

# 3

## The Environment

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### PURPOSE

The purpose in writing this chapter is to introduce students to the economics of environmental protection and to make them aware that economics and the problem of pollution are indeed linked. I have chosen to use cost-benefit analysis rather than “marginal social cost equals marginal social benefit” as the framework for evaluating environmental policy. I feel that the marginal approach is too difficult to teach quickly in a text covering issues, too abstract when used to describe a “unit of pollution control,” and not necessary for teaching environmental economics at this level. I think that at an introductory level, weighing the monetary and non-monetary costs and benefits of pollution control is more intuitive, and I therefore leave the marginal approach for a Principles course.

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### LEARNING OBJECTIVES

The learning objectives for this chapter are:

1. to raise students’ consciousness of environmental problems and their own role in causing and preventing these problems.
  2. to introduce the concept of externalities, particularly negative ones, and how they result in inequity associated with spillover costs and benefits and inefficiency associated with misallocation of resources.
  3. to review demand and supply analysis in terms of the misallocation of resources in the case of externalities, the market power of OPEC, and the impact of gasoline taxes.
  4. to review the history of U.S. and global pollution control, and policy choices that include the standards approach, pollution fees, and marketable pollution permits.
  5. to address climate change and petroleum use in a global context.
  6. to evaluate environmental policies in terms of cost-benefit analysis and to address the economics of conservation and recycling.
  7. to help students recognize the appropriate level of government to be involved in pollution control.
  8. to develop a novel three-pronged approach to externalities as spillovers from production and consumption, geographical spillovers, and intertemporal spillovers.
  9. to consider the effects of environmental policy on the U.S. economy and to relate it to trade policy.
  10. to help students understand the economically liberal and conservative views on environmental issues, as well as the role of populism.
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### LECTURE SUGGESTIONS

- Students often know more about specific types of pollution than we do. (They’ve studied it in high school and their college biology and natural resource courses.) It may boost their self-confidence if you ask them to tell you what they know!
- I’ve found that students are often surprised to think of pollution and the environment as economic issues. You will want them to see that economics is involved in decisions to pollute, policies to control pollution, consumer decisions to recycle, and incentives to conserve.

- Students sometimes wonder why an over-allocation of resources to the production of a particular product is a problem. You will probably want to explain this in terms of scarcity and opportunity costs.
- The example of the beer industry may not be a good choice for getting students involved in an example, because we hope that minor students are not drinking beer! I often use the example of bottled water companies operating downstream from agricultural producers in class.
- I've noticed that students often think that policy should be made at the local level of government because that level of government is closer to the people and their needs. They haven't given much thought as to why environmental policy is sometimes (often?) more appropriate at the federal (or higher) levels of government. You may want to discuss this with your students, recognizing that people on the economic right are generally more supportive of policy decisions at the local level.
- Students may have difficulty understanding the intricacies of marketable pollution permits, but once they do understand, they are usually delighted with this approach to pollution control! It isn't a complete solution for pollution, but it does attract growing support. I think the hypothetical, but concrete example used in the text is a good one.
- Among the issues that students are interested in, it seems that pollution control, particularly as it relates to climate change and consumer choices, ranks near the top. Everyone, including the Pope, is finally discussing the problem of climate change. Students will probably also be enthusiastic about any discussion that has to do with recycling, conservation, and incentives for these practices! They may also be interested in the ways to become "carbon neutral".

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## ANSWERS TO TEXT DISCUSSION AND ANSWER QUESTIONS

1. Businesses and consumers pollute because there is an economic incentive to do so. Industrial pollution—whether it is due to highly polluting energy sources, failure to use certain technology, or refusal to adapt conservation measures—occurs because it is the cheaper alternative. Consumers who burn their garbage, buy nonrecyclables, or discard their newspapers do so because it is cheaper (in time or money) than the other alternatives.
2. The beer and paper example shows how resources are over-allocated to the production of goods whose production entails pollution, and how resources are under-allocated to the production of goods whose production requires the additional expense of cleaning up someone else's pollution.
3. Costs are varied and include:
  - the cost of more expensive, but less polluting energy sources and other inputs
  - the cost of antipollution technology such as scrubbers for smokestacks
  - the cost of pollution cleanup
  - the cost of maintaining safe landfills
  - the cost of time in consumer recycling
  - the cost of layoffs in industries that reduce their output in response to rising costs of production in the form of complying with pollution standards or paying fees
  - the cost to businesses in the form of falling profits as costs of production rise
  - the cost to consumers in the form of higher prices that they pay for products produced by firms with rising costs of production due to pollution standards or fees

