CHAPTER OUTLINE

1. Explain why negative externalities lead to inefficient overproduction and how property rights, pollution charges, and taxes can achieve a more efficient outcome.
   
   A. Externalities in Our Daily Lives
      1. Negative Production Externalities
      2. Positive Production Externalities
      3. Negative Consumption Externalities
      4. Positive Consumption Externalities
   
   B. Private Costs and Social Costs
      1. Valuing an External Cost
      2. External Cost and Output
   
   C. Production and Pollution: How Much?
   
   D. Property Rights
   
   E. The Coase Theorem
      1. Application of the Coase Theorem
   
   F. Government Actions in the Face of External Costs
      1. Emission Charges
      2. Marketable Permits
      3. Taxes
      4. Effects of Government Actions

2. Explain why positive externalities lead to inefficient underproduction and how public provision, subsidies, vouchers, and patents can achieve a more efficient outcome.

   A. Private Benefits and Social Benefits
   
   B. Government Actions in the Face of External Benefits
      1. Public Provision
      2. Private Subsidies
      3. Vouchers
      4. Patents and Copyrights
CHAPTER ROADMAP

■ What’s New in this Edition?
Slight changes in Chapter 9 have been made from the second edition.

■ Where We Are
We’ll use the demand and supply curves to show how externalities affect the efficient use of resources. We’ll see that external costs result in overproduction and that external benefits result in underproduction. By developing the marginal social cost curve and marginal social benefit curve, we incorporate these external costs and external benefits into the basic demand-supply graph. Finally, we investigate how the government intervenes in the market to promote efficient use of resources.

■ Where We’ve Been
We’ve explored the interactions of supply and demand that bring about the efficient use of resources by equating marginal benefit to marginal cost. We use the concept of efficiency in this chapter to discuss the deadweight loss from externalities and how government action can overcome the inefficiency.

■ Where We’re Going
After this chapter, we conclude studying how the government influences markets by examining public goods and common resources.

IN THE CLASSROOM

■ Class Time Needed
You can complete this chapter in one and a half sessions. This chapter is particularly suitable to the use of current event examples. You can take one class period to cover the mechanics of the marginal social cost curve, marginal social benefit curve, and government intervention. Then you can spend part of the next class period discussing real world examples.

An estimate of the time per checkpoint is:
- 9.1 Negative Externalities: Pollution — 30 minutes
- 9.2 Positive Externalities: Knowledge — 25 minutes
CHAPTER LECTURE

9.1 Negative Externalities: Pollution

Externalities in Our Daily Lives

- An externality is a cost or benefit that arises from production and falls on someone other than the producer, or a cost or benefit that arises from consumption and falls on someone other than the consumer. A negative externality imposes an external cost and a positive externality creates an external benefit.

- There are four types of externalities:
  - Negative Production Externalities: noise from aircraft and trucks, polluted rivers and lakes, the destruction of native animal habitat, air pollution in major cities from auto exhaust.
  - Positive Production Externalities: honey and fruit production, in which fruit production gets an external benefit from locating bee hives next to a fruit orchard, where the bees pollinate the trees to boost fruit output and honey production gets an external benefit from the orchard trees that generate the pollen necessary for honey production.
  - Negative Consumption Externalities: smoking in a confined space and posing a health risk to others, or having noisy parties or loud car stereos that disturb others.
  - Positive Consumption Externalities, flu vaccination because everyone who comes into contact with the person benefits because they are less likely to catch the flu.

Private Costs and Social Costs

- A private cost of production is a cost that is borne by the producer. Marginal private cost (MC) is the cost of producing an additional unit of a good or service that is borne by the producer of that good or service.

- An external cost is a cost of producing a good or service that is not borne by the producer but is born by other people. A marginal external cost is the cost of producing an additional unit of a good or service that falls on people other than the producer.

