

# Cost-Benefit Analysis of Climate Policy

EES 3310/5310

Global Climate Change

Jonathan Gilligan

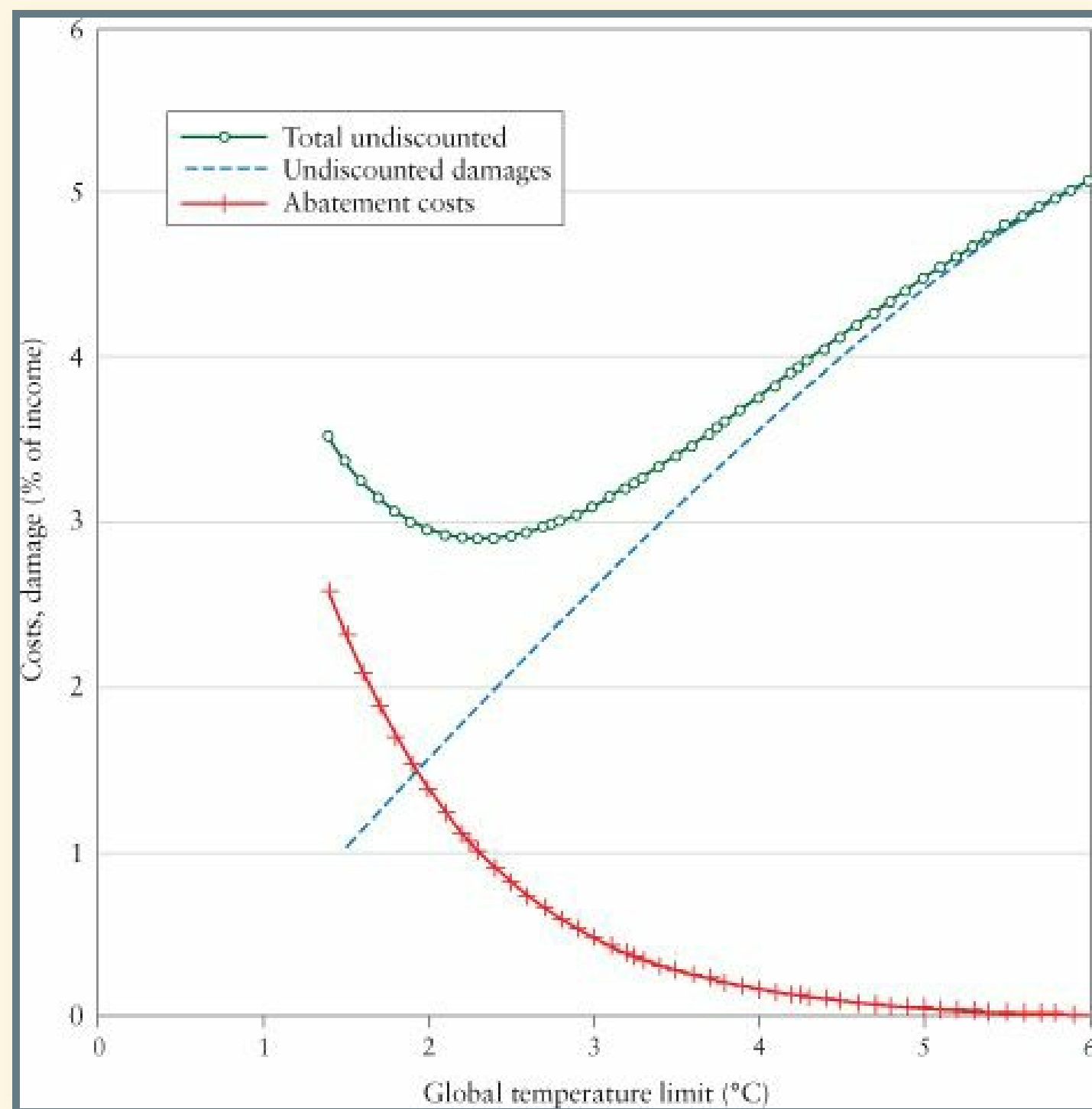
Class #29: Monday, Oct. 29 2018



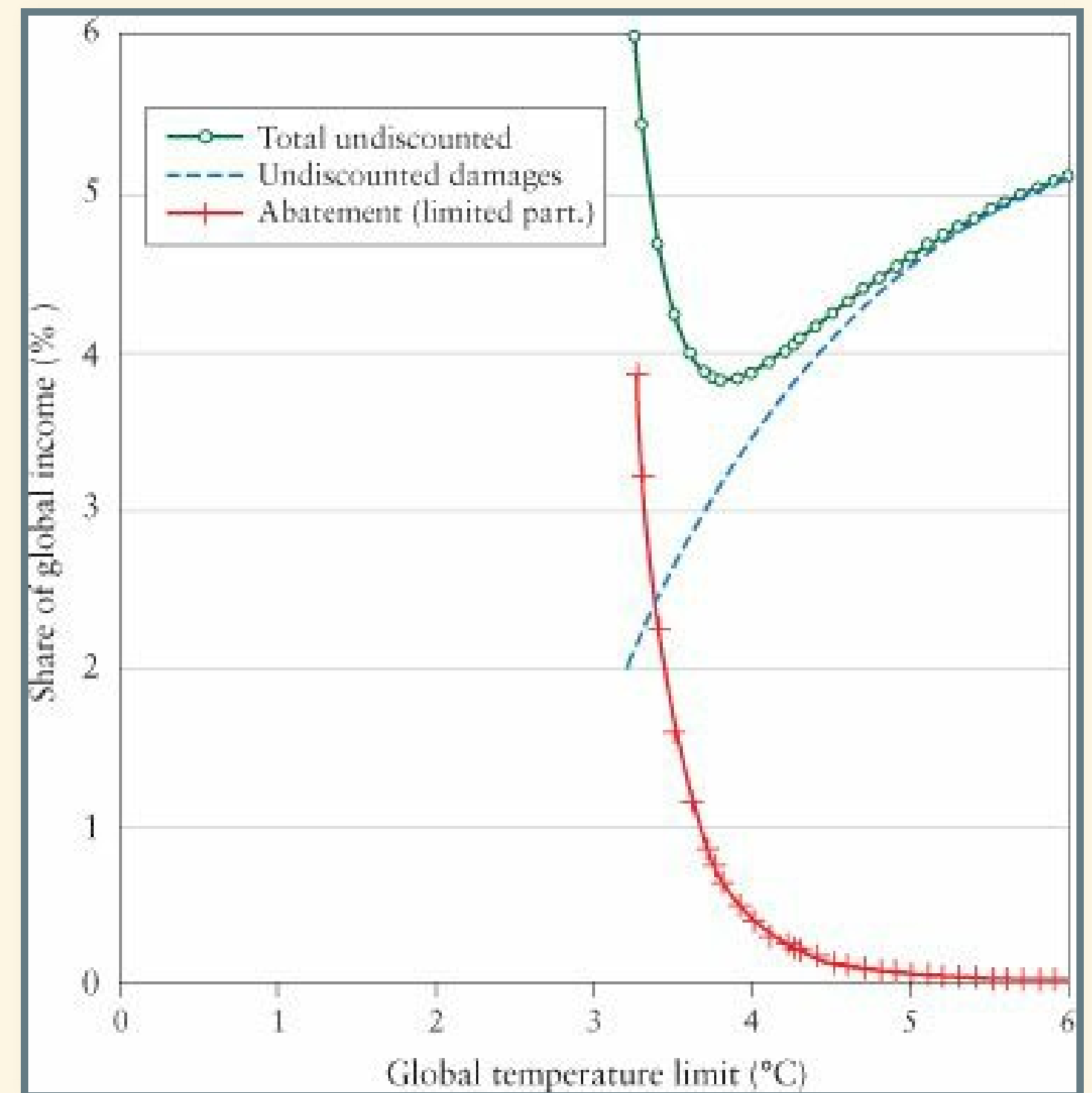
# Climate Casino

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Optimal Policy:  
100% efficient

