



Chapter 13 Exercises

Self-Check Questions

1. Classify the following situations as an example of a negative or positive externality:
 - a. You are a birder (bird watcher); your neighbor has put up several birdhouses in the yard and planted trees and flowers that attract birds.
 - b. Your neighbor paints his house a hideous color.
 - c. Investments in private education raise your country's standard of living.
 - d. Trash dumped upstream flows downstream, right past your home.
 - e. Your roommate is a smoker, but you do not smoke.
2. Identify whether the market supply curve will shift right, shift left, or stay the same for the following scenarios:
 - a. Firms in an industry are required to pay a fine for their emissions of carbon dioxide.
 - b. Companies are sued for polluting the water in a river.
 - c. Power plants in a specific city are not required to address the impact of their emissions on the quality of air.
 - d. Companies that use fracking to remove oil and gas from rock are required to clean up the damage.
3. For each of your answers to the prior question, will equilibrium price rise, fall, or stay the same?
4. The supply and demand conditions for a manufacturing firm are given in the following table. The third column represents a supply curve without taking the social cost of pollution into account. The fourth column represents the supply curve when the firm is required to take the social cost of pollution into account. Identify the equilibrium before the social cost of production is included and after the social cost of production is included.

Price	Quantity Demanded	Quantity Supplied without Paying the Cost of Pollution	Quantity Supplied after Paying the Cost of Pollution
\$10	450	400	250
\$15	440	440	290
\$20	430	480	330
\$25	420	520	370
\$30	410	560	410

5. Consider two approaches to reducing emissions of CO₂ into the environment from manufacturing industries in the United States. In the first approach, the U.S. government makes it a policy to use only predetermined technologies. In the second approach, the U.S. government determines which technologies are cleaner and subsidizes their use. Of the two approaches, which is the command-and-control policy?
6. Classify the following pollution-control policies as command-and-control or market-based.
 - a. A state passes an emissions tax on the quantity of carbon emitted by each firm.
 - b. The federal government requires domestic auto companies to improve car emissions by 2026.
 - c. The EPA sets national standards for water quality.

- d. A city sells permits to firms that allow them to emit a specified quantity of pollution.
- e. The federal government pays fishermen to preserve salmon.
7. An emissions tax on a quantity of emissions from a firm is not a command-and-control approach to reducing pollution. Why?
8. Four firms called Elm, Maple, Oak, and Cherry produce wooden chairs. However, they also produce a great deal of garbage (a mixture of glue, varnish, sandpaper, and wood scraps). The first row in the following table shows the total amount of garbage (in tons) currently produced by each firm. The other rows of the table show the cost of reducing garbage produced by the first 5 tons, the second 5 tons, and so on. First, calculate the cost of requiring each firm to reduce the weight of its garbage by one-fourth. Now, imagine that marketable permits are issued for the current level of garbage, but the permits will shrink the weight of allowable garbage for each firm by one-fourth. What will be the result of this alternative approach to reducing pollution?

	Elm	Maple	Oak	Cherry
Current production of garbage (in tons)	20	40	60	80
Cost of reducing garbage by first 5 tons	\$5,500	\$6,300	\$7,200	\$3,000
Cost of reducing garbage by second 5 tons	\$6,000	\$7,200	\$7,500	\$4,000
Cost of reducing garbage by third 5 tons	\$6,500	\$8,100	\$7,800	\$5,000
Cost of reducing garbage by fourth 5 tons	\$7,000	\$9,000	\$8,100	\$6,000
Cost of reducing garbage by fifth 5 tons	\$0	\$9,900	\$8,400	\$7,000

9. The rows in the following table show three market-oriented tools for reducing pollution. The columns of the table show three complaints about command-and-control regulation. Fill in the table by stating briefly how each market-oriented tool addresses each of the three concerns.

	Incentives to Go Beyond	Flexibility about Where and How Pollution Will Be Reduced	Political Process Creates Loopholes and Exceptions
Pollution Charges			
Marketable Permits			
Property Rights			

10. Suppose a city releases 16 million gallons of raw sewage into a nearby lake. The following table shows the total costs of cleaning up the sewage to different levels, together with the total benefits of doing so. (Benefits are environmental, recreational, health, and industrial.)

