Public Finance II.

Lecture V - **Externalities**

Matej Lorko
matej.lorko@euba.sk
www.lorko.sk

Office Hours (Room 5C.30)
Tue 10:00 – 10:45
Thu 12:30 – 13:15

Readings:

- Gruber, J. (2005). Public finance and public policy. Macmillan.
- Congdon, W. J., Kling, J. R., & Mullainathan, S. (2011). Policy and choice: Public finance through the lens of behavioral economics. Brookings Institution Press.

Externalities

- Burning of fossil oils (such as coal, oil, natural gas, and gasoline) for heating, transportation, electricity production -> production of carbon dioxide -> trapping the heat from the sun in the earth's atmosphere -> global warming

- **externality -** arises whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.

- can arise either from the production of goods or from their consumption and can be negative or positive

- externalities are examples of market failures (A problem that causes the market economy to deliver an outcome that does not maximize efficiency.)

- externalities present a classic justification for government intervention.

Negative production externality

- When a firm's production reduces the well-being of others who are not compensated by the firm.

- One way to see this externality is to compare the private benefits and costs of production to the social benefits and costs.

- *Private benefits and costs* are the benefits and costs borne directly by the actors in the market (the producers and consumers).

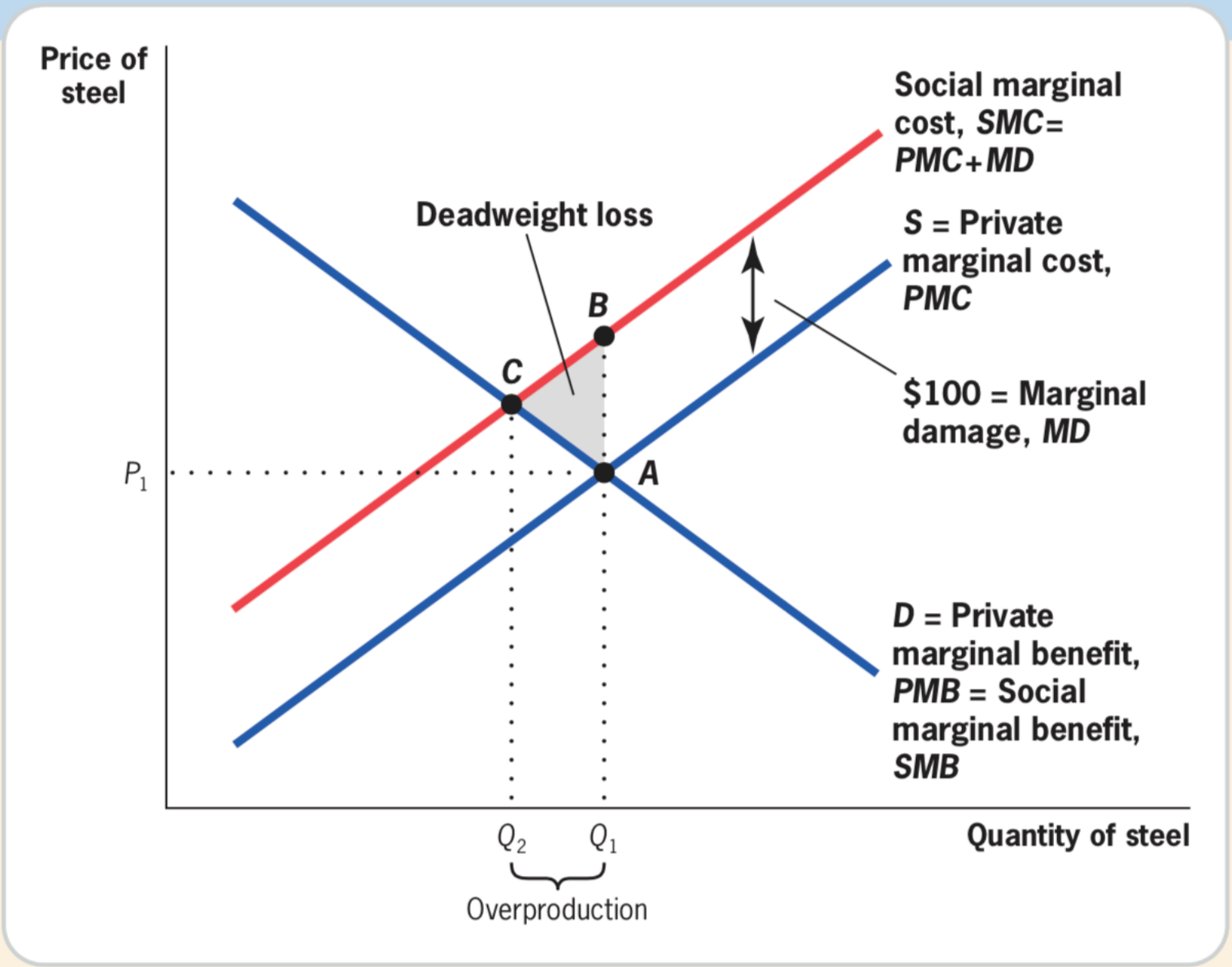
- *Social benefits and costs* are the private benefits and costs *plus* the benefits and costs to any actors outside the market who are affected by the production process.

Private vs. social

- private marginal cost (PMC) - The direct cost to producers of producing an additional unit of a good.
- social marginal cost (SMC) - The private marginal cost to producers plus any costs associated with the production of the good that are imposed on others.
- private marginal benefit (PMB) - The direct benefit to consumers of consuming an additional unit of a good by the consumer.
- social marginal benefit (SMB) - The private marginal benefit to consumers minus any costs associated with the con- sumption of the good that are imposed on others.

Negative production externality

■ FIGURE 5-2



Market Failure Due to Negative Production Externalities in the Steel Market • A negative production externality of $100 per unit of steel produced (marginal damage, *MD*) leads to a social marginal cost that is above the private marginal cost, and a social optimum quantity (Q_2) that is lower than the competitive market equilibrium quantity (Q_1). There is overproduction of $Q_1 - Q_2$, with an associated deadweight loss of area *BCA*.

