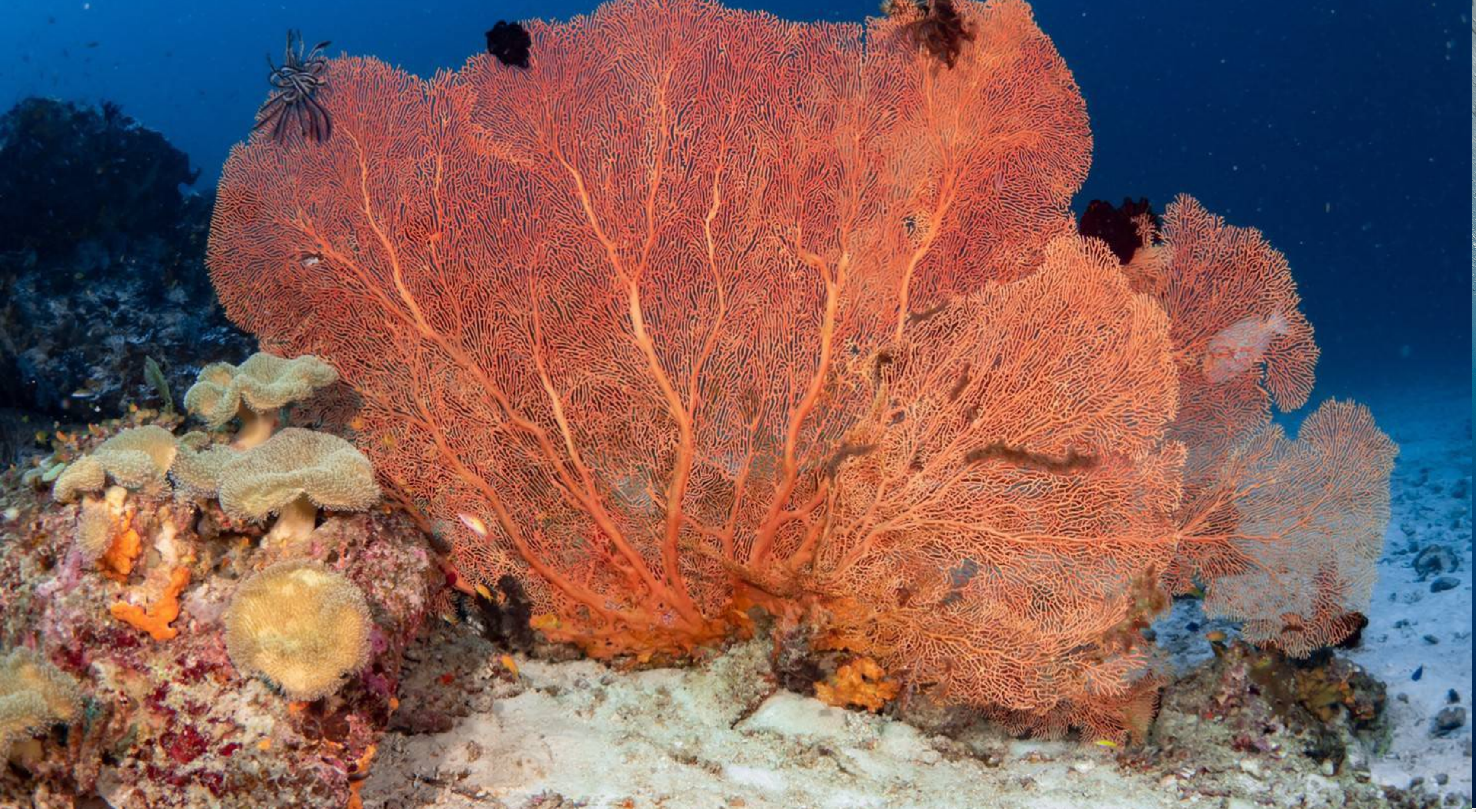
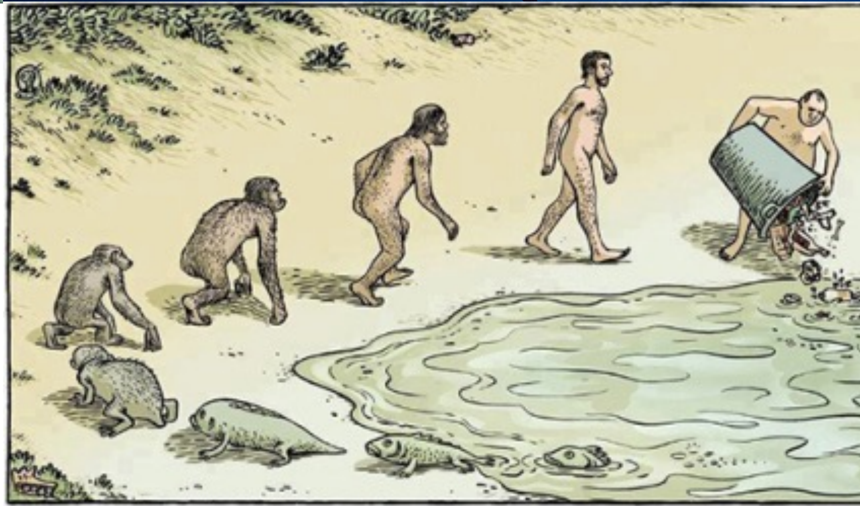



# EE476
# Environmental Economics

## Lecture 5

## 2022



# The Economics of Environmental Quality

1. Identifying the most appropriate level of environmental quality we ought to try to achieve

2. Dividing the task and costs of meeting environmental quality goals

3. Distributing benefits and costs across society appropriately

# Pollution Control : a General Model

- On the one hand, reducing emissions reduces the damages that people suffer from environmental pollution;

- On the other hand, reducing emissions takes resources that could have been used in some other way.

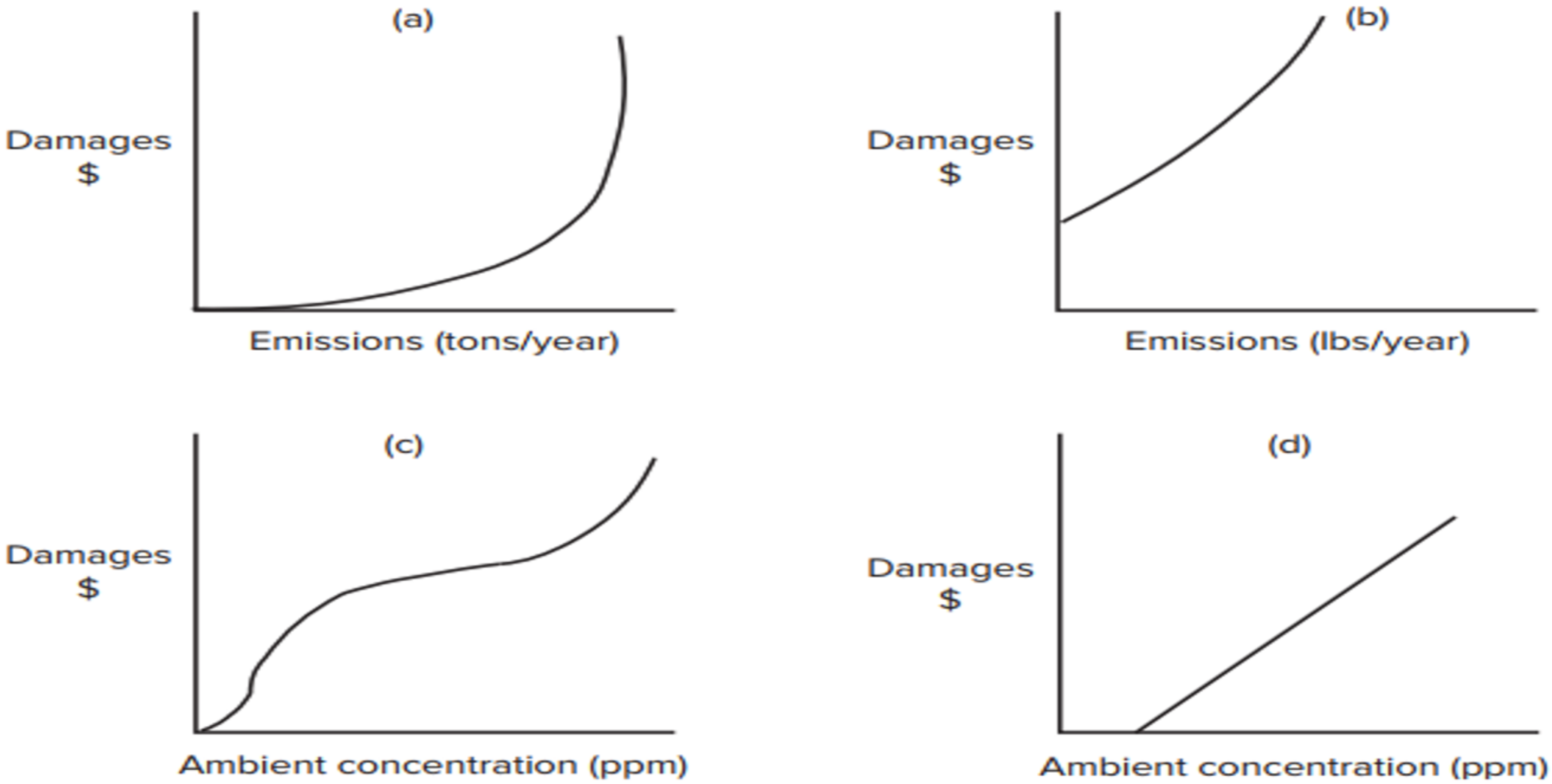
# Damage function

- Show the relationship between the quantity of a residual and the damage that residual causes. There are two types of damage functions:

