public good in a laboratory setting by contributing tokens they were given to a common fund. He set up the payoffs for this experiment so that each player, if acting as a free-rider, should choose to contribute 3 tokens in order to maximize the player's likely return. This predicted contribution (3 tokens) was close to the level actually chosen by each participant (2.78 tokens).[8]

Andreoni then made the following change to the laboratory game: using the same payment schedule, he instituted a 2-token tax on every player. This tax was then contributed to the public good. This change mirrors the full earlier crowd-out example, so, without warm glow effects, players should have reduced their contributions by 2 tokens to 0.78 tokens to offset the government contribution plan. In fact, however, each player cut his or her contributions by only 1.43 tokens, so that contributions fell only to 1.35 tokens. That is, crowd-out was less than full; each token of government contribution crowded out only 0.715 tokens of private contributions.

This crowd-out estimate is much higher than that obtained from empirical studies: recall that Kingma's estimate was that a dollar of government contribution would crowd out only 0.135 dollars of private contributions. At the same time, as already noted, laboratory experiments have their limitations as a source of economic evidence. Thus, the true extent of crowd-out remains an important question.

There are even more difficult problems facing the government as it tries to assess the benefits of the project. What is the value of the time saved for commuters due to reduced traffic jams? And what is the value to society of the reduced number of deaths if the highway is improved?

[7] See Steinberg (1991) or Straub (2003) for reviews; Straub even finds that the small Kingma crowd-out is not significant when using an updated and larger sample.

[8] Andreoni's subjects did behave very much like free-riders, unlike the altruistic cases discussed earlier, perhaps because they were economics students who were given time to study the structure of the game. In one public goods experiment, Marwell and Ames (1981) showed that graduate students in economics free ride much more than the general population, contributing only 20% of their tokens compared to 49% for the other subjects.

These difficult questions are addressed by the field of *cost-benefit analysis,* which provides a framework for measuring the costs and benefits of public projects. Chapter 8 provides a detailed discussion of cost-benefit analysis, within the context of this highway example.

How Can we Measure Preferences for the Public Good?

In our discussion of optimal public goods provision, the government knows each individual's preferences over private and public goods. The government can therefore compute for each individual that person's marginal valuation of public goods (his or her marginal rate of substitution of the public for the private good), sum these valuations across all individuals, and set this equal to the marginal cost of the public good (relative to the marginal cost of the private good).

In practice, of course, there are at least three problems facing a government trying to turn individual preferences into a decision about public goods provision. The first is *preference revelation*: individuals may not be willing to tell the government their true valuation, for example, because the government might charge them more for the good if they say that they value it highly. The second is *preference knowledge:* even if individuals are willing to be honest about their valuation of a public good, they may not know what their valuation is, since they have little experience pricing public goods such as highways or national defense. The third is *preference aggregation:* how can the government effectively put together the preferences of millions of citizens in order to decide on the value of a public project?

These difficult problems are addressed by the field of *political economy,* the study of how governments go about making public policy decisions such as the appropriate level of public goods. In Chapter 9, we'll discuss the various approaches used by governments to address these problems, and their implications for the ability of governments to effectively intervene in problems such as the free rider problem.

7.4 Conclusion

A major function of governments at all levels is the provision of public goods. The potential gains from such government intervention are apparent from free rider problems, such as those impeding garbage collection in Bangladesh. In some cases, the private sector can provide public goods, but in general it will not achieve the optimal level of provision.

When there are problems with private market provision of public goods, government intervention can potentially increase efficiency. Whether that potential will be achieved is a function of both the ability of the government to appropriately measure the costs and benefits of public projects and the ability of the government to carry out the socially efficient decision. In the next two chapters, we investigate those two concerns in detail.