

## ► QUESTIONS AND PROBLEMS

1. Peterson, Hoffer, and Millner (1995) showed that air bag use has led to increases in car crashes. Despite this finding, the government mandates that new cars have air bags, rather than taxing their use. Is this policy a contradiction?
2. When the state of Virginia imposed stricter regulations on air pollution in 2003, it also authorized an auction of pollution permits, allowing some plants to emit larger amounts of ozone-depleting chemicals than would otherwise be allowed, and some to emit less. Theory predicts that this auction led to a socially efficient allocation of pollution. Describe how this outcome would occur.
3. Can an activity generate both positive and negative externalities at the same time? Explain your answer.
4. In the midwestern United States, where winds tend to blow from west to east, states tend to more easily approve new polluting industries near their eastern borders than in other parts of the state. Why do you think this is true?
5. Can government assignment and enforcement of property rights internalize an externality? Will this approach work as well as, better than, or worse than direct government intervention? Explain your answers and describe one of the difficulties associated with this solution.
6. In close congressional votes, many members of Congress choose to remain “undecided” until the last moment. Why might they do this? What lesson does this example teach about a potential shortcoming of the Coasian solution to the externality problem?
7. Suppose that a firm’s marginal production costs are given by  $MC = 10 + 3Q$ . The firm’s production process generates a toxic waste, which imposes an increasingly large cost on the residents of the town where it operates: the marginal external cost associated with the  $Q$ th unit of production is given by  $6Q$ . What is the marginal private cost associated with the 10th unit produced? What is the total marginal cost to society associated with producing the 10th unit (the marginal social cost of the 10th unit)?
8. In two-car automobile accidents, passengers in the larger vehicle are significantly more likely to survive than are passengers in the smaller vehicle. In fact, death probabilities are decreasing in the size of the vehicle you are driving, and death probabilities are increasing in the size of the vehicle you collide with. Some politicians and lobbyists have argued that this provides a rationale for encouraging the sale of larger vehicles and discouraging legislation that would induce automobile manufacturers to make smaller cars. Critically examine this argument using the concept of externalities.
9. Why do governments sometimes impose quantity regulations that limit the level of negative-externality-inducing consumption? Why do governments sometimes impose price regulations by taxing this consumption?
10. Answer the following two questions for each of the following examples: (i) smoking by individuals; (ii) toxic waste production by firms; (iii) research and development by a high-tech firm; and (iv) individual vaccination against communicable illness.
  - a. Is there an externality? If so, describe it, including references to whether it is positive or negative, and whether it is a consumption or production externality.
  - b. If there is an externality, does it seem likely that private markets will arise that allow this externality to be internalized? Why or why not?