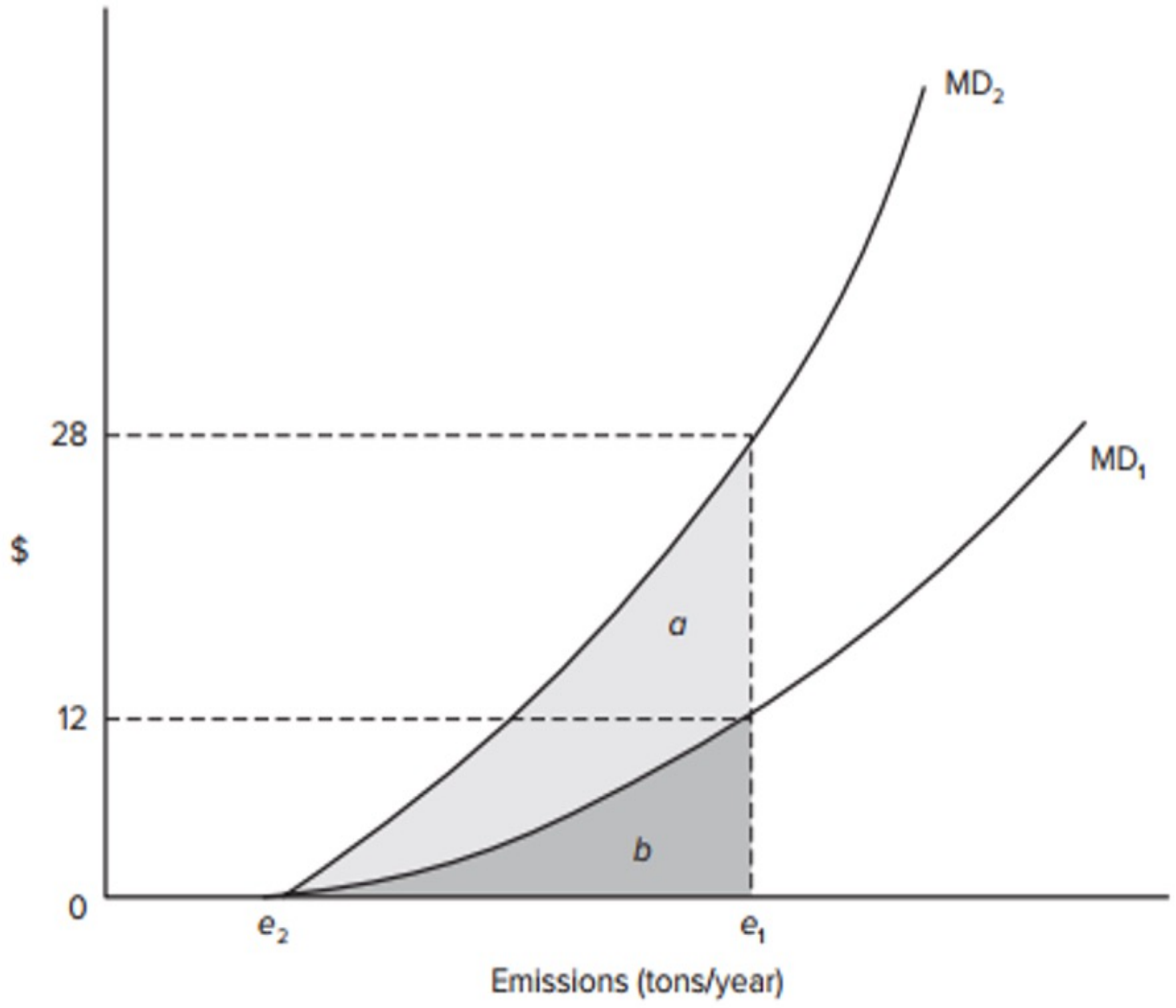
- **Emission damage functions:** show the connection between the quantity of a residual emitted from a source or group of sources and the resulting damage.

- **Ambient damage functions:** These show the relationship between the concentration of particular pollutants in the ambient environment and the resulting damages.

# Damage function



# Marginal damage function




Some factors that move damage functions upward/downward.

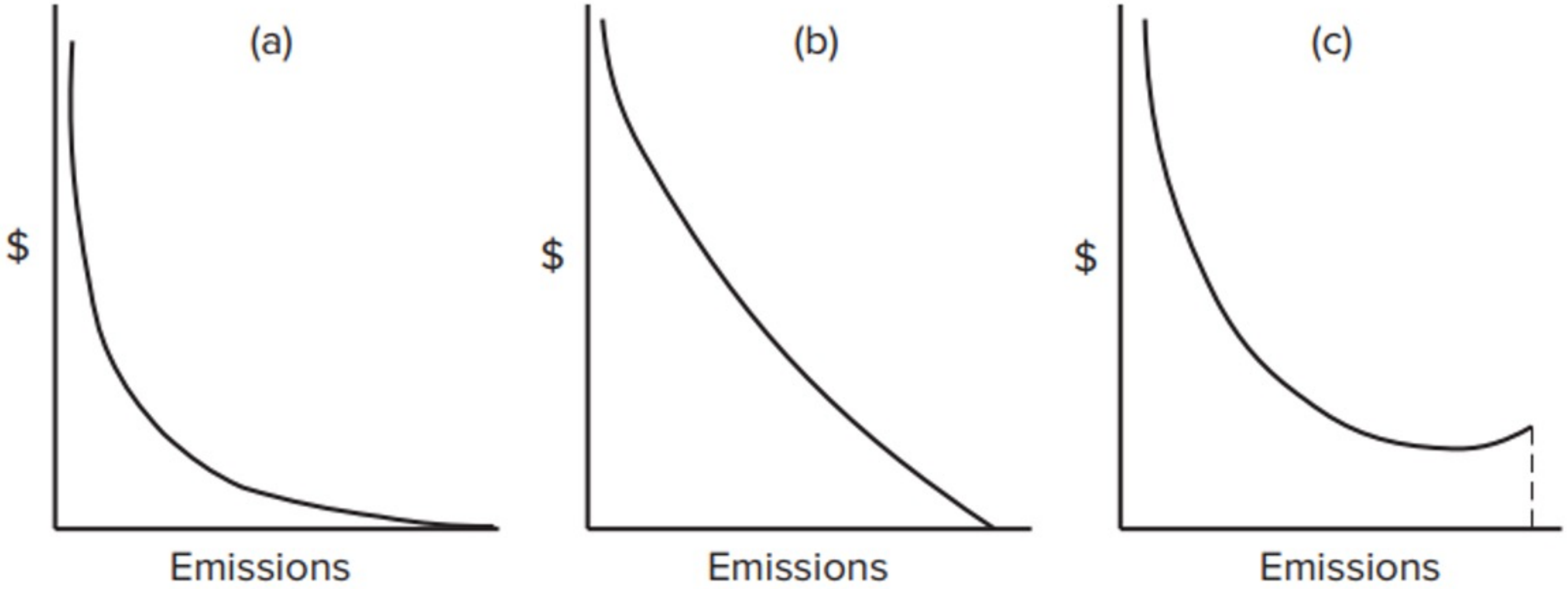
1. Differences in population exposed, such as more people
2. Different time periods
3. New scientific estimates of increased pollution impact.