We should not be willing to sacrifice everything in order to eliminate all pollution because we need to balance the costs and benefits of pollution control. (This is the economist's argument. Students may vehemently disagree!) Furthermore, there are many benefits of pollution control beyond the obvious ones, including expanded economic opportunity and employment in developing green technology and products. And, we have reached an era where green resources and technology might actually be a cheaper than more-polluting resources and technology.

4. While local government is “closer to the governed,” the federal government has the resources for and the national interest in pollution control, especially because pollution generated in one area can easily spread to other areas. In some types of pollution, the governing body should be at the global level, since problems such as climate change occur at the international level. The type of pollution does matter, because some types cause only local spillover costs, whereas others cause national and even international spillovers.
5. Negative externalities: residential locations near prisons or toxic landfills, loss of wildlife and aesthetic beauty as highways and shopping malls are built in rural areas. Positive externalities: business firms that provide child care for their workers’ children, business firms that train workers or support their further education, business firms and residences that beautify their property (trees, flowers, etc.).
6. Incentive-based pollution control (taxes, subsidies, improved convenience of recycling, pollution permits, etc.) allows research and development of least-cost technology and production processes to control pollution, allows the costs as well as the benefits of pollution control to be considered, and often results in the largest polluters having more incentive to reduce pollution than small polluters. Economists often favor these incentive-based pollution controls. On the other hand, standards may assure greater compliance and pollution control.
7. It is appropriate that consumers pay a higher price for a product whose production entails pollution because consumers are indirectly causing this pollution when they buy and use the product. (It is also appropriate that firms receive lower profits when their costs of production go up with a fee because they are directly causing the pollution.) In the case of necessities such as gasoline, subsidies to poor consumers who cannot afford the higher prices caused by pollution control may be appropriate.
8. Cost-benefit analysis compares the costs of an activity (such as pollution control) with the benefits of the activity. Long-run cost-benefit analysis would differ from short-run analysis because the long run includes the benefits to future generations of a cleaner, safer environment and natural resource base.
9. Student answers will vary.
10. At the moment, this is questionable. Some suggest that diverting corn production to the production of ethanol actually causes more CO<sub>2</sub> emissions than the use of gasoline for fuel. Nevertheless, a tax on gasoline might be justified as a penalty for pollution, whereas a subsidy on ethanol is a reward for avoiding pollution. These measures would make ethanol more economical for producers and consumers. Students may note spillover effects on food markets as corn is diverted to fuel (especially if higher priced corn is exported to poor countries or consumed by poor citizens).
11. Citizens of poor countries generally do not have the luxury of environmental protection. Environmental protection is expensive, and poor residents and countries have little income. When forests are cleared to create farms, timber cut down to create export earnings, and environmentally unsound mining used to create jobs, it is because these are necessary for the nation and its residents. Environmental quality is a luxury good. Perhaps the international community should assist low-income countries and consumers as they seek to reduce pollution.
12. Additional roads and parking structures tend to enable additional people to drive in cities, thereby causing more pollution and congestion and being self-defeating. The measures used in Oslo, Norway that are mentioned in the text include some incentive-based policies: high gasoline taxes, road tolls, automobile fees, expensive parking and auto insurance, and cheap and convenient mass transit. (Nevertheless, perhaps low-income residents who need to drive should receive assistance to cover the higher costs of transportation.)
13. Students will have strong opinions. Additional parking structures might encourage more students to drive to school and gasoline use will increase. On the other hand, high parking charges might discourage people from driving and encourage them to car pool, use mass transportation, or even ride a bike (or walk!)
14. Student answers will vary.
15. Student answers will vary but should exhibit an analysis based on economics.
16. Student activity.
17. Student activity.