## ▶ ADVANCED QUESTIONS

11. Warrenia has two regions. In Oliviland, the marginal benefit associated with pollution cleanup is  $MB = 300 - 10Q$ , while in Linneland, the marginal benefit associated with pollution cleanup is  $MB = 200 - 4Q$ . Suppose that the marginal cost of cleanup is constant at \$12 per unit. What is the optimal level of pollution cleanup in each of the two regions?
12. The private marginal benefit associated with a product's consumption is  $PMB = 360 - 4Q$  and the private marginal cost associated with its production is  $PMC = 6P$ . Furthermore, the marginal external damage associated with this good's production is  $MD = 2P$ . To correct the externality, the government decides to impose a tax of  $T$  per unit sold. What tax  $T$  should it set to achieve the social optimum?
13. Suppose that demand for a product is  $Q = 1200 - 4P$  and supply is  $Q = -200 + 2P$ . Furthermore, suppose that the marginal external damage of this product is \$8 per unit. How many more units of this product will the free market produce than is socially optimal? Calculate the deadweight loss associated with the externality.
14. The marginal damage averted from pollution cleanup is  $MD = 200 - 5Q$ . The marginal cost associated with pollution cleanup is  $MC = 10 + Q$ .
- What is the optimal level of pollution reduction?
  - Show that this level of pollution reduction could be accomplished through taxation. What tax per unit would generate the optimal amount of pollution reduction?
15. Two firms are ordered by the federal government to reduce their pollution levels. Firm  $A$ 's marginal costs associated with pollution reduction is  $MC = 20 + 4Q$ . Firm  $B$ 's marginal costs associated with pollution reduction is  $MC = 10 + 8Q$ . The marginal benefit of pollution reduction is  $MB = 400 - 4Q$ .
- What is the socially optimal level of each firm's pollution reduction?
  - Compare the social efficiency of three possible outcomes: (1) require all firms to reduce pollution by the same amount; (2) charge a common tax per unit of pollution; or (3) require all firms to reduce pollution by the same amount, but allow pollution permits to be bought and sold.
16. One hundred commuters need to use a strip of highway to get to work. They all drive alone and prefer to drive in big cars—it gives them more prestige and makes them feel safer. Bigger cars cost more per mile to operate, however, since their gas mileage is lower. Worse yet, bigger cars cause greater permanent damage to roads. The weight of the car is  $w$ . Suppose that the benefits from driving are  $4w$ , while the costs are  $3/2 \times w^2$ . The damage to roads is  $1/3 \times w^3$ . Assume that individuals have utility functions of the form  $U = x$ , where  $x$  are the net benefits from driving a car of a given size.
- What car weight will be chosen by drivers?
  - What is the optimal car weight? If this differs from (a), why does it?
  - Can you design a toll system that causes drivers to choose the optimal car weight? If so, then how would such a system work?
17. Firms  $A$  and  $B$  each produce 80 units of pollution. The federal government wants to reduce pollution levels. The marginal costs associated with pollution reduction are  $MC^A = 50 + 3Q^A$  for firm  $A$  and  $MC^B = 20 + 6Q^B$  for firm  $B$ , where  $Q^A$  and  $Q^B$  are the quantities of pollution reduced by each firm. Society's marginal benefit from pollution reduction is given by  $MB = 590 - 3Q^{tot}$ , where  $Q^{tot}$  is the total reduction in pollution.
- What is the socially optimal level of each firm's pollution reduction?
  - How much total pollution is there in the social optimum?
  - Explain why it is inefficient to give each firm an equal number of pollution permits (if they are not allowed to trade them).
  - Explain how the social optimum can be achieved if firms are given equal numbers of pollution permits but are allowed to trade them.
  - Can the social optimum be achieved using a tax on pollution?

## ► QUESTIONS AND PROBLEMS

1. We add the demands of *private* goods horizontally but add the demands of *public* goods vertically when determining the associated marginal benefit to society. Why do we do this and why are the procedures different for public and private goods?
2. The citizens of Balaland used to pave 120 miles of roadways per year. After the government of Balaland began paving 100 miles of roadways per year itself, the citizens cut back their paving to 30 miles per year, for a total number of roadway miles paved per year of only 130 miles. What might be happening here?
3. Bill's demand for hamburgers (a private good) is  $Q = 20 - 2P$  and Ted's demand is  $Q = 10 - P$ .
  - a. Write down an equation for the social marginal benefit of the consumption of hamburger consumption.
  - b. Now suppose that hamburgers are a *public* good. Write down an equation for the social marginal benefit of hamburger consumption.
4. People in my neighborhood pay annual dues to a neighborhood association. This association refunds neighborhood dues to selected home owners who do a particularly nice job in beautifying their yards.
  - a. Why might the neighborhood association provide this refund?
  - b. At the most recent home owners' association meeting, home owners voted to end this practice because they felt that it was unfair that some people would not have to pay their share of the costs of maintaining the neighborhood.
 

What is likely to happen to the overall level of neighborhood beautification? Explain.
5. Zorroland has a large number of people who are alike in every way. Boppoland has the same number of people as Zorroland, with the same average income as Zorroland, but the distribution of incomes is wider. Why might Boppoland have a higher level of public good provision than Zorroland?
6. Think about the rival and excludable properties of public goods. To what degree is *radio broadcasting* a public good? To what degree is a *highway* a public good?
7. Think of an example of a free rider problem in your hometown. Can you think of a way for your local government to overcome this problem?
8. In order to determine the right amount of public good to provide, the government of West Essex decides to survey its residents about how much they value the good. It will then finance the public good provision by taxes on residents. Describe a tax system that would lead residents to underreport their valuations. Describe an alternative system that could lead residents to overreport their valuations.
9. Why is it difficult to empirically determine the degree to which government spending crowds out private provision of public goods?
10. Think back to Chapter 5. Why can the public good provision problem be thought of as an externality problem?