Assumption

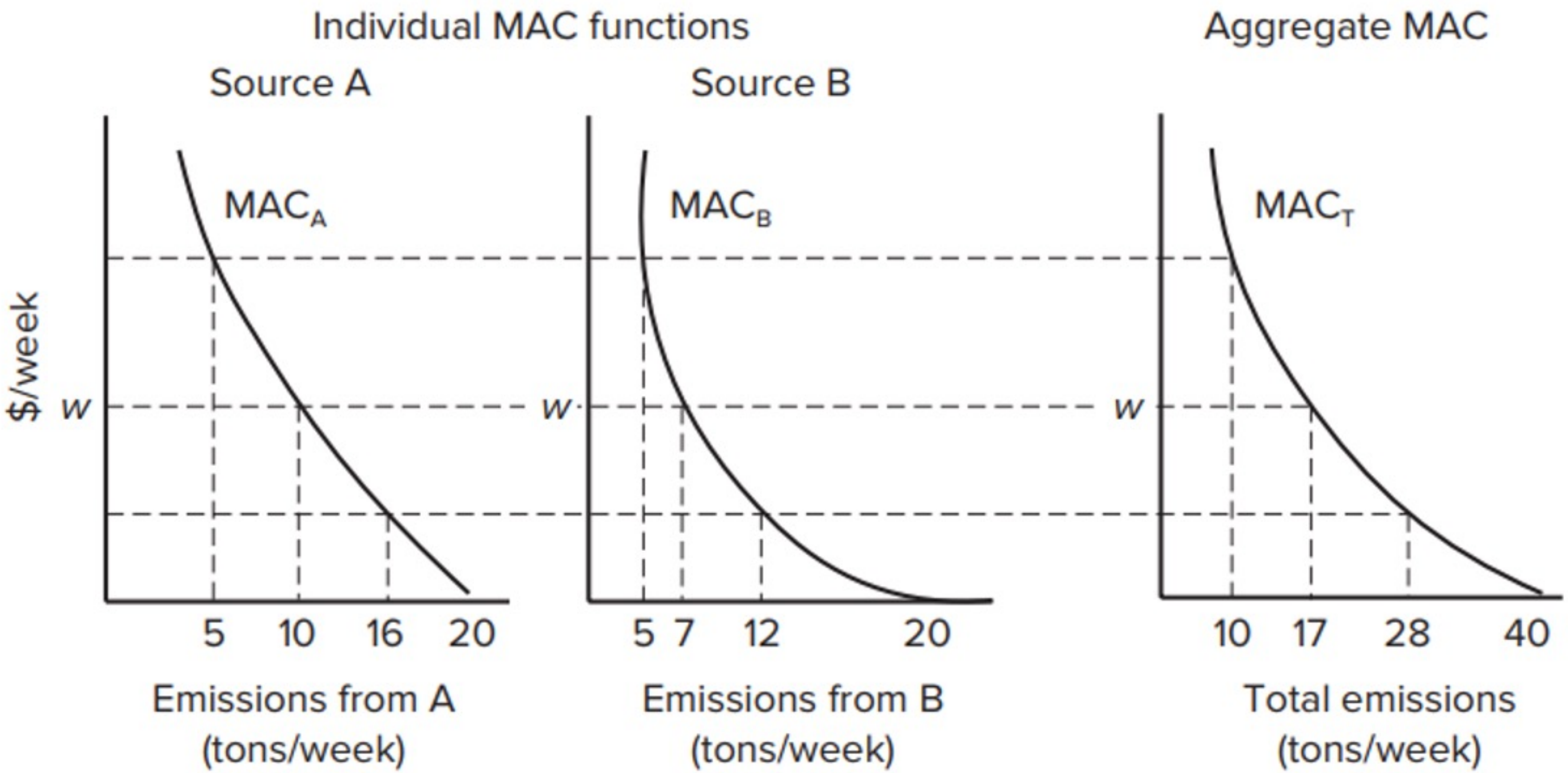
1. No uncertainty about damages
2. Reversible

# Marginal Abatement Cost function

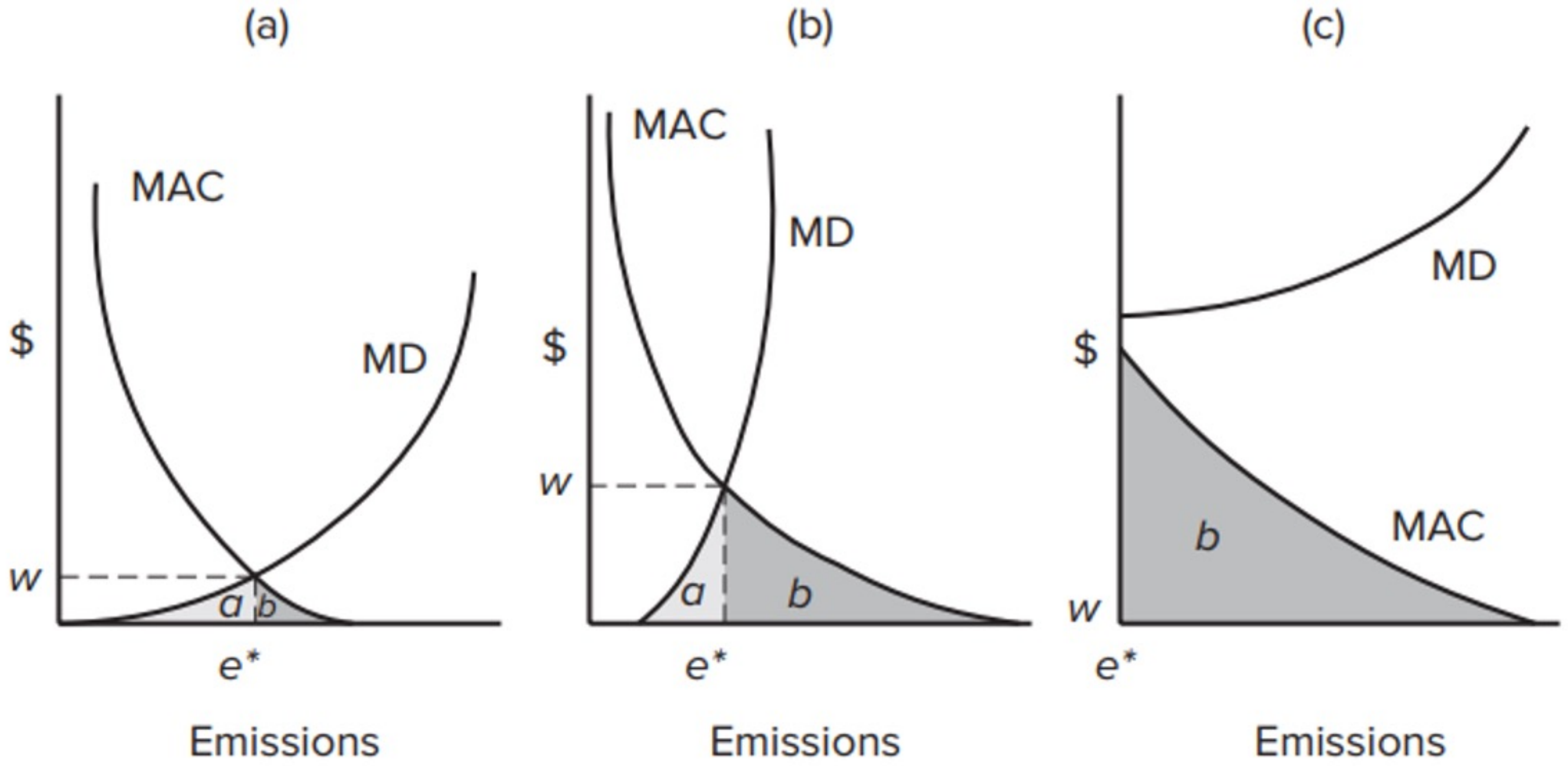
- Marginal costs of reducing extra unit of residuals being emitted into the environment, or of lowering ambient concentrations  (from right to left)