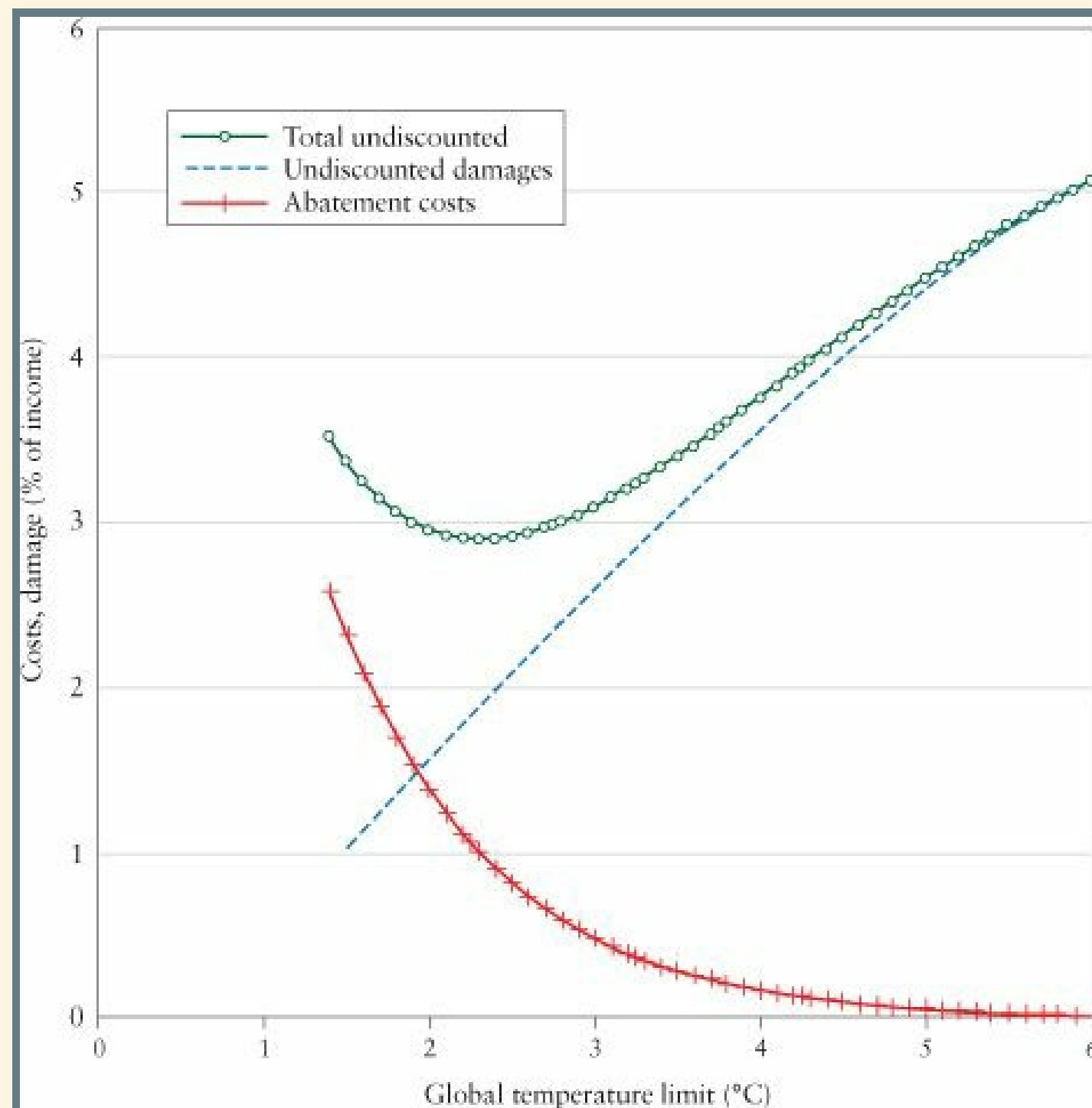


Inefficient:  
Limited Participation

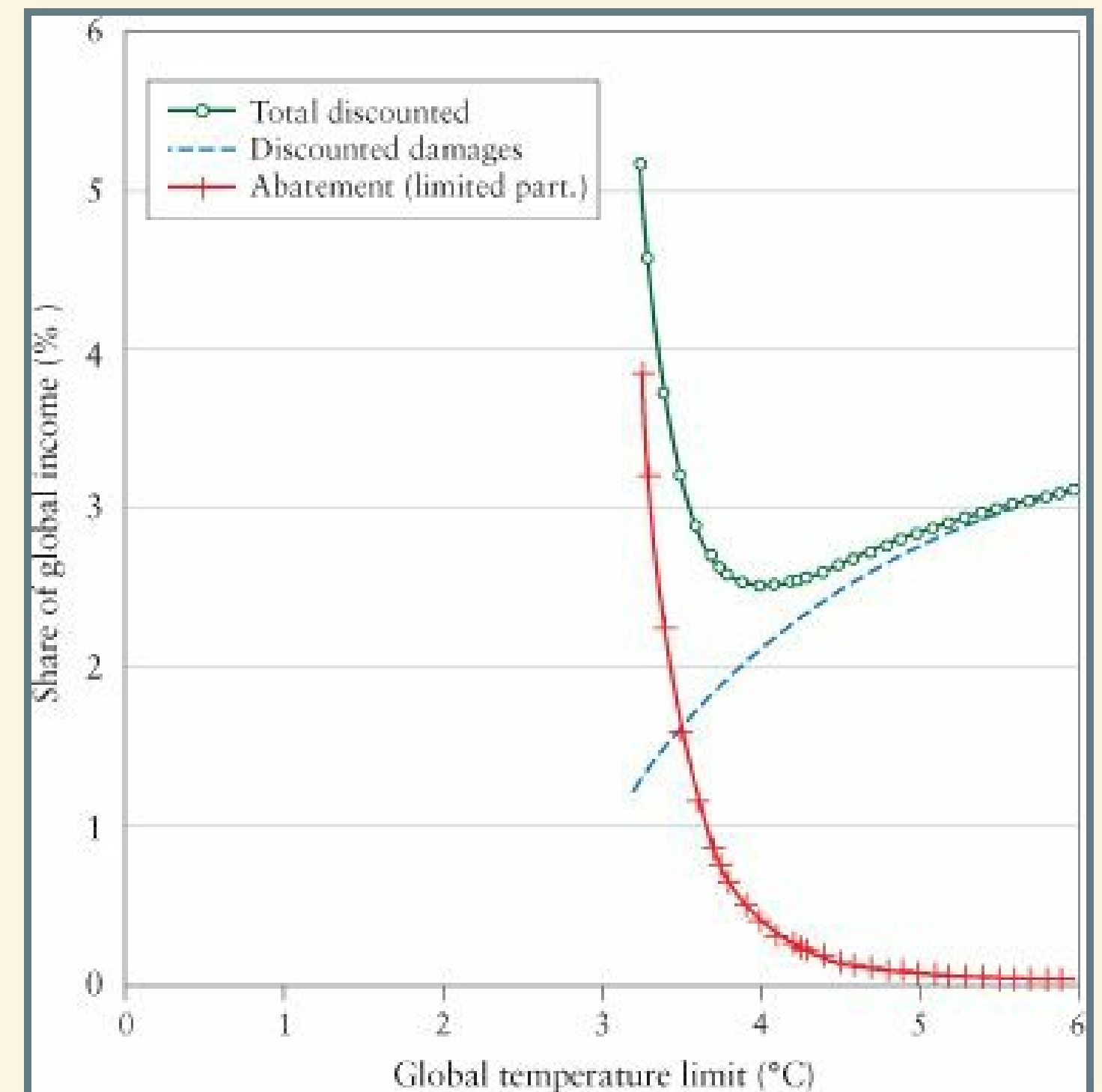


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Optimal Policy:  
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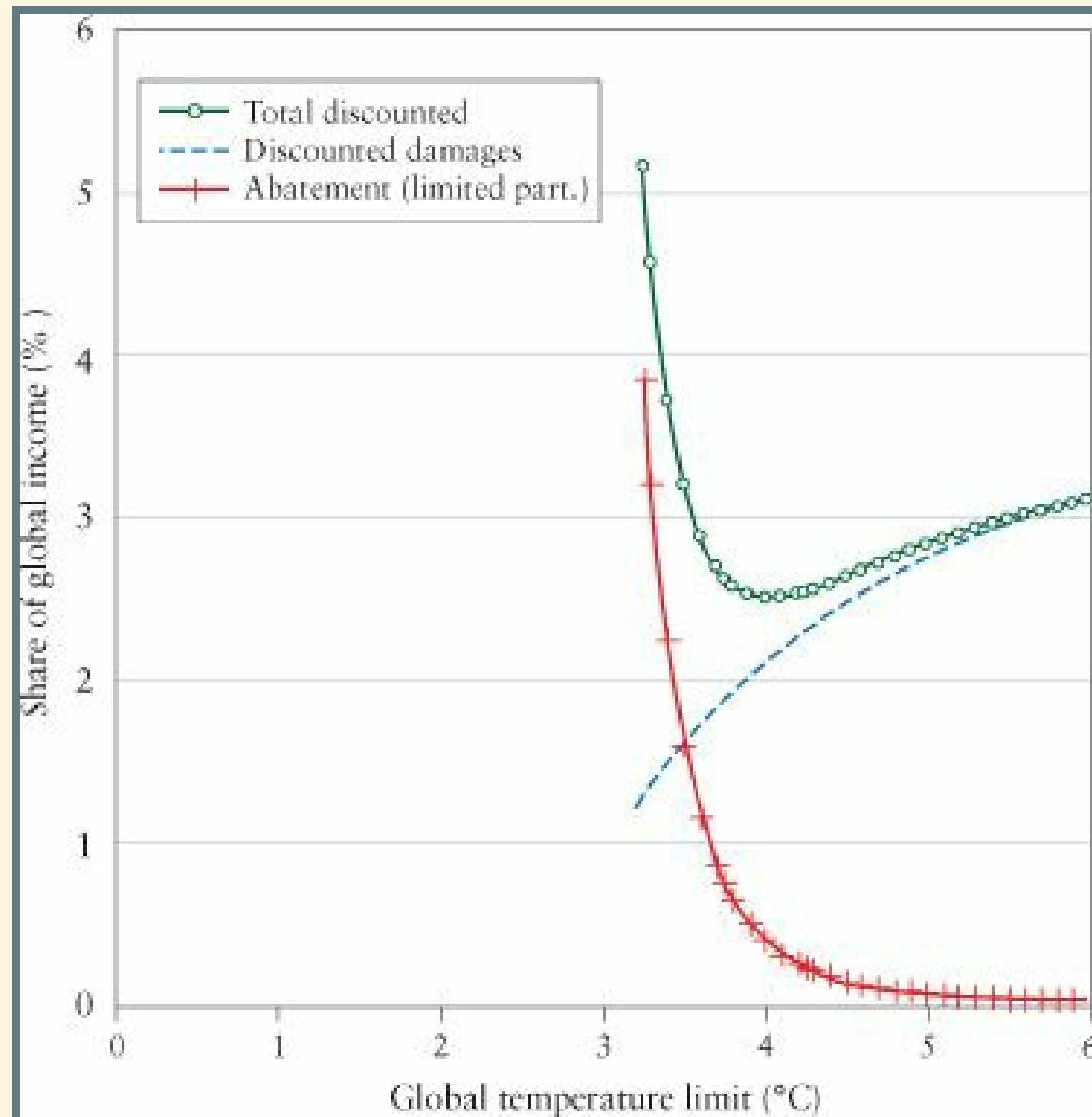


Limited Participation  
with Discounting

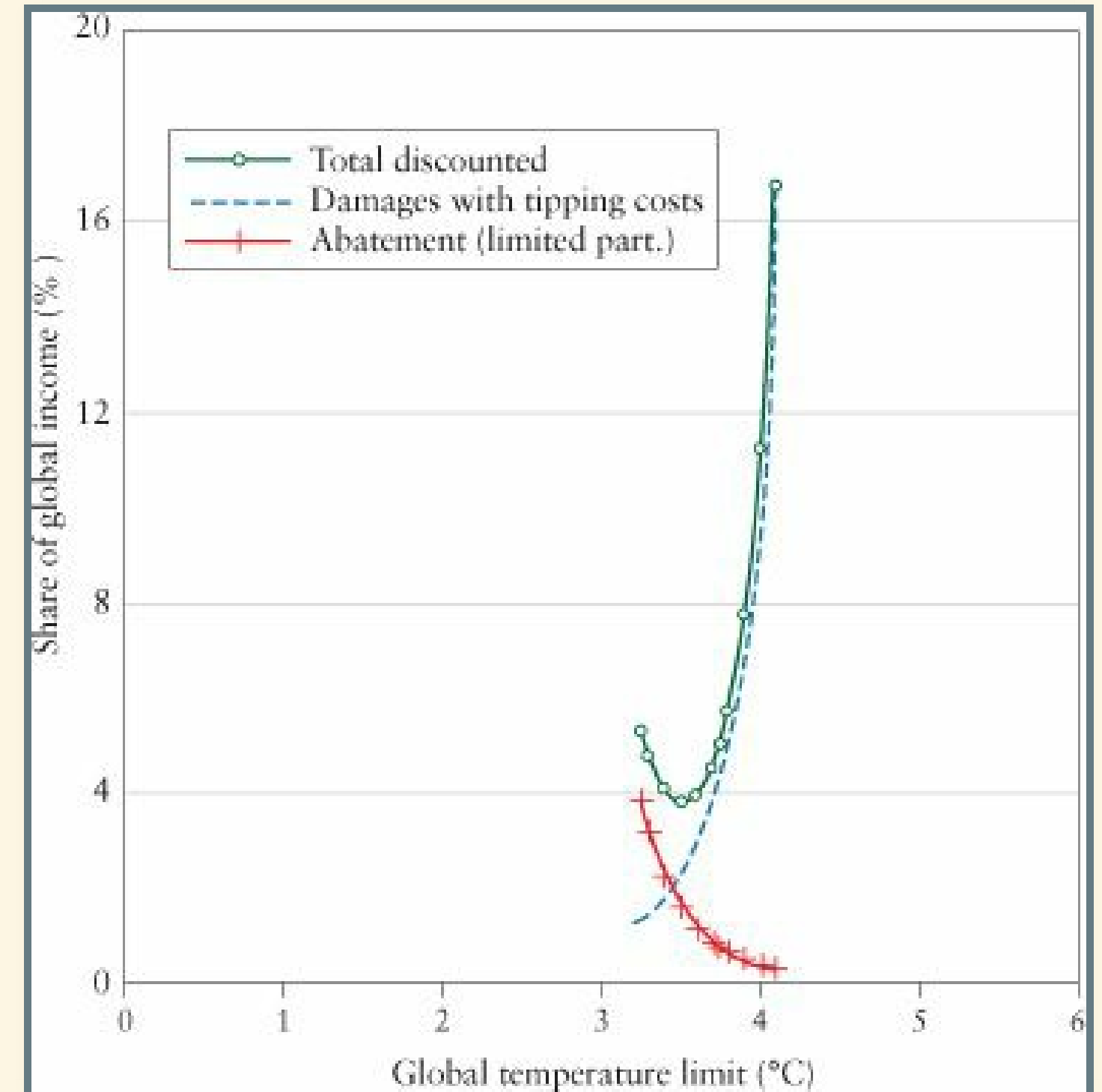


# Climate Casino

## Limited Participation with Discounting



## Limited Participation with Discounting and Tipping Points



# Summary of Principles:

- Higher damages with higher temperatures
- Higher costs of emissions abatement for lower temperature targets
- Higher costs when participation is limited and abatement is inefficient
- Lower damages when you account for discounting
- Tipping points can change everything