18. Student activity.
19. Student activity and opinions.
20. Student activity.

## ADDITIONAL DISCUSSION AND ACTION QUESTIONS

Some of the following additional discussion questions may be helpful in preparing lectures.

1. Draw a hypothetical market for potatoes alongside of a hypothetical market for fish. Assume that demand and supply in each market are identical. Also, assume that if farmers use a cheap fertilizer, the runoff from potato production would harm the health of downstream fish when they drink the polluted water. Shift the curve in the potato market if farmers decide to switch from using an expensive fertilizer that is safe for fish, to the cheaper fertilizer that is harmful to fish. Shift the curve in the fish market if fish producers must now provide a new, clean water source for their fish. What is the effect of the decision to use the cheap fertilizer on the market quantity and market price of potatoes? What is the effect of this decision on the market quantity and price of fish? What is the effect on the allocation of resources in both the potato and fish markets? Which situation is more equitable and efficient from the perspective of society?
2. Draw a hypothetical market for refrigerators, assuming that pollution is caused by the production of refrigerators. What shift will occur in the graph if the government imposes an emissions fee on the polluting firms? What effect will this have on the price paid by consumers? Is it appropriate that consumers of televisions pay a higher price?
3. Suppose that farmers, business firms, drivers, and consumers all contribute to pollution in a small rural town. Describe the best policies the town should use to control its pollution.
4. Why is it appropriate for communities to charge per bag of garbage pickup rather than a flat fee? What could be the effect of fees that are outrageously high? (People might dump their garbage along rural roadsides or burn it.)
5. How can we as consumers reduce pollution and contribute to environmental quality?
6. Why is it too simplistic for U.S. citizens to point their fingers at the less developed countries of the world and insist that residents of *those* countries reduce their pollution emissions and their contributions to global warming? Which people in the world are harmed first and most severely by global warming?

### (Appendix 3-1)

7. Draw the graph of a hypothetical market for steel, assuming that the production of steel results in air pollution. Label the private market supply curve as  $S_p$ , and label the social supply curve as  $S_s$ .  $S_s$  reflects the full social costs of production. The supply and demand schedules are as follows. Quantities are in tons.

<u>Price</u>	<u>Quantity Demanded</u>	<u>Private Quantity Supplied</u>	<u>Public Quantity Supplied</u>
\$1000	5	1	–
\$2000	4	2	0
\$3000	3	3	1
\$4000	2	4	2
\$5000	1	5	3

- a. What is represented by the vertical distance between the two supply curves? What amount is this? (You may or may not want to explain it to students, as it is not explained carefully in the text.)
- b. Specifically, what costs are reflected in the social supply curve?
- c. Why is it possible that production of less than 1 ton of steel results in no spillover costs?

- d. What is the equilibrium quantity of steel produced in the private market? What is the socially optimal quantity of steel? Why do we say that the private market results in an over-allocation of resources to steel production? Why is this a problem?
- e. Suppose an emissions fee of \$2,000 is imposed on the steel producers for every ton of steel produced. What will be the effect of the fee on the market supply and market price of steel? Is it appropriate that consumers pay a higher price for a product whose production creates pollution?