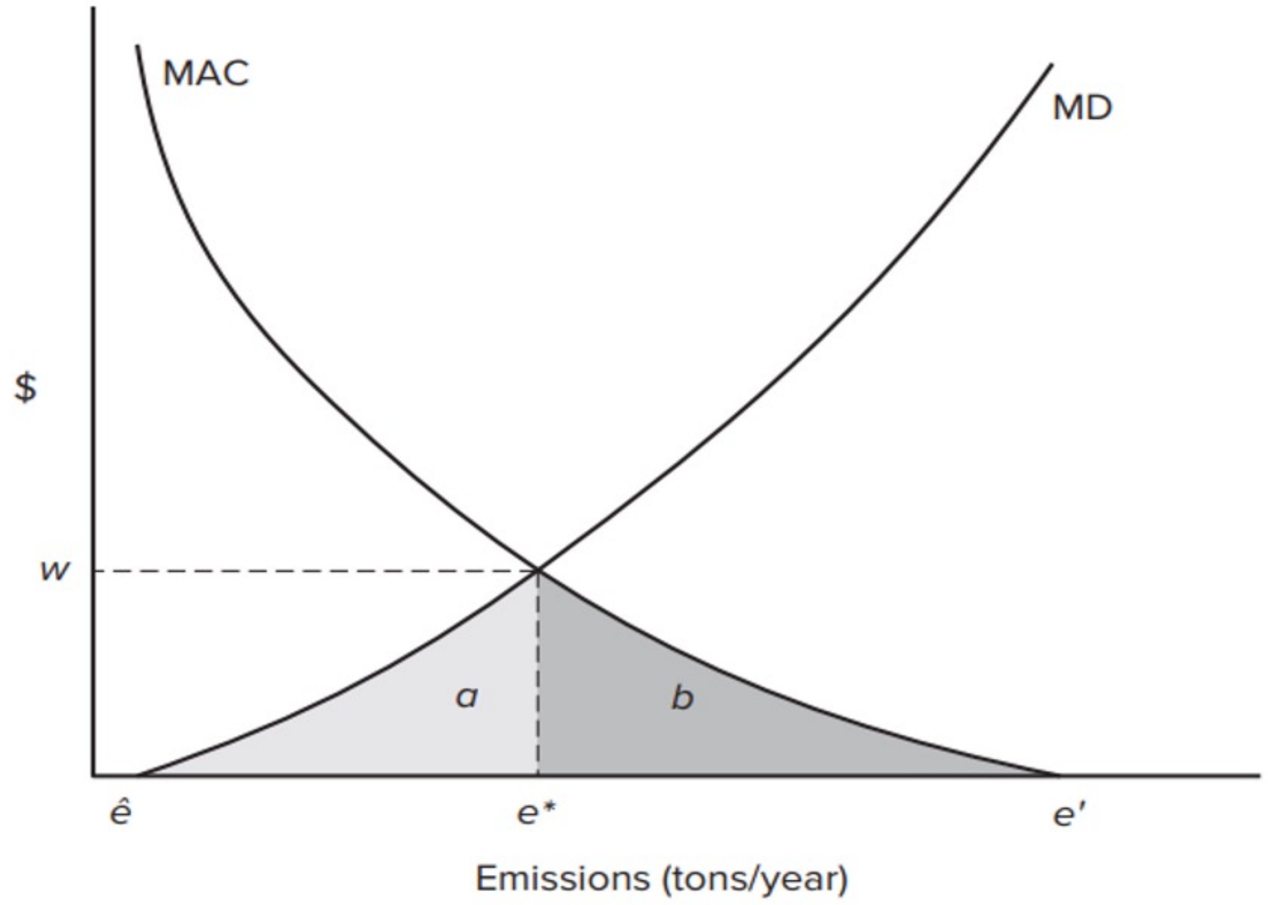
# Aggregated MAC



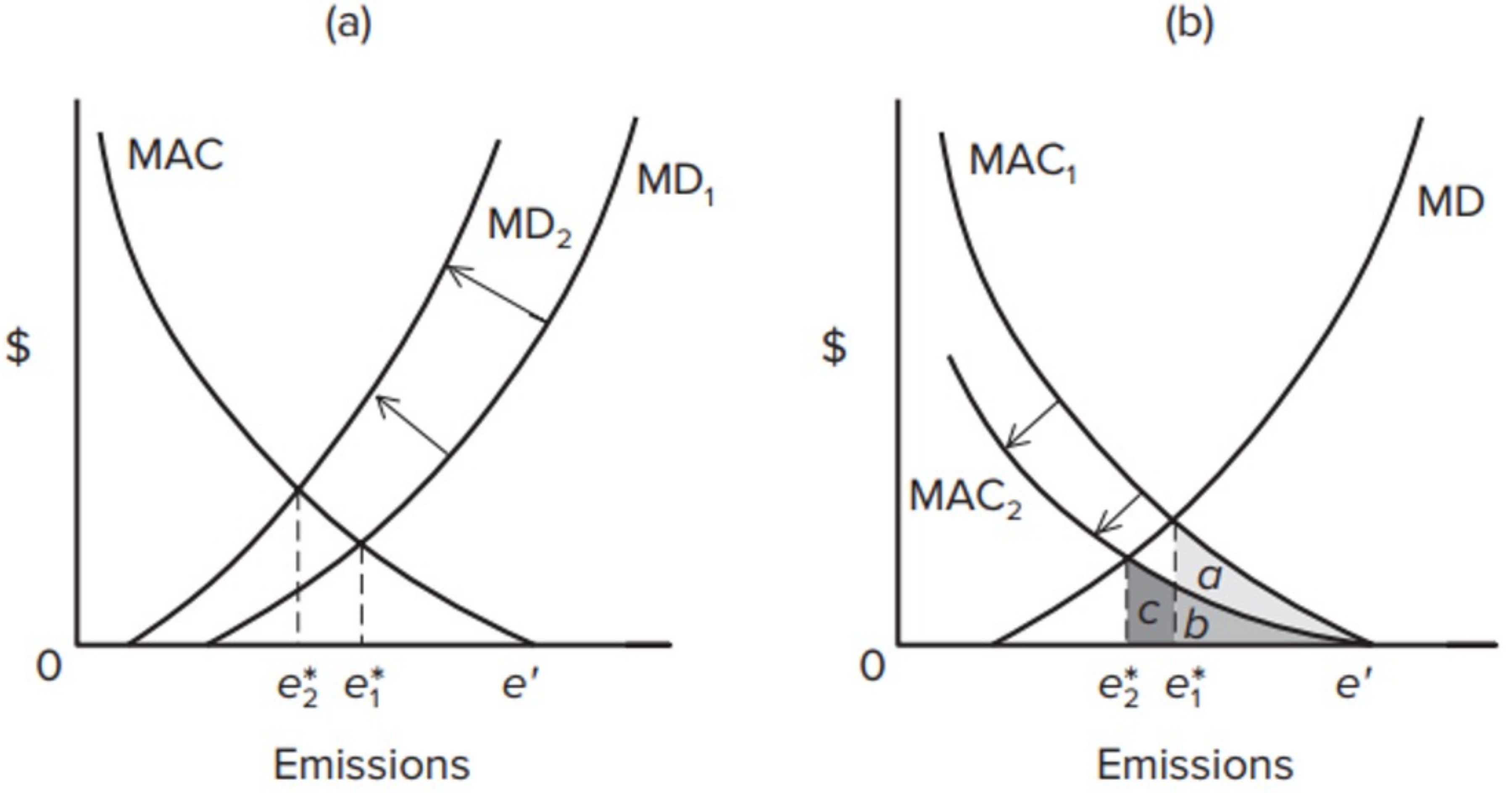
# The Socially Efficient Level of Emissions



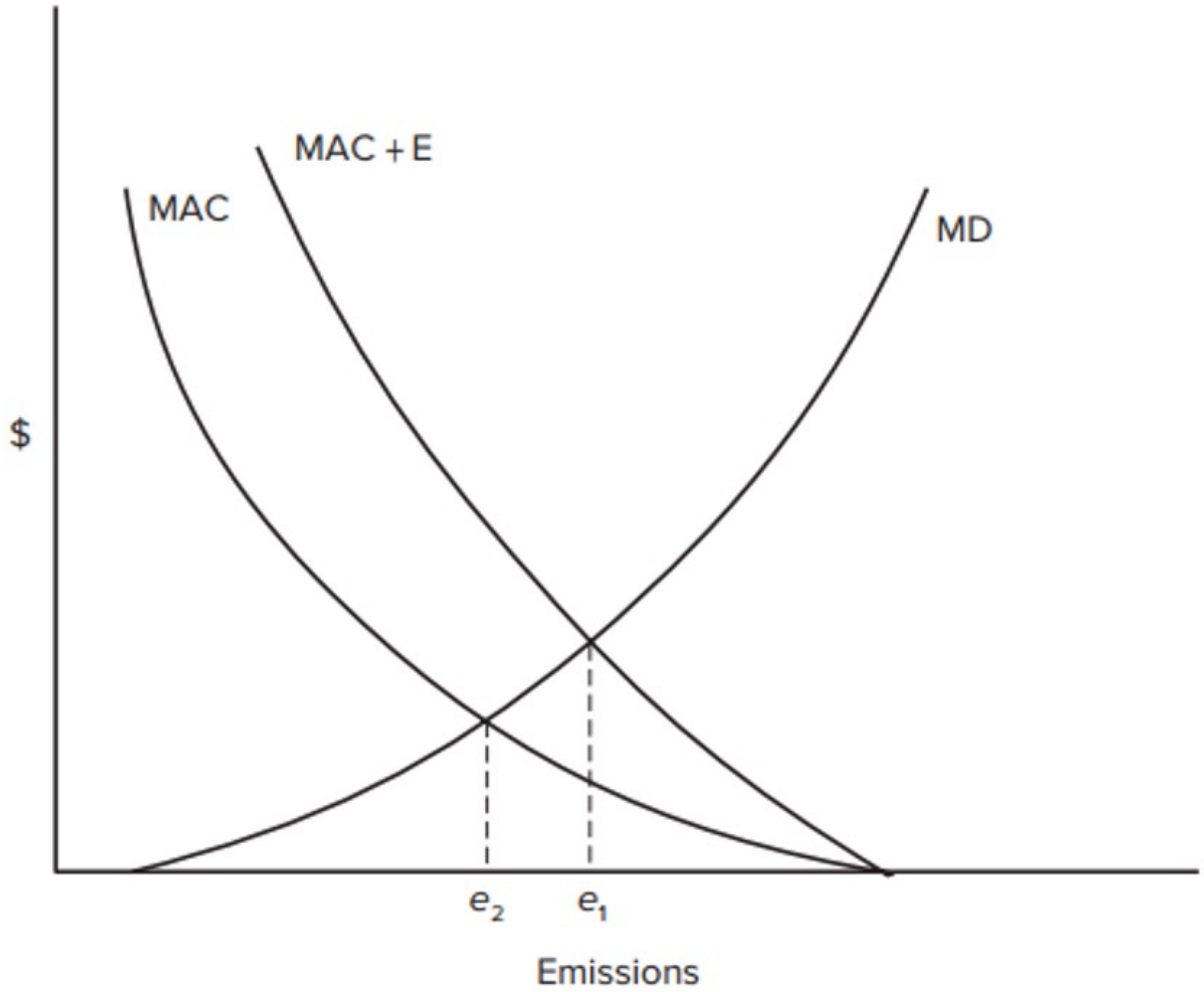
# The Socially Efficient Level of Emissions and social cost of emission



