Lecture 7: Externalities

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OUTLINE

Second part of course is going to cover market failures and show how government interventions can help

1) Externalities and public goods

2) Asymmetric information (social insurance)

3) Individual failures (savings for retirement)

EXTERNALITIES

Market failure: A problem that violates one of the assumptions of the 1st welfare theorem and causes the market economy to deliver an outcome that does not maximize efficiency

Externality: Externalities arise whenever the actions of one economic agent **directly** affect another economic agent outside the market mechanism

Externality example: a steel plant that pollutes a river used for recreation

Not an externality example: a steel plant uses more electricity and bids up the price of electricity for other electricity customers

Externalities are one important case of market failure

EXTERNALITY THEORY: ECONOMICS OF NEGATIVE PRODUCTION EXTERNALITIES

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

Private marginal cost (PMC): The direct cost to producers of producing an additional unit of a good

Marginal Damage (MD): Any additional costs associated with the production of the good that are imposed on others but that producers do not pay

Social marginal cost (SMC = PMC + MD): The private marginal cost to producers plus marginal damage

Example: steel plant pollutes a river but plant does not face any pollution regulation (and hence ignores pollution when deciding how much to produce)

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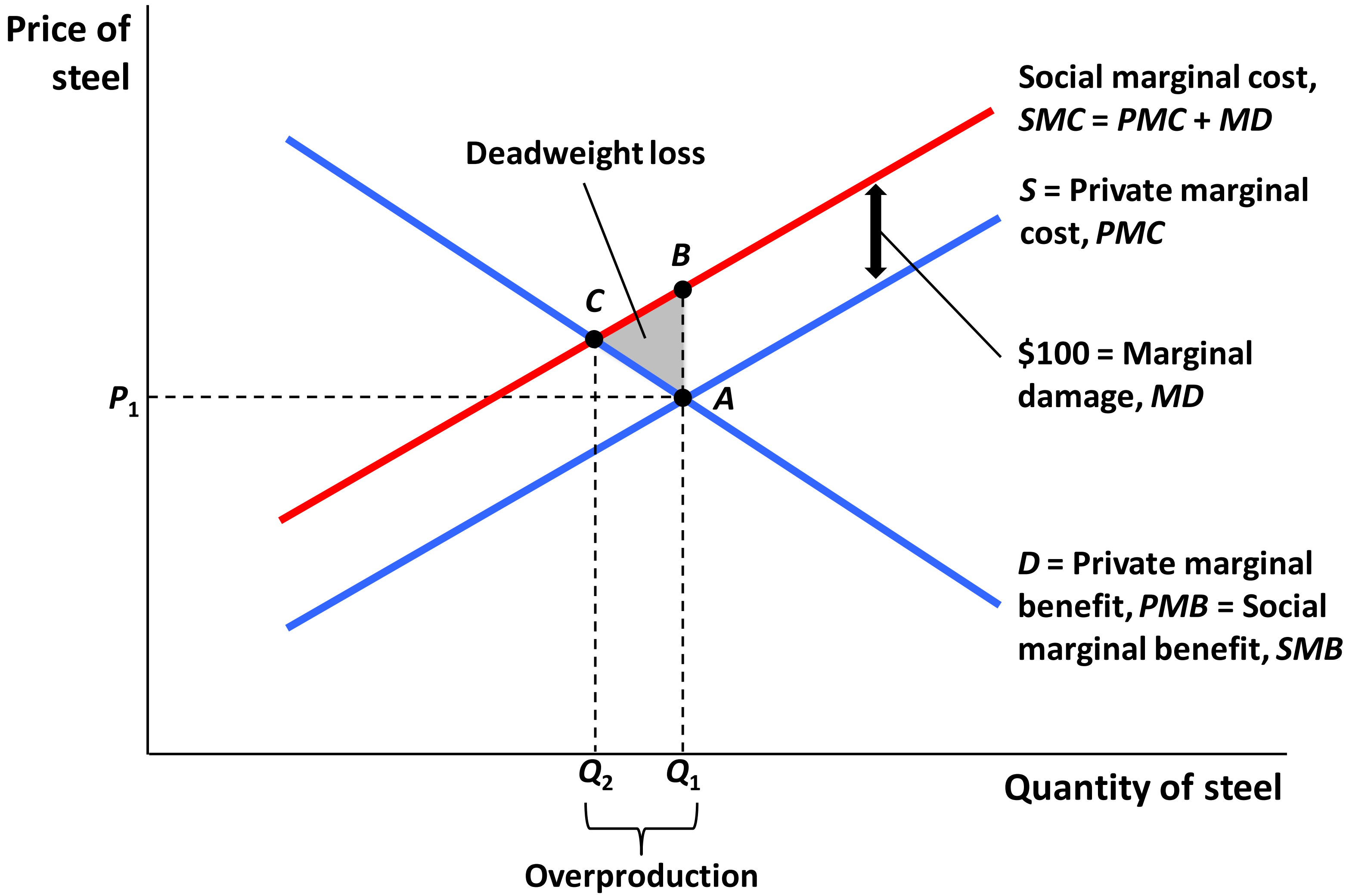
Economics of Negative Production Externalities: Steel Production



EXTERNALITY THEORY: ECONOMICS OF NEGATIVE CONSUMPTION EXTERNALITIES

Negative consumption externality: When an individual's consumption reduces the well-being of others who are not compensated by the individual.

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 plus any costs associated with the consumption of the good that are imposed on others

Example: Using a car and emitting carbon contributing to global warming

5.1

APPLICATION: The Externality of SUVs

The consumption of large cars such as SUVs produces three types of negative externalities:

1. Environmental externalities: Compact cars get 25 miles/gallon, but SUVs get only 20.
2. Wear and tear on roads: Larger cars wear down the roads more.
3. Safety externalities: The odds of having a fatal accident quadruple if the accident is with a typical SUV and not with a car of the same size.

Externality Theory: 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.

Example: Beehives of honey producers have a positive impact on pollination and agricultural output

Positive consumption externality: When an individual's consumption increases the well-being of others but the individual is not compensated by those others.