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## SUGGESTED TEST QUESTIONS

### *Multiple-Choice Questions*

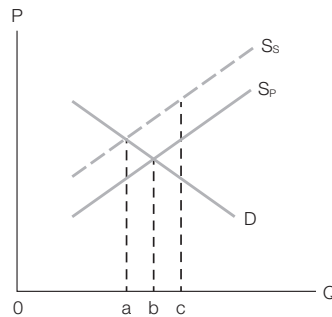
1. Pollution causes:
  - a. spillover costs.
  - b. inefficient resource allocation.
  - c. an inequitable burden of costs.
  - d. All of the above**
2. Spillover benefits derive from:
  - a. childhood vaccinations.
  - b. education tuition provided by employers.
  - c. your education.
  - d. All of the above**
3. The earliest efforts to control pollution in the U.S. through legislation came from:
  - a. city governments.**
  - b. state governments.
  - c. the federal government.
  - d. None of the above
4. According to the textbook, the decisions about pollution control in the case of pollution that extends beyond state boundaries should be made by:
  - a. city governments.
  - b. county governments.
  - c. state governments.
  - d. the federal (and possibly international) governments.**
5. Which of the following economic term represents a regulation that is more likely to encourage research into new technologies and lower cost methods of meeting environmental quality?
  - a. performance standard**
  - b. design standard
  - c. technology standard
  - d. business standard
6. A tax on production that causes air pollution is called:
  - a. a pollution permit.
  - b. a specific standard.
  - c. an effluent fee.
  - d. an emissions fee.**

7. Why is the over-allocation of resources to a particular market a problem?
  - a. **Society values other products produced by these scarce resources more than it values the product produced in the market where the over-allocation occurs.**
  - b. Society values other products less than it values the product produced in the market where the over-allocation occurs.
  - c. Society should balance the over-allocation of resources in some markets with under-allocation of resources in others.
  - d. It is not really a problem.
8. Technology forcing is defined as:
  - a. allowing firms to choose the type of technology to be used in pollution control.
  - b. **requiring firms to use specific types of technology to be used in pollution control.**
  - c. forcing firms to purchase the technology to be used in pollution control.
  - d. forcing firms to produce the technology to be used in pollution control.
9. Marketable pollution permits:
  - a. allow producers to buy and sell permits.
  - b. minimize the costs of pollution control.
  - c. utilize the marketplace.
  - d. **All of the above**
10. The creation of a market for pollution permits:
  - a. completely eliminates air and water pollution.
  - b. **causes firms to seek out low-cost pollution-reducing technologies.**
  - c. is only supported by economic liberals.
  - d. All of the above
11. Economists and environmentalists may differ in that:
  - a. **environmentalists often want to eliminate all pollution, but economists may believe that some pollution is acceptable if society values the production of the goods that cause the pollution.**
  - b. environmentalists care about the environment, but economists do not.
  - c. economists rarely support a cost/benefit approach.
  - d. All of the above
12. Two reasons that the environmental movement developed in modern, industrialized countries are that:
  - a. there was no pollution prior to the 1900s.
  - b. **pollution control is a luxury good, and the type of many pollutants we have in modern times are more toxic than pollutants used to be.**
  - c. increased population has stressed the environment, and people in the U.S. have greatly decreased their consumption of goods as a result.
  - d. This was not discussed in the text.
13. If an emissions fee equal to the spillover cost of pollution is levied on the polluting firm:
  - a. it will eliminate the over-allocation of resources to the product produced by the firm.
  - b. it will increase the price of the firm's product.
  - c. it will decrease the firm's output.
  - d. **All of the above**
14. Based on data in the text, which country causes the largest total amount of carbon dioxide emissions?
  - a. **China**
  - b. The United States
  - c. Russia
  - d. India

15. Based on data in the text, which country causes the largest carbon dioxide emissions per capita (per person)?
- China
  - The United States**
  - Russia
  - India
16. Based on data in the text, which country uses the largest total amount and largest world share of petroleum consumption?
- China
  - the United States**
  - Russia
  - India
17. The Organization of Petroleum Exporting countries (OPEC) in the past has been able to keep petroleum prices high by:
- increasing demand.
  - increasing supply.
  - decreasing demand.
  - decreasing supply.**
18. When performing cost-benefit analysis of environmental protection, we should include:
- monetary costs such as business firms using less polluting but more expensive inputs.
  - monetary costs such as consumers buying high-efficiency but more expensive appliances.
  - non-monetary costs such as consumers' inconvenience associated with recycling.
  - All of the above**
19. A major problem with recycling is:
- that people absolutely refuse to recycle.
  - finding a market for recyclable materials.**
  - incentives simply do not work.
  - most such programs make recycling very convenient.
20. Which of the following environmental problems have not be fully successful overcome in developing countries?
- loss of bio-diversity
  - deforestation
  - desertification
  - All of the above**
21. Which of the following should be considered when comparing costs and benefits of pollution control?
- spillovers of production activity
  - spillovers of consumption activity
  - spillovers that occur over time
  - All of the above**

