EC2106 PUBLIC ECONOMICS
LECTURE 3

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Fall 2022

Externalities

- Outline:
- What if market does not work?
- Role of externalities.
- Go to (Menti).

Repetition

- **Market failure:** A problem that violates one of the assumptions of the 1st Welfare theorem. $\Rightarrow$ Market outcome does not maximize efficiency.

- **Externality:** Externalities arise when the actions of one agent **directly** affects another agent outside of the market mechanism.

- Externality-Example: A steel plant that pollutes a river, which is used for recreation.

- Non-Externality-Example: A steel plant uses more electricity and bids up the price of electricity for other customers.

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Externality Theory

1. Negative **production** externality.

   A firm's production reduces the well-being of others (not compensated by the firm).

- Concepts:

(i) **Private marginal cost (PMC):** The direct cost of producing one additional good.

(ii) **Marginal Damage (MD):** Additional cost of producing one additional good imposed on others and not paid by the firm.

- **Social Marginal Cost (SMC = PMC + MD):** The private marginal cost to producers plus the marginal damage.

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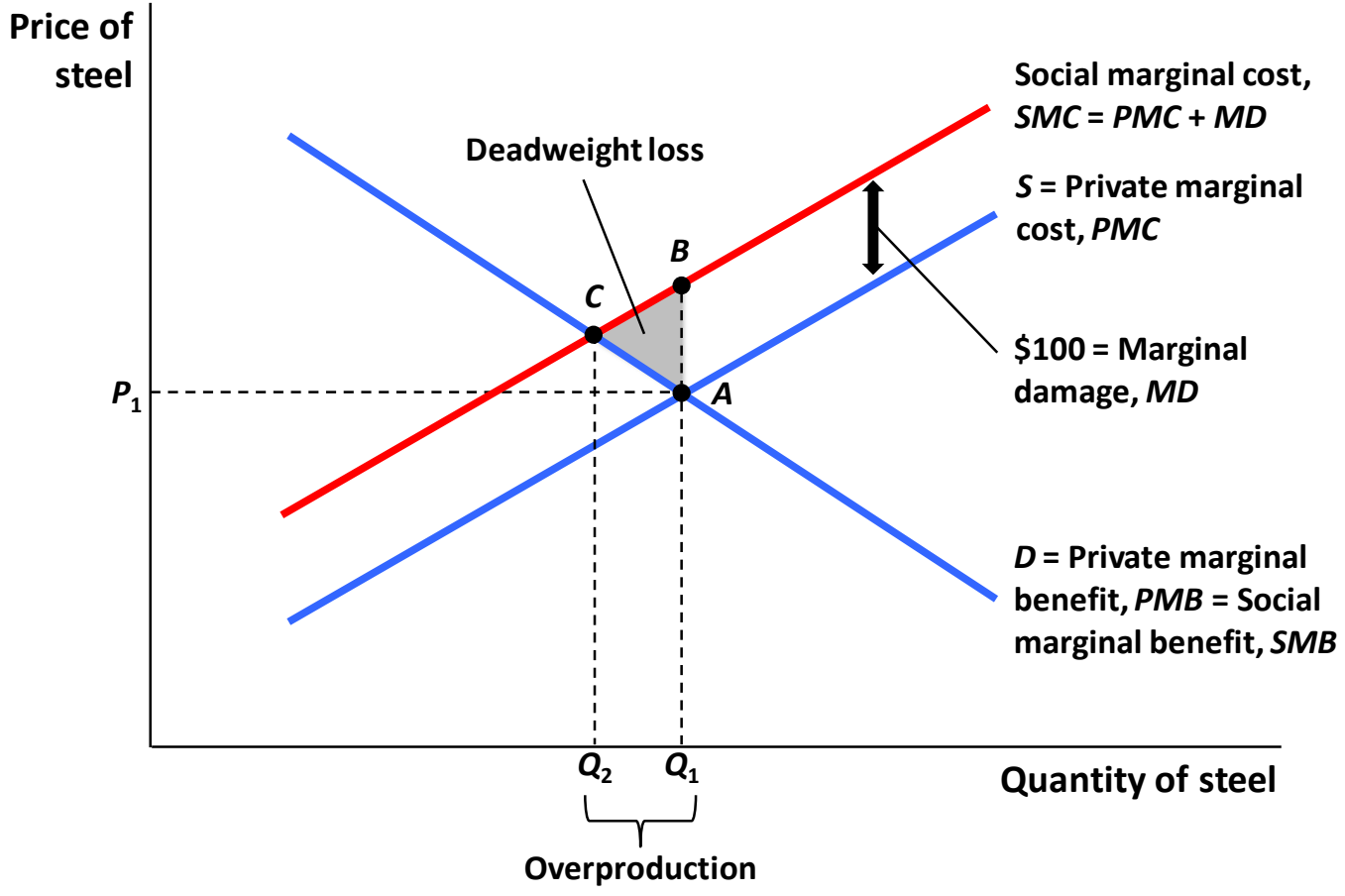
5.1

Economics of Negative Production Externalities: Steel Production



Externality Theory

2. Negative **consumption** externality.

   An individual's consumption reduces the well-being of others (not compensated by the individual).