Example: Beautiful private garden that passers-by enjoy seeing

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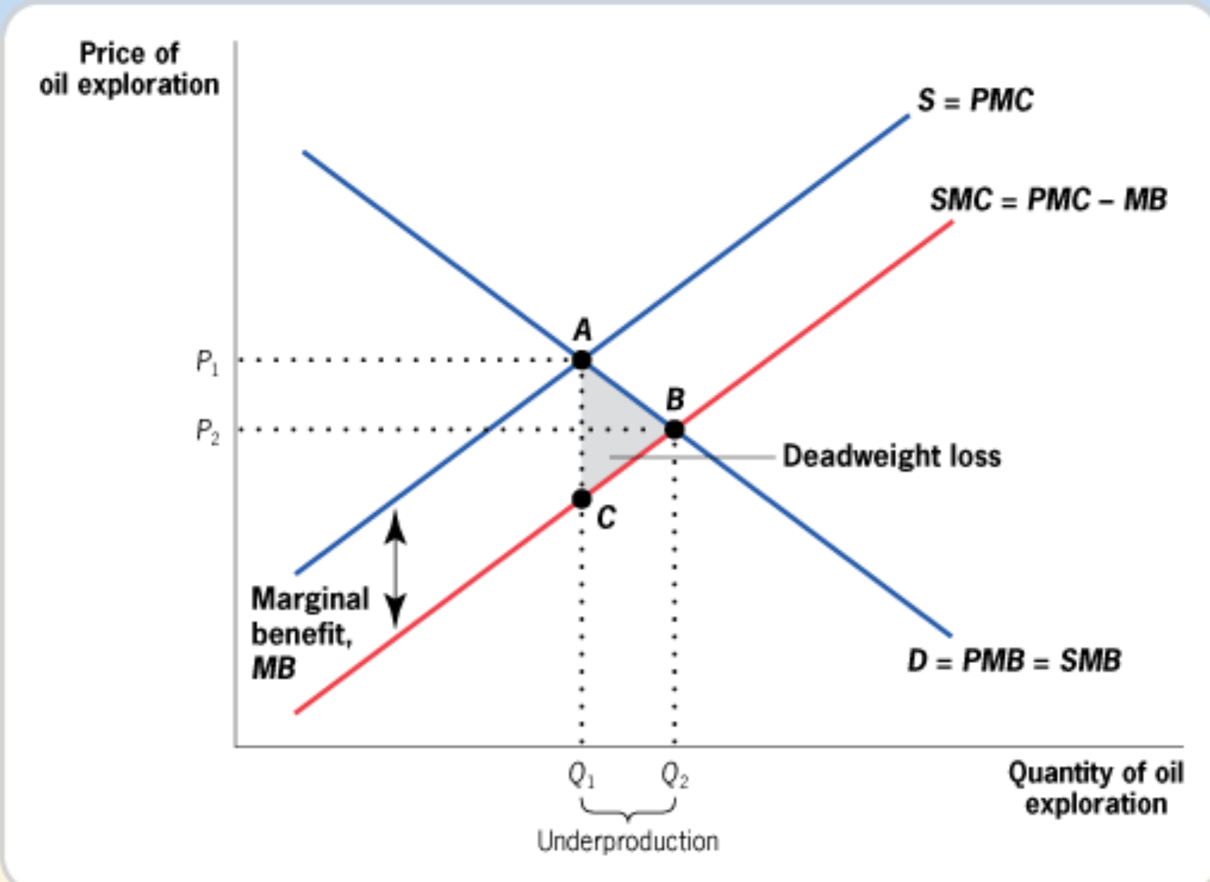
Externality Theory

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*.

Externality Theory: Market Outcome is Inefficient

With a free market, quantity and price are such that $PMB = PMC$

Social optimum is such that $SMB = SMC$

$\Rightarrow$ Private market leads to an inefficient outcome (1st welfare theorem does not work)

Negative production externalities $\rightarrow$ over production (SMC curve above PMC curve)

Positive production externalities $\rightarrow$ under production (SMC curve below PMC curve)

Negative consumption externalities $\rightarrow$ over consumption (SMB curve lies below PMB curve)

Positive consumption externalities: $\rightarrow$ under consumption (SMB curve lies above PMB curve)

Private-Sector Solutions to Negative Externalities

Key question raised by Ronald Coase (famous Nobel Prize winner Chicago libertarian economist):

Are externalities really outside the market mechanism?

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.

PRIVATE-SECTOR SOLUTIONS TO NEGATIVE EXTERNALITIES: COASE THEOREM

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.

Coase Theorem (Part II): The efficient quantity for a good producing an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights.

COASE THEOREM EXAMPLE

Firms producing steel pollute a river enjoyed by swimmers. If the firms ignore swimmers, there is too much pollution

1) Swimmers own river: If river is owned by swimmers, then swimmers can charge firms for polluting the river. They will charge firms the marginal damage (MD) per unit of pollution. (Shifts up the PMC of the firm to the level of SMC).

Why price pollution at MD? If price is above MD, swimmers would want to sell an extra unit of pollution and get hit by pollution damage MD, so price must fall. MD is the equilibrium efficient price in the newly created pollution market.

2) Firms own river: If river is owned by firms, then swimmers are willing to pay firms MD for each unit of steel it does NOT produce. This increases the firms' cost of producing each unit of steel. Their cost shifts from PMC to SMC = PMC + MD for each quantity of steel produced.

Final level of pollution will be the same in 1) and 2)

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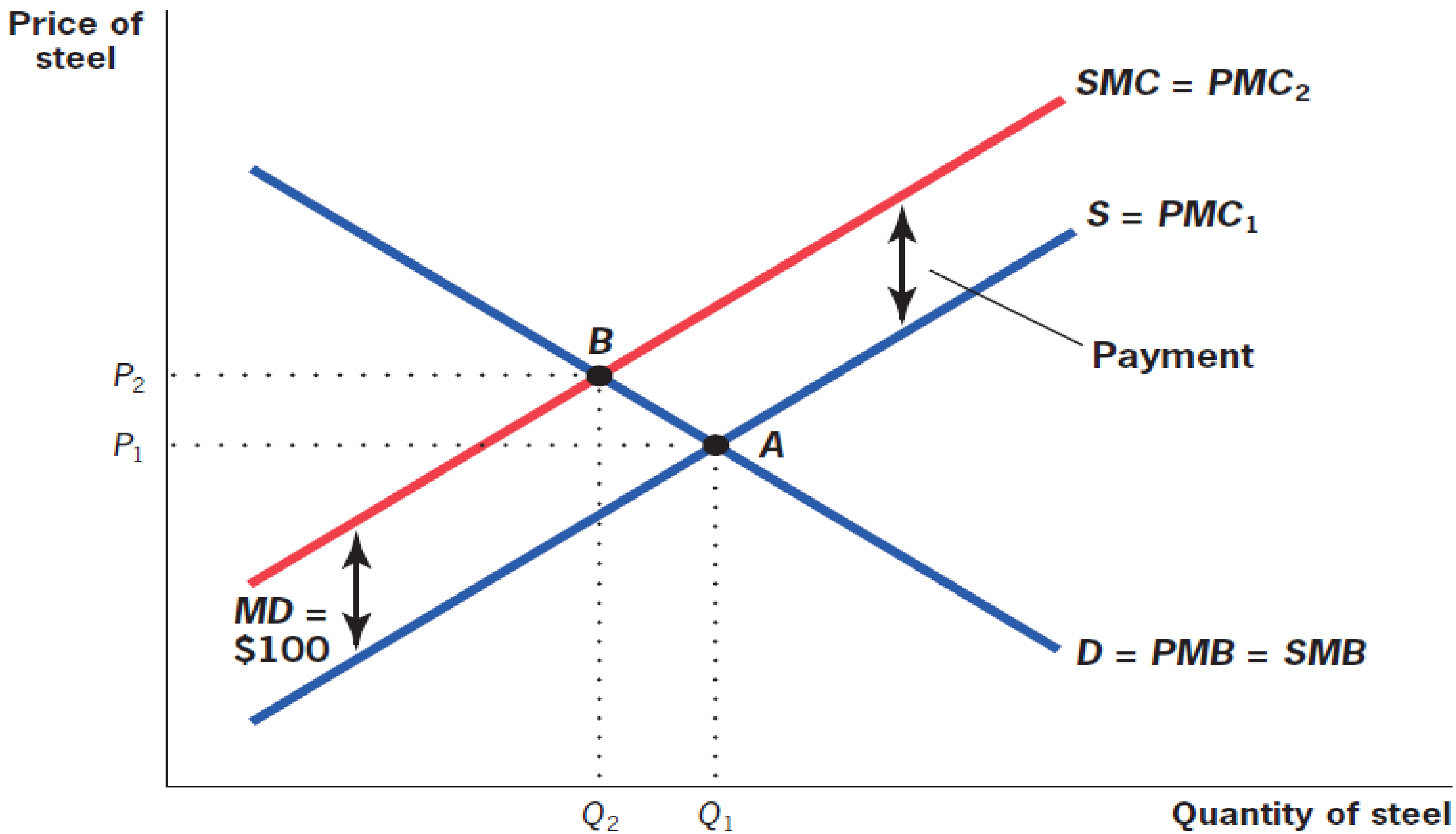
The Solution: Coasian Payments