# Microeconomics and Emissions Reduction

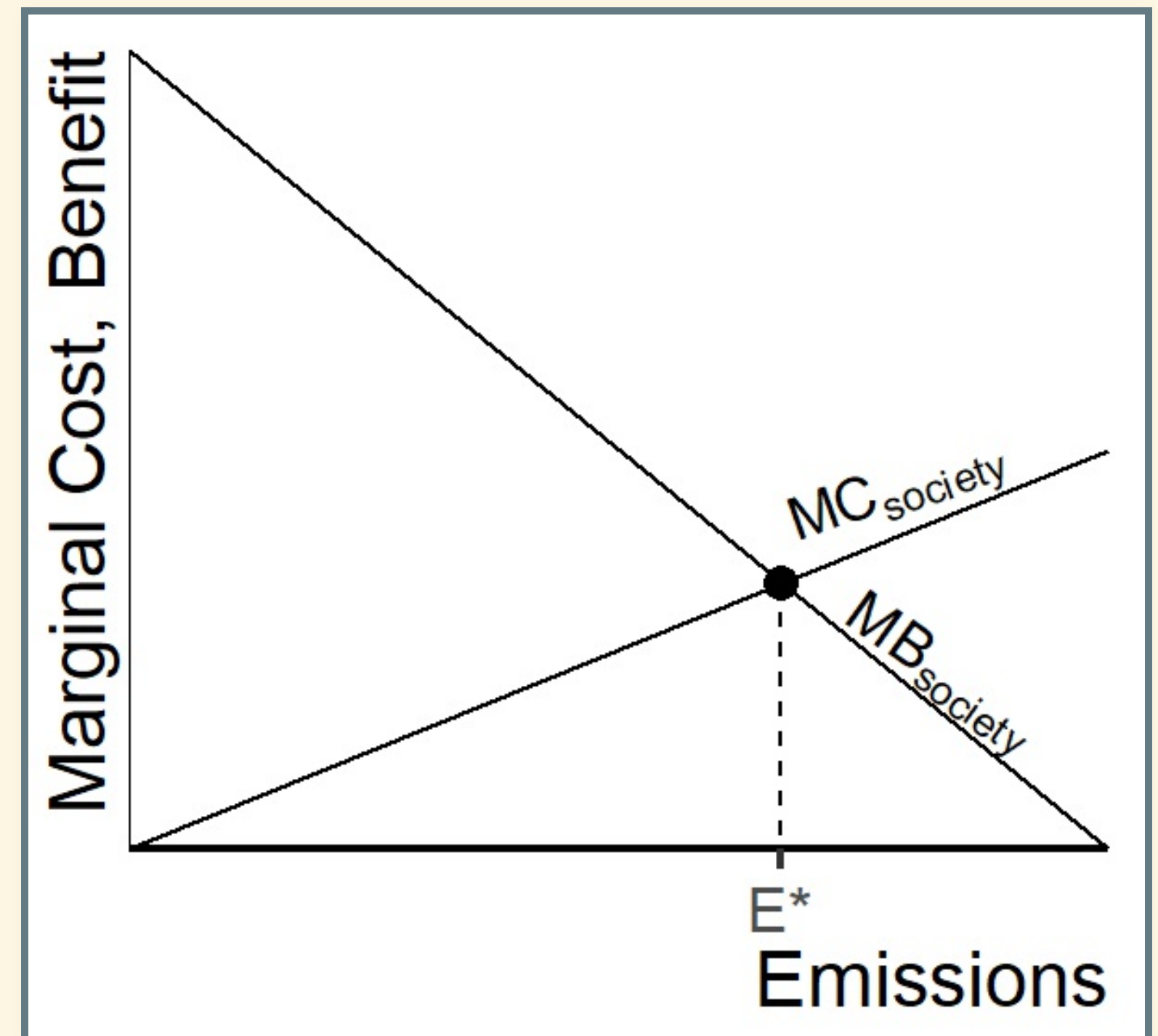
# Technical Microeconomics

- Marginal costs and benefits:
  - iPods:
    - Hundreds of millions to build the first iPod
    - Less than \$100 to build the millionth iPod
  - Production possibilities:
    - Economies of scale
      - Marginal costs fall as volume increases
    - Diminishing returns:
      - Marginal costs rise as volume increases
- Gross costs:
  - Sum of marginal costs for all units produced



# Using Graphs to Avoid Math

- Costs vs. benefits for increasing CO<sub>2</sub> abatement
- MC = marginal cost to society of emissions (pollution)
- MB = marginal benefit of emissions (economic output)
- When  $MC > MB$ , it's worth cutting emissions.
- When  $MC < MB$ , cutting emissions costs more than it's worth.
- When  $MC = MB$ : equilibrium, optimal amount of emissions.



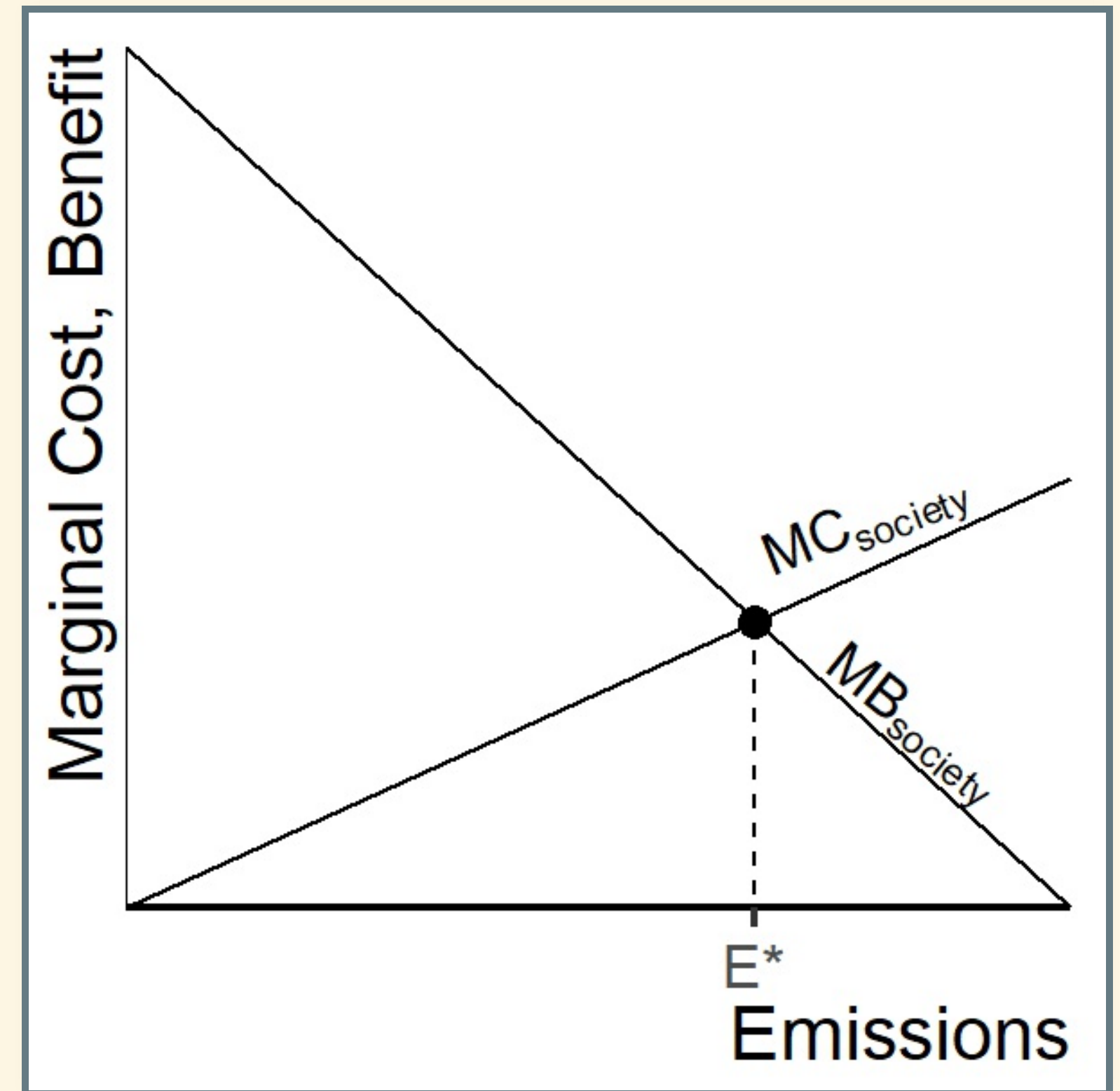
# Slope of MB

- Costs vs. Benefits of Emissions

- Why does MB slope down?

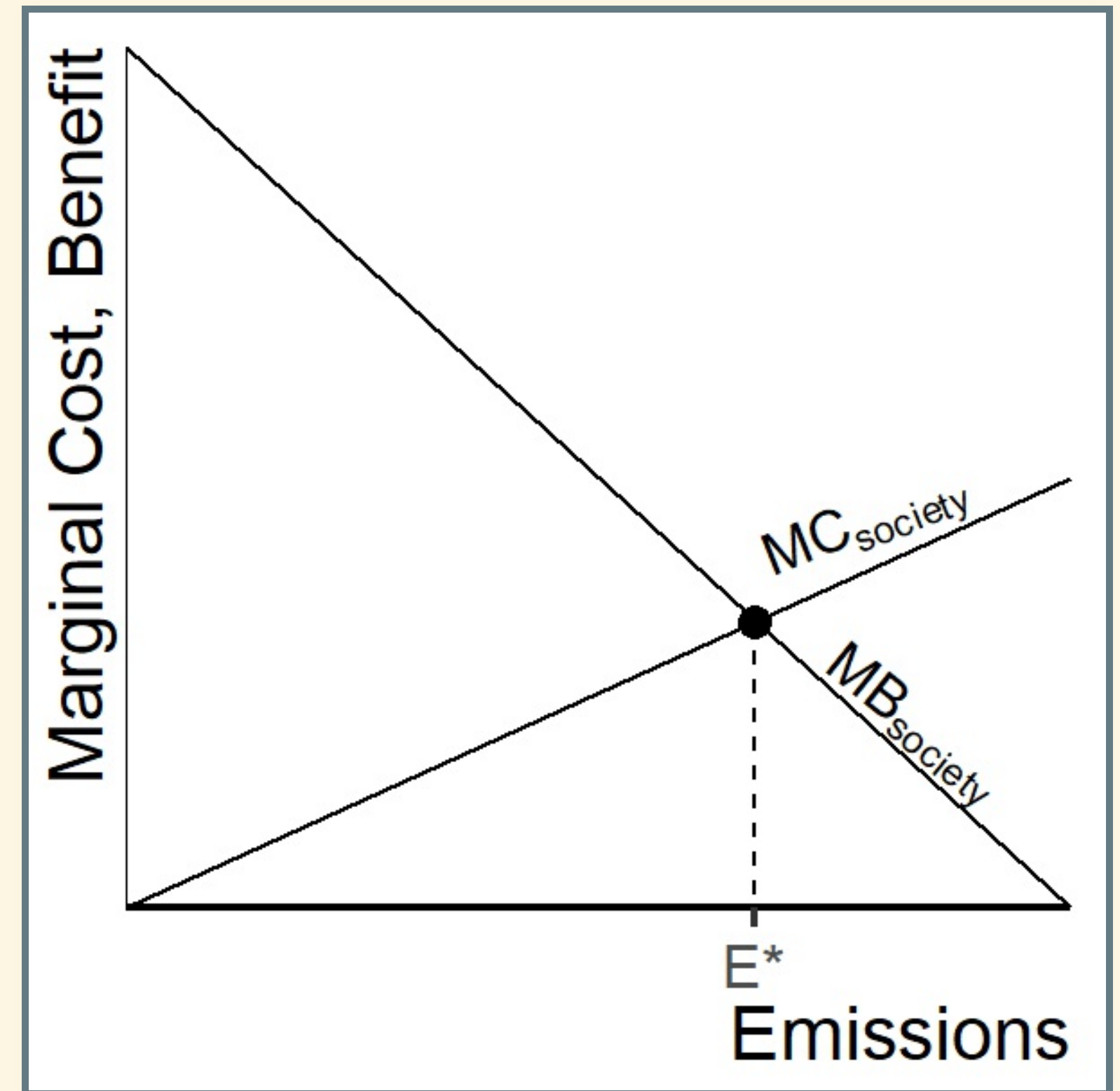
- Optimal emissions:

- When energy is plentiful, diminishing returns on using more
- Implications for cutting emissions:
  - Marginal benefit of emissions = marginal cost of cutting emissions.
  - Do cheap things first (small marginal cost to reduce emissions)
  - When you run out of cheap things, turn to expensive ones



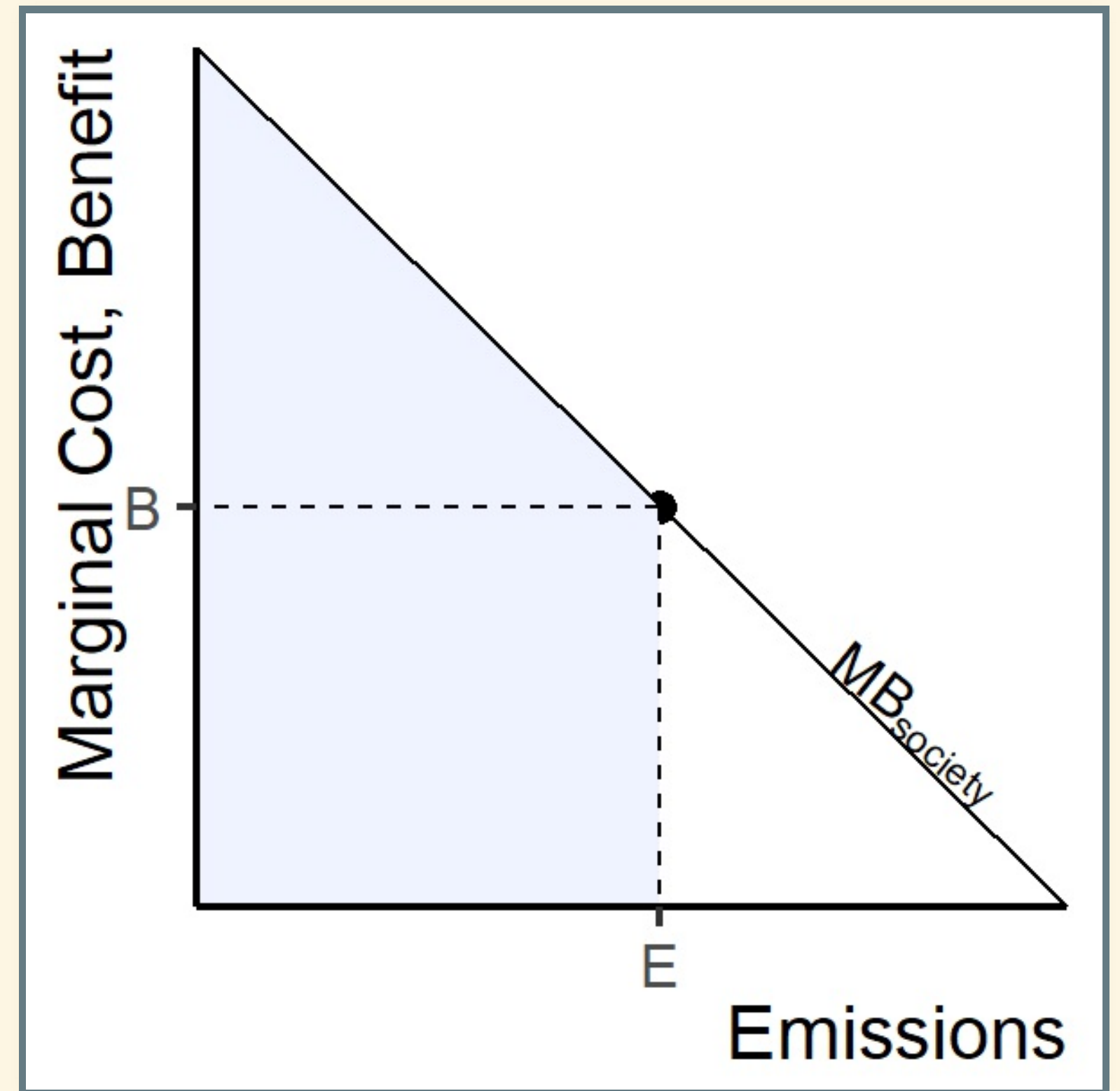
# Slope of MC

- Costs vs. Benefits of Emissions
- Why does MC slope up?
  - Greater emissions mean more warming
  - Greater warming = greater damage:
    - Going from 3°C to 4°C is much worse than going from 2°C to 3°C
    - Benefit of reducing warming from 4°C to 3°C is worth more than reducing it from 3°C to 2°C