Quantity of Sewage Released in Nearby Lake	Total Cost (in thousands of dollars)	Total Benefits (in thousands of dollars)
16 million gallons	Current situation	Current situation
12 million gallons	50	800
8 million gallons	150	1,300
4 million gallons	500	1,650
0 gallons	1,200	1,900

- Use the information from the table to calculate the marginal costs and marginal benefits of reducing sewage emissions for this city. See Chapter 8 if you need a refresher on how to calculate marginal costs.
- What is the optimal level of sewage for this city?
- Why not just pass a law that zero sewage can be released in the lake? After all, the total benefits of zero emissions exceed the total costs.

11. The state of Colorado requires oil and gas companies who use fracking techniques to return the land to its original condition after the oil and gas extractions. The following table shows the total cost and total benefits (in dollars) of this policy.

Land Restored (in acres)	Total Cost	Total Benefit
0	\$0	\$0
200	\$20	\$140
300	\$80	\$240
400	\$160	\$320
500	\$280	\$380

- a. Calculate the marginal cost and marginal benefit at each quantity (acre) of land restored. See Chapter 8 if you need a refresher on how to calculate marginal costs and benefits.
- b. If we apply marginal analysis, what is the optimal amount of land to be restored?
12. Consider the case of global environmental problems that spill across international borders as a prisoner's dilemma of the sort studied in Chapter 11. Say that there are two countries, A and B. Each country can choose whether to protect the environment, at a cost of 10, or not to protect it, at a cost of zero. If one country decides to protect the environment, there is a benefit of 16, but the benefit is divided equally between the two countries. If both countries decide to protect the environment, there is a benefit of 32, which is divided equally between the two countries.

In the following table, fill in the costs, benefits, and total payoffs to the countries of the following decisions. Explain why, without some international agreement, they are likely to end up with neither country acting to protect the environment.

		Country B	
		Protect	Not Protect
Country A	Protect		
	Not Protect		

13. A country called Sherwood is covered with a forest of 50,000 trees. There are proposals to clear some of Sherwood's forest and grow corn, but obtaining this additional economic output will have an environmental cost from reducing the number of trees. The following table shows possible combinations of economic output and environmental protection.

Combo	Bushels of Corn (thousands)	Number of Trees (thousands)
<i>P</i>	9	5
<i>Q</i>	2	30
<i>R</i>	7	20
<i>S</i>	2	40
<i>T</i>	6	10

- Sketch a graph of a production possibility frontier with environmental quality on the horizontal axis, measured by the number of trees, and the quantity of economic output, measured in corn, on the vertical axis.
- Which choices display productive efficiency? How can you tell?
- Which choices show allocative efficiency? How can you tell?
- In the choice between *T* and *R*, decide which one is better. Why?
- In the choice between *T* and *S*, can you say which one is better and why?
- If you had to guess, which choice would you think is more likely to represent a command-and-control environmental policy, and which choice is more likely to represent a market-oriented environmental policy, *Q* or *S*? Why?

Review Questions

- What is an externality?
- Give an example of a positive externality and a negative externality.
- What is the difference between private costs and social costs?
- In a market without environmental regulations, will the supply curve for a firm take into account private costs, external costs, both, or neither? Explain.
- What is command-and-control environmental regulation?
- What are the three problems that economists have noted with regard to command-and-control regulation?
- What is a pollution charge, and what incentive does it provide for a firm to take external costs into account?
- What is a marketable permit, and what incentive does it provide for a firm to take external costs into account?
- What are better-defined property rights, and what incentive do they provide to take external costs into account?
- As the extent of environmental protection expands, would you expect marginal costs of environmental protection to rise or fall? Why or why not?
- As the extent of environmental protection expands, would you expect the marginal benefits of environmental protection to rise or fall? Why or why not?
- What are the economic tradeoffs between low-income and high-income countries in international conferences on global environmental damage?
- What arguments do low-income countries make in international discussions of global environmental clean-up?

27. In the tradeoff between economic output and environmental protection, what do the combinations on the production possibility frontier represent?
28. What does a point inside the production possibility frontier represent?