PROBLEMS WITH THE COASIAN SOLUTION

In practice, the Coase theorem is unlikely to solve many of the types of externalities that cause market failures.

1) The assignment problem: Can you assign blame to one single entity (e.g., a long river with many polluting firms); can you assign the exact damage (how is MD really measured?); who gets the property rights? In cases where externalities are caused by and affected many agents (e.g. global warming), assigning property rights is difficult

$\Rightarrow$ Coasian solutions are likely to be more effective for small, localized externalities than for larger, more global externalities involving large number of people and firms

PROBLEMS WITH THE COASIAN SOLUTION (II)

2) The holdout problem: Shared ownership of property rights gives each owner power over all the others (because joint owners have to all agree to the Coasian solution).

Imagine the swimmers who own property rights for a clean river. After 99 swimmers have agreed to receive their compensation from the firm, the 100th swimmer has an incentive to ask for more (to hold out). Anticipating this, all swimmers should try to hold out.

$\Rightarrow$ As with the assignment problem, the holdout problem would be amplified with an externality involving many parties.

PROBLEMS WITH THE COASIAN SOLUTION (III)

3) The Free Rider Problem: When an investment has a personal cost but a common benefit, individuals will underinvest.

In the swimmers' example, if property rights are assigned to the firm, the 100th swimmer has no incentive to pay for their share of pollution reduction, as the pollution is almost at socially optimal level and the damage caused by the last unit of pollution that they have to pay for is shared among all swimmers.

PROBLEMS WITH THE COASIAN SOLUTION (IV)

4) Transaction Costs and Negotiating Problems: The Coasian approach ignores the fundamental problem that it is hard to negotiate when there are large numbers of individuals on one or both sides of the negotiation.

This problem is amplified for an externality such as global warming, where the potentially divergent interests of billions of parties on one side must be somehow aggregated for a negotiation.

PROBLEMS WITH COASIAN SOLUTION: BOTTOM LINE

Ronald Coase's insight that externalities can sometimes be internalized was useful.

It provides the competitive market model with a defense against the onslaught of market failures.

It is also an excellent reason to suspect that the market may be able to internalize some small-scale, localized externalities.

It won't help with large-scale, global externalities, where only a "government" can successfully aggregate the interests of all individuals suffering from externality

Public Sector Remedies For Externalities

Public policy makers employ two types of remedies to resolve the problems associated with negative externalities:

1) quantity regulation: government limits use of externality producing chemicals. Example CFCs [chlorofluorocarbons] that deplete ozone layer

2) corrective taxation: corrective tax or subsidy equal to marginal damage per unit. Example: Carbon tax to fight global warming due to CO2 emissions

1) and 2) can be combined with **tradable emissions permits** to firms that can then be traded (cap-and-trade for carbon emissions)

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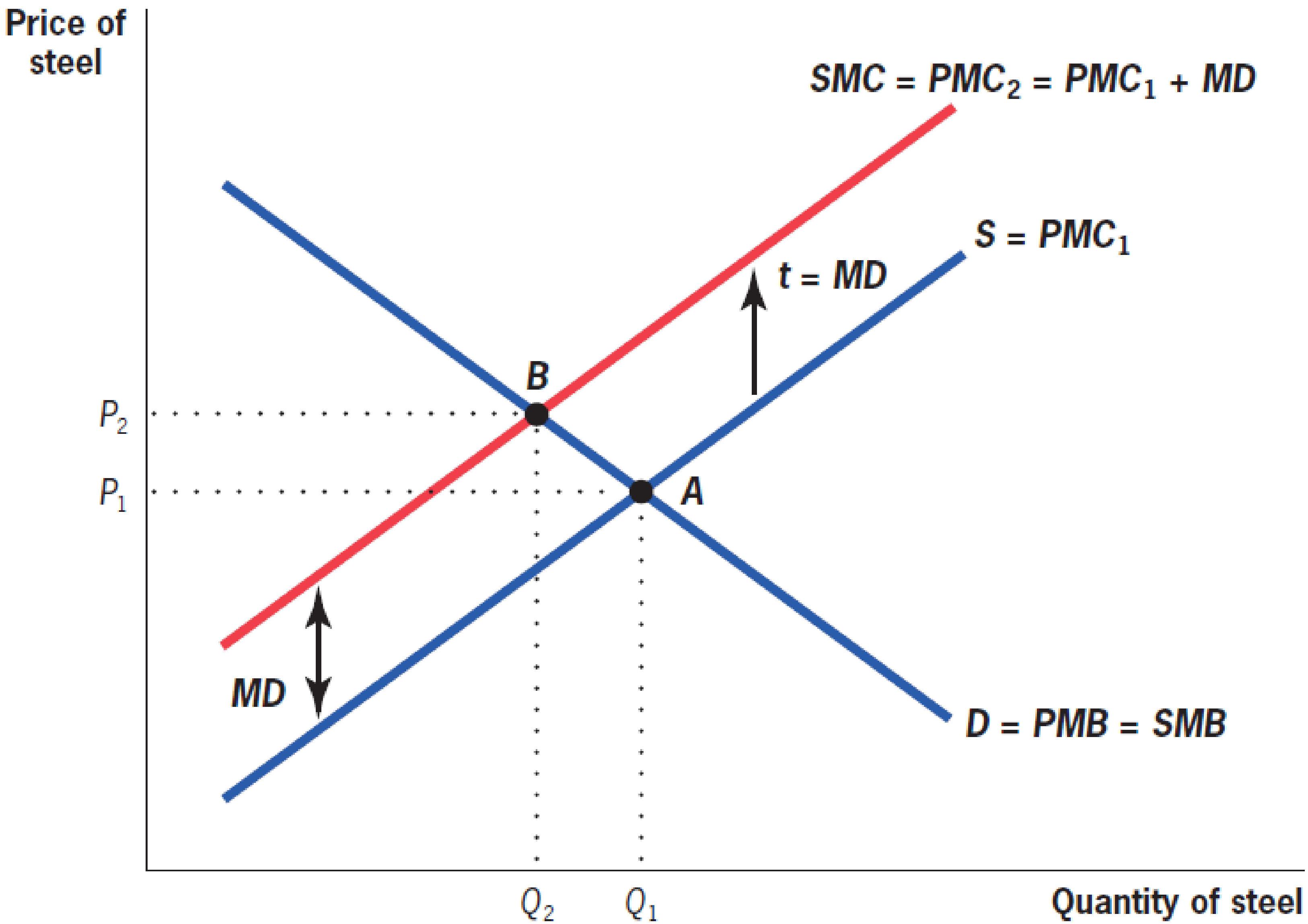
Corrective Taxation