*(Appendix 3-1)*

22. Assuming that the production of paint results in chemical pollution of the land and water and that  $S_p$  represents the private supply curve and  $S_s$  represents the social supply curve, the socially optimal output of paint in the graph on the next page is:
- amount a.**
  - amount b.
  - amount c.
  - We don't know because we've ignored social costs of production.



### True-and-False Questions

1. Generally speaking, the economist's view is that all pollution should be eliminated. (F)
2. Environmental quality is a luxury good. (T)
3. Externalities can be positive or negative. (T)
4. Over-allocation of resources occurs in markets that are harmed by pollution caused in another market. (F)
5. Both positive and negative externalities cause inequity and inefficiency. (T)
6. Economists believe that the proper level of government to enact pollution control policies is almost always the local government, as opposed to the national or international level, since the local government knows most clearly the needs of the local community. (F)
7. The performance standard approach to regulation specifies the maximum level of pollution as well as the specific means of compliance. (F)
8. The term 'pollution fees' can include both effluent fees and emissions fees. (T)
9. A design standard specifies not only the required level of performance (in controlling pollution), but also the means to reach that performance. (T)
10. Marketable pollution permits are considered efficient but have never actually been used. (F)
11. Effluent and emissions fees are more likely to result in least-cost pollution control than the use of standards. (T)
12. People are more likely to recycle and purchase recyclable products if they are charged per bag of garbage rather than a fixed fee for garbage pick-up. (T)
13. If the supply of recyclable materials increases, the price of these materials will increase. (F)
14. A higher gasoline tax is more likely to encourage conservation than a lower one. (T)
15. Pollution permits usually result in firms that are initially not heavy polluters doing all the cleanup. (F)
16. Cost-benefit analysis is useless in evaluating environmental policy. (F)
17. Present U.S. laws do not allow trade in pollution permits. (F)
18. Ten cent deposits on aluminum soda cans would be an example of an incentive to recycle. (T)
19. Critics of environmental regulation argue that higher production costs and decreased output will make products less competitive in the international market. (T)
20. Economists on the economic left are more likely than those on the right to support government regulation, including standards regulation, as well as policies drafted at the national and international levels. (T)
21. When adjusted for inflation, gasoline prices have risen in the United States every year since 1930. (F)



**(Appendix 3-1)**

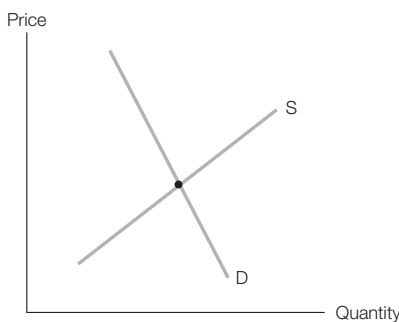
22. The social costs of production that causes pollution include both the private costs of production and the spillover costs of pollution. (T)

**(Appendix 3-2)**

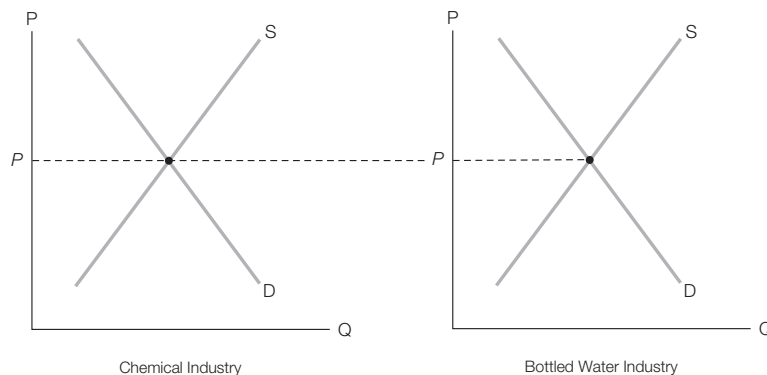
23. Under President Trump, the number of environmental regulations has increased dramatically and even surpass those of President Obama. (F)