- Marginal social cost (MSC) is the marginal cost incurred by the entire society—by the producer and by everyone else on whom the cost falls—and is the sum of marginal private cost and marginal external cost:

\[ MSC = MC + \text{Marginal external cost}. \]

Have the students consider what is included in the idea of marginal external costs. Be sure that they understand that external costs are the costs of either cleaning up the damage caused by the polluting activity or the extra costs of having to take actions to avoid the damage in the first place. Emphasize that both actions require payment by people other than the producer or consumer, which is why the costs are considered “external.”
• The figure shows the marginal private cost curve (MC) and the marginal social cost curve (MSC) for a good with an external cost. The vertical distance between the two curves is the marginal external cost.

• Because the marginal social cost includes the marginal external cost, the marginal social cost exceeds the marginal private cost (MSC > MC) for all quantities.

• The efficient quantity of output occurs where the marginal social cost equals marginal benefit, that is, where MSC = MB. In the figure, the efficient quantity is Q₁.

• An unregulated market, however, produces where the MC = MB (which is equivalent to producing where S = D). In the figure, the unregulated market is at Q₀. At this level of output, MSC exceeds MB so there is, as illustrated, a deadweight loss.

Property Rights

• Property rights are legally established titles to the ownership, use, and disposal of factors of production and goods and services that are enforceable in the courts. Assigning property rights can reduce the inefficiency arising from an externality.

The Coase Theorem

• The Coase theorem is the proposition that if property rights exist, if only a small number of parties are involved, and if the transactions costs are low, then private transactions are efficient. Transactions costs are the opportunity costs of conducting a transaction.

• A remarkable feature of the Coase theorem is that it does not matter if the property right is given to the creators of the externality (the polluters) or to the victims. In either case, the result will be efficient.

• If the polluters value the benefits from the activity generating the pollution more highly than the victims value being free from the pollution, (that is, the cost of reducing the pollution exceeds the benefit from the reduction) then the efficient outcome is for the pollution to continue. If polluters are assigned the right to pollute, the victims are not able to pay enough to convince the polluters to stop. If the victims are assigned the property right to be free from pollution, then the polluters are able to pay the victims sufficient compensation to continue polluting. Either way, the pollution continues.
• If the victims value the benefits from being free from pollution more highly than the polluters value the benefits of the pollution, (that is, the benefit from reducing pollution exceeds the cost of the reduction) then the efficient outcome is for the pollution to stop. If the polluters are assigned the right to pollute, then the victims are willing to pay the polluters sufficient compensation to stop the pollution. If the victims are assigned the right to be free from pollution, then the polluters are not able to pay the victims enough to allow them to continue polluting. Either way, the pollution stops.

**Government Actions in the Face of External Costs**

- The government can use emissions charges, which are a price per unit of pollution. If the charges are set equal to the marginal external cost, the efficient outcome will result. However, the government would need a lot of information that is usually unavailable to determine the correct amount of the charge.
- The government can use marketable permits, wherein each firm is assigned permits that allow it to emit a certain amount of pollution and the firms are allowed to trade the permits. The market in permits determines the price of a permit and firms will buy or sell permits until their marginal cost of pollution reduction equals the price of a permit.
- The government can set a tax equal to the marginal external cost, so that marginal private cost plus the tax equals marginal social cost, $MSC = MC + Tax$. In the figure above, the appropriate tax equals the length of the double headed arrow.

### 9.2 Positive Externalities: Knowledge

**Private Benefits and Social Benefits**

- A *private benefit* is a benefit that the consumer of a good or service receives. **Marginal private benefit** ($MB$) is the benefit from an additional unit of a good or service that the consumer of that good or service receives.
- An *external benefit* from a good or service is a benefit that someone other than the consumer receives. A **marginal external benefit** is the benefit from an additional unit of a good or service that people other than the consumer enjoy.
- **Marginal social benefit** ($MSB$) is the marginal benefit enjoyed by the entire society—by the consumer and by everyone else who enjoys a benefit—and is the sum of marginal private benefit and marginal external benefit:

$$MSB = MB + \text{Marginal external benefit}.$$
• The figure shows the marginal private benefit curve \((MB)\) and the marginal social benefit curve \((MSB)\) for a good with an external benefit. The vertical distance between the two curves equals the marginal external benefit. For instance, the length of the arrow in the figure equals the marginal external benefit at the quantity \(Q_1\).