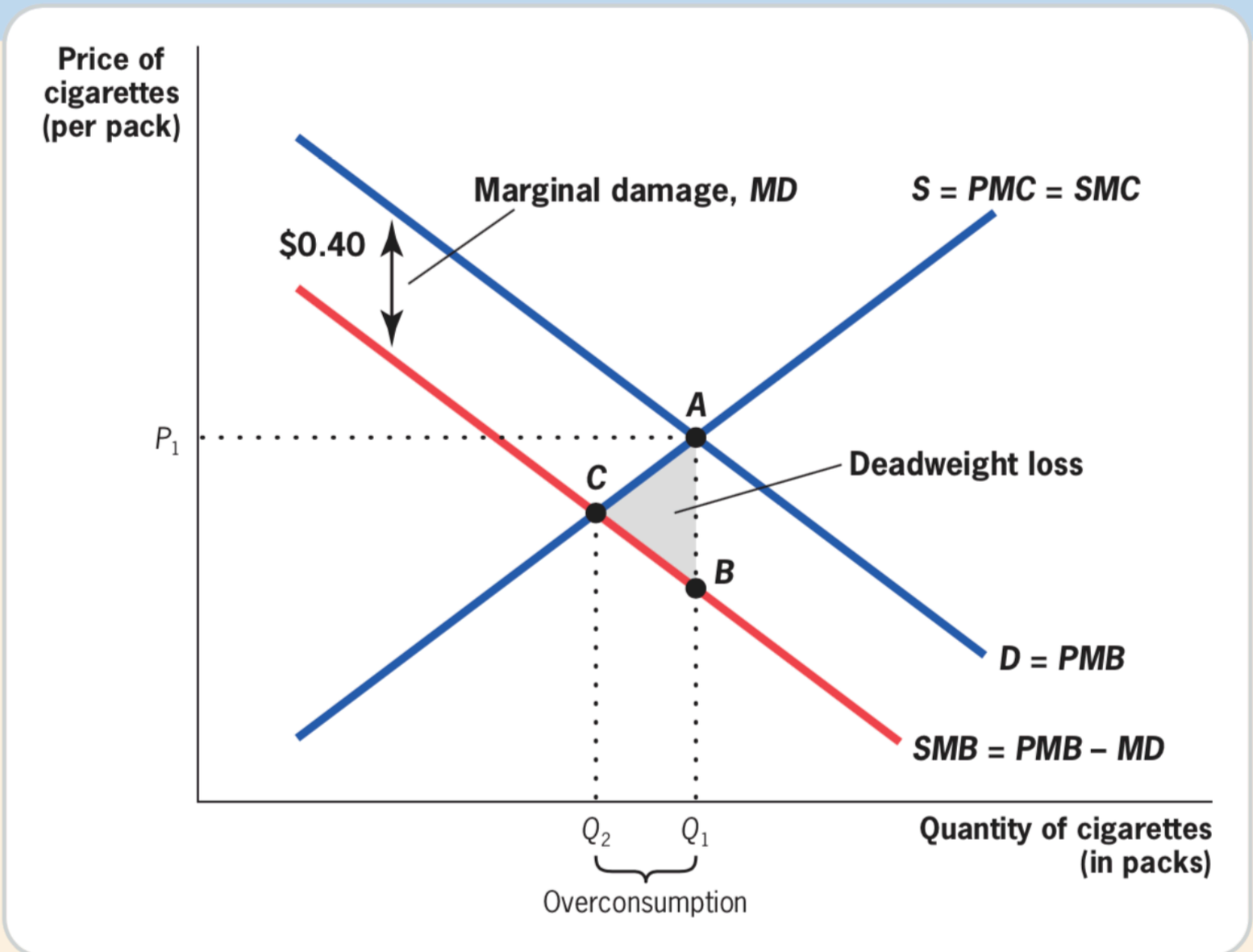
Marginal damage

- Without market failures, SMC = PMC and SMB = PMB
- in the presence of externalities:
  - SMC = PMC + MD, where MD is the marginal damage done to others caused by your production
  - SMB = PMB - MD, where MD is the marginal damage done to others caused by your consumption
- (For previous slide): When we move away from the social-efficiency-maximizing quantity, we create a deadweight loss for society because units are produced and consumed for which the cost to society (summarized by curve SMC) exceeds the social benefits (summarized by curve D = SMB). The deadweight loss is equal to the area *BCA.* The width of the deadweight loss triangle is determined by the number of units for which social costs exceed social benefits (Q_1 - Q_2).The height of the triangle is the difference between the marginal social cost and the marginal social benefit, the marginal damage.

.

Negative consumption externality

■ FIGURE 5-3



Market Failure Due to Negative Consumption Externalities in the Cigarette Market • A negative consumption externality of 40¢ per pack of cigarettes consumed leads to a social marginal benefit that is below the private marginal benefit, and a social optimum quantity (Q_2) that is lower than the competitive market equilibrium quantity (Q_1). There is overconsumption $Q_1 - Q_2$, with an associated deadweight loss of area *ACB*.

Negative consumption externality

- When an individual's consumption reduces the well-being of others who are not compensated by the individual.
- SMB is now below the PMB by MD per unit; every unit consumed has a social benefit that is below its private benefit.
- (For previous slide): The social-welfare-maximizing level of consumption, Q2, is identified by point C, the point at which SMB = SMC.There is overconsumption by Q1 - Q2: the social costs (point A on the SMC curve) exceed social benefits (on the SMB curve) for all units between Q1 and Q2. As a result, there is a deadweight loss (area ACB) in the market.

Application - The Externality of SUV cars

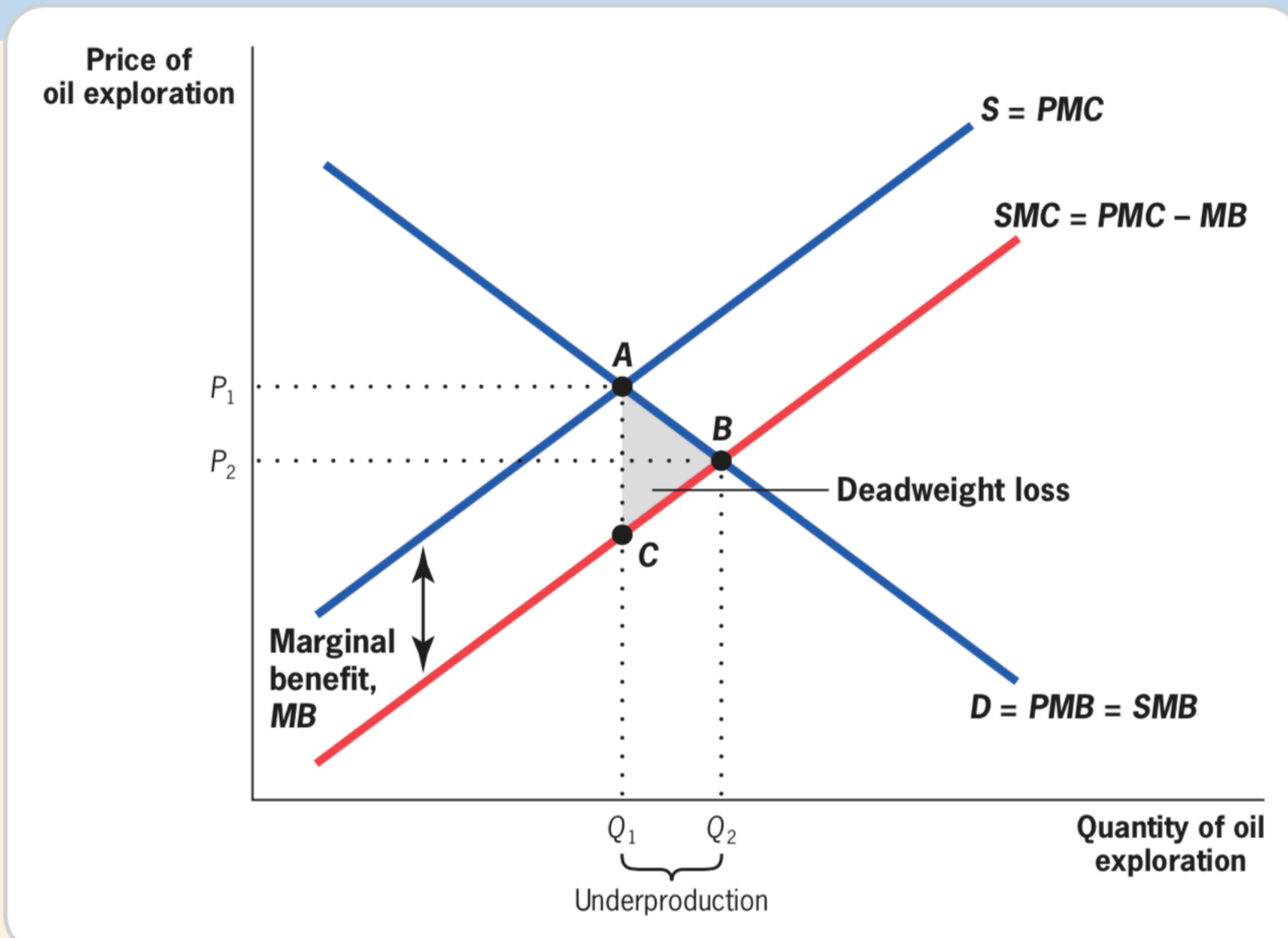
- Environmental Externalities - SUV drivers use more gas, increasing fossil fuel emissions.