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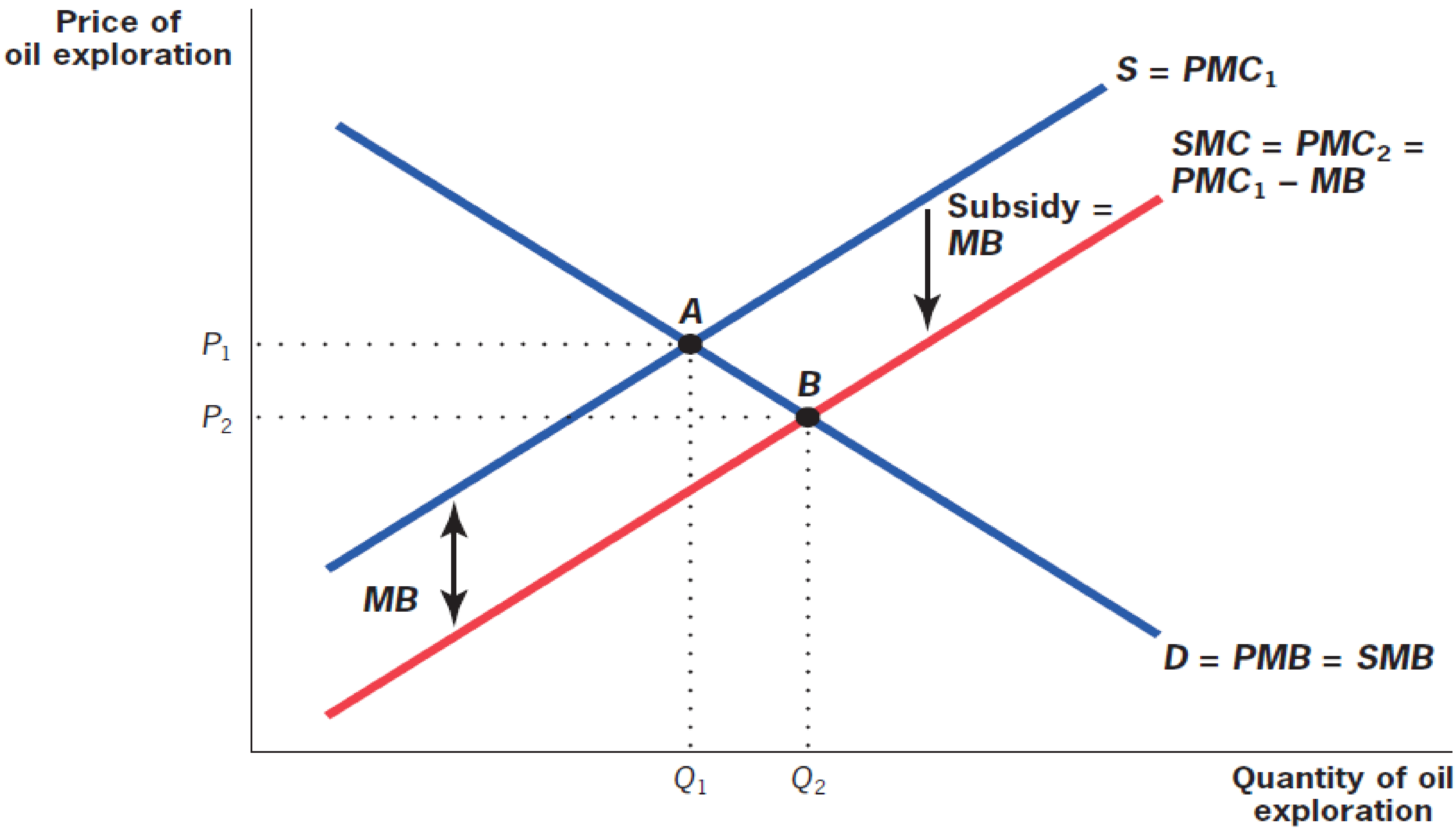
Corrective Subsidies



UNDERSTANDING DIFFERENCE BETWEEN TAX AND QUANTITY REGULATION (I)

To understand the differences between price and quantity approaches to pollution reduction, shift focus from the market for a good (e.g., steel) to the "market" for pollution reduction (see next slide).

Pollution reduction can happen in many ways, other than reducing quantity of the good produced (abatement technologies, changing production technology).

Horizontal axis measures extent of *pollution reduction* undertaken by a plant; a value of zero indicates that the plant is not engaging in any pollution reduction.

Axis also measures amount of pollution: more pollution reduction and less pollution as you move to the right.

UNDERSTANDING DIFFERENCE BETWEEN TAX AND QUANTITY REGULATION (II)

Vertical axis represents cost of pollution reduction to the plant, or the benefit of pollution reduction to society. MD curve represents the marginal damage that is averted by addition-al pollution reduction = the social marginal benefit of pollution reduction (drawn flat here)

Private marginal benefit of pollution reduction is zero.

PMC curve represents plant's private marginal cost of reducing pollution: slopes upward because each additional unit of reduction become more expensive, until it is incredibly expensive to have a completely pollution-free production process. PMC = SMC since pollution reduction causes no externality.