• Because marginal social benefit includes marginal external benefit, the marginal social benefit exceeds the marginal private benefit \((MSB > MB)\) for all quantities.

• The efficient quantity of output occurs where the marginal social benefit equals marginal cost, that is, where \(MSB = MC\). In the figure, the efficient quantity is \(Q_1\).

• An unregulated market produces where the \(MC = MB\) (which is equivalent to producing where \(S = D\)). In the figure, the unregulated market equilibrium is \(Q_0\). At this level of output, \(MSB\) exceeds \(MC\) so there is, as illustrated in the figure, a deadweight loss.

**Government Actions in the Face of External Benefits**

• **Public provision**, which is when a public authority that receives its revenue from the government produces the good or service. (Public colleges are an example.) In this case, the government can direct the authority to produce the efficient quantity.

• A **subsidy**, is a payment that the government makes to a producer to cover part of the cost of production, can be used. If the government pays the producer a subsidy equal to the marginal external benefit, then the quantity produced by the private firm increases to that at which the marginal cost equals the marginal social benefit and an efficient allocation of resources occurs. In the figure, the correct subsidy is equal to the length of the double headed arrow.

• A **voucher**, which is a token that the government provides to households to buy specified goods or services, can be used. Households receiving a voucher pay a lower price to acquire the specific good or service, which increases their demand and increases the quantity consumed.

• **Patents** and **copyrights** are government-sanctioned exclusive rights granted to the inventor of a good, service, or productive process to produce, use, and sell the invention for a number of years. These are a form of **intellectual property rights**, which...
give the creator of knowledge the property right to any use of that specific knowledge.

Have the students consider the implications of bootlegging music or movies off the Internet. What incentive do artists, authors and screenwriters have to continue performing their craft as bootlegging increases? Ask the students to consider both the short run and the long run: Once the music or movie is created, then bootlegging might be efficient because the marginal cost of another copy is near zero. But how much music and how many movies will be created if artists and movie producers cannot collect any revenue for their creations? Is there more music and movies in a world with bootlegging or a world with strictly enforced intellectual property rights?
Lecture Launchers

1. Launch your Chapter 9 lecture by asking your students if they have seen the movie Erin Brockovich. It’s a great (not necessarily in a review sense, but in an economic sense!) movie that shows how pollution creates external costs and how residents required Pacific Gas & Electricity (PG&E) to account for both private costs and external costs in the use of hexavalent chromium (chromium 6). PG&E used the chemical to clean its equipment. According to the movie, PG&E improperly discharged the chemical and polluted the ground and water, causing death and disease. The movie starts with PG&E recognizing there is a problem because it offers a homeowner $55,000 for his home and medical bills. The movie ends with this family receiving $5 million from PG&E. PG&E now claims that chromium 6 is not deadly if you drink it, only if you inhale it and that it presents no external costs. Still, PG&E settled the case for $330 million.

2. To overcome potential language problems, be sure to relate the word “externality” to the more familiar phrase “side effect.”

3. Students quite often are surprised that economists have a lot to say about pollution. Many students think that pollution is a topic handled only by scientists, technicians, and engineers working in the field. You can point out to your students that in truth economists have had a lot of influence in the nation’s pollution policies. So, if a student is considering a career in a pollution related field, he or she might also want to consider economics as a potential major.

Land Mines

1. This chapter tests students’ graphing abilities with the addition of the marginal social cost curve and the marginal social benefit curve. Using colored chalk, colored markers on the overhead, or colored lines on your PowerPoint slides is very helpful in distinguishing these different lines.

2. Draw the supply (marginal cost) curve for a good, say electricity, that when produced creates pollution. Remind students that this curve represents the costs paid by the producers to produce one more unit of the good. Pick a point on the curve and say “To increase the production of electricity one more unit, the graph shows that the producer must incur a cost of $100 (or whatever price and quantity you have chosen). If I tell you that the utility is polluting the environment, do we as a society face a higher cost?” Most students will answer “yes” and you can plot a point higher on the graph at the same quantity. Do the same analysis for other production points and you now have a new supply curve, the marginal social cost (MSC) curve.
Remind students that the distance between the curves is the added cost of the pollutants, which is the marginal external cost.