- Wear and Tear on Roads - when individuals drive SUVs, they increase the cost to government of repairing the roads.

- Safety Externalities - One major appeal of SUVs is that they provide a feeling of security because they are so much larger than other cars on the road. Off-setting this feeling of security is the added insecurity imposed on other cars on the road.

Positive externalities

■ FIGURE 5-4



Market Failure Due to Positive Production Externality in the Oil Exploration Market • Expenditures on oil exploration by any company have a positive externality because they offer more profitable opportunities for other companies. This leads to a social marginal cost that is below the private marginal cost, and a social optimum quantity (Q_2) that is greater than the competitive market equilibrium quantity (Q_1). There is underproduction of $Q_2 - Q_1$, with an associated deadweight loss of area *ABC*.

Positive externalities

- positive production externality
  - When a firm's production increases the well-being of others but the firm is not compensated by those others.
  - the social marginal cost (SMC) is lower than the private marginal cost (PMC) if production has a positive effect on the future profits of other companies.
  - the private equilibrium in the market leads to underproduction relative to the socially optimal level
- positive consumption externality - when an individual's consumption increases the well-being of others but the individual is not compensated by those others.

Graphical analysis hints

- One confusing aspect of the graphical analysis of externalities is knowing which curve to shift, and in which direction. To review, there are four possibilities:

- Negative production externality: SMC curve lies above PMC curve.

- Positive production externality: SMC curve lies below PMC curve.

- Negative consumption externality: SMB curve lies below PMB curve.

- Positive consumption externality: SMB curve lies above PMB curve.

- Armed with these facts, the key is to assess which category a particular example fits into. This assessment is done in two steps. First, you must assess whether the externality is associated with producing a good or with consuming a good. Then, you must assess whether the externality is positive or negative.

Private-Sector solutions

- Ronald Coase: Why won't the market simply compensate the affected parties for externalities?

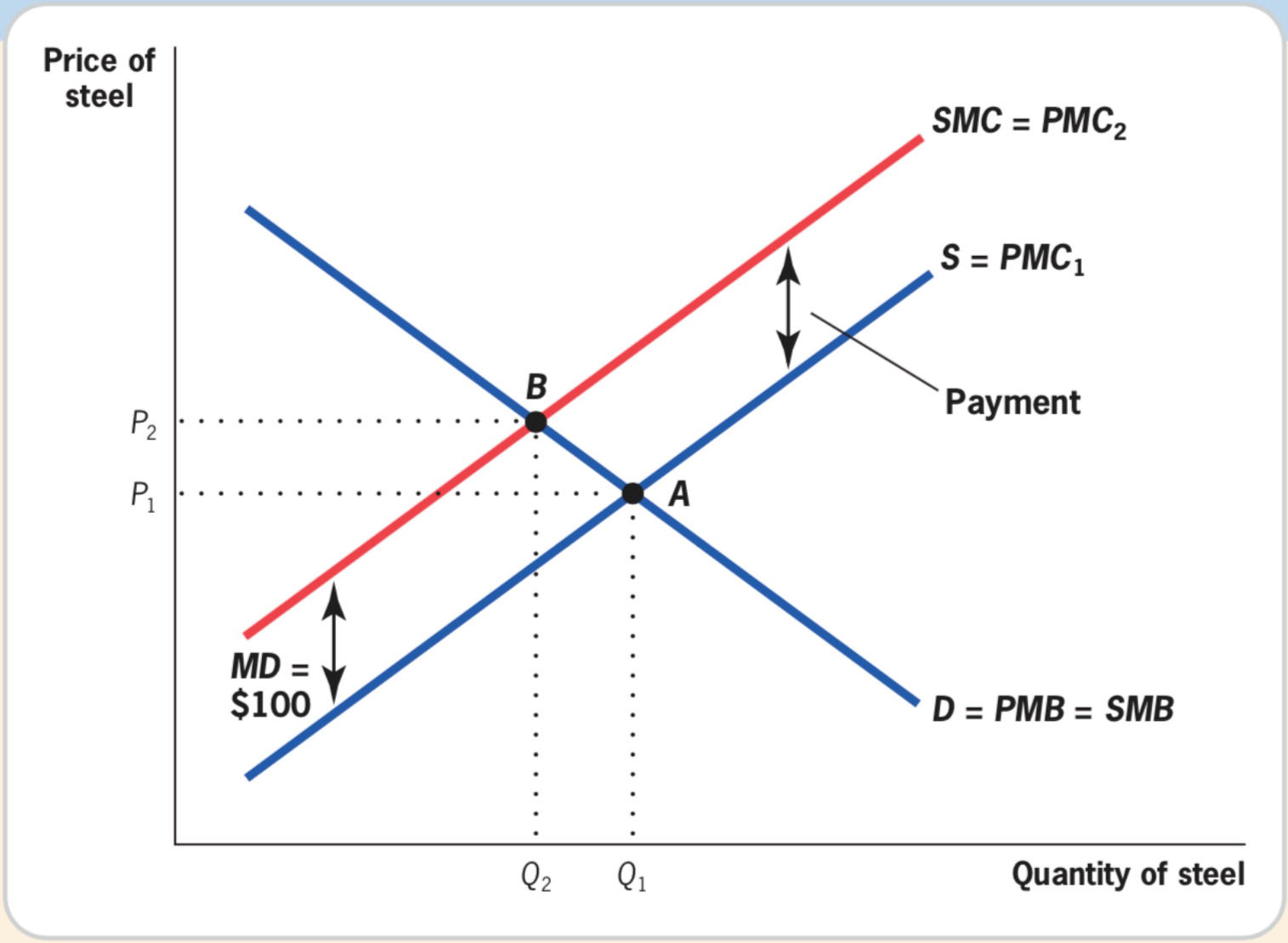
- Coase Theorem (Part I): When there are well-defined property rights and costless bargaining, then negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity.