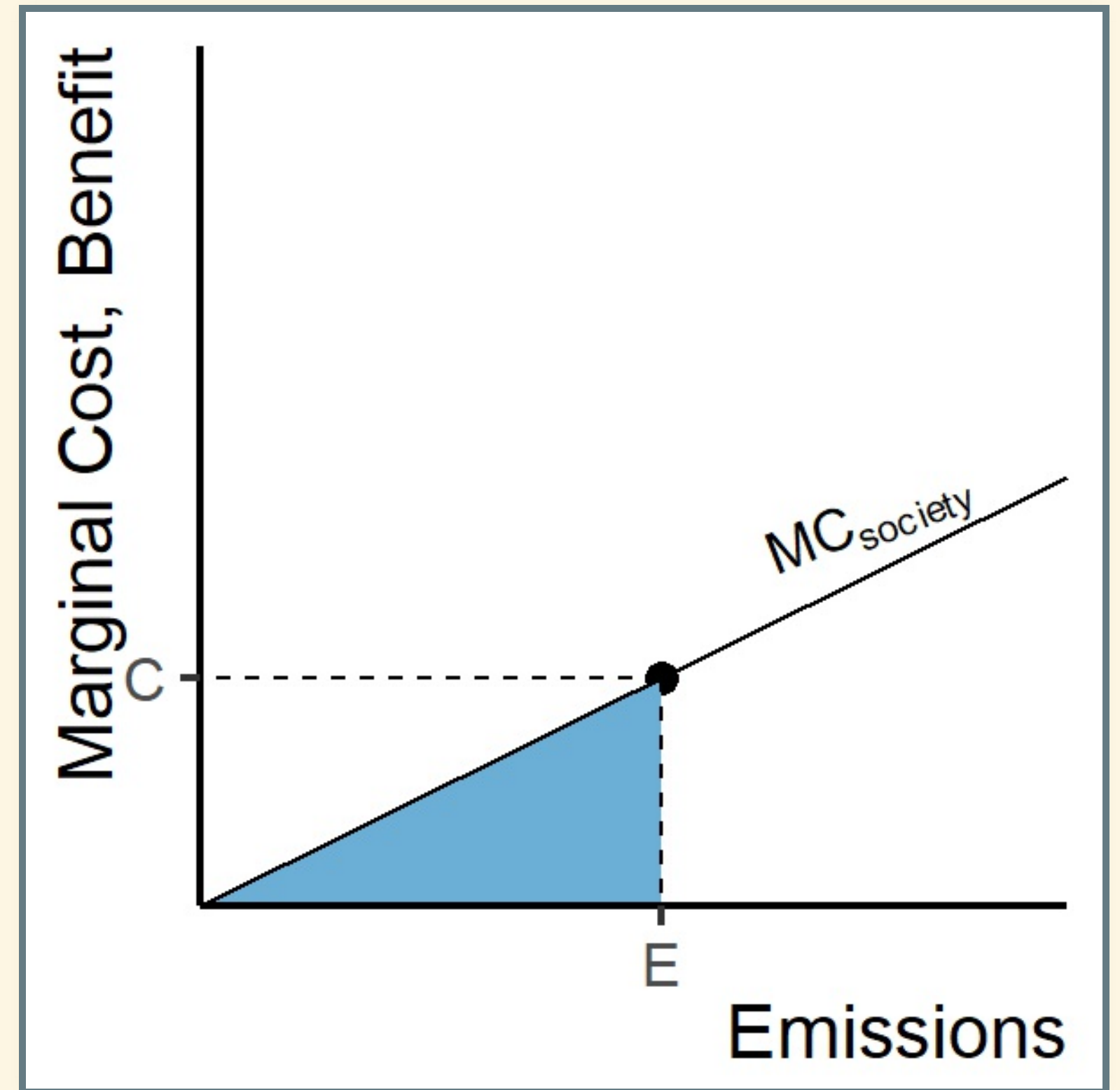
# Marginal vs. Gross Benefit

- $E$  = emissions (abatement)
- $B$  = marginal benefit
- Blue area = total gross benefit to society from emissions



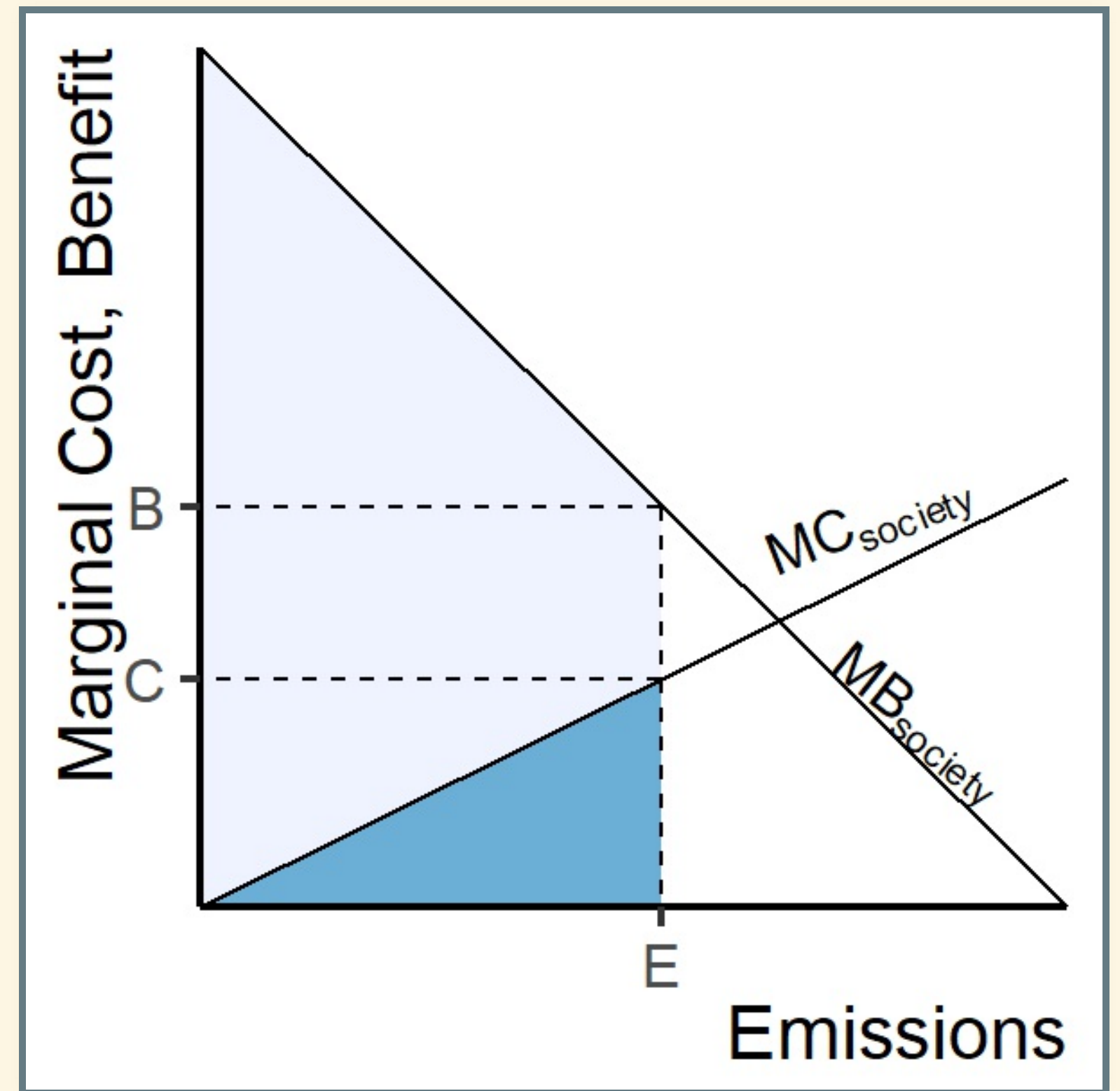
# Marginal vs. Gross Cost

- $E$  = emissions (abatement)
- $C$  = marginal cost
- Blue area = total gross cost to society from emissions



# Putting it Together

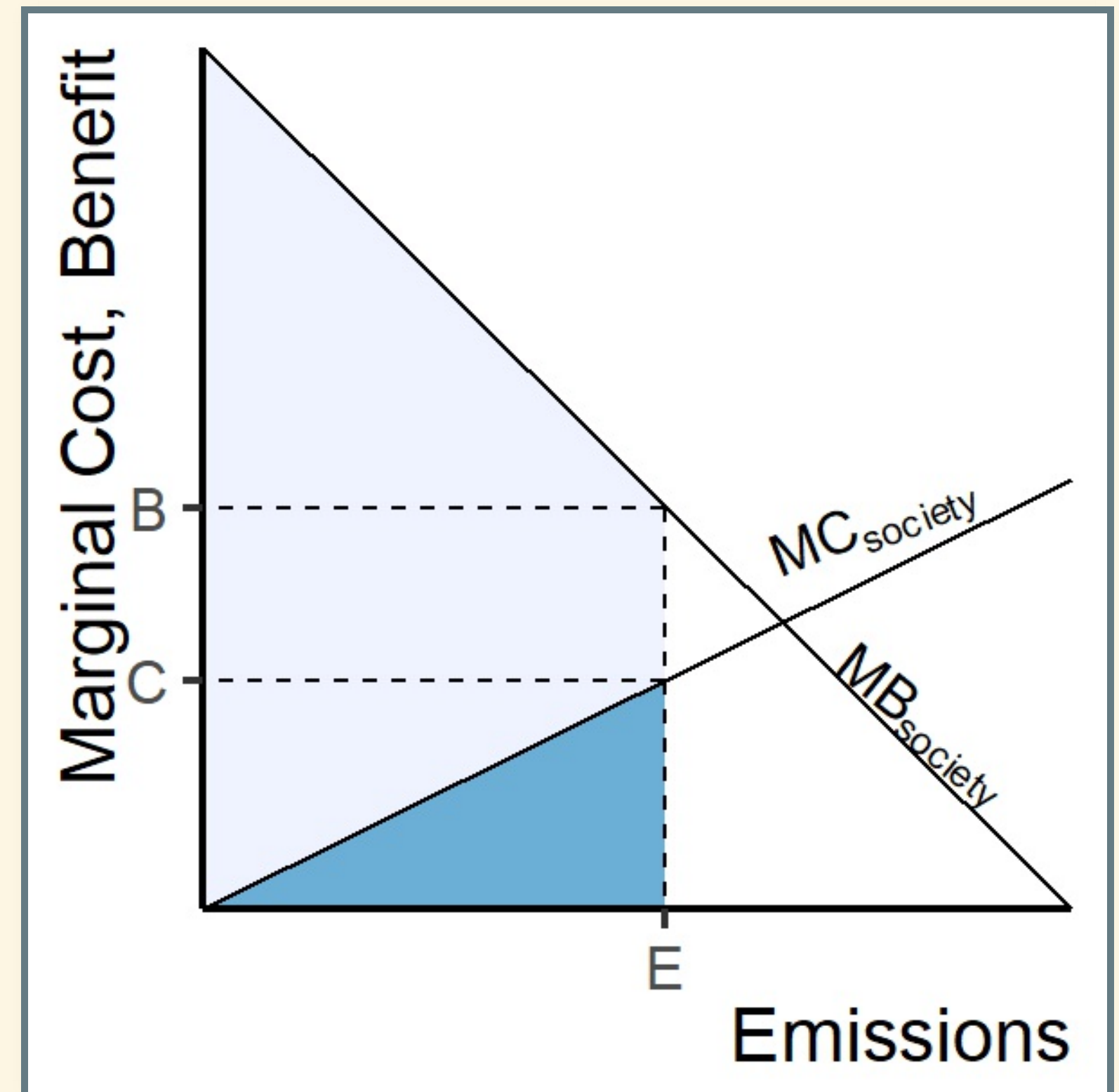
- Marginal benefit at  $E = B$
- Marginal cost at  $E = C$
- Marginal net benefit at  $E = (B - C)$