3. To clarify the effects of the government’s options of using public provision, private subsidies, and vouchers to deal with external benefits, draw all three options as headings across the board at one time. Under each heading, start with identical demand and supply curves that result in underproduction. Add the MSB curve in each case. Start with the voucher case first because it is the simplest and show how the voucher increases demand so that it becomes the same as the MSB curve. You can then show how a subsidy shifts the supply curve creating the same outcome. Compare the value of the subsidy with the value of the voucher …it’s the same. Then draw the public provision case showing how the taxpayer pays the marginal external cost (the same amount in the two other cases) and produces the efficient amount. Review how each option produces the same outcome for the same “price” and that it’s just the process to the efficient outcome that differs.
ANSWERS TO CHECKPOINT EXERCISES

■ CHECKPOINT 9.1 Negative Externalities: Pollution

1a. Figure 9.1 illustrates the situation when the marginal external cost is twice the marginal private cost. The efficient quantity is determined where the MB curve intersects the MSC curve, at 15 tons a week. So the government issues enough permits so that 15 tons of pesticide are allowed to be produced.

1b. The price of the permit is equal to the marginal external cost when 15 tons a week are produced. This marginal external cost is equal to $75.

1c. When the town’s residents receive the permits, the factory buys the permits and the residents sell the permits. If, however, the factory received 15 permits, the residents do not buy the permits. Instead, the factory uses the permits to produce 15 tons of pesticide.

■ CHECKPOINT 9.2 Positive Externalities: Knowledge

1a. The equilibrium tuition is $12,000 and the equilibrium number of students is 5,000.

1b. The efficient number of students is 15,000.

1c. The public schools will charge a tuition of $4,000 because that is the tuition necessary to have 15,000 enrolled.

1d. The subsidy must be $8,000.

1e. The voucher must be for $8,000.
ANSWERS TO CHAPTER CHECKPOINT EXERCISES

1a. With no pollution control, the marginal cost to the firm of polluting is $0. The firm pollutes until the marginal benefit from polluting equals $0, which means that there will be 100 percent pollution.

1b. The amount of pollution is efficient when the marginal cost of an additional cut in pollution equals its marginal benefit. The marginal benefit is measured by the change in the amount of property tax citizens are willing to pay. For instance, the marginal benefit of increasing the reduction in pollution from 10 percent to 20 percent is $13.50 per percentage point reduction, the increase in the property tax citizens are willing to pay. This marginal benefit is recorded in the table as the marginal benefit from cutting pollution 15 percent, the average of 10 percent and 20 percent. The marginal cost of pollution reduction is the change in the total cost of pollution reduction. For instance, the marginal cost of reducing pollution from 10 percent to 20 percent is $1.50 per percentage point reduction, the increase in the firm’s total cost. The complete marginal benefit and marginal cost schedules are in the table. The table shows that the efficient amount of pollution reduction is 75 percent.

<table>
<thead>
<tr>
<th>Pollution cut (Percentage)</th>
<th>Marginal benefit (dollars)</th>
<th>Marginal cost (dollars)</th>
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<tbody>
<tr>
<td>5</td>
<td>15.00</td>
<td>1.00</td>
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<tr>
<td>15</td>
<td>13.50</td>
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<td>45</td>
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<tr>
<td>85</td>
<td>3.00</td>
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</tr>
</tbody>
</table>

1c. If the city owns the steel mill, then pollution will be cut by 75 percent.

1d. If the city is a company town, pollution will be cut by 75 percent. The Coase theorem points out that regardless of whether the city owns the mill or the mill owns the city, the amount of pollution is the efficient amount.