**Short-Answer Questions**

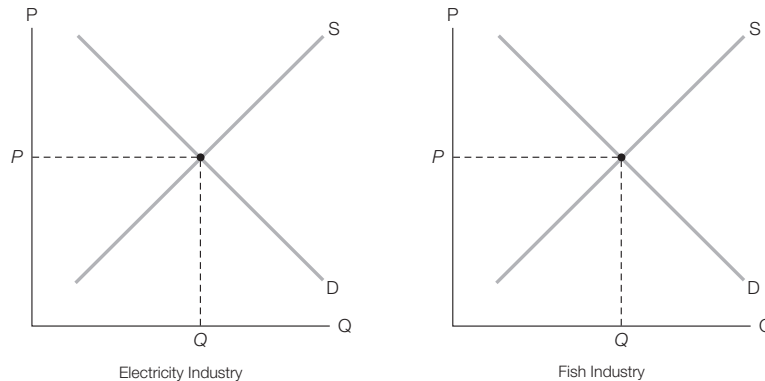
1. The graph below depicts the global petroleum market under the assumption that the Organization of Petroleum Exporting countries (OPEC) controls the vast majority of exported oil. Shift the appropriate curve to show what will occur if OPEC decides to act to increase the price of oil. (**backward shift in supply**) Does OPEC has the extent of this type of market power in today's oil markets? (**no**)



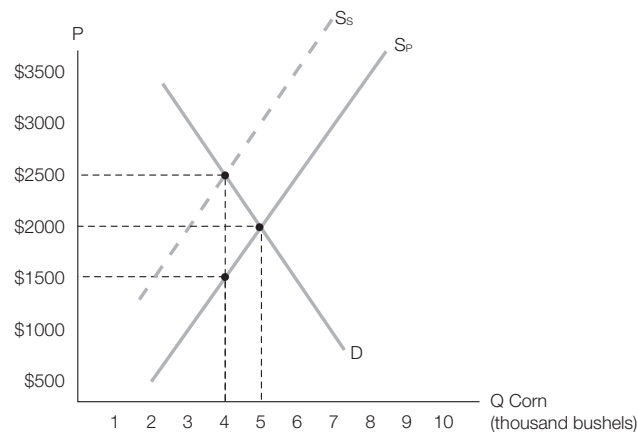
2. Consider the graphs of the markets for the chemical industry and the bottled water industry below. Assume the chemical companies operate upstream of a river, while the bottled water companies operate downstream. Also assume the neither industry initially pollutes. Now suppose that the chemical industry decides that it is cheaper to dump their waste into the river, rather than treat it to avoid pollution. As a result of this decision,
- Shift the curve that occurs in the chemical industry. (**Supply shifts forward.**)
  - Shift the curve that occurs in the bottled water industry. (**Supply shifts backwards.**)
  - What is the effect on equilibrium price (**decrease**) and quantity (**increase**) in the chemical industry?
  - What is the effect on equilibrium price (**increase**) and quantity (**decrease**) in the bottled water industry?
  - Is this situation equitable? **No**
  - Is it efficient? **No** If not, why not? **There is an over-allocation of resources to the chemical industry and an under-allocation of resources to the bottled water industry.**



3. Consider the graphs for the electrical industry and the fish industry below. Assume the electrical industry operates upstream of a river, while the fish industry operates downstream. Also assume the neither industry initially pollutes. Shift the curve to show what would occur if an electrical industry decides it is too expensive to cool off water before dumping it into a stream and goes ahead to cause this water (thermal) pollution. (**Its supply curve shifts forward.**) Next shift the curve to show what happens in the downstream fishing industry if it must undergo the expense of cooling the water before it can be used to raise fish. (**Its supply curve shifts backwards.**)
- What is the effect of the decision by the electrical industry on the price of electricity? (**decrease**)
  - What is the effect on the price of fish? (**increase**)
  - In which industry is there now an over-allocation of resources? (**electricity**)
  - In which industry is there now an under-allocation of resources? (**fish**)