- Concepts:
- **Private Marginal Benefit (PMB):** The direct benefit of consuming one additional good.
- **Social Marginal Benefit (SMB):** The private marginal benefit to consumers net of costs imposed on others.
- Example: using a car and emitting carbon.

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Example of negative consumption externalities

- Increased consumption of large cars, such as SUVs.

    1. **Environmental externalities:** SUV's more thirsty $\equiv$ emit more CO2.
    2. SUVs wear down roads more.
    3. **Safety externalities:** The likelihood of fatal accident in collision with SUV is many times larger.

Externality Theory

3. Positive **production** externality.

   A firm's production increases the well-being of others (but is not compensated by the individual).

   Example: Beehives of honey producers affect pollination and agriculture positively.

4. Positive **consumption** externality.

   An individual's consumption increases the well-being of others (but is not compensated by others).

   Example: Beautiful private garden that passers-by enjoy.

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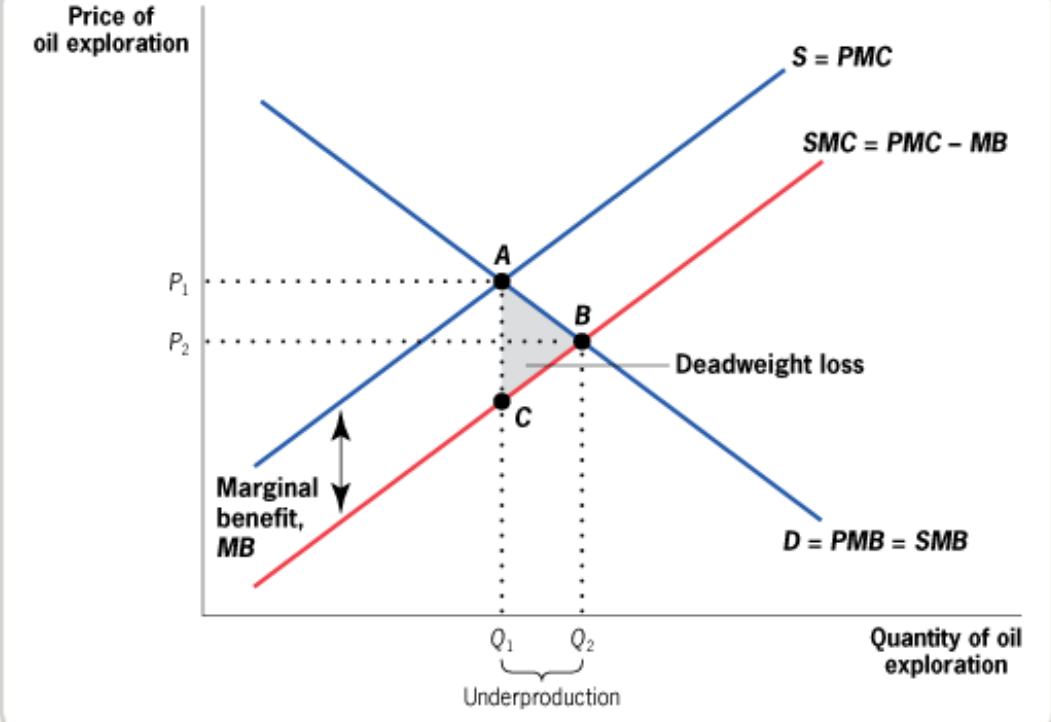
Externality Theory

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

- On the free market, quantities and prices are set as:

$$PMB = PMC. \tag{1}$$

- But, social optimum is achieved when

$$SMB = SMC. \tag{2}$$

$\Rightarrow$ Private market leads to an inefficient outcome (1st welfare theorem).

- Cases:
  1. **Negative** production externality $\Rightarrow$ over-production.
  2. **Positive** production externality $\Rightarrow$ under-production.
  3. **Negative** consumption externality $\Rightarrow$ over-consumption.
  4. **Positive** consumption externality $\Rightarrow$ under-consumption.

Solutions

- "In microeconomics, the market is innocent until proven guilty." *Jon Gruber*, Ch 5.
- Ronald Coase, Nobel Prize winner, libertarian:
  - Are externalities really outside the market mechanism?
- **Internalizing the externality:**
  - When private negotiations or government action leads the market price to **include** the external costs or benefits.

Solutions

- **Coase Theorem (part I):** When property rights are well-defined, negotiations b/w the party creating the externality and the party affected by the externality can achieve the socially optimal market quantity.

- **Coase Theorem (part II):** The socially optimal quantity does not depende on which party is assigned property rights. Key is that someone is assigned them.

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Coase Theorem Example

- Setup: Firms pollute a river enjoyed by swimmers.

1. **Swimmers own river.**
   - Swimmers charge firm for pollution.

     In equilibrium, they charge firms the marginal damage (MD) per pollution unit.

     Why is the price at MD? If $p > MD$, swimmers would want to sell one unit of pollution more and gain $p - MD$, so price must fall.