2a. Larry is willing to pay Tom up to $25 to not smoke. Tom’s net benefit from smoking is $18 (the marginal benefit minus the price of the cigar). The Coase theorem says that in this case, with Tom and Larry meeting at Tom’s home, Larry pays Tom some amount between $18 to $25 not to smoke and Tom does not smoke.

2b. If Tom and Larry meet at Larry’s house, Tom is willing to pay up to $18 to be allowed to smoke. But Larry will accept nothing less than $25 to allow Tom to smoke. Tom cannot offer enough to Larry, so Tom does not smoke. In both parts (a) and (b), the efficient outcome, Tom not smoking, is attained regardless of who is given the property right, that is, regardless of who owns the house in which the meeting occurs.

3a. Larry is willing to pay Tom up to $20 to not smoke. Tom’s net benefit from smoking is $23 (the marginal benefit minus the price of the cigar). When
Tom and Larry meet at Tom’s house, Larry cannot offer enough to Tom to make Tom quit smoking, so Tom smokes.

3b. If Tom and Larry meet at Larry’s house, Tom is willing to pay up to $23 to be allowed to smoke. And Larry will accept anything more than $20 to allow Tom to smoke. So, Tom can offer Larry some amount between $20 and $23 and Tom smokes. As in Exercise 1, the efficient outcome (in this case, Tom smoking) is attained regardless of who is given the property right, that is, regardless of who owns the house in which the meeting occurs.

4a. With no public college and no government involvement, 1 million students enroll in college and the tuition is $5,000 a year.

4b. The efficient number of students is 2 million. The required subsidy is $2,000 a student, which leads to 2 million students enrolling.

4c. If the government offers a $2,000 voucher, the efficient number of students, 2 million, enroll.

5. With the reduction in cost to $3,500 a year, 1.75 million students will enroll in college when there is no government involvement. (This answer assumes that the demand curve between 1 and 2 million students is linear.) The efficient number of students is 8 million, because this is the number of students for which the marginal social benefit ($3,500, the sum of the marginal private benefit, $500, plus the marginal external benefit, $3,000) equals the marginal cost. The required subsidy is $3,000 and the required voucher is a $3,000 voucher.

6a. If researchers could not obtain patents for their discoveries, they could not be certain of profiting from their discoveries. In this case, people are less likely to undertake research and so the pace of technological change slows.

6b. As long as existing patents continued to be enforced, slowing the pace of technological change by denying new patents harms both producers and consumers. Producers lose because they do not profit from new inventions (that are not made) and consumers lose because they are not able to consume the goods and services that would have been produced with the new inventions.

6c. If existing patents are no longer enforced, consumers of the goods and services previously protected by patents gain because their prices fall.

7a. The quantity and quality of new music would fall.

7b. Consumers can buy cheaper CDs but there are fewer new CDs and the quality is lower.
**Critical Thinking**

8a. The United States is hesitant to sign the Kyoto Protocol because the United States believes that the costs to the United States of ratifying the Kyoto Protocol exceed the benefits to the United States.

8b. The European Union ratified the Kyoto Protocol because the European Union believes that benefits to the European Union of ratifying the Kyoto Protocol exceed the costs to the European Union.

8c. The emission target is efficient if the marginal benefit of meeting the target equals the marginal cost of meeting the target. To determine if the emission target is efficient requires that the United States determine what are the benefits from reducing greenhouse gas emissions to meet the target and what are the costs of reducing greenhouse gas emissions. Benefits are the reduced chance of global warming; costs are the opportunity cost of utilizing the necessary technology to decrease greenhouse gas emissions.

8d. The question of whether the United States should ratify the Kyoto Protocol depends on the student’s assessment of the marginal benefit of ratification compared to the marginal cost.

9a. Driving automobiles creates congestion, air pollution, and might also contribute to global warming.

9b. The efficient amount of driving automobiles is the amount such that the marginal benefit equals the marginal social cost. Because driving automobiles creates a negative externality, marginal social cost exceeds marginal private cost. Imposing a tax equal to the marginal external cost sets the marginal private cost equal to marginal social cost and leads to the efficient amount of driving. If the tax on gasoline in the United States is less than the marginal external cost, raising the gasoline tax leads to greater efficiency.