- This theorem states that externalities do not necessarily create market failures, because negotiations between the parties can lead the offending producers (or consumers) to *internalize the externality,* or account for the external effects in their production (or consumption).

- **internalizing the externality =** When either private negotiations or government action lead the price to the party to fully reflect the external costs or benefits of that party's actions.

Internalizing the externality

■ FIGURE 5-5



A Coasian Solution to Negative Production Externalities in the Steel Market • If the fishermen charge the steel plant $100 per unit of steel produced, this increases the plant's private marginal cost curve from PMC_1 to PMC_2, which coincides with the *SMC* curve. The quantity produced falls from Q_1 to Q_2, the socially optimal level of production. The charge internalizes the externality and removes the inefficiency of the negative externality.

Property rights

- http://www.bazinganomics.com/bazinganomics?category=Externalities%20and%20Public

Property rights

- The Coase theorem suggests a very particular and limited role for the government in dealing with externalities: establishing property rights. In Coase's view, the fundamental limitation to implementing private-sector solutions to externalities is poorly established property rights. If the government can establish and enforce those property rights, then the private market will do the rest.

- The Coase theorem also has an important Part II: the efficient solution to an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights.

- Thus, if the property rights are assigned to those that are negatively affected, they will receive compensation from the externality producer, while if the producer is assigned the property rights, then those affected will compensate producer for restricting its production

Problems with Coasian solution

- The Assignment Problem - in many cases, it is impossible to assign blame for externalities to one specific entity. Also, it is complicated to assign damage.

- The Holdout Problem - can arise when the property rights in question are held by more than one party: shared ownership of property rights gives each owner power over all the others.

- The Free Rider Problem - when an investment has a personal cost but a common benefit, individuals will underinvest.

- Transaction Costs and Negotiating Problems - it is hard to negotiate when there are large numbers of individuals on one or both sides of the negotiation

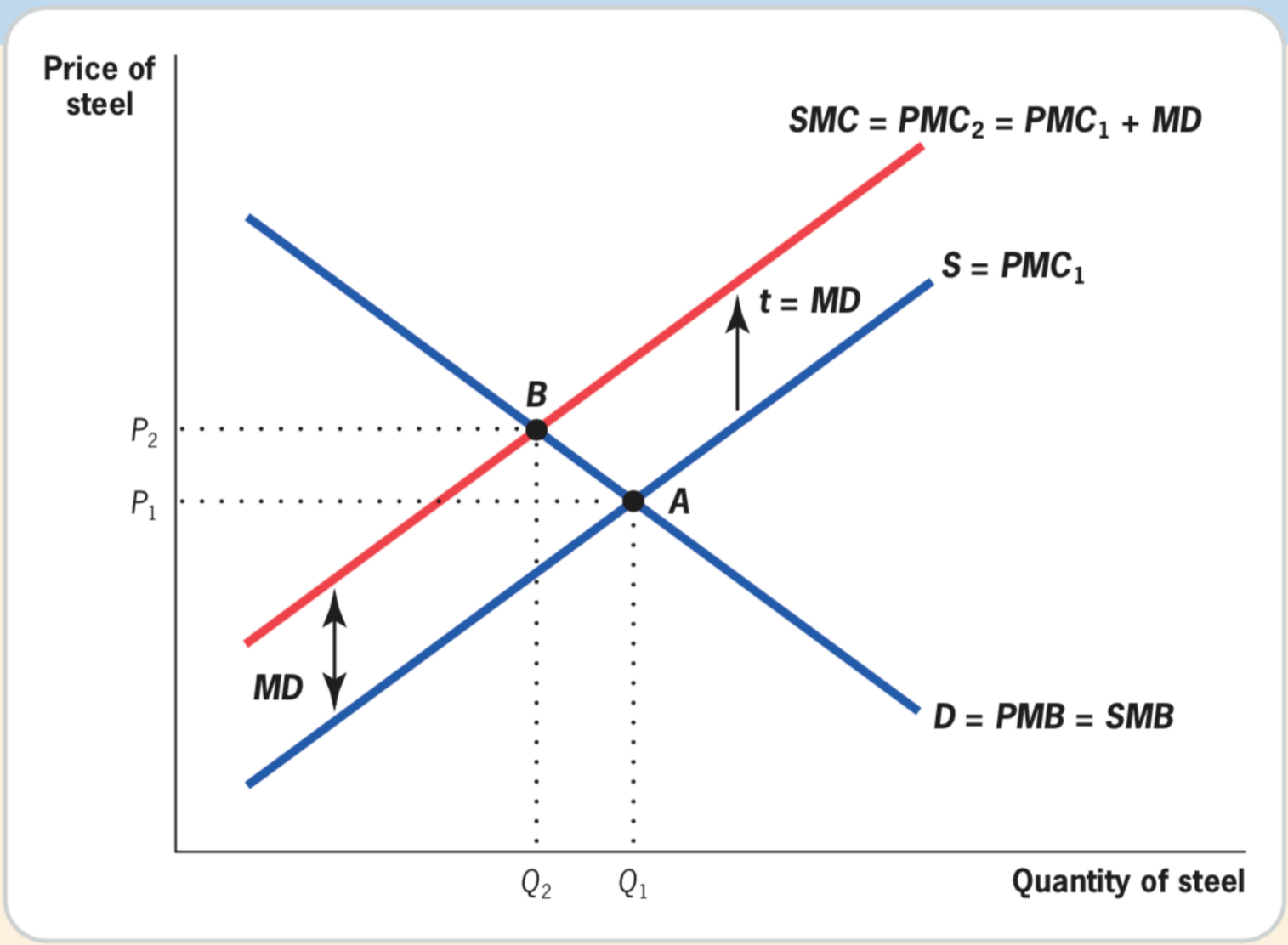
- Bottom Line - the market may be able to internalize some small-scale, localized externalities. However, for addressing larger externalities, the government intervention is needed.