# The Socially Efficient Level of Emissions



# Enforcement Costs



# Criteria for Evaluating Environmental Policies

- Efficiency & Cost-effectiveness
- Fairness
- Enforceability
- Flexibility
- Incentives for technological innovations

# Efficiency and cost-effectiveness

- To be efficient, the policy must balance marginal benefits with marginal costs.
- environmental damages cannot be measured accurately.
- useful to employ **cost-effectiveness** as a primary policy criterion
- For a policy to be efficient it must be cost-effective, but not necessarily vice versa.

# Fairness

| Program | Total Costs | Total Benefits | Net Benefits | Distribution of Net Benefits | |
|---|---|---|---|---|---|
| | | | | Group X | Group Y |
| A | 50 | 100 | 50 | 25 | 25 |
| B | 50 | 100 | 50 | 30 | 20 |
| C | 50 | 140 | 90 | 20 | 70 |
| D | 50 | 140 | 90 | 40 | 50 |

- Group X and Group Y refer to a low-income group and a high-income group, respectively.
- How should we choose between B and C? Some might argue that B is best, for equity reasons; others might argue for C on overall efficiency grounds.
- Suppose, on the other hand, that Group X and Group Y refer to people in two generation. Now we see that there is an issue of **intergeneration equity**. (international equity, interregional equity)

# Efficiency and cost-effectiveness

- Accurate information about pollution-control costs is for the most part **private information**
- Asymmetric information : polluters have better information about the costs of different pollution-control technologies than do public policymakers.

# Enforceability

- There are two main steps in enforcement: **monitoring** and **sanctioning**.
- Monitoring refers to measuring the performance of polluters in comparison to whatever requirements are set out in the relevant law.
- Sanctioning refers to the task of bringing to justice those whom monitoring has shown to be in violation of the law.

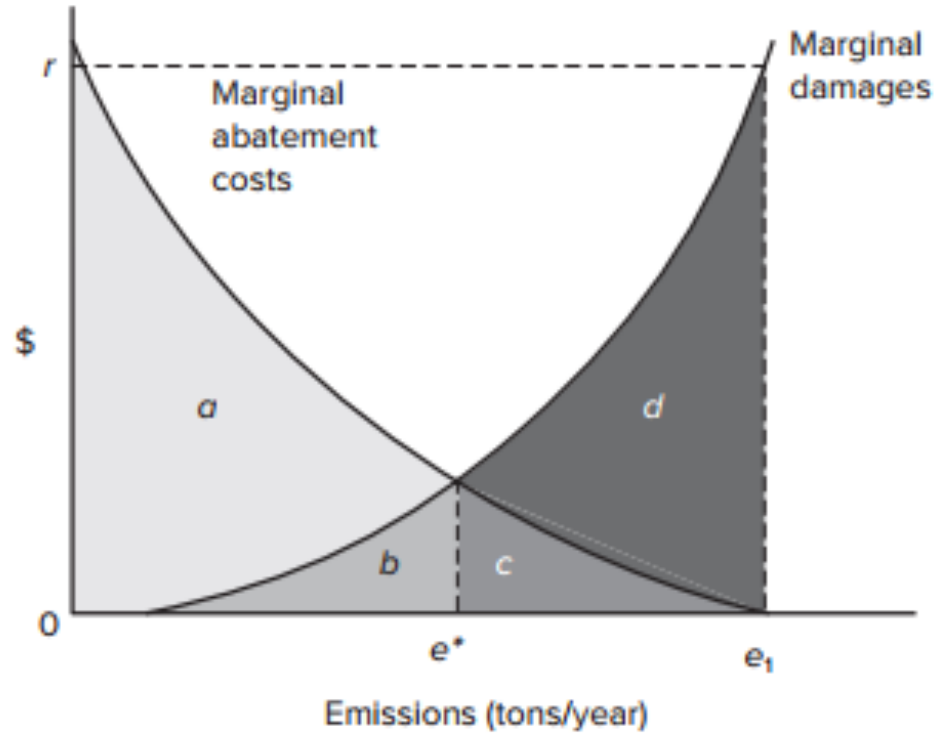
# Decentralized Policies: Liability Laws, Property Rights, Voluntary Action

- By **"decentralized"** policies we mean policies that essentially allow the individuals involved in a case of environmental pollution to work it out themselves.
- the parties involved are the ones producing and suffering the environmental externalities, they have strong incentives to seek out solutions to the environmental problems.
- The people involved may be the ones with the best knowledge of damages and abatement costs; therefore, they may be best able to find the right balance among them, that is, to find efficient solutions.

# Liability Laws

- Compensation requires that those causing the damage compensate those damaged in amounts appropriate to the extent of the injury

FIGURE 10.1 Policy Options: Liability and Property Rights Approaches




- At $e_1$, the total damages, and hence the amount of the compensation payment, would be a monetary amount equal to the area $(b + c + d)$
- a liability system could automatically lead this polluter to emission level $e^*$ (Why?)