9c. If the gasoline tax in the United States equals the marginal external cost, then this level of tax leads to the efficient amount of driving. Raising the tax still higher creates inefficiency and a deadweight loss.

9d. Whether the United States should raise its tax on gasoline depends on whether the student believes the tax is less than the marginal external cost of driving.

10a. School vouchers are controversial because vouchers create winners and losers. A major loser is the teachers’ union because it fears its members will either lose their jobs or else face pay cuts. Voucher opponents also claim that students remaining in public schools will be losers because private schools will not accept students with discipline problems. However, this outcome is not certain because private schools that specialize in students with discipline problems might be founded. Winners include youngsters who receive a voucher and gain a better education.
10b. Public provision and vouchers can both lead to the efficient level of education. A school voucher allows parents to choose the school their children will attend. The benefit of a voucher system is that the parents can monitor school performance more effectively than the government.

10c. If public provision can provide high quality schooling at lower cost than could competing private schools, public provision is the optimal policy.

11a. Some research and development has an external benefit because once a process is invented or discovered, everyone can benefit. However, other research and development is more proprietary because it benefits only the inventor. For instance, research by Microsoft into how to better pack their boxes so that the CDs are not broken is not likely to benefit anyone other than Microsoft. Subsidizing research and development that has an external benefit helps set marginal social benefit equal to marginal cost. Subsidizing research and develop that does not have an external benefit leaves marginal social benefit less than marginal cost and creates a deadweight loss.

11b. Basic research can be used by many people. Basic research has a marginal external benefit, so government subsidization helps set marginal social benefit equal to marginal cost.

11c. Awarding prizes to firms that develop technology helps subsidize the technology. If the technology has an external benefit, subsidization helps set marginal social benefit equal to marginal cost.

11d. Giving tax breaks to firms that develop technology helps subsidize the technology. If the technology has an external benefit, subsidization helps set marginal social benefit equal to marginal cost.

11e. Patent laws allow inventors to profit from their work, which gives them the incentive to undertake the development of the invention. However, the patent holder controls the market for the product while the patent is in place and so can set a price higher than otherwise. Extending the length of time a patent is in place increases the incentive to develop new inventions but at the cost of increasing the length of time the patent holder controls the market.

11f. The case of subsidizing basic research is the clearest because it generally has the largest external benefits. Between direct subsidization, awarding prizes, giving tax breaks, and lengthening the time a patent is in place, all methods increase the quantity of research and development and new inventions. Direct subsidization and tax breaks have the drawback that they can be politicized. Awarding prizes has the difficulty of determining the amount of the price. Lengthening the time a patent is in place has the drawback of increasing the time a single producer controls the market for the good or service.
# Web Exercises

12a. Your students’ answers depend on your community.

12b. Your students’ answers depend on your community.

12c. Your students’ answers depend on your community.

12d. Your students’ answers depend on your community.

13a. There are various contaminants that can occur in drinking water, such as arsenic, lead, copper, disinfection byproducts, MTBE, radionuclides, and radon. Of these, the disinfection byproducts are an externality that can arise in the production of drinking water.

13b. The EPA has been charged to use cost-benefit analysis when studying proposed drinking water regulations. A regulation will be enacted only if the benefit from the regulation exceeds the cost. The costs are relatively straightforward. But the benefits are more difficult to quantify. From the web page, “The benefits of regulatory action are reflected in improvements in human welfare. … A broad categorization of the possible benefits of drinking water regulations to include: human health improvements, enhanced aesthetic qualities, avoided costs of averting behavior, avoided materials damages, avoided costs of market production, nonuse benefits, and information benefits.”

13c. The Safe Drinking Water Act was passed in 1974. A problem with this act was that it focused only on the benefits of cleaning up water and ignored the costs. Efficiency is attained when the marginal social benefit of cleaner water equals the marginal (social) cost. So, in 1996 the law was amended to require that the EPA undertake a cost-benefit analysis of proposed new regulations. If the EPA does “correct” cost/benefit analyses, then cleaning up U.S. drinking water can be made more economically efficient.