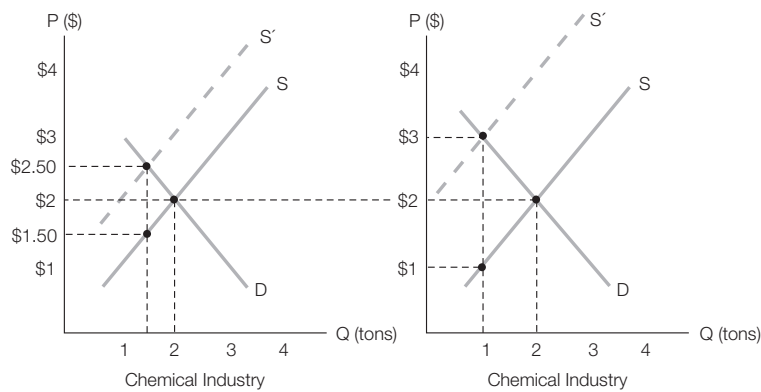


4. Consider the graph of a market for corn in a small country, assuming that production of corn results in chemical fertilizer and pesticide runoff that pollutes nearby streams.  $S_p$  represents the private market supply curve, while  $S_s$  is the social supply curve.  $S_s$  reflects the full social costs of production.



- Specifically, what costs are reflected in the social supply curve? (**private and spillover costs**)
- What is represented by the vertical distance between the two supply curves? (**pollution per unit**) What amount is this? (**\$1,000**)
- What is the equilibrium quantity of corn produced in the private market? (**5,000**) What is the socially optimal quantity of corn? (**4,000**) Why do we say that the private market results in an over-allocation of resources to corn production? (**Society produces and consumes more corn than it would if the spillover costs were considered.**) Why is this a problem? (**Scarcity: if there is an over-allocation of resources to one industry, there is an under-allocation of resources to other industries.**)

- d. Suppose an effluent fee of \$1,000 is imposed on the corn producers for every thousand bushels of corn produced. What will be the effect of the fee on the market price of corn? (**increase**) Is it appropriate that consumers pay a higher price for a product whose production creates pollution? (**yes**) Why? (**They consume a product that is associated with causing pollution. However, if some consumers are very poor, there should perhaps be subsidies to assist them.**)
5. Consider the following graphs of demand and supply in a polluting chemical industry, under two different scenarios. In the first case, an effluent fee of \$1.00 per pound of chemicals is placed on the industry, and in the second case, an even larger effluent fee of \$2.00 per pound is placed on the industry.
- Why does the supply curve shift up (**back**) in each case with the imposition of the effluent fee? (**larger cost of production**)
  - What is the value of the vertical distance between the two supply curves in the first graph (**\$1**), and in the second graph? (**\$2**)
  - What is the effect of the fee on the equilibrium price of chemicals (**increase**) and on the equilibrium quantity of chemicals bought and sold? (**decrease**)
  - In which graph is the quantity of chemicals (**and therefore the amount of pollution**) reduced the most? (**2nd**)



6. Why is it important to analyze costs as well as benefits of pollution control? What are some of these costs? (**We wish to balance costs and benefits of any economic activity. Costs include the expense of new technology, less polluting but more expensive inputs, expensive procedures that reduce pollution, government workers to enforce pollution control, and possible loss of production and jobs. Note that there are also benefits in addition to the cleaner environment, including research, development, and production of green technology, thereby expanding production and jobs.**)

### ***Critical Thinking Question***

A few years ago, we became aware that disposable diapers were a major item being put into U.S. landfills. Some communities discussed banning disposable diapers from their landfills. There were protests from parents groups whose members found disposable much more convenient than cloth diapers. Rationally evaluate this policy from both the community environmentalists and the parents groups' viewpoints.