Public-Sector Remedies for Externalities

- Price based
  - Corrective (Pigouvian) Taxation - the government can achieve the same outcome as the outcome of internalizing the negative externality in a straightforward way, by taxing the producer an amount *MD* for each unit produced.
  - Subsidies - government payment to an individual or firm that lowers the cost of consumption or production, respectively - form of internalizing positive externality
- Quantity based
  - Regulation - if the government knows where the socially optimal level of production is, it can mandate that production takes place at that level instead of incentivizing via taxes or subsidies. The effects of Pigouvian taxation and regulation (restriction in this case) are identical in theory.

Corrective taxation

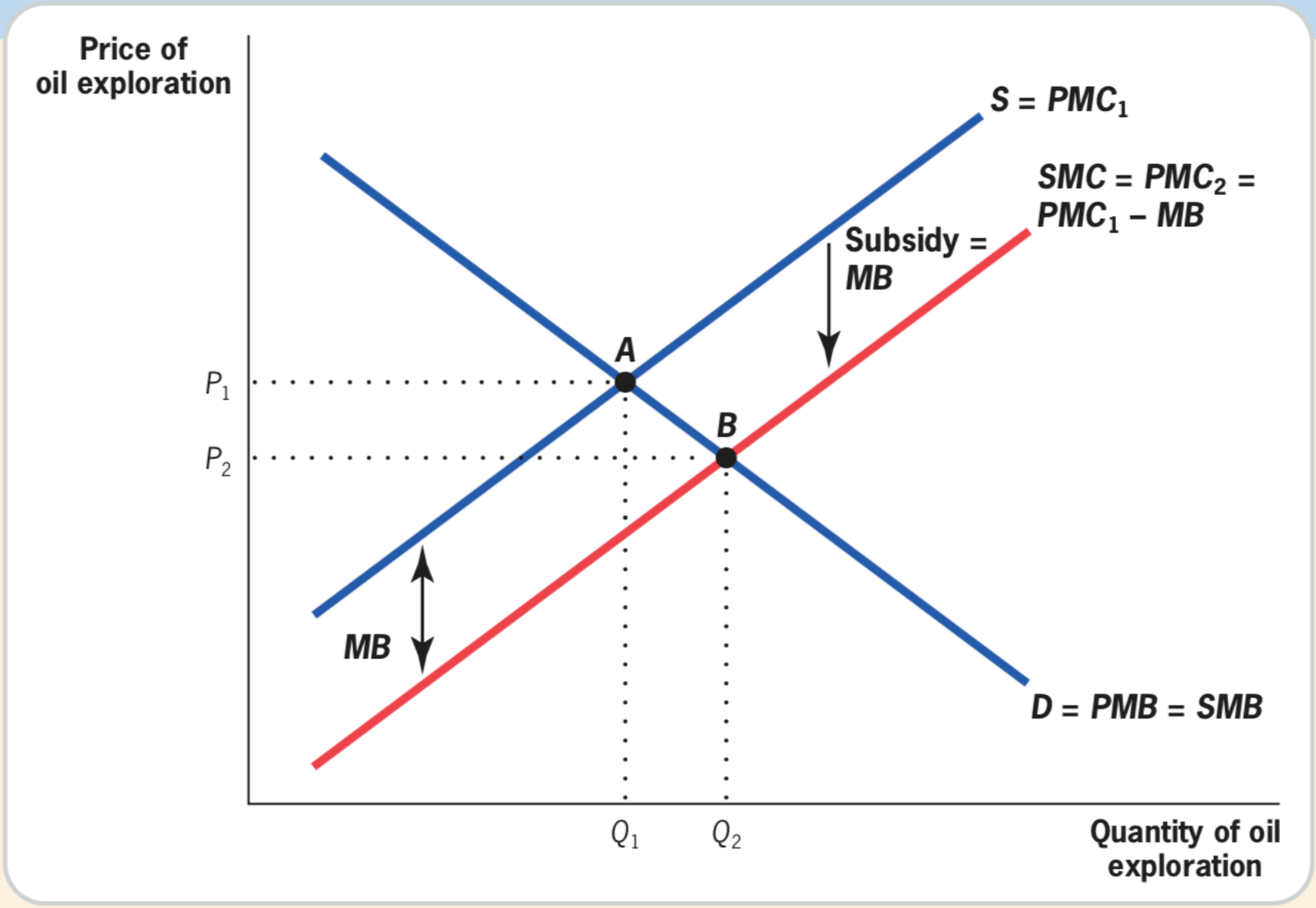
■ FIGURE 5-6



Taxation as a Solution to Negative Production Externalities in the Steel Market • A tax of $100 per unit (equal to the marginal damage of pollution) increases the firm's private marginal cost curve from PMC_1 to PMC_2, which coincides with the *SMC* curve. The quantity produced falls from Q_1 to Q_2, the socially optimal level of production. Just as with the Coasian payment, this tax internalizes the externality and removes the inefficiency of the negative externality.

Subsidies

■ FIGURE 5-7



Subsidies as a Solution to Positive Production Externalities in the Market for Oil Exploration • A subsidy that is equal to the marginal benefit from oil exploration reduces the oil producer's marginal cost curve from PMC_1 to PMC_2, which coincides with the *SMC* curve. The quantity produced rises from Q_1 to Q_2, the socially optimal level of production.

Price vs. Quantity Approaches to Addressing Externalities

- implications of intervention might differ between the use of price (taxation) and quantity (regulation) approaches to addressing externalities