14a. The externalities that arise directly from the wind farm are generally negative. The opponents of the wind technologies point to visual pollution from the towers that will hurt tourism; interference with the marine environment; and the death of untold numbers of birds that fly into the blades. Proponents of the wind farm assert that it will decrease externalities elsewhere by decreasing greenhouse gasses and fossil fuel emissions.

14b. The externalities from burning coal and oil include air pollution, acid rain, the destruction of the ozone layer, and possibly global warming. The externalities from burning oil and coal are more widespread and affect more people than the externalities from wind powered turbines.

14c. The government could impose a tax equal to the external costs. A problem with this approach is the difficulty in determining the proper amount of tax. Marketable permits might be issued, but the permits would need to be in units of “visual pollution,” which seems a difficult concept to measure.
Finally, the government could assign property rights. It’s unlikely the government can assign property rights to the birds that are killed, but the main externality opponents point to is the visual pollution. In this instance, the government could either give the property right to the view to the landowners upon which the towers will be built or to landowners who own properties that will gaze upon the towers. In either case, the Coase solution should allow for an efficient outcome.

14d. Even though generating power using wind towers generate lower external costs than using coal or oil, wind towers probably face more opposition. Wind towers face opposition because they are situated in populated areas, where a few people are heavily harmed. These few people find it in their interest to organize and lobby the government to ban wind towers. The people harmed by the externalities from coal and oil are more widespread and organization is more difficult. So politicians hear more from opponents of wind towers than they hear from opponents of oil and gas.

15a. Cutting trees for use as timber is disrupting the owls’ home.

15b. One externality of cutting trees is discussed in the article: It destroys the forest used by northern spotted owls.

15c. The government has dealt with this externality by limiting the amount of land available for timbering. The government could impose a tax on lumber companies and use the proceeds to buy additional old growth forest in which timbering is not allowed. For efficiency, the tax would need to be equal to the marginal external cost, which is difficult to measure. Presumably the property right to the land has already been granted, but the Coase solution probably will not work because there are too many parties involved—many timber companies and many environmental groups.

16. A carbon tax is imposed on burning fuels that produce carbon dioxide. The concern is that carbon dioxide leads to global warming and using fuels, such as coal, oil, and natural gas, that produce carbon dioxide leads to global warming. A carbon tax is based on the carbon content of the fuel. Burning coal produces the most carbon dioxide, so it would face the highest tax. Imposing a tax on burning these fuels would increase the cost of generating electricity and decrease the supply. The price of electricity would rise and the quantity of electricity consumed would decrease. Because the tax on coal would exceed that on oil and natural gas, less electricity would be generated by coal and more would be generated by oil and natural gas. The costs of the tax would be borne by everyone who uses electricity. Those workers who lose their jobs mining coal and need to find others as well as owners of coal mines also are harmed by the tax. If limiting the production of carbon dioxide limits global warming, the benefits would be enjoyed by future generations.
Questions

CHECKPOINT 9.1 Negative Externalities: Pollution

1. Figure 9.2 illustrates the unregulated market for pesticide. When the factories produce pesticide, they also create waste, which they dump into a lake on the outskirts of the town. The marginal external cost of the dumped waste is equal to the marginal private cost of producing the pesticide, so the marginal social cost of producing the pesticide is double the marginal private cost. Suppose that the government issues marketable pollution permits that are just sufficient to enable the factories to produce the efficient output of pesticide. The permits are divided equally between the townspeople and the factories.

1a. What is the efficient amount of pesticide?
1b. What is the price of a marketable permit?
1c. Who buys permits and who sells permits?
1d. How would the outcome differ if all the permits were allocated to the factories?
1e. How would the outcome differ if all the permits were allocated to the townspeople?

2. Figure 9.3 shows the marginal cost and marginal benefit curves facing a small scenic seaside village that has a water-polluting paper mill next to it.