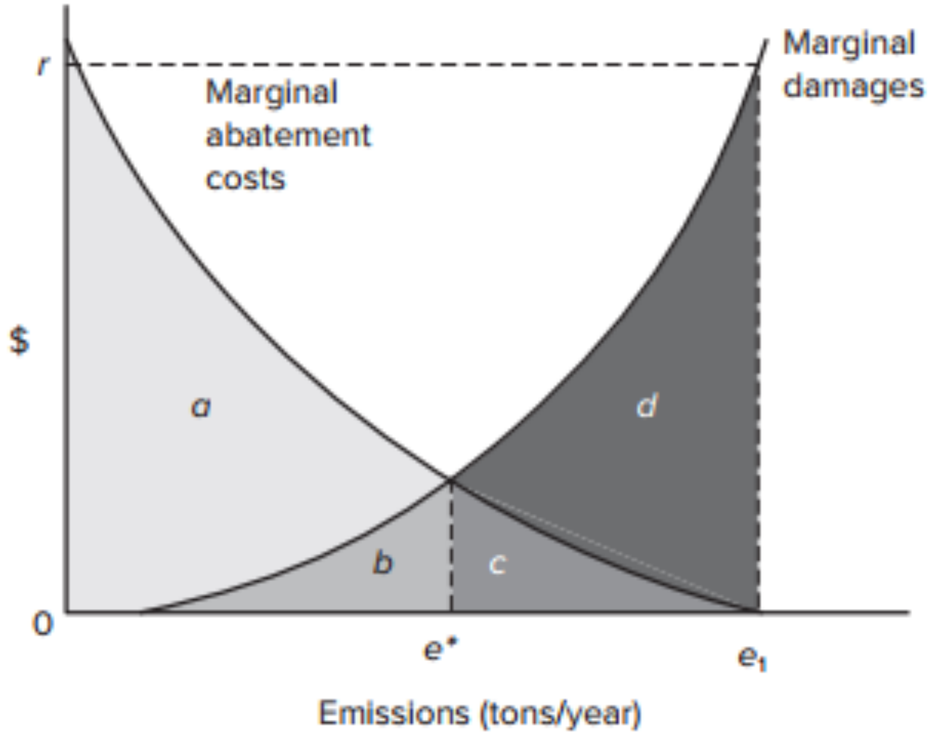
# Liability Laws

helps to lead to efficient pollution levels when

1. Relatively few people are involved,
2. Causal linkages are clear, and
3. Damages are easy to measure.

# Property Rights : Coase Theorem.

**FIGURE 10.1** **Policy Options: Liability and Property Rights Approaches**

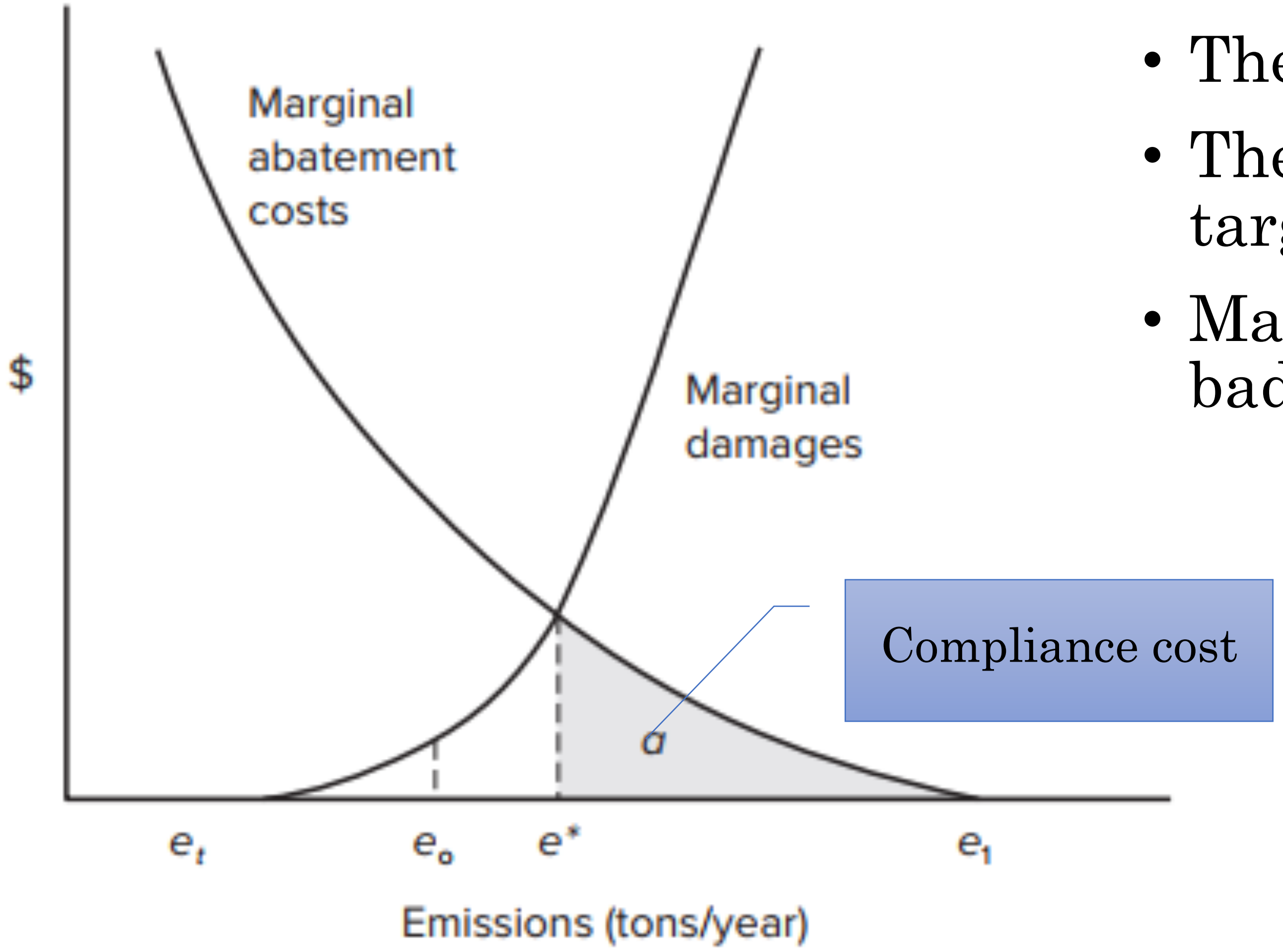



If property rights over the environmental asset are clearly defined, and bargaining among owners and prospective users is allowed, the efficient level of effluent will result irrespective of who was initially given the property right. ➔ the Coase theorem

## Command-and-Control Strategies: The Case of Standards

- a standard is simply a mandated level of performance that is enforced in law.
- For example, a maximum level of a toxic, such as ppm (parts per million) of arsenic in drinking water.

# Command-and-Control Strategies: The Case of Standards




- They appear to be simple and direct.
- They apparently set clearly specified targets.
- Make ethical sense that pollution is bad and ought to be declared illegal.

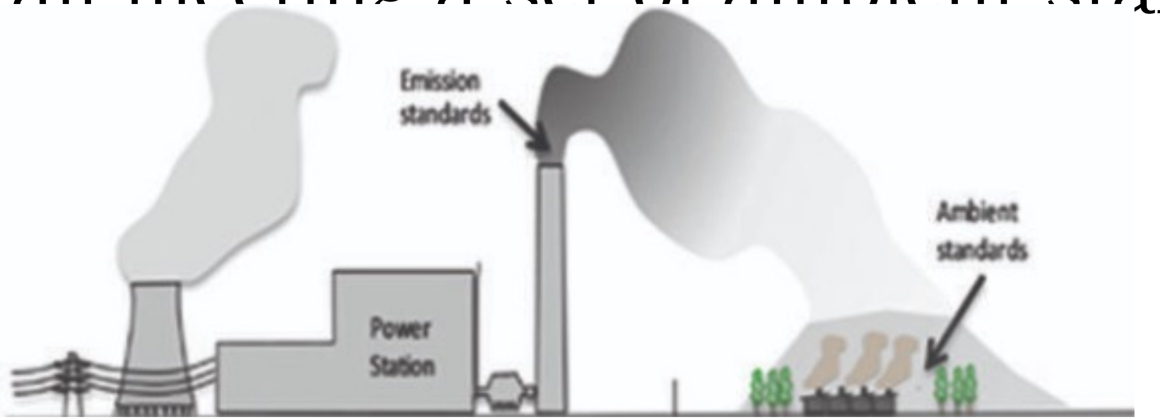
# Types of Standards

1. **Ambient Standards**
   - refers to the qualitative dimensions of the surrounding environment; it could be the ambient quality of the air over a particular city or the ambient quality of the water in a particular river.
   - Ambient standards are normally expressed in terms of average concentration levels over some period of time to recognize that there are seasonal and daily variations in meteorological conditions, as well as in the emissions that produce variations in ambient quality
   - For example, the ambient air quality standard for carbon monoxide (CO) is 9 ppm based on an 8-hour averaging time and 35 ppm based on a 1-hour averaging time. Neither can be exceeded more than once per year.

# Types of Standards

**2 Emission standards**

- are never-exceed levels applied directly to the quantities of emissions coming from pollution sources.
- Emission (or effluent) standards are normally expressed in terms of quantity of material per some unit of time—for example, grams per minute or tons per week.
- Setting emission standards at a certain level does not necessarily entail meeting a set of ambient standards.