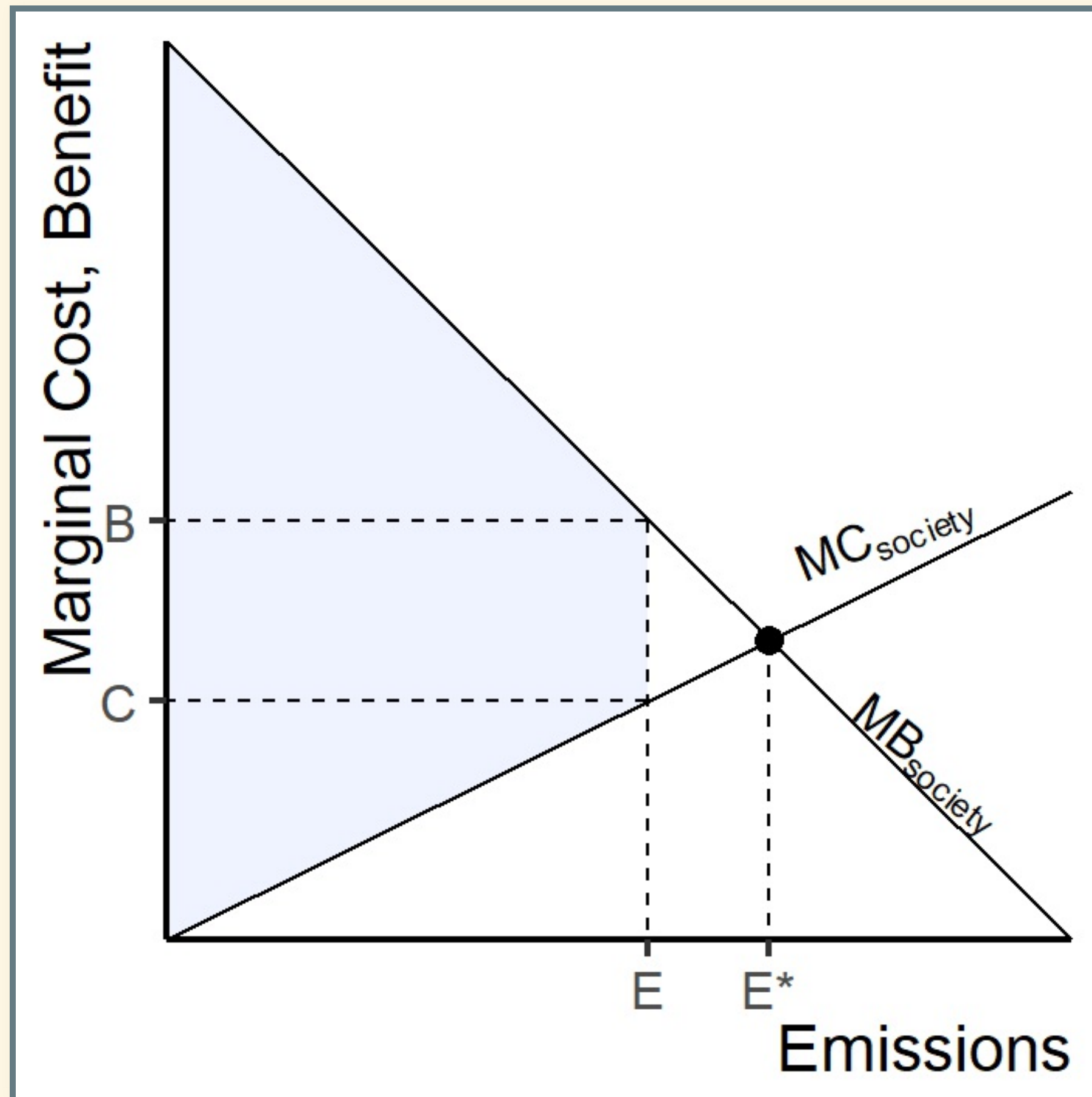


# Putting it Together

- Gross benefit at  $E$  = area under MB (light + dark blue)
- Gross cost at  $E$  = area under MC (dark blue)
- Gross net benefit at  $E$  = gross benefit - gross cost
  - Light-blue trapezoid