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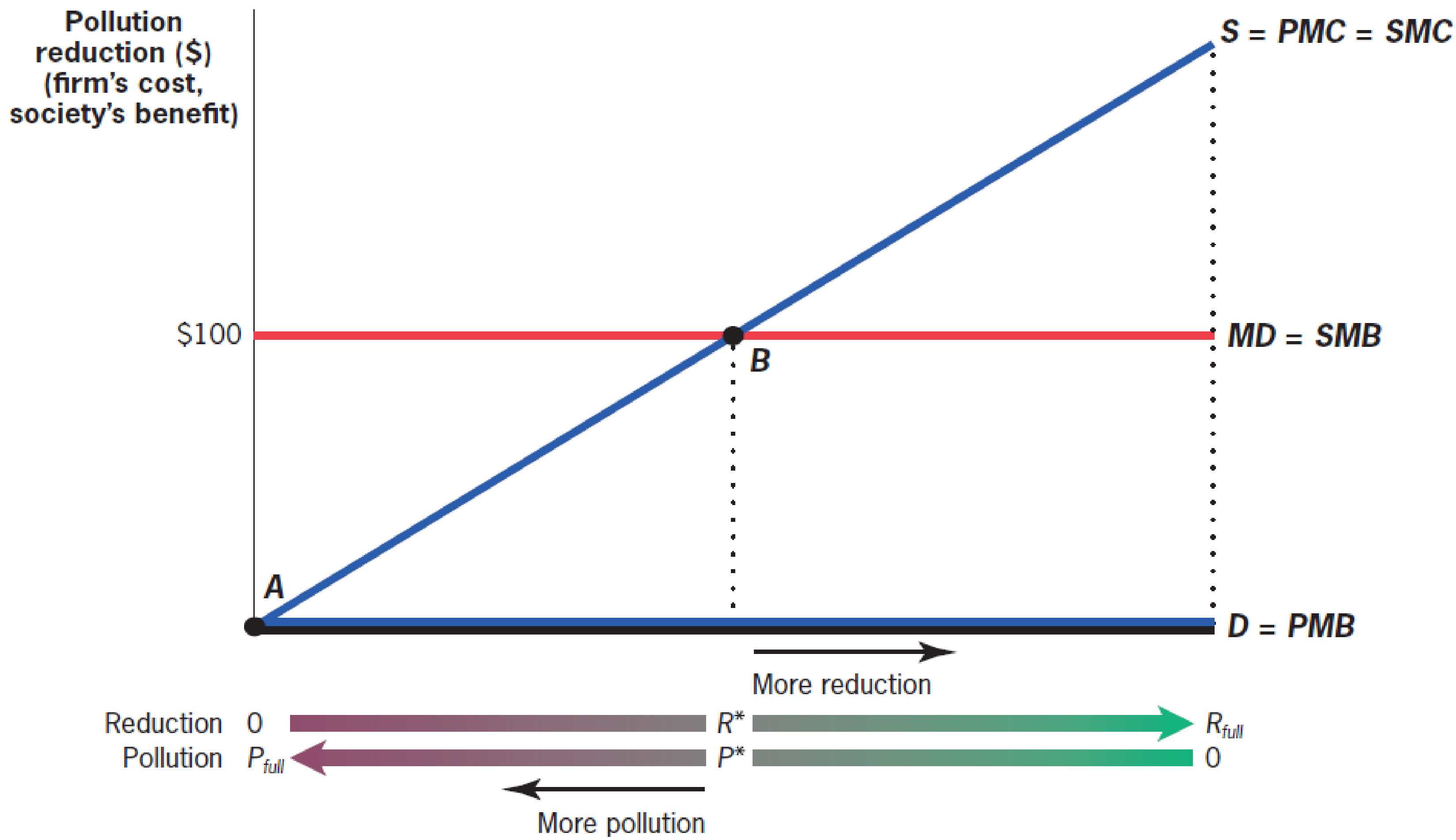
Distinctions Between Price and Quantity Approaches to Addressing Externalities: Basic Model



IN THIS SIMPLE MODEL, TAX AND QUANTITY REGULATION ARE EQUIVALENT

Can impose a tax per unit of pollution of $\$100$ or can mandate the quantity of reduction to be R^* (or the amount of pollution to be P^*) on the slide above.

But what happens if we do not know the firms' costs of abating pollution?

FIRST, IMAGINE THE MD CURVE IS QUITE FLAT

Example: global warming. What does it mean to have a flat MD curve? It means the exact amount of pollution does not matter that much for the damage it causes.

Imagine costs could be either MC_1 or MC_2. If the government thinks costs are MC_1, it should impose a tax $t = C_2$, such that the curve MC_1 and the line $t = C_2$ intersect exactly where the MC_1 and MD curves intersect.

Alternatively, if the government decided to impose a quantity regulation, it would impose pollution levels P_1, or reduction levels R_1.

But suppose now that the firm turns out to have costs MC_2. The DWL from the tax is triangle BDE. The DWL from the quantity regulation is ABC. The loss from the quantity regulation is larger when the MD curve is flat. The firm is forced to abate too much pollution, which is too costly.

Intuition: if it's not critical to get the quantity exactly right, it's better to let the firm choose the quantity (since it knows its costs) and impose a tax.

