

INTERNALIZING EXTERNALITIES

Public Finance, 10th Edition
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Outline: Chapter 3 INTERNALIZING EXTERNALITIES

1. Externalities: A Classification and Some Examples
2. Internalization of Externalities
3. Property Rights to Resource Use and Internalization of Externalities: The Coase Theorem
4. Environmental Protection Policies in the United States
5. Markets for Pollution Rights in Practice: Sulfur Dioxide Allowances, and Capping and Trading the Right to Emit

Externalities

1. Externalities: A Classification and Some Examples

- *Externalities* are costs or benefits of market transactions **not reflected** in prices.
- A third party is affected by production or consumption
- Benefits or costs to the third party not considered by buyers or sellers

Types of Externalities

1. Externalities: A Classification and Some Examples

- *Negative externalities* – costs to third parties other than buyers or sellers not reflected in the market price
 - Damage by industrial pollution to people and property
- *Positive externalities* – benefits to third parties other than buyers or sellers not reflected in prices
 - Fire prevention, such as smoke alarms and fireproofing
- Pecuniary externalities – effects of increases or decreases in the price of a good on existing customers as a result of changes in the demand or supply of a good

Negative Externalities

1. Externalities: A Classification and Some Examples

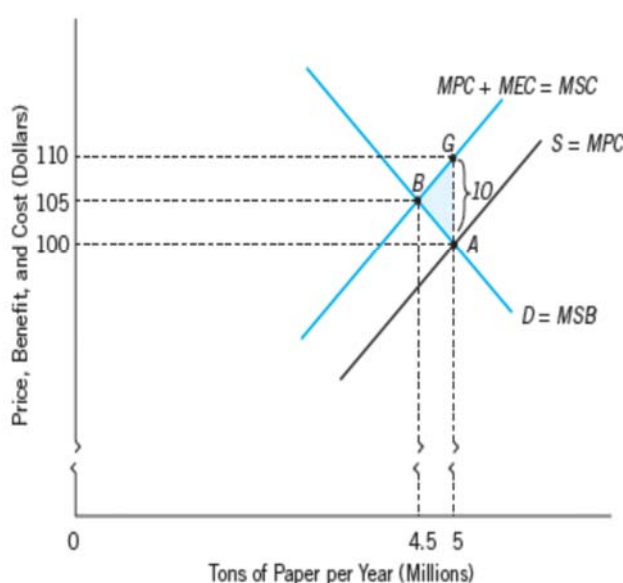
- Marginal external cost (*MEC*) – extra cost to third parties resulting from production of another unit of a good or service
- MEC vs MSC
 - ✓ MEC is part of the marginal social cost (*MSC*) of making a good available
- MEC is not reflected in the price of the good
- Producers base decisions on marginal private cost (*MPC*)

Negative Externalities

1. Externalities: A Classification and Some Examples

FIGURE 3.1

Market Equilibrium, Negative Externality, and Efficiency



The market equilibrium output of 5 million tons per year is inefficient because $MSC > MSB$ at that output.

The efficient output corresponds to point B, where the annual output of paper is 4.5 million tons per year.

The price of paper would have to rise to \$105 per ton to move to the efficient output.

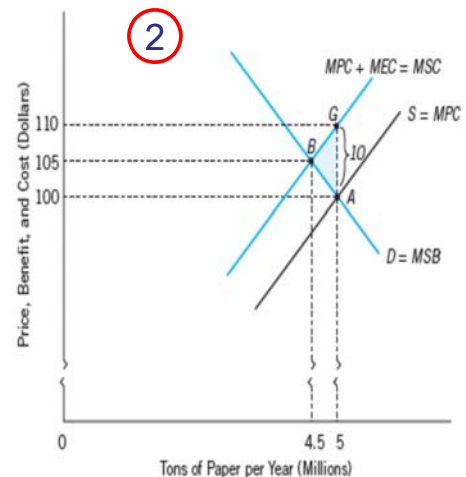
This will reduce the marginal social cost of paper from \$110 to \$105 per ton and result in net gains equal to the area BGA.

4. A city can subsidize commuting via public transit by giving public funds to buses and subways. A city also subsidizes commuting by car by spending public funds to maintain roads and bridges. How are total negative externalities affected by public funding of buses and subways?
- 1 How are negative externalities affected by public funding of roads and bridges?
 - 2 How are negative externalities affected by public funding for roads and bridges? If a city wants to engage in corrective taxation, how might it adjust public subsidies of various methods of urban travel?

ANSWER

- 1 By funding public transportation, the negative externality of pollution from auto emissions is reduced assuming people choose to use public transportation instead of driving individual cars.
- 2 By public funding of roads and bridges, the negative externality of increasing pollution exists because such infrastructure enables more individuals to use cars to a greater extent and possibly in areas where cars had not been previously.
- 3 The city can impose a corrective tax in the form of tolls or meter parking or a car tax that could be used to subsidize public transportation.