2a. If property rights are not assigned and the market is unregulated, how much paper is produced and what is the price?
2b. If the transactions costs are low and property rights to the water are assigned, how much paper is produced? Does it matter whether the town or the factory is assigned the property rights?
2c. If the city wants to tax the factory to achieve the efficient amount of pollution, what must the tax be and what is the city’s total tax revenue from the tax?
CHECKPOINT 9.2 Positive Externalities: Knowledge

3. Obtaining a college education has a marginal external benefit. Figure 9.4 shows the market for college education.

3a. What is the efficient number of students?
3b. If the government decides to provide public colleges, what must the tuition equal to attain efficiency? How much of the cost of a student’s tuition will be funded by taxes and how much will be paid for by the student?

Answers

CHECKPOINT 9.1 Negative Externalities: Pollution

1a. The efficient quantity is 20 tons a week because this quantity is where the marginal benefit curve intersects the marginal social cost curve, as shown in Figure 9.5.

1b. The price of the permit is $50, the marginal external cost when 20 tons a week are produced.

1c. The factory buys the permits and the town sells the permits.

1d. If the factory received all the permits, the factory would not sell any permits. The factory would use the permits to produce the efficient quantity of pesticide.

1e. If the townspeople received all the permits, the factory would buy the permits for $50 a ton.
2a. With no property rights and no government intervention, the quantity of paper is determined by the demand and supply curves and is 60 tons of paper at a price of $150 a ton.

2b. If property rights to the water are assigned, the efficient amount of paper is produced, which is 40 tons. The Coase theorem points out that it does not matter to whom the property rights are assigned.

2c. To attain efficiency, the tax must equal the marginal external cost at the efficient quantity, which is $100 a ton. With this tax, 40 tons of paper are produced, so the city collects ($100 a ton) \times (40 tons), which equals $4,000 a week in tax revenue.

**CHECKPOINT 9.2 Positive Externalities: Knowledge**

3a. The efficient number of students is 12 million because that is the quantity at which the marginal social benefit, \( MSB \), equals the marginal cost, \( MC \).

3b. To have 12 million students enroll, the demand curve shows that the tuition must be $2,000 a student. The marginal cost when 12,000 students enroll is $6,000, so with each student paying $2,000, taxpayers must pay $4,000 a student.
USING EYE ON THE U.S. ECONOMY

- **Pollution Trends**
  This article focuses on the three main types of pollution: air, water, and land. The story notes that most types of air pollution have decreased over the past 30 years. These results show that the cost of reducing some contaminants (lead and sulfur dioxide) is lower than other contaminants (nitrogen dioxide and ozone). If the costs were equally low, we would see all types of pollution decrease by similar percentages. You can ask students when or how they think the most common types of pollutants will effectively be reduced. Their answers should contain intuition about comparing the opportunity cost of reduction versus pollution and the ability to assign property rights.

USING EYE ON THE GLOBAL ECONOMY

- **A Carbon Fuel Tax?**
  This story highlights three aspects of carbon emissions: the debate over the danger of carbon emissions, the comparison of today’s costs to reduce pollution versus the benefits that accrue in the future, and the role of developing countries in increasing pollution.

  The debate over the danger of carbon emissions means that it will be difficult to get the U.S. government to agree on any tax imposition. If scientists would agree on the emissions’ negative (or negligible) effects, a meaningful policy might well adopted in the United States. As long as developing countries’ governments subsidize the pollution, actions in the United States will account for a decreasing portion of the world’s total. Attempts to reduce pollution will have to focus more on these countries than on the United States.

  You can ask students how much are they willing to pay for cleaner air, land, and water. For example, electricity deregulation is supposed to allow you to choose among various utility providers. Some providers will claim “clean” production of electricity, while others will offer electricity at the lowest price. Ask your students which provider they would pick. How many of those choosing the “green” provider are willing to pay higher prices? How much higher? Ask your students how many of them buy the “green” paper towels and napkins in the grocery store. They are usually higher priced and lower quality. How many of them are willing to give up their cars for public transportation? These choices represent the opportunity cost of reducing pollution. Obviously, in some cases, the costs are too high.