## ► ADVANCED QUESTIONS

11. Suppose ten people each have the demand  $Q = 20 - 4P$  for streetlights, and 5 people have the demand  $Q = 18 - 2P$  for streetlights. The cost of building each streetlight is 3. If it is impossible to purchase a fractional number of streetlights, how many streetlights are socially optimal?
12. Andrew, Beth, and Cathy live in Lindhville. Andrew's demand for bike paths, a public good, is given by  $Q = 12 - 2P$ . Beth's demand is  $Q = 18 - P$ , and Cathy's is  $Q = 8 - P/3$ . The marginal cost of building a bike path is  $MC = 21$ . The town government decides to use the following procedure

for deciding how many paths to build. It asks each resident how many paths they want, and it builds the largest number asked for by any resident. To pay for these paths, it then taxes Andrew, Beth, and Cathy the prices  $a$ ,  $b$ , and  $c$  per path, respectively, where  $a + b + c = MC$ . (The residents know these tax rates before stating how many paths they want.)

- a. If the taxes are set so that each resident shares the cost evenly ( $a = b = c$ ), how many paths will get built?
- b. Show that the government can achieve the social optimum by setting the correct tax prices  $a$ ,  $b$ , and  $c$ . What prices should it set?

13. The town of Springfield has two residents: Homer and Bart. The town currently funds its fire department solely from the individual contributions of these residents. Each of the two residents has a utility function over private goods ( $X$ ) and total firefighters ( $M$ ), of the form  $U = 4 \times \log(X) + 2 \times \log(M)$ . The total provision of firefighters hired,  $M$ , is the sum of the number hired by each of the two persons:  $M = M_H + M_B$ . Homer and Bart both have income of \$100, and the price of both the private good and a firefighter is \$1. Thus, they are limited to providing between 0 and 100 firefighters.

- a. How many firefighters are hired if the government does not intervene? How many are paid for by Homer? By Bart?
- b. What is the socially optimal number of firefighters? If your answer differs from (a), why?

14. The town of Musicville has two residents: Bach and Mozart. The town currently funds its free outdoor concert series solely from the individual contributions of these residents. Each of the two residents has a utility function over private goods ( $X$ ) and total concerts ( $C$ ), of the form  $U = 3 \times \log(X) + \log(C)$ . The total number of concerts

given,  $C$ , is the sum of the number paid for by each of the two persons:  $C = C_B + C_M$ . Bach and Mozart both have income of 70, and the price of both the private good and a concert is 1. Thus, they are limited to providing between 0 and 70 concerts.


- a. How many concerts are given if the government does not intervene?
- b. Suppose the government is not happy with the private equilibrium and decides to provide 10 concerts in addition to what Bach and Mozart may choose to provide on their own. It taxes Bach and Mozart equally to pay for the new concerts. What is the new total number of concerts? How does your answer compare to (a)? Have we achieved the social optimum? Why or why not?
- c. Suppose that instead an anonymous benefactor pays for 10 concerts. What is the new total number of concerts? Is this the same level of provision as in (b)? Why or why not?

15. Consider an economy with three types of individuals, differing only with respect to their preferences for monuments. Individuals of the first type get a fixed benefit of 100 from the mere existence of monuments, whatever their number. Individuals of the second and third type get benefits according to:

$$B_{II} = 200 + 30M - 1.5M^2$$

$$B_{III} = 150 + 90M - 4.5M^2$$

where  $M$  denotes the number of monuments in the city. Assume that there are 50 people of each type. Monuments cost \$3,600 each to build. How many monuments should be built?

The  icon indicates a question that requires students to apply the empirical economics principles discussed in Chapter 3 and the Empirical Evidence boxes.