FIGURE 3.1 Market Equilibrium, Negative Externality, and Efficiency



Positive Externalities

1. Externalities: A Classification and Some Examples

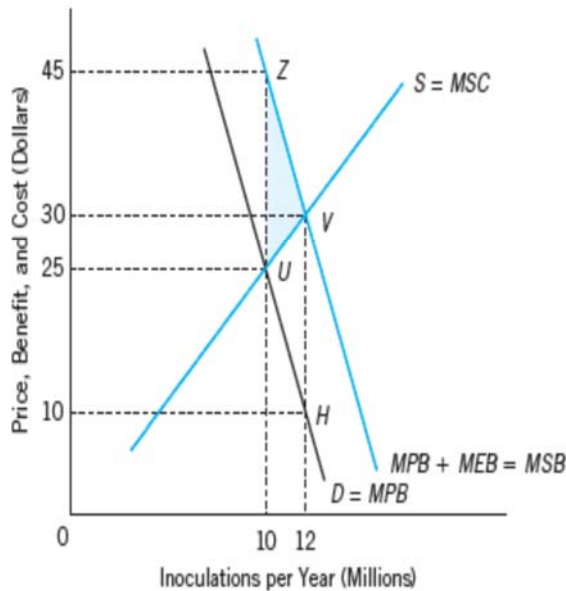
- In a positive externality, prices do not fully equal the marginal social benefit (MSB) of a good or service.
- MEB vs MSB
 - ❑ Marginal external benefit (MEB) – benefit of additional output accruing to parties other than buyers and sellers of the good
- Consumers base decisions on marginal private benefit (MPB)

Positive Externalities

1. Externalities: A Classification and Some Examples

FIGURE 3.2

Market Equilibrium, Positive Externality, and Efficiency



The market equilibrium corresponds to point U , at which $MPB = MSC$.

The resulting output of 10 million inoculations per year is inefficient because $MSB > MSC$ at that point.

The efficient annual output corresponds to point V , at which 12 million inoculations would be consumed per year.

The price to consumers would have to fall from \$25 to \$10 per inoculation to move to that point.

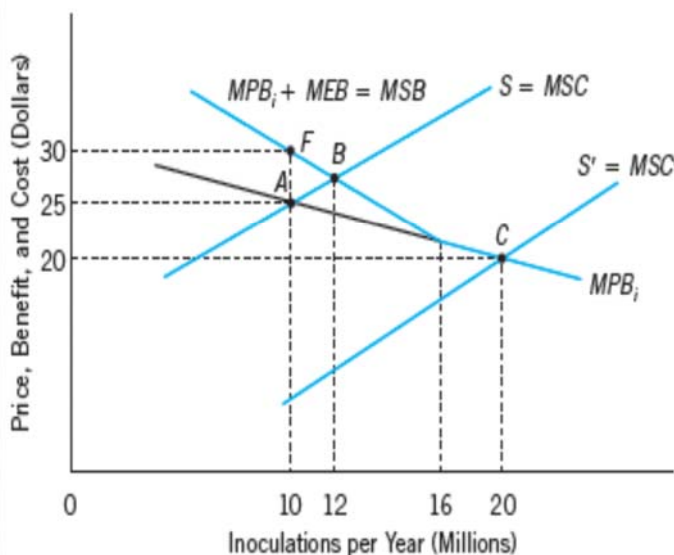
Moving to the efficient point allows net gains equal to the area UZV .

MEB Declines with Annual Output

1. Externalities: A Classification and Some Examples

E 3.3

A Positive Externality for which MEB Declines with Annual Output



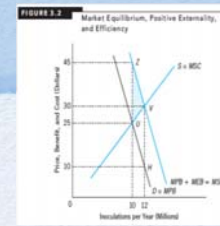
In this case, MEB declines as more persons are inoculated per year.

If market price is \$25 per inoculation, a loss in efficiency occurs because $MEB > 0$ at the corresponding output of 10 million inoculations per year.

However, when the market price is \$20, the market equilibrium is efficient because $MEB = 0$ at the corresponding output of 20 million inoculations per year.

3. The following data show how the marginal external benefit and marginal private benefit associated with a soil treatment agent to control Japanese beetles vary with the gallons of the control agent sold per year:

GALLONS PER YEAR(IN MILLIONS)	MPB	MEB
20	\$30	\$10
30	25	6
40	20	2
50	15	0



1

Draw the demand curve for the control agent and show how the marginal private benefit

2

differs from the marginal social benefit. Suppose the supply of the agent is infinitely elastic at

3

the current price of \$25 per gallon. Will the market equilibrium be efficient? How would your

4

answer differ if the market supply were infinitely elastic at a price of \$15 per gallon? What

policies could you suggest to achieve efficiency?