# Total Net Benefit

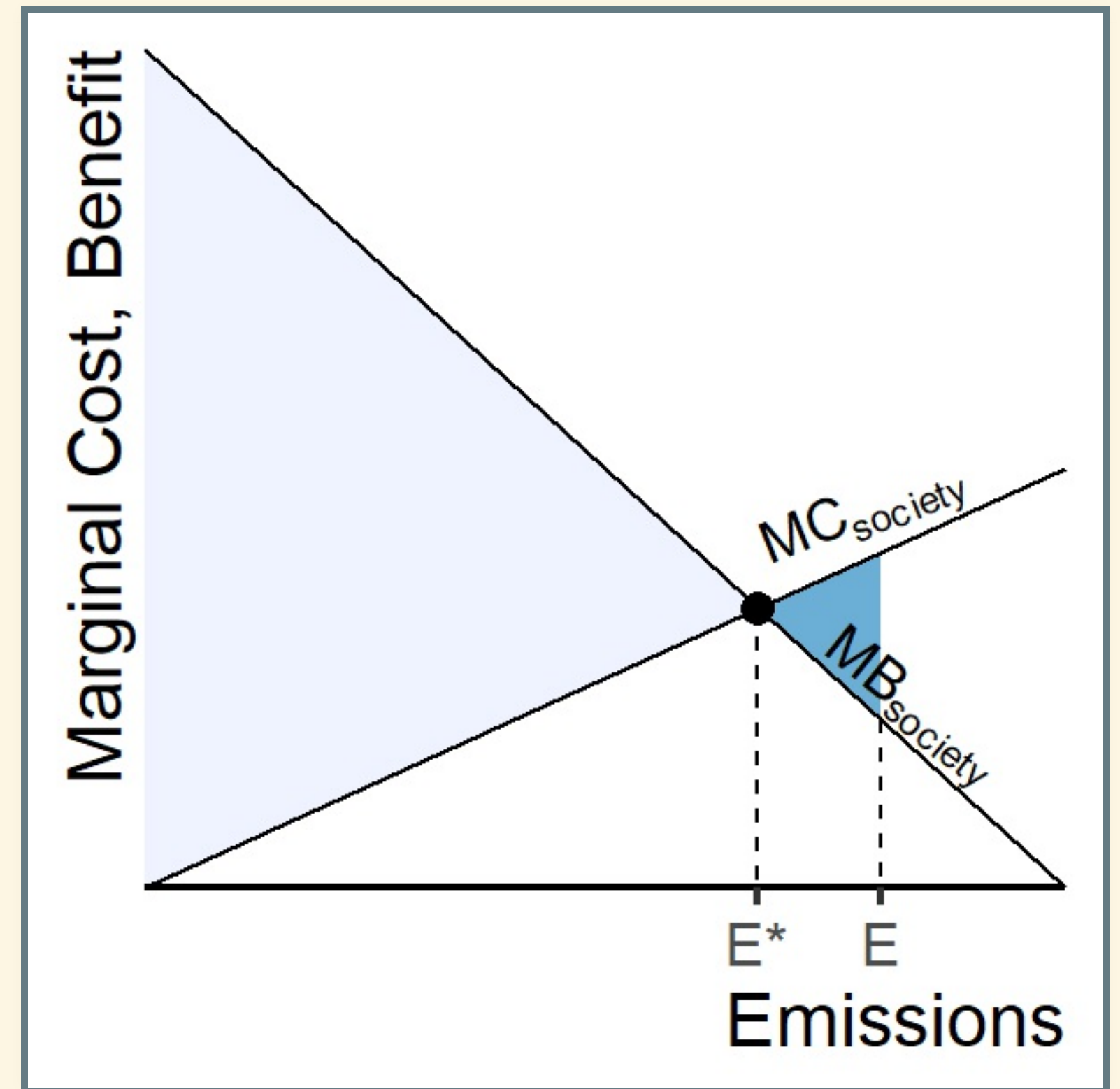




# Optimizing Emissions

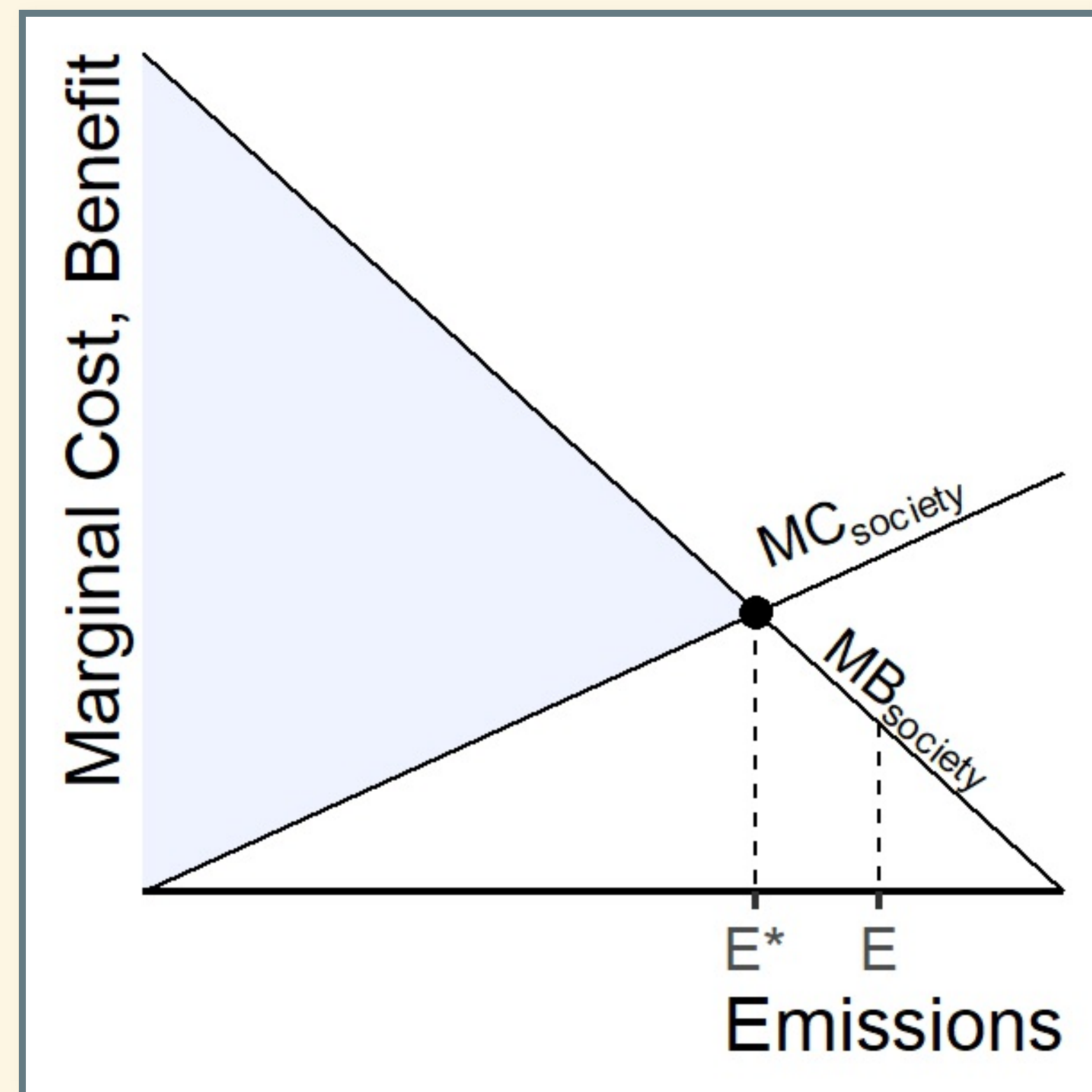
# Optimum Emissions

- Optimum emissions =  $E^*$
- Actual emissions =  $E$
- Little triangle on right:  
Costs > Benefits (net loss)
- EPA issues enough permits to cut emissions of  $E^*$
- Free trading in permits cuts emissions to  $E^*$  at lowest possible cost
- Total net benefits to society are maximized.



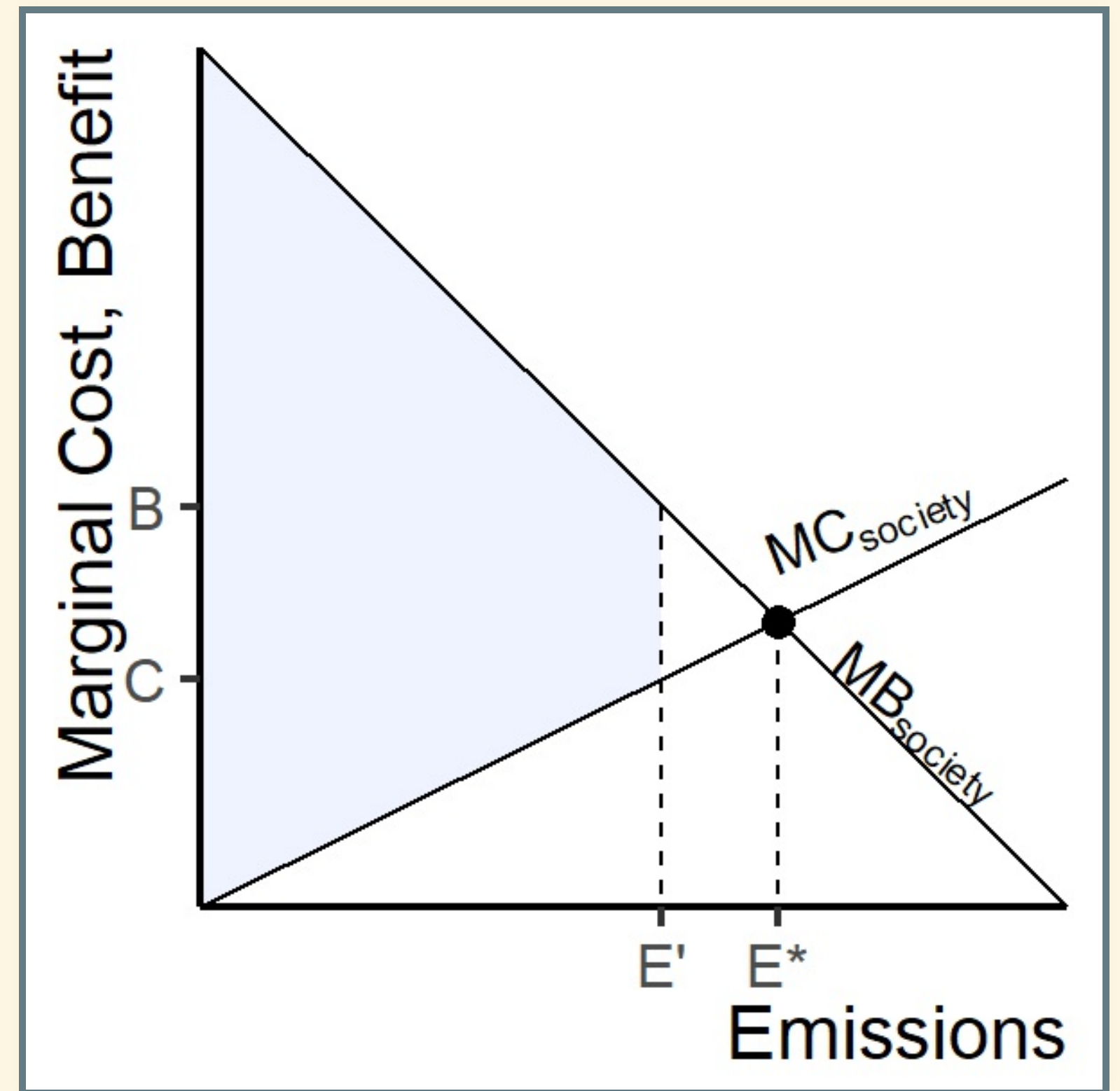
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# Deadweight Losses

- Optimum:  $E^*$
- EPA cuts emissions too far, to  $E'$
- Deadweight loss = empty triangle (difference between actual net benefit and optimum net benefit).



# Deadweight Losses

- Optimum:  $E^*$
- EPA cuts emissions too far, to  $E'$
- Deadweight loss = blue triangle (difference between actual net benefit and optimum net benefit).