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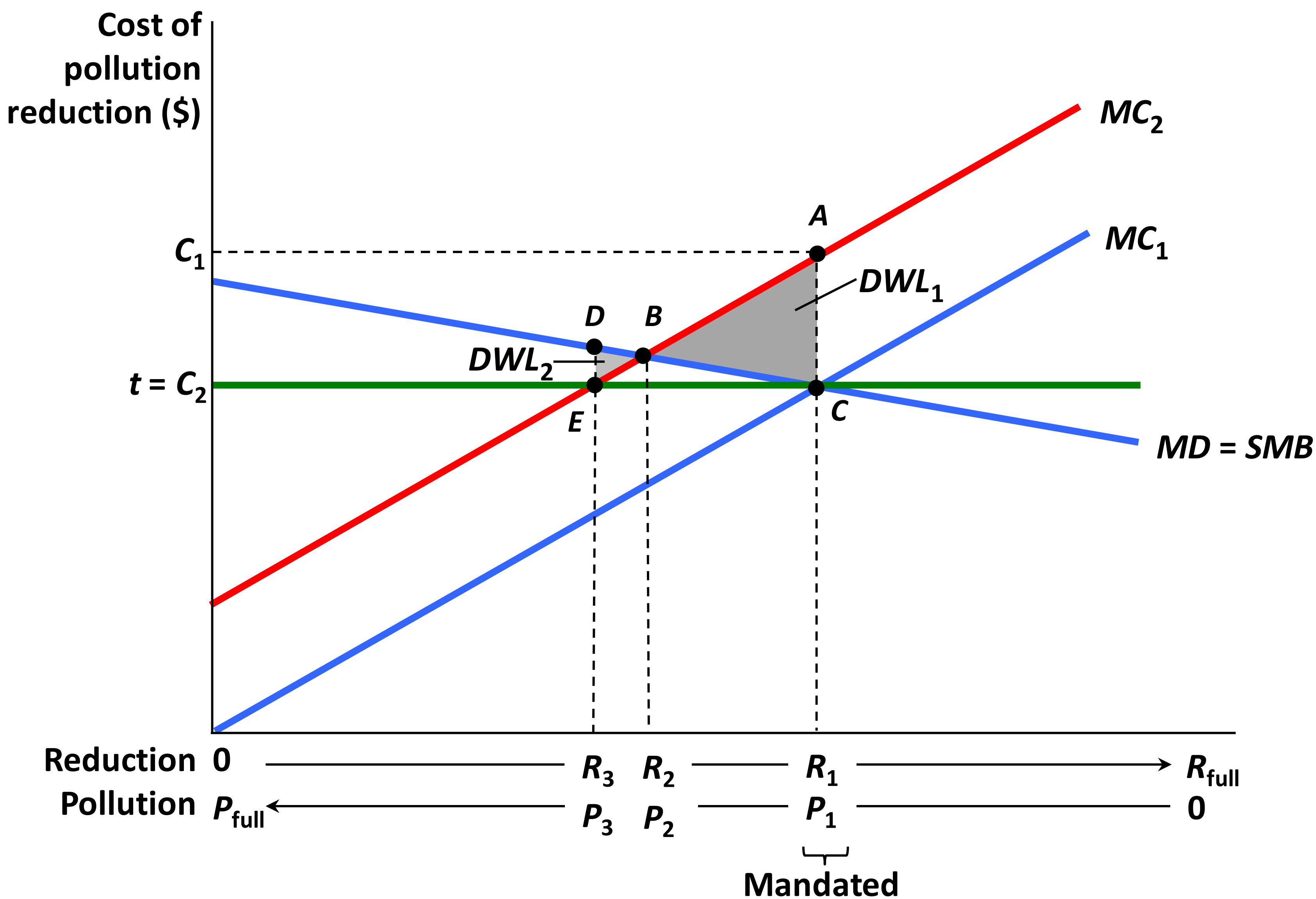
Uncertainty About Costs of Reduction: Case 1: Flat *MD* Curve (Global Warming)



NEXT, IMAGINE THE MD CURVE IS QUITE STEEP

Example: Nuclear leakage. Each additional unit of pollution could cost many lives.

Going through the same steps, suppose the government imposes a tax or a quantity regulation, thinking that the cost is M_1, but the cost turns out to be MC_2.

The DWL from the tax (BDE) is much larger than the DWL from the quantity regulation (ABC).

Intuition: In this case, it is critical to get the quantity right. Even if we make the firm abate too much or too little relative to its costs.

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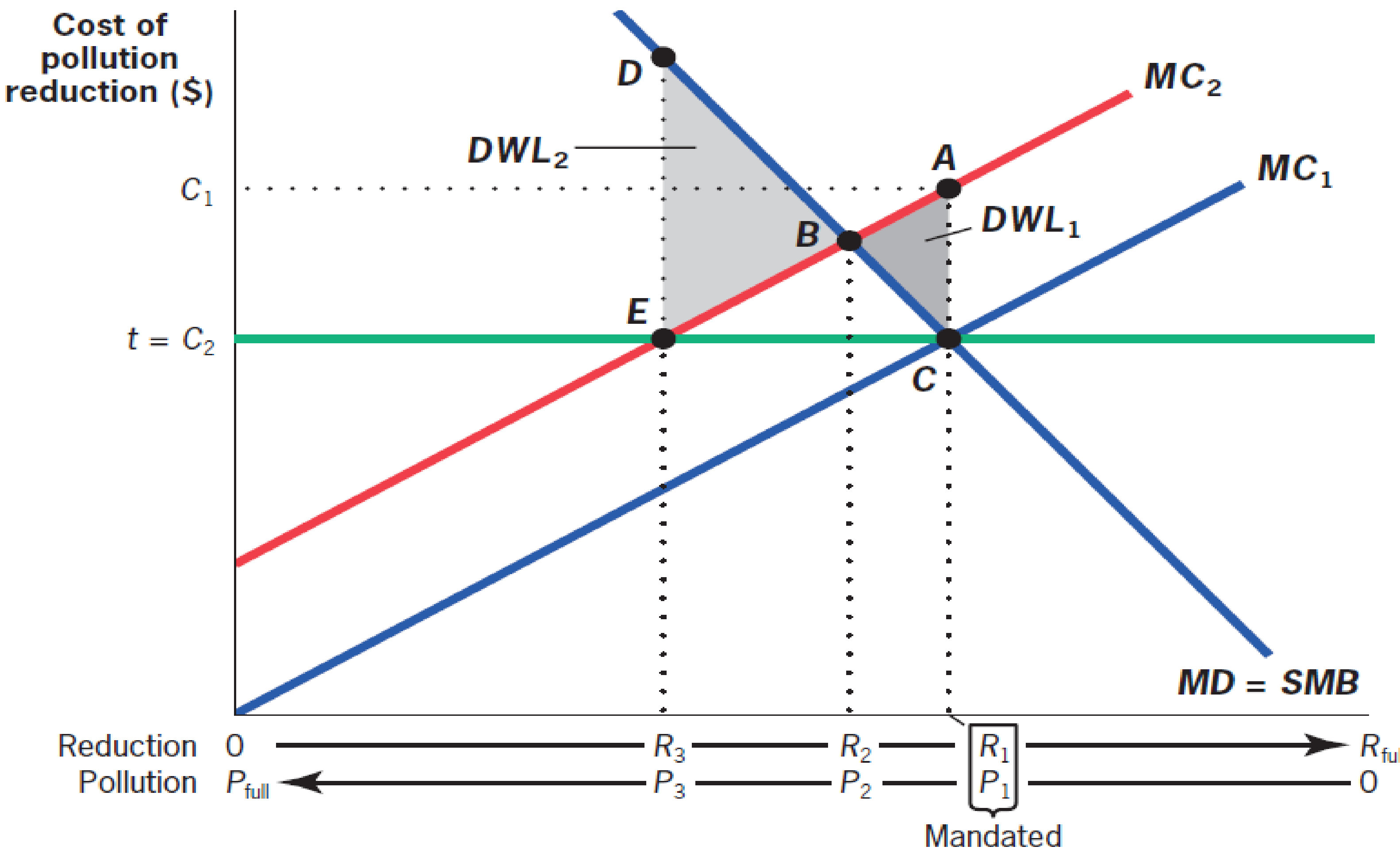
Uncertainty About Costs of Reduction: Case 2: Steep *MD* Curve (Nuclear leakage)



CORRECTIVE TAXES VS. TRADABLE PERMITS

Two differences between corrective taxes and tradable permits (carbon tax vs. cap-and-trade in the case of CO2 emissions)

1) Uncertainty in marginal costs just discussed: With uncertainty in costs of reducing pollution, taxes preferable when MD curve is flat. Tradable permits are preferable when MD curve

2) Initial allocation of permits: If the government sells them to firms, this is equivalent to the tax

If the government gives them to current firms for free, this is like the tax + large transfer to initial polluting firms.