ANSWER

1

The demand curve is obtained by plotting the data for MPB on the vertical axis and plotting the quantity on the horizontal axis. The difference between the marginal social benefit and the marginal private benefit is the MEB.

2

At a price of \$25 per gallon, the market equilibrium is not efficient because there is a marginal external benefit of \$6 when 30 million gallons are sold per year.

3

At a \$15 price, the marginal external benefit is zero, and the market equilibrium is therefore efficient.

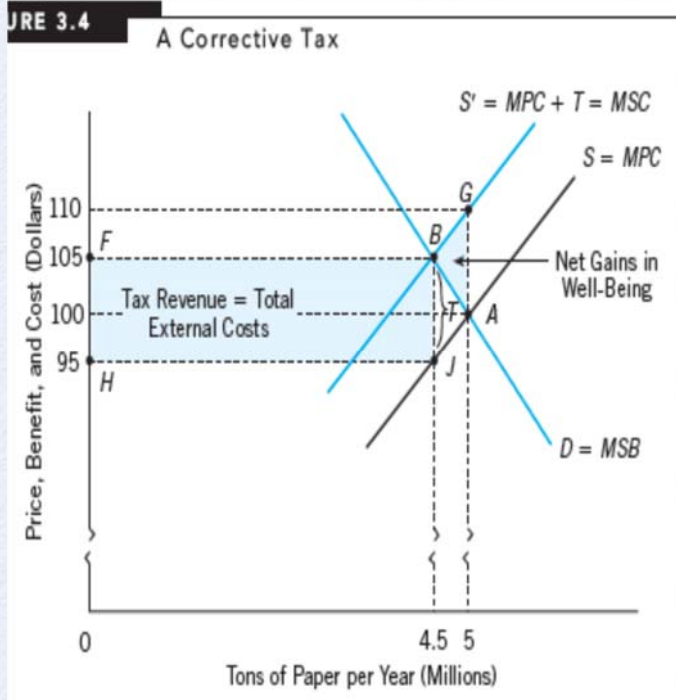
Internalization of Externalities

2. Internalization of Externalities

- **Internalization of an externality** – marginal private benefit or cost of goods and services are adjusted so that users consider the actual marginal social benefit or cost of their decisions
 - Negative externality: MEC is added to MPC
 - Positive externality: MEB is added to MPB
- **Corrective tax** – designed to adjust MPC of a good or service in such a way as to internalize the externality; must equal MEC per unit

Corrective Tax

2. Internalization of Externalities



A corrective tax of $T = 10$ per unit output increases marginal private cost by an amount equal to the marginal external cost and results in the efficient annual output of paper.

The tax revenue collected is represented by the area **FBHJ**.

This revenue equals the total external costs at the efficient output, provided that MEC does not vary with output.

The tax allows net gains in well-being equal to the area **BGA**.

7 The supply of paper is described by the following equation:

$$Q_s = 5,000P$$

where Q_s is tons supplied per year and P is the price per ton. The demand is described by

$$Q_D = 400,000 - 1,000P$$

where Q_D is tons demanded per year. Because of the pollution associated with paper production, marginal external costs of \$20 are associated with each ton of paper. Assuming

- 1 what is the market price?
- 2 How many tons of paper will be produced per year at that price?
- 3 What is the efficient annual output of paper?
- 3 How can a corrective tax achieve efficiency?

Ans.

- 1 Market equilibrium price
 - $MPC = MSB$
 - Setting $Q_s = Q_d$ and interpreting P as P_g gives:

$$5000P = 400,000 - 1000P$$

$$P^* = P^g = P^N = \$66.7$$

$$Q^* = 333,333$$
- 2 New market equilibrium price
 - $MSC = MSB$
 - $MSC = MPC + MEBC$

$$Q_s = 5000(P - 20)$$
 - Setting $Q_s = Q_d$ and interpreting P as P_g gives:

$$5000(P - 20) = 400,000 - 1000P$$

$$P^* = P^g = \$83.3$$

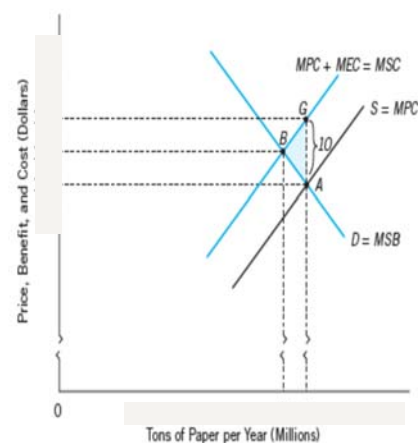
$$Q^* = 316,667$$

Ans.

- 3
 - $MPC + t = MSB$

$$5000(P - 20) = 400,000 - 1000P$$
 - $P^* = P^g = \$83.3$ which is the new market equilibrium price after the corrective tax.
 - $P^N = \$63.33$ which is the net price received by the seller.
 - $Q^* = 316,670$ which is the efficient equilibrium quantity given that $t = MEC = \$20$.