Critical Thinking Questions

29. Suppose you want to put a dollar value on the external costs of carbon emissions from a power plant. What information or data would you obtain to measure the external (social) cost?
30. Would environmentalists favor command-and-control policies as a way to reduce pollution? Why or why not?
31. Consider two ways of protecting elephants from poachers in African countries. In one approach, the government sets up enormous national parks that have sufficient habitat for elephants to thrive and forbids all local people to enter the parks or injure either the elephants or their habitat in any way. In a second approach, the government sets up national parks and designates ten villages around the edges of the park that become places where tourists can stay and bases for guided tours inside the national park. Consider the different incentives of local villagers—who often are very poor—in each of these plans. Which plan seems more likely to help the elephant population?
32. Will a system of marketable permits work with thousands of firms? Why or why not?
33. Is zero pollution possible under a marketable permits system? Why or why not?
34. Is zero pollution an optimal goal? Why or why not?
35. From an economic perspective, is it sound policy to pursue a goal of zero pollution? Why or why not?
36. Recycling is a relatively inexpensive solution to much of the environmental contamination from plastics, glass, and other waste materials. Is it a sound policy to make it mandatory for everybody to recycle?
37. Can extreme levels of pollution hurt the economic development of a high-income country? Why or why not?
38. How can high-income countries benefit from covering much of the cost of reducing pollution created by low-income countries?
39. Technological innovations shift the production possibility curve. Examine the graph you sketched for Exercise 13a. Which types of technologies should a country promote? Should “clean” technologies be promoted over other technologies? Why or why not?

Problems

40. Show the market for cigarettes in equilibrium, assuming that there are no laws banning smoking in public. Label the equilibrium private market price and quantity as P_m and Q_m . Add whatever is needed to the model to show the impact of the negative externality from secondhand smoking. (*Hint*: in this case, it is the consumers, not the sellers, who are creating the negative externality.) Label the social optimal output and price as P_e and Q_e . On the graph, shade in the deadweight loss at the market output.

41. Refer to the following table. The externality created by the production of refrigerators was \$100. However, once both the private and additional external costs were taken into consideration, the market price increased by only \$50. If the external costs were \$100, why did the price only increase by \$50 when all costs were taken into account?

Price	Quantity Demanded	Quantity Supplied before Considering Pollution Cost	Quantity Supplied after Considering Pollution Cost
\$600	50,000	40,000	30,000
\$650	45,000	45,000	35,000
\$700	40,000	50,000	40,000
\$750	35,000	55,000	45,000
\$800	30,000	60,000	50,000
\$850	25,000	65,000	55,000
\$900	20,000	70,000	60,000

42. The following table shows the supply and demand conditions for a firm that will play trumpets on the streets when requested. Q_s^1 is the quantity supplied without social costs. Q_s^2 is the quantity supplied with social costs. What is the negative externality in this situation? Identify the equilibrium price and quantity when only private costs are taken into account, and then when social costs are taken into account. How does taking the externality into account affect the equilibrium price and quantity?

P	Q_d	Q_s^1	Q_s^2
\$20	0	10	8
\$18	1	9	7
\$15	2.5	7.5	5.5
\$12	4	6	4
\$10	5	5	3
\$5	7.5	2.5	0.5

43. In the Land of Purity, there is only one form of pollution, called “gunk.” The following table shows possible combinations of economic output and reduction of gunk, depending on what kinds of environmental regulations are chosen.

Combo	Economic Output	Gunk Cleaned Up
<i>J</i>	800	10%
<i>K</i>	500	30%
<i>L</i>	600	40%
<i>M</i>	400	40%
<i>N</i>	100	90%

- Sketch a graph of a production possibility frontier with environmental quality on the horizontal axis, measured by the percentage reduction of gunk, and quantity of economic output on the vertical axis.
- Which choices display productive efficiency? How can you tell?
- Which choices show allocative efficiency? How can you tell?
- In the choice between *K* and *L*, can you say which one is better and why?
- In the choice between *K* and *N*, can you say which one is better and why?
- If you had to guess, which choice would you think is more likely to represent a command-and-control environmental policy and which is more likely to represent a market-oriented environmental policy, *L* or *M*? Why?