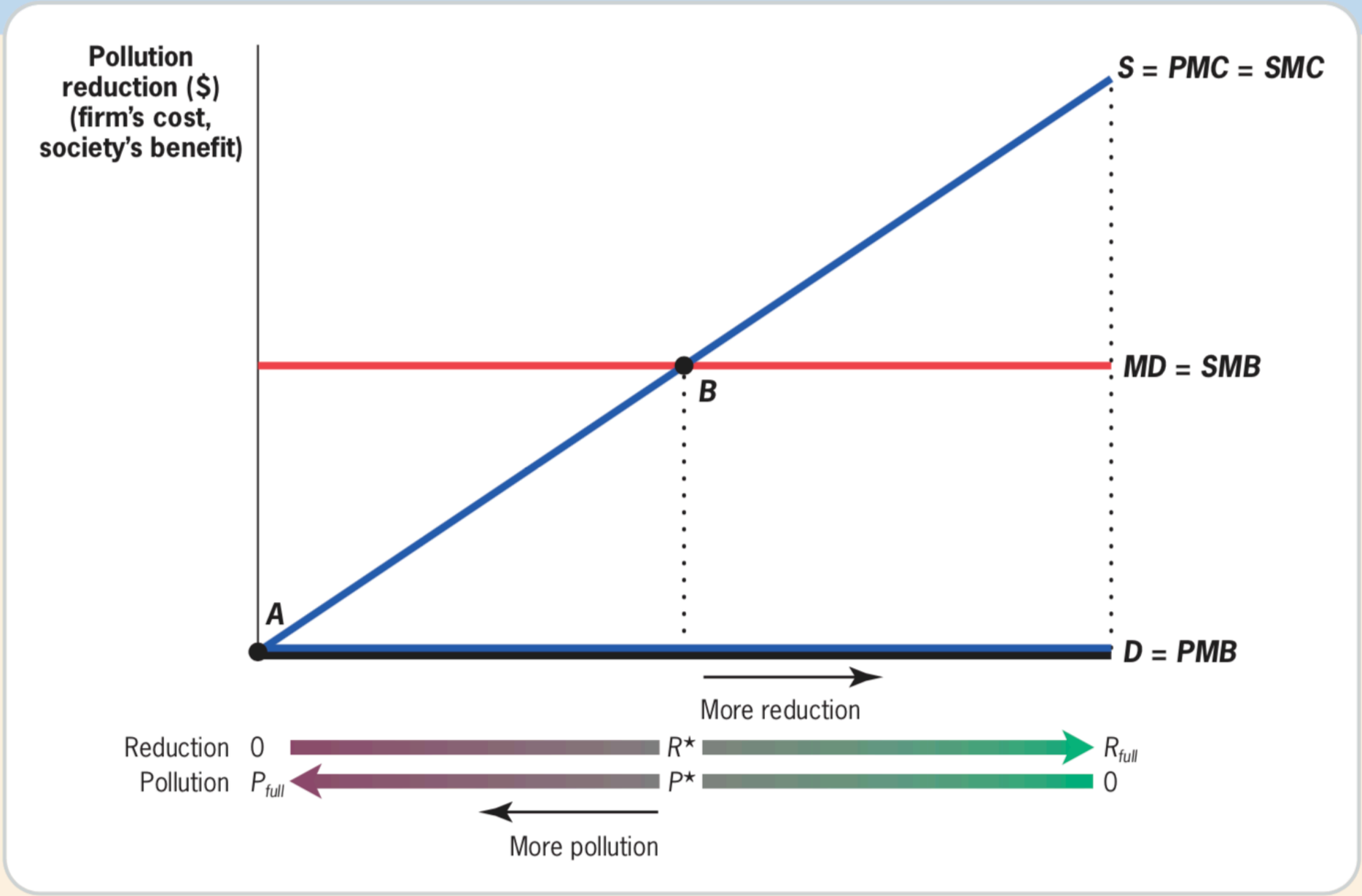
- The goal in comparing these approaches is to find the lowest-cost means of achieving the remedy.

- To understand the differences between price and quantity approaches to pollution reduction, it is useful to shift our focus from the market for a good to the “market” for pollution reduction. The MD curve represents the marginal damage that is averted by additional pollution reduction. This measures the social marginal benefit of pollution reduction. The PMC curve represents the plant’s private marginal cost of reducing pollution. The PMC curve slopes upward because of diminishing marginal productivity of this input.

- The free market outcome in any market would be zero pollution reduction. Since the cost of pollution is not borne by the plant, it has no incentive to reduce pollution.

- What is the optimal level of pollution reduction? The optimum is always found at the point at which social marginal benefits and costs are equal.

■ FIGURE 5-8



The Market for Pollution Reduction • The marginal cost of pollution reduction (*PMC* = *SMC*) is a rising function, while the marginal benefit of pollution reduction (*SMB*) is (by assumption) a flat marginal damage curve. Moving from left to right, the amount of pollution reduction increases, while the amount of pollution falls. The optimal level of pollution reduction is R^*, the point at which these curves intersect. Since pollution is the complement of reduction, the optimal amount of pollution is P^*.

Price vs. Quantity Approaches to Addressing Externalities

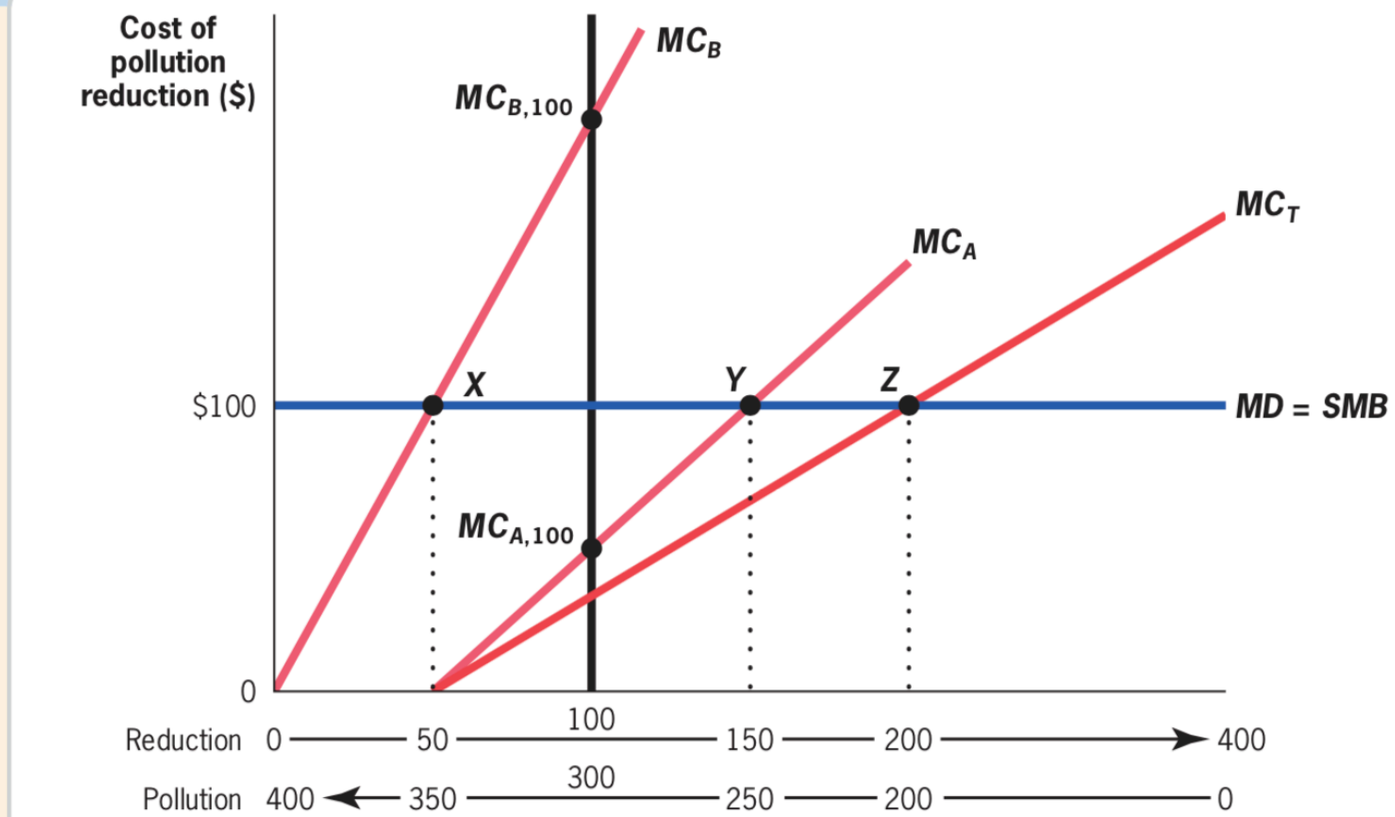
- The optimal tax, is equal to the marginal damage done by pollution. Consider the plant's decision under this tax. For each unit of pollution the plant makes, it pays a tax of $X. If there is any pollution reduction that the plant can do that costs less than $X, it will be cost-effective to make that reduction: the plant will pay some amount less than $X to get rid of the pollution, and avoid paying a tax of $X. With this plan in place, plants will have an incentive to reduce pollution up to the point at which the cost of that reduction is equal to the tax of $X.