Empirical Example: Acid Rain and Health

Acid rain due to contamination by emissions of sulfur dioxide (SO_2) and nitrogen oxide (NO_x).

1970 Clean Air Act: Landmark federal legislation that first regulated acid rain-causing emissions by setting maximum standards for atmospheric concentrations of various substances, including SO_2.

The 1990 Amendments and Emissions Trading:

SO_2 allowance system: The feature of the 1990 amendments to the Clean Air Act that granted plants permits to emit SO_2 in limited quantities and allowed them to trade those permits.

Empirical Example: Effects of Clean Air Act of 1970

How does acid rain (or SO2) affect health?

Observational approach: relate mortality in a geographical area to the level of particulates (such as SO2) in the air

Problem: Areas with more particulates may differ from areas with fewer particulates in many other ways, not just in the amount of particulates in the air

Chay and Greenstone (2003) use clean air act of 1970 to resolve the causality problem:

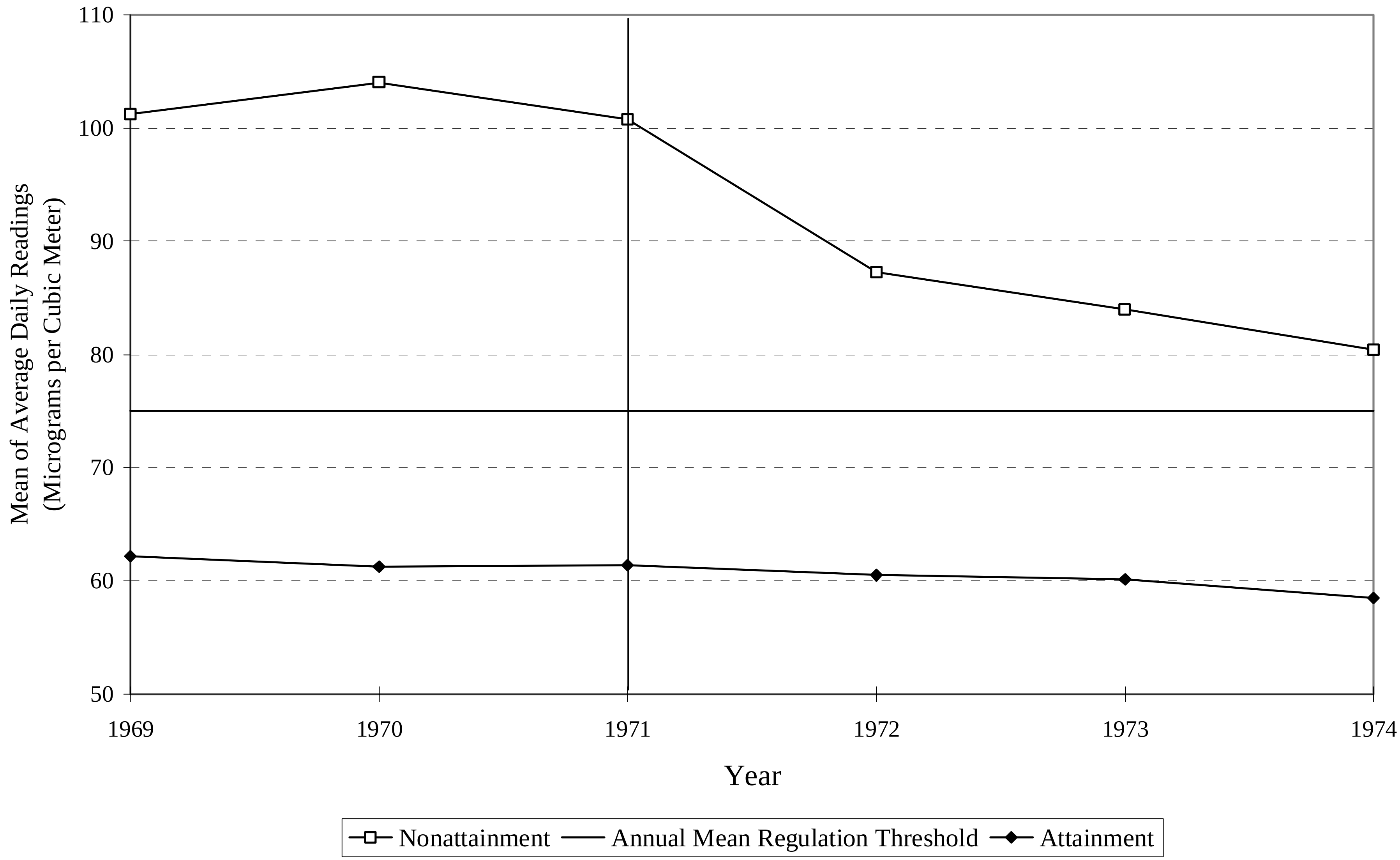
Areas with more particulates than threshold required to clean up air [called "non-attainment" areas = treatment group].

Areas with less particulates than threshold are control group [were not required to clean up].

Compares infant mortality across 2 types of places before and after (DD approach)