# Setting the Level of the Standard

FIGURE 11.1 Emission Standards

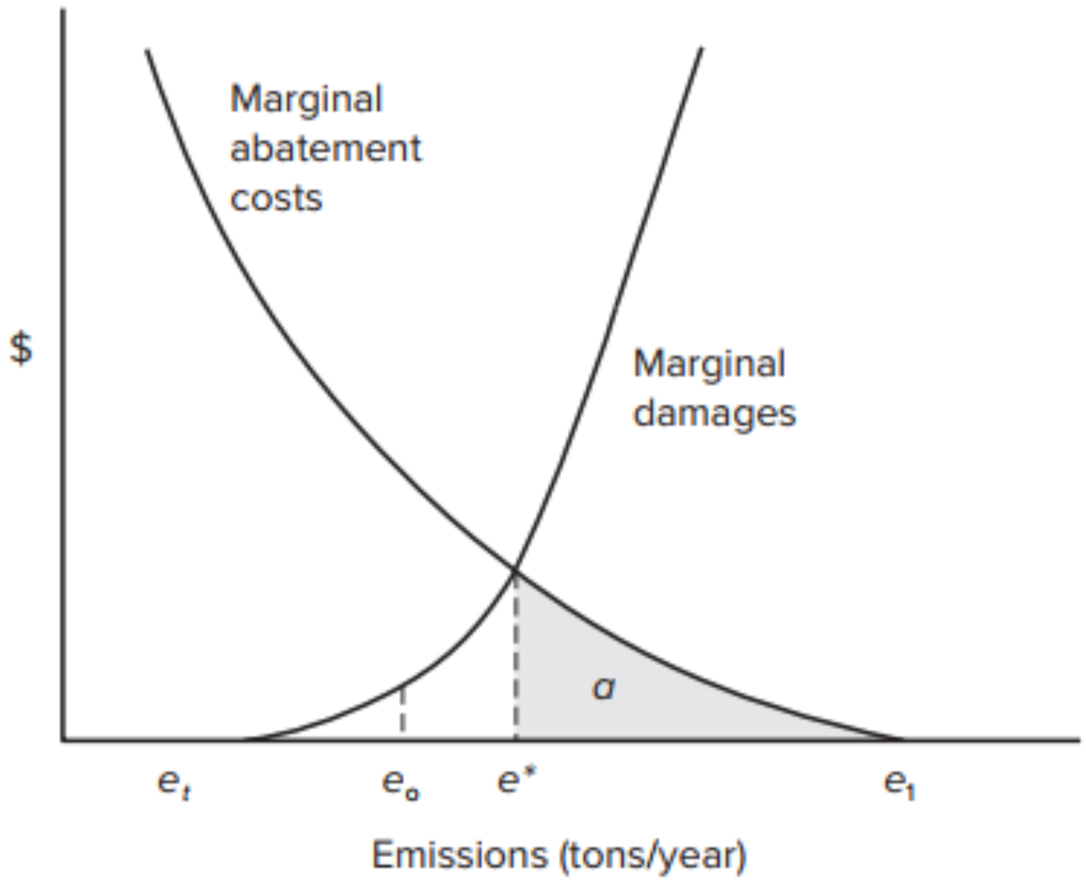
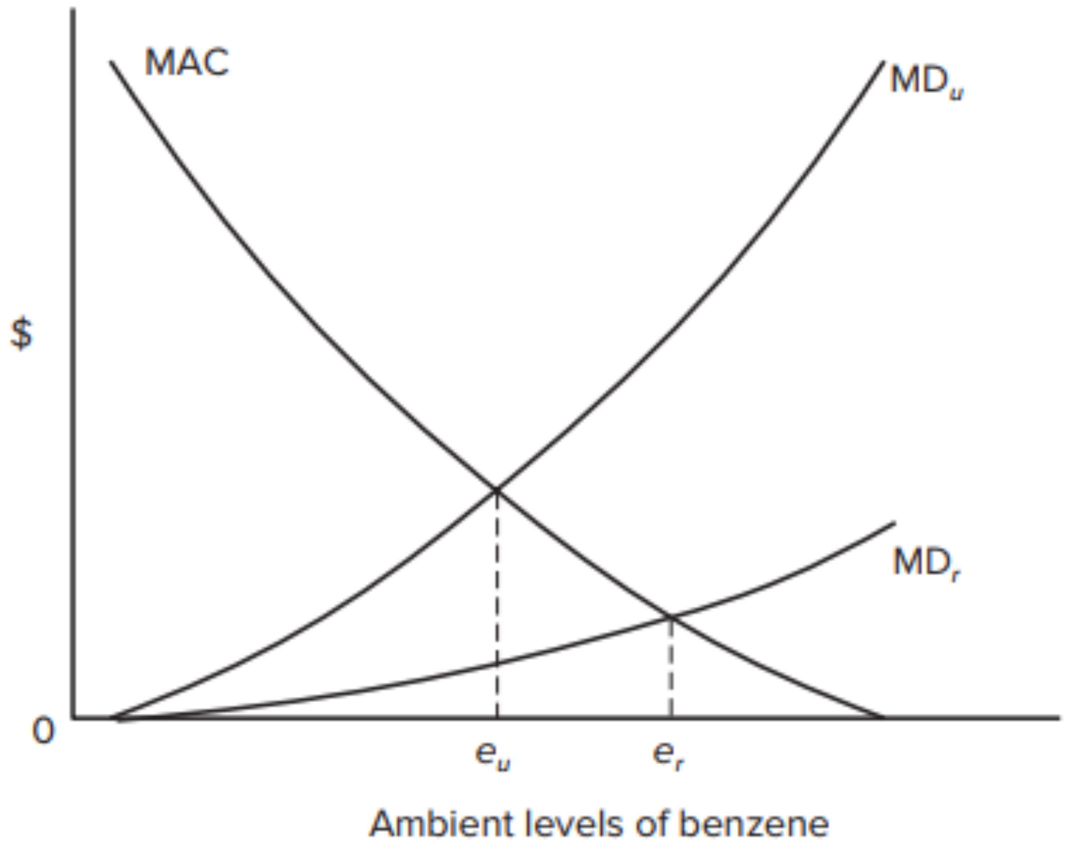
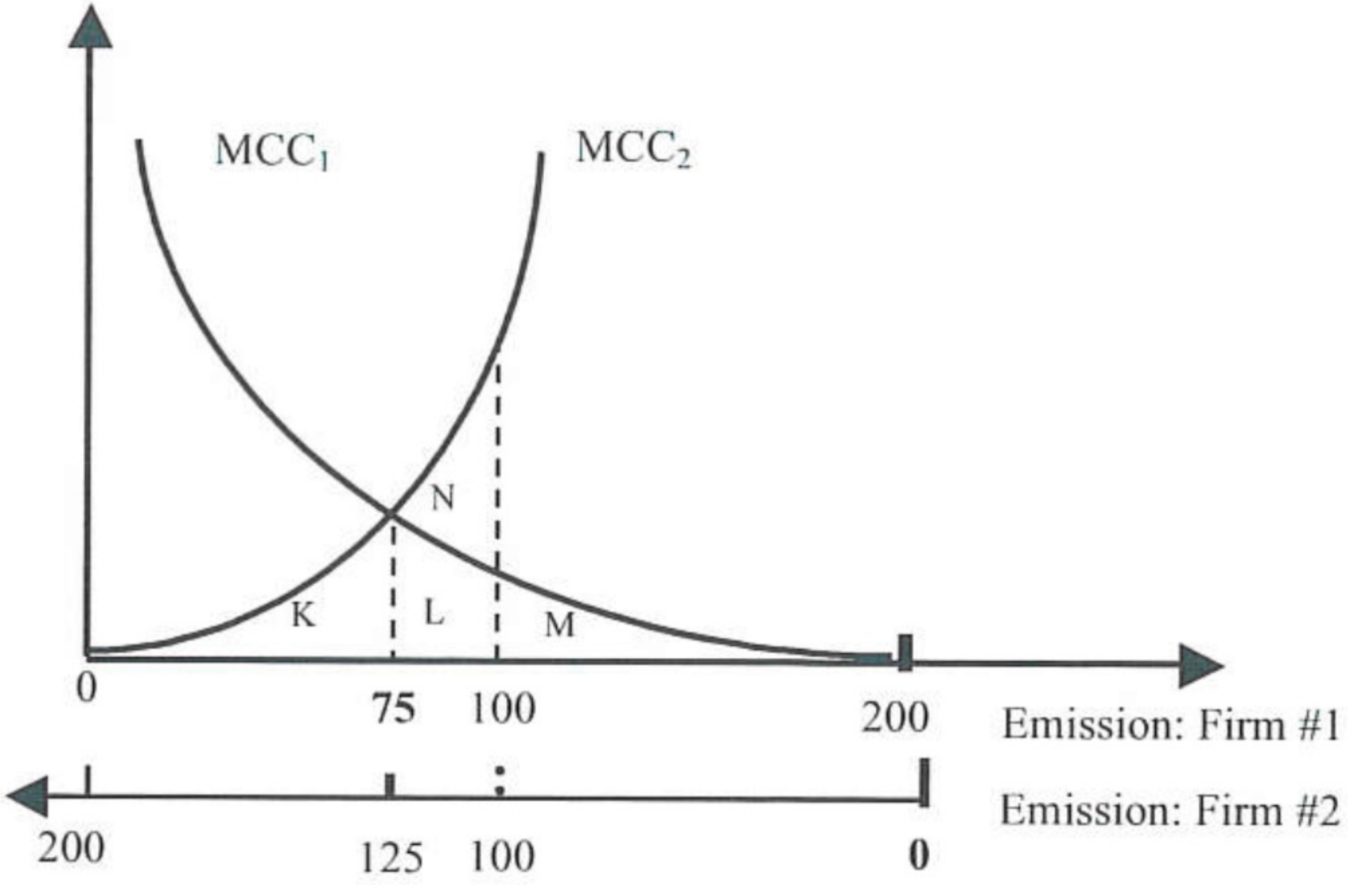