- Regulation is even more straightforward to analyze. The government simply mandates that the plant reduce pollution by an amount of the optimal pollution level. Regulation seems more difficult than taxation because, in this case, the government needs to know not only MD but also the shape of the MC curve as well.

- This difficulty is, however, just a feature of our assumption of constant MD; for the more general case of a falling MD, the government needs to know the shapes of both MC and MD curves in order to set either the optimal tax or the optimal regulation.

Multiple Plants with Different Reduction Costs

■ FIGURE 5-9



Pollution Reduction with Multiple Firms • Plant *A* has a lower marginal cost of pollution reduction at each level of reduction than does plant *B*. The optimal level of reduction for the market is the point at which the sum of marginal costs equals marginal damage (at point *Z*, with a reduction of 200 units). An equal reduction of 100 units for each plant is inefficient since the marginal cost to plant *B* (MC_B) is so much higher than the marginal cost to plant *A* (MC_A). The optimal division of this reduction is where each plant's marginal cost is equal to the social marginal benefit (which is equal to marginal damage). This occurs when plant *A* reduces by 150 units and plant *B* reduces by 50 units, at a marginal cost to each of $100.

Multiple Plants with Different Reduction Costs

- Suppose there are now two plants causing pollution and that technology is available to reduce pollution associated with production, but this technology has is cheaper for plant A than for plant B.

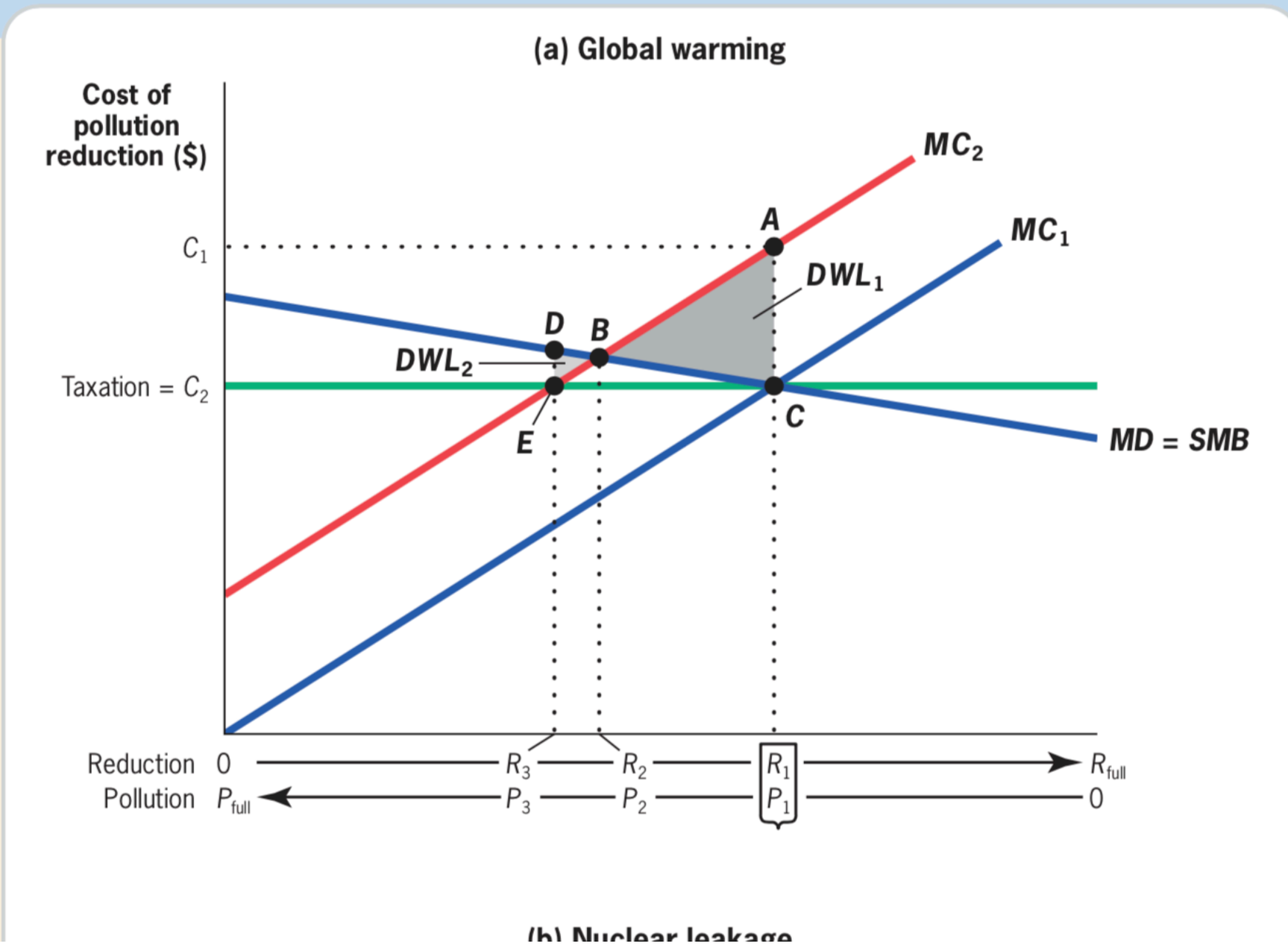
- Policy Option 1: Quantity Regulation - the government can demand a total reduction of X units of pollution from the market. The typical regulatory solution to this problem in the past was to ask the plants to split the bur- den: each plant reduces pollution by X/2 units. This is not an efficient solution, however, because it ignores the fact that the plants have different marginal costs of pollution reduction.