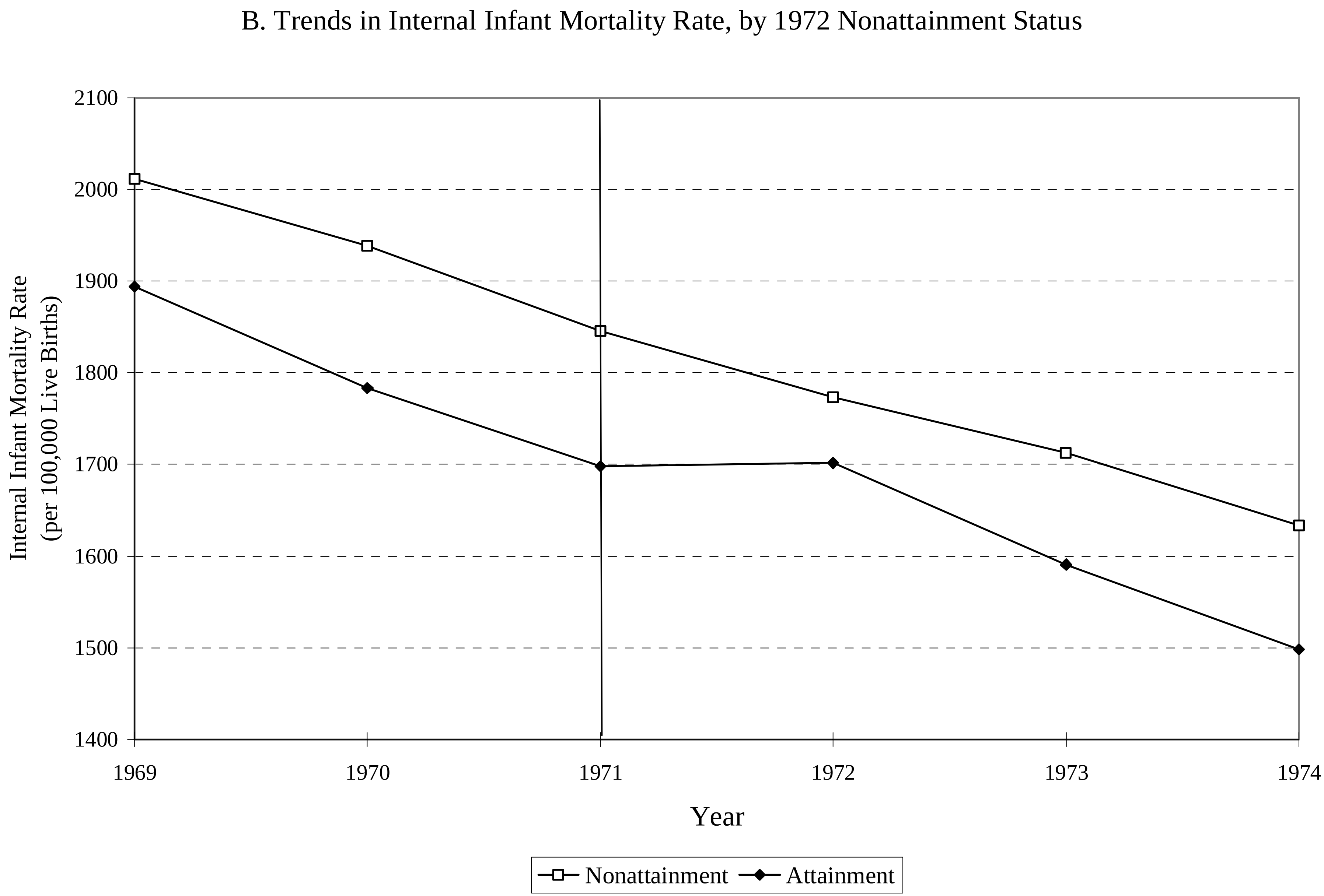
Figure 2: Trends in TSPs Pollution and Infant Mortality, by 1972 Nonattainment Status

A. Trends in Mean TSPs Concentrations, by 1972 Nonattainment Status



Source: Authors' tabulations from EPA's "Quick Look Reports" data file.

Source: Chay and Greenstone (2003)



Source: Chay and Greenstone (2003)

Climate Change and CO2 Emissions

Industrialization has dramatically increased CO2 emissions and atmospheric CO2 generates global warming

Four factors make this challenging (Wagner-Weitzman 2015):

1) Global: Emissions in one country affect the full world

2) Irreversible: Atmospheric CO2 has long life (centuries) [absent carbon capture tech breakthrough]

3) Long-term: Costs of global warming are decades/centuries away [how should this be discounted?]

4) Uncertain: Great uncertainty in costs of global warming [mitigation vs. amplifying feedback loops]

How fast should we start reducing emissions? slower path]

Main costs of global warming

Enormous variation across geographical areas and economic development. Pace of change makes adaptation daunting

1) Sea rise will flood low lying coasts and major population centers in many countries (e.g., Miami, Florida; value of real estate subject to regular flooding has dropped)

2) Impact on bio-diversity (mass extinctions)

3) Agricultural production could be disrupted by climate change and the increased weather variability it generates:

demand for food is very inelastic in the short-run $\Rightarrow$ Spikes in prices if agricultural output falls $\Rightarrow$ disruption/famines possible in low income countries

4) Droughts and heat waves will make many places less livable

Some societies may collapse and generate mass migration movements

Empirical Example: Costs of Global Warming

Estimating costs of Global warming is daunting because society will adapt and reduce costs (relative to a scenario with no adaptation)

Example: heat waves and mortality analysis of Barreca et al. (2016)

1) The mortality effect of an extremely hot day (80^oF+) declined by about 75% between 1900-1959 and 1960-2004.

2) Adoption of residential air conditioning (AC) explains the entire decline

3) Worldwide adoption of AC will speed up the rate of climate change (if fossil fuel powered)

Global Warming: Narrow View

If we view global warming as a classical externality, it poses challenges because it is such a long-run problem.

CO2 emissions impose a global warming externality $\Rightarrow$ Solution is to impose a carbon tax equal to the marginal damage of CO2 emissions and let market forces work their magic

But what is the marginal damage of CO2? It depends greatly on how you discount the future

Economists use interest rate r to discount future: $\$1$ today is worth $\$(1+r)^T$ in T years (long-distance future heavily discounted: e.g., $r = 4\%$ and $T = 1000 \Rightarrow (1+r)^T = 10^{17}$)

If interest rate is high, it is desirable to let global warming happen and societies collapse!

Global Warming: Broader View

Massive CO2 emissions pose existential civilizational risk (like CFC destroying vital ozone layer)

Only solution is to decarbonize and we need to do it fast (within decades not centuries)

Decarbonization is within sight: renewable electricity (solar/wind) + grid + big batteries could power most energy needs and replace most fossil fuels

$\Rightarrow$ could be done without killing economic growth and without huge short-term disruptions

Economists' useful point: some sectors are easier to decarbonize than others (e.g. cars easier than planes)
$\Rightarrow$ start decarbonizing easiest sectors first (Sachs 2020)

How to Decarbonize? Richer countries

Must become a clear policy choice that mobilizes society

Encourage research on renewable technologies both public and private (King, David et al. 2015)

Plan phase out of carbon in various sectors [industrial policy] and weaken fossil fuel industry political power (Sachs 2020)

Raising carbon tax could be one tool (but we should not bet everything on it)

Be flexible and compensate low income losers (to avoid yellow vests protests as in France with higher gas tax)

How to Decarbonize? Developing countries

Disagreement between higher- and lower-income countries on who should bear the cost of curbing greenhouse gas emissions

Higher-income countries responsible for most of historical CO2 emissions

Lower-income countries want to develop using the cheapest available technologies (coal power is cheaper than solar power, etc.)

Makes sense for high-income countries to encourage/help low-income countries leapfrog carbon in favor of renewable energy

Carrot: R&D on renewables can be adopted in low-income countries, direct subsidies can help

Stick: Impose tariffs on carbon content of imported goods

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