FIGURE 3.1 Market Equilibrium, Negative Externality, and Efficiency



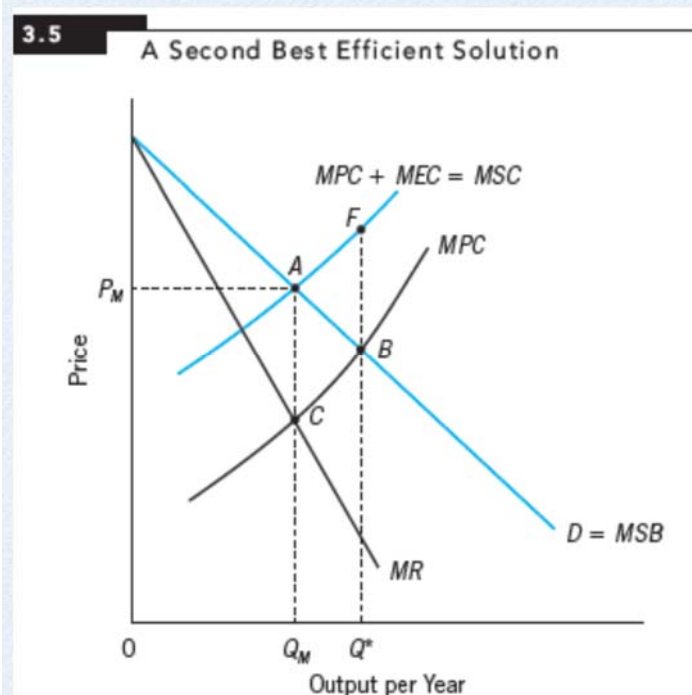
Other Means of Internalizing Externalities

2. Internalization of Externalities

- *General theory of second best* – states that when two opposing factors contribute to efficiency losses, they can offset one another's distortions
 - Economists treat each problem on an ad hoc basis to determine if there are any “second best” problems present.
- *Corrective subsidy* – payment made by government to either buyers or sellers so that the price paid by consumers is reduced

Second Best Efficient Solution

2. Internalization of Externalities



The monopolist produces less than the efficient output under normal circumstances.

Here, however, the monopolist also generates external costs.

The loss in well-being due to monopoly power is the area ABC .

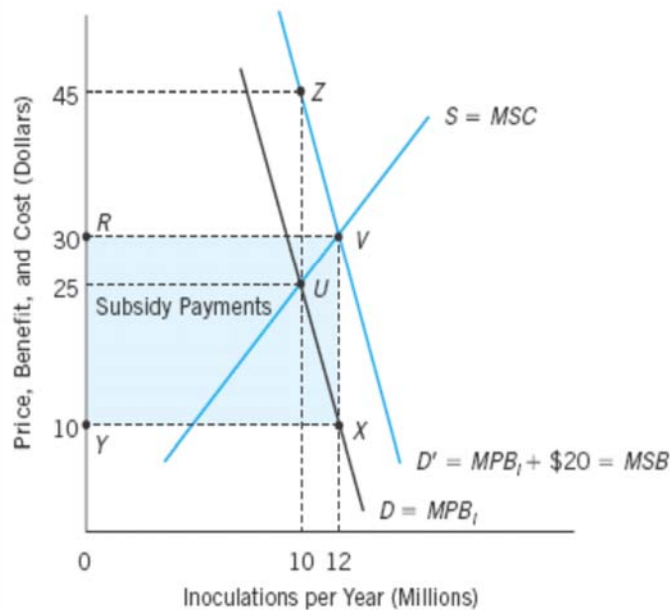
This is offset by a gain in well-being equal to the area AFB that would be lost if a competitive industry produced this output.

Corrective Subsidy

2. Internalization of Externalities

3.6

A Corrective Subsidy



A corrective subsidy to consumers increases the demand for inoculations and achieves the efficient output.

After subsidy payments are received by consumers, the net price of an inoculation falls to \$10, inducing them to purchase the efficient amount of 12 million per year.

The area RVXY represents the total subsidy payments at the efficient output.

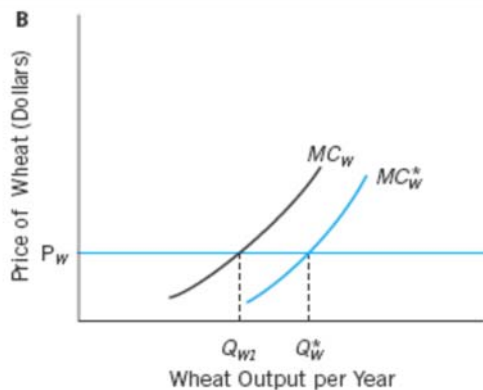
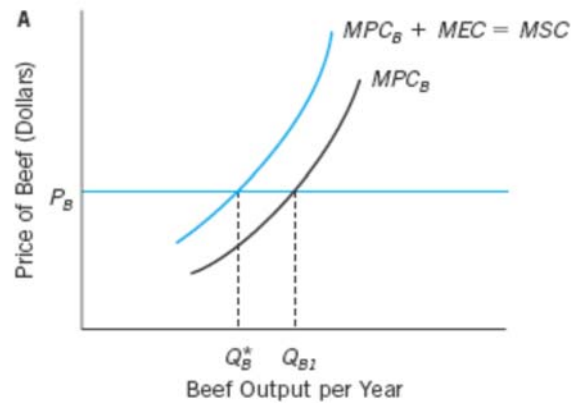
The Coase Theorem

3. Property Rights to Resource Use and Internalization of Externalities: The Coase Theorem

- Governments, by merely establishing rights to use resources, can internalize externalities when transactions costs of bargaining are zero.
- Users initially granted the right are better off, because they own a valuable property right that can either be used or exchanged.
- The assignment of the right affects the distribution of income between two parties using the resource.

3.7

The Coase Theorem



The Coase Theorem

The graph in A shows the marginal cost of producing beef and the price of beef, while that in B indicates marginal cost and price for a neighboring wheat farmer.

The Coase theorem holds that the efficient output of beef, Q_B^* , and the efficient output of wheat, Q_W^* , will be produced on the adjacent lands, irrespective of who is liable for damages the cattle cause to the wheat crop each year.

Coase Theorem & Pollution Rights

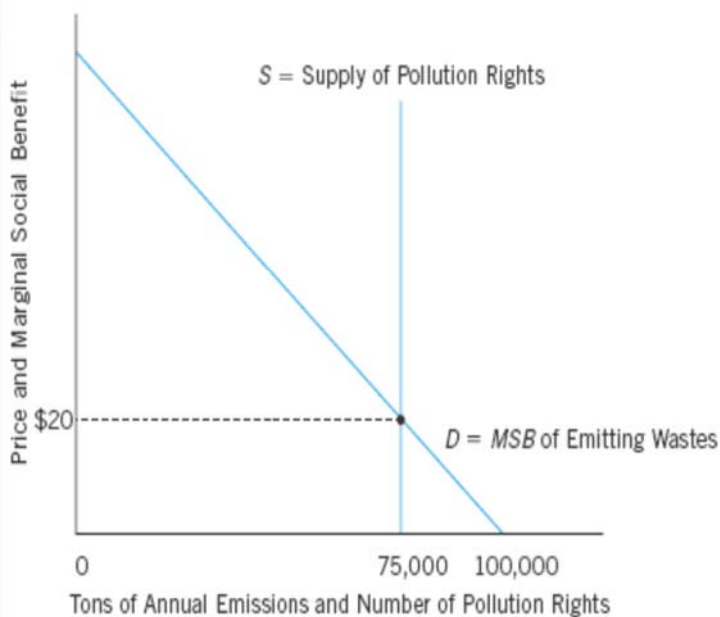
3. Property Rights to Resource Use and Internalization of Externalities: The Coase Theorem

- *Pollution rights* – transferable permits to emit a certain amount of particular wastes into the atmosphere or water per year
- Firms purchasing the rights are free to sell them to other firms.
- Regulatory authorities can therefore strictly control emissions by issuing a fixed number of permits.

Coase Theorem & Pollution Rights

RE 3.8

Pollution Rights and Emissions



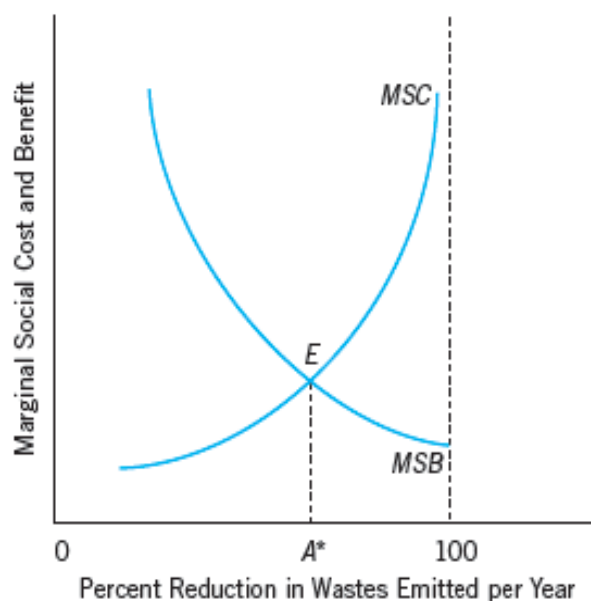
If the fixed amount of pollution rights, one of which is required for each ton of emissions, is issued, the price of rights will be determined by the demand, which reflects the marginal social benefit of emitting wastes.

In this case, competition for the 75,000 pollution rights issued results in a price of \$20 per right.

Efficient Amount of Abatement

3.9

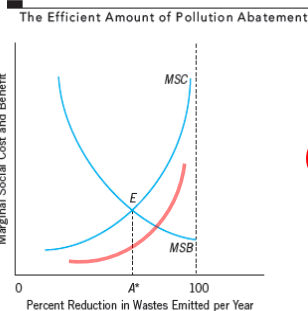
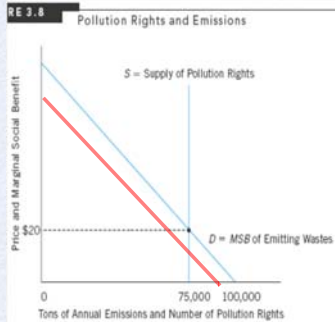
The Efficient Amount of Pollution Abatement



The efficient amount of abatement corresponds to the point at which the marginal social cost of additional reduction in wastes emitted just equals the marginal social benefit of that reduction.

This corresponds to A^* percent of abatement per year.

2. Assume that the market for tradable emissions permits by power plants has been operating efficiently for several years. An engineering firm then invents a lower cost device for pollution abatement. What happens to the equilibrium market price of a tradable permit, and why?
- Draw a supply and demand diagram, with a fixed supply of pollution permits, along with your answer. Has the socially optimal amount of pollution increased or decreased? Explain.



ANSWER

- 2 The creation of a lower cost device for pollution abatement will shift the demand curve (the MSB to polluting) to the left

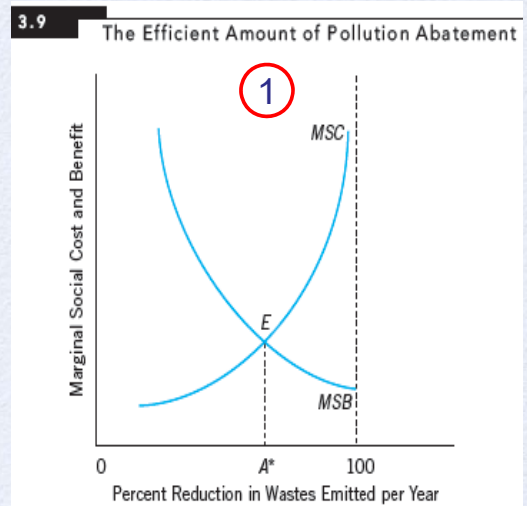
(draw an initial demand curve with a vertical line for supply similar to Figure 3.8 and then draw a second demand curve to the left to demonstrate the effect of the new technology) and lower the price of the permits.

- 1
- 3 The socially optimal amount of pollution will be reduced by the new technology because the MSC of abatement (see Figure 3.9) will shift to the right (i.e. a lower MSC) with the MSB of abatement being unchanged indicating a greater level of pollution abatement.

6. Economists argue that there is an efficient amount of pollution abatement. Explain why the efficient amount of abatement is unlikely to be either zero or 100 percent. List all the information that would be required to determine the efficient amount of pollution abatement. Why is it difficult in practice to determine the efficient amount of pollution abatement?

ANSWER

- 1 The efficient amount of pollution abatement occurs at the point at which the marginal social cost of abatement is equal to its marginal social benefit. Because the marginal social cost rises while the marginal social benefit declines, the efficient amount of abatement is likely to be greater than zero but less than 100 percent.
- 3 In practice it is difficult to determine the efficient level of pollution abatement because of difficulty in assessing the costs and benefits of abating pollution and the way they vary at the margin as more abatement is achieved.



Command-and-Control Policies

4. Environmental Protection Policies in the United States

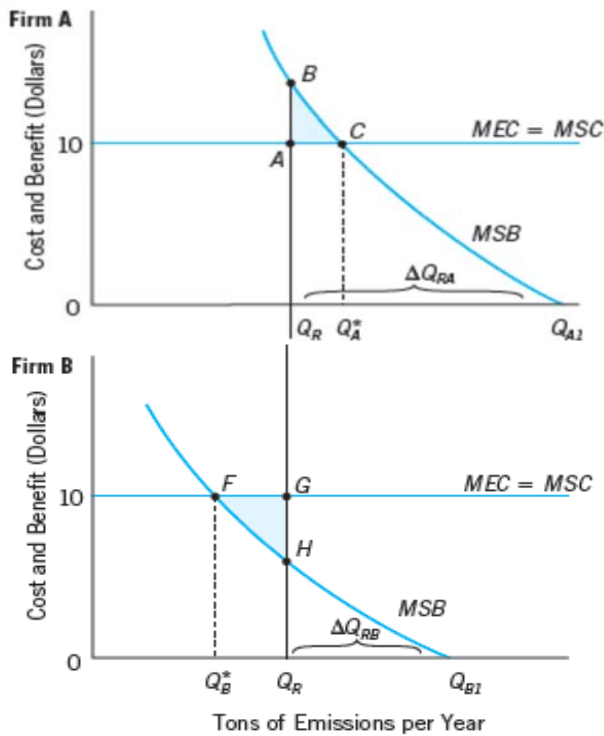
- A system of rules established by government authorities requiring all emitters to meet strict emissions standards for sources of pollution
 - Requires use of specific pollution control devices
 - Results have been:
 - Court challenges, causing delayed implementation
 - High compliance costs
 - Heavy political opposition
 - Are difficult to enforce
- Standards that limit the amount of pollutants that can be emitted into the air or water
 - Limits on auto emissions established by the 1970 Amendments to the Clean Air Act
 - **Thailand: National Environmental Act B.E. 2535 (1992)**

Emissions Standards

4. Environmental Protection Policies in the United States

- Differ from corrective taxes in that they do not charge for emissions damages if the amounts emitted are less than legally established standards
- Reduced emissions result in reduction of pollution or *pollution abatement*.
- Flexible standards more likely to achieve an efficient outcome that uniform standards
 - Adjust for differences in MSB and MEC among firms and regions
 - **Financial Measures for Environment Act B.E 25xx (Draft)**

0 Regulating Emissions: Losses in Efficiency from Differences in the Marginal Social Benefit of Emissions



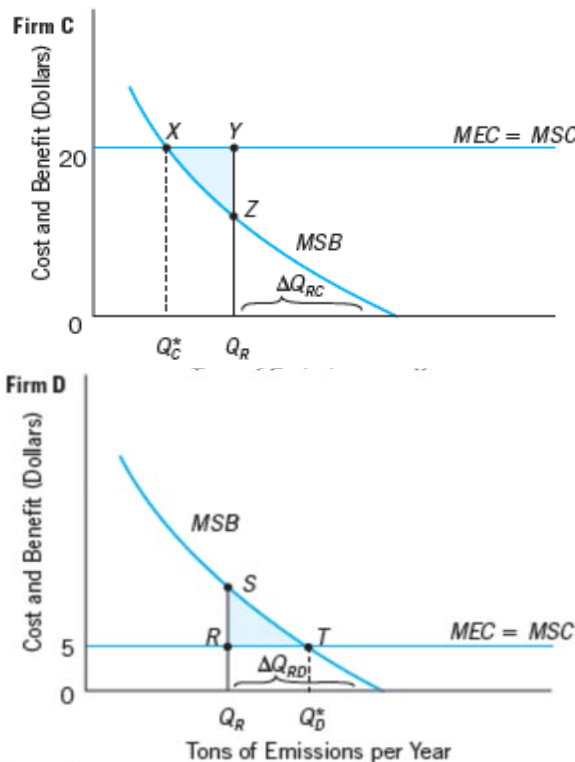
Differences in MSB of Emissions

When the marginal social benefits of emissions differ among firms,

uniform emissions

regulations at Q_R result in less than the efficient level of emissions for firms such as A and more than the efficient amount of emissions for firms such as B.

3-11 Losses in Efficiency from Emissions Standards When MEC Differs among Regions



Differences in MEC of Emissions

The marginal social cost of a ton of emissions is greater for firm C, located in an urban area, than for firm D, located in a rural area.

A uniform standard of emissions of Q_R tons per year results in more than the efficient amount of emissions from firm C and less than the efficient amount from firm D.

Markets for Pollution Rights: Sulfur Dioxide

5. Markets for Pollution Rights in Practice: Sulfur Dioxide Allowances, and Capping and Trading the Right to Emit

- The EPA issues marketable rights to emit sulfur dioxides to electric power-generating companies.
- New plants must buy allowances from existing owners of permits or from annual EPA allowance auctions.
- Violators must pay a fine and reduce emissions the following year by the amount exceeded.
- An example of financial measures in Financial Measures for Environment Act B.E 25xx (Draft)

Benefits of Markets for Pollution Rights

5. Markets for Pollution Rights in Practice: Sulfur Dioxide Allowances, and Capping and Trading the Right to Emit

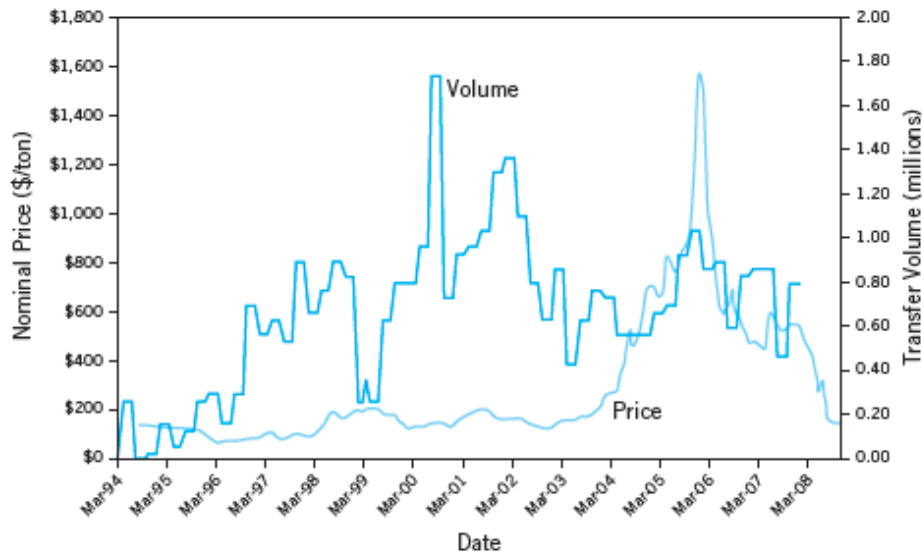
- Firms must compare cost of emissions with the price they could get for their pollution rights.
 - Cost of polluting a factor in profit calculation, causing pressure from stockholders to reduce pollution
- Trading of rights will allow companies to meet EPA requirements at lower costs
- Encourages electric power companies to develop new technology for reducing emissions
 - Can add to profits by selling the therefore unused pollution rights
- Program has been effective in reducing emissions.

Variation in Allowance Prices

5. Markets for Pollution Rights in Practice: Sulfur Dioxide Allowances, and Capping and Trading the Right to Emit

FIGURE 3.12

Sulfur Dioxide Allowance Prices and Trade Volume, 1994–2008



Innovations in EPA Policies

5. Markets for Pollution Rights in Practice: Sulfur Dioxide Allowances, and Capping and Trading the Right to Emit

- *Emissions offset policy*: new firms can enter an area in which standards are already met or exceeded, provided they pay other firms to reduce their pollutants in an amount equal to or greater than that to be generated by the new firms
 - Encourages new business in areas where emissions are already met or exceeded
- *The bubble*: the new firm is allowed to exceed emissions standards for one type of pollutant if it compensates by reducing emissions by more than the required standard for another
- *Banking emissions*: firms that exceed current standards are given credits allowing them to fall short of the standards at a point in the future; may sell the credits

Benefits and Costs of Environmental Protection

5. Markets for Pollution Rights in Practice: Sulfur Dioxide Allowances, and Capping and Trading the Right to Emit

- In 1990, the EPA estimated that the benefits of the Clean Air Act were nearly 50 times the costs.
 - Implies that, in the aggregate, clean air programs have resulted in net gains, improved efficiency
- It is argued, however, that disaggregating programs provides a better picture of specific clean air programs on efficiency.
 - In which case, programs targeting leaded gasoline specifically account for 90 percent of the benefits.
- Water pollution policy has been command-and-control; effects have apparently been modest.

5. The EPA wants to reduce emissions of sulfur dioxides from electric power-generating plants by 20 percent during the next year. To achieve this goal, the EPA will require each power-generating plant in the nation to reduce emissions by 100 tons per year. Suppose five power plants emit sulfur dioxides and serve a given metropolitan area. The following table shows the cost per ton of reducing emissions for each of the five plants:

PLANT	COST PER TON OF PLANT FOR EMISSIONS REDUCTION
1	\$600
2	500
3	500
4	400
5	200

Assuming that the cost per ton of emissions reduction is constant and that the improvement in the air for the metropolitan area is the same no matter which plant reduces emissions, calculate the following:

- a) Cost of meeting EPA regulations.
- b) Least-cost method of achieving the EPA goal of reducing emissions of sulfur dioxides from power plants in the metropolitan area

ANSWER

- a. The cost of meeting the standards is obtained by multiplying cost per ton for each plant and summing the results, which gives \$220,000 per year.
- b. The least cost method would be to have Plant 5 reduce its emissions by 500 tons per year, which would cost only \$100,000 per year.

1. Instead of using regulations to achieve the 20 percent reduction in emissions discussed in the preceding problem, suppose the EPA requires each of the five emitters to pay a fee of \$450 for each ton of sulfur dioxide it dumps in the air during the year. Use the data from the table for problem 5 (emission reduction = 100 tons) to predict which companies will purchase pollution rights, total cost of achieving the reduction in sulfur dioxide emissions, and revenue generated from the sale of pollution rights in the area.

- 1
- 2
- 3

PLANT	COST PER TON OF PLANT FOR EMISSIONS REDUCTION
1	\$600
2	500
3	500
4	400
5	200

ANSWER

- 1 At a \$450 per ton charge, Plants 4 and 5 would cut back emissions. Plants 1, 2, and 3 would find it cheaper to pay the \$450 fee, rather than cut back emissions.
- 2 Plants 4 and 5 would pay emissions at a total cost of \$60,000.
- 3 The total revenue generated by the purchase of the pollution rights by these firms for the 300-ton reduction in annual emissions would therefore be \$135,000.

RECAP: Chapter 3 INTERNALIZING EXTERNALITIES

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