- Policy Option 2: Price Regulation Through a Corrective Tax - Pigouvian taxes cause efficient production by raising the cost of the input by the size. of its external damage, thereby raising private marginal costs to social marginal costs.

- Policy Option 3: Quantity Regulation with Tradable Permits - Does this mean that taxes always dominate quantity regulation with multiple plants? Not necessarily. Quantity regulation can be rescued, by adding a key flexibility: issue permits that allow a certain amount of pollution and let the plants trade - effectively internalizing the externality by providing property rights to pollution.

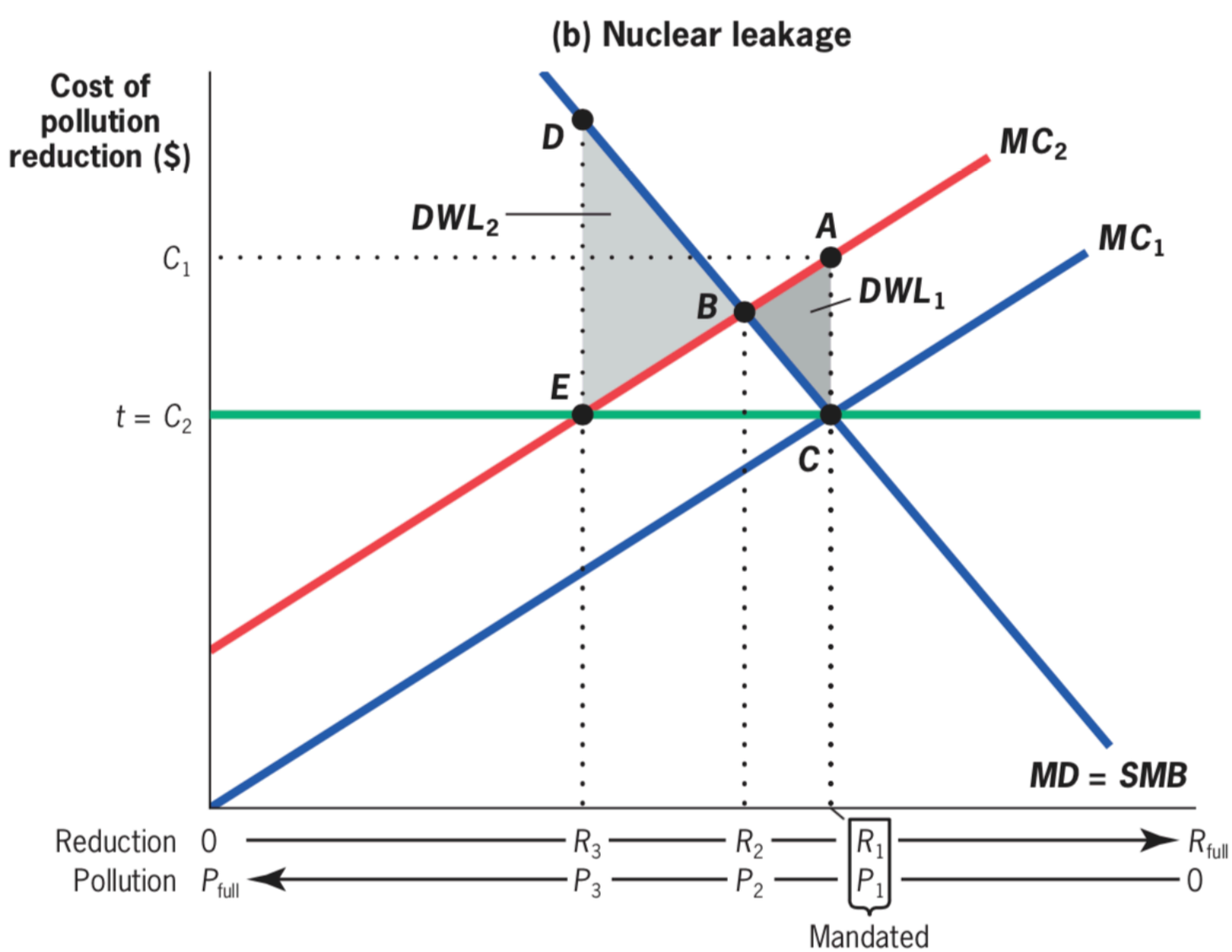
Uncertainty about cost of reduction

■ FIGURE 5-10



Market for Pollution Reduction with Uncertain Costs • In the case of global warming (panel (a)), the marginal damage is fairly constant over large ranges of emissions (and thus emission reductions). If costs are uncertain, then taxation at level $t = C_2$ leads to a much lower deadweight loss (*DBE*) than does regulation of R_1 (*ABC*). In the case of nuclear leakage (panel (b)), the marginal damage is very steep. If costs are uncertain, then taxation leads to a much larger deadweight loss (*DBE*) than does regulation (*ABC*).

Uncertainty about cost of reduction



(ABC).

Uncertainty about cost of reduction

- Differences in reduction costs across firms are not the only reason that taxes or regulation might be preferred.Another reason is that the costs or benefits of regulation could be uncertain.

- Imagine that we don't know the true costs of pollution reduction on the part of firms or individuals.The government's best guess is that the true marginal cost of pollution reduction is represented by curve MC1 in both panels.There is a chance, however, that the marginal cost of pollution reduction could be much higher, as represented by the curve MC2.

- The central intuition here is that the instrument choice depends on whether the government wants to get the amount of pollution reduction right or whether it wants to minimize costs. Quantity regulation assures there is as much reduction as desired, regardless of the cost. So, if it is critical to get the amount exactly right, quantity regulation is the best way to go.

- Price regulation through taxes, on the other hand, assures that the cost of reductions never exceeds the level of the tax, but leaves the amount of reduction uncertain.That is, firms will never reduce pollution beyond the point at which reductions cost more than the tax they must pay (the point at which the tax intersects their true marginal cost curve, MC2). If marginal costs turn out to be higher than anticipated, then firms will just do less pollution reduction.

- If the value of getting the environmental protection close to right is high, then quantity regulations will be preferred; but if getting the protection close to right is not so important, then price regulations are a preferred option.

- Firms A and B each produce 80 units of pollution. The federal government wants to reduce pollution levels.The marginal costs associated with pollution reduction are:
- MCA = 50 + 3QA for firm A
- MCB = 20 + 6QB for firm B
  - where QA and QB are the quantities of pollution reduced by each firm.
- Society's marginal benefit from pollution reduction is given by MB = 590 - 3QT, where QT is the total reduction in pollution.
- 1) What is the socially optimal level of each firm's pollution reduction?
- 2) How much total pollution is there in the social optimum?
- 3) Explain why it is inefficient to give each firm an equal number of pollution permits (if they are not allowed to trade them).
- 4) Explain how the social optimum can be achieved if firms are given equal numbers of pollution permits but are allowed to trade them.
- 5) Can the social optimum be achieved using a tax on pollution?