FIGURE 11.2 Regional Variation in Efficiency Levels



# Uniform emission control is bad

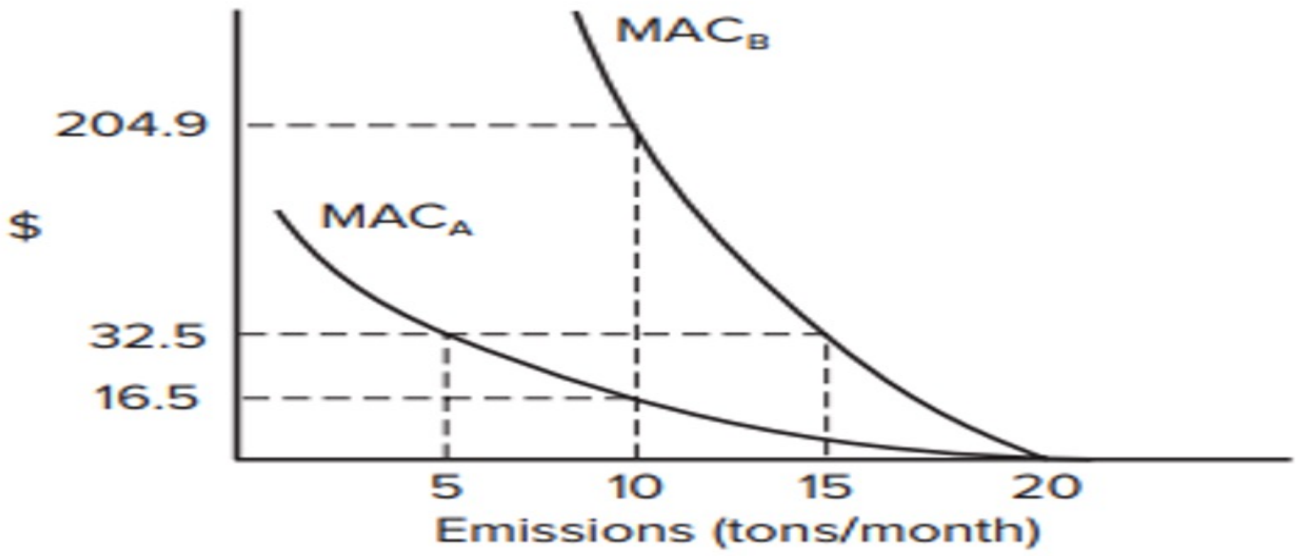



- 200 units must be reduced
- Uniform emission control : each firm reduces 100 units
- Cost = ?
- Better option?

# Standards and the Equi-marginal Principle

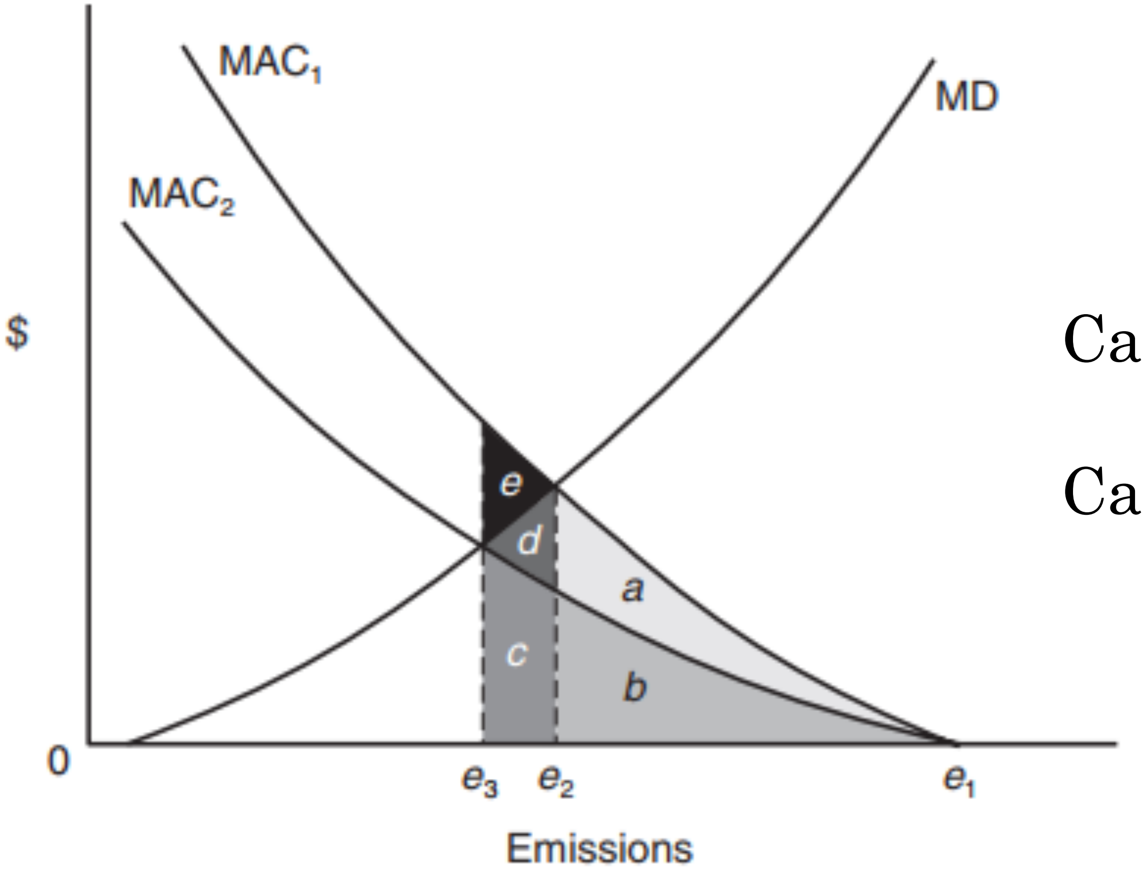
| Emission Level (tons/ month) | Marginal Abatement Costs ($) A | B |
|---|---|---|
| 20 | 0.00 | 0.00 |
| 19 | 1.00 | 2.10 |
| 18 | 2.10 | 4.60 |
| 17 | 3.30 | 9.40 |
| 16 | 4.60 | 19.30 |
| 15 | 6.00 | 32.50 |
| 14 | 7.60 | 54.90 |
| 13 | 9.40 | 82.90 |
| 12 | 11.50 | 116.90 |
| 11 | 13.90 | 156.90 |
| 10 | 16.50 | 204.90 |
| 9 | 19.30 | 264.90 |
| 8 | 22.30 | 332.90 |
| 7 | 25.50 | 406.90 |
| 6 | 28.90 | 487.00 |
| 5 | 32.50 | 577.00 |
| 4 | 36.30 | 677.20 |
| 3 | 40.50 | 787.20 |
| 2 | 44.90 | 907.20 |
| 1 | 49.70 | 1,037.20 |
| 0 | 54.90 | 1,187.20 |

| | Firm A | Firm B | Total |
|---|---|---|---|
| **Beginning Solution** | | | |
| Emissions (tons) | 20 | 20 | 40 |
| Marginal abatement costs | $0 | $0 | $0 |
| Total abatement costs | $0 | $0 | $0 |
| **Equiproportionate Reduction** | | | |
| Emissions (tons) | 10 | 10 | 20 |
| Marginal abatement costs | $16.50 | $204.90 | |
| Total abatement costs | $75.90 | $684.40 | $760.30 |
| **Equimarginal Reduction** | | | |
| Emissions (tons) | 5 | 15 | 30 |
| Marginal abatement costs | $32.50 | $32.50 | |
| Total abatement costs | $204.40 | $67.90 | $272.30 |



# Standard and incentives

**FIGURE 11.4** **Cost Savings from Technological Change: The Case of Standards**




Case 1. standard at $e_2$

Case 2. new tech new standard $e_3$

# input-based vs output-based

- Historically, most standards have been applied to emissions **per unit of input.**
- Eg. a maximum amounts of $SO_2$ emissions allowed per ton of coal burned in electricity production.

emissions per unit of output.

$$\text{Total emissions} = \text{Total output} \times \text{Inputs used for unit of output} \times \text{Emissions per unit of input}$$

- If you place an **output-based** standard that is, standards expressed in terms of allowable emissions per unit of output , polluters can reduce it in two ways:
    1. By reducing inputs per unit of output  (reduce the amount of coal needed per unit of electricity generated)
    2. By reducing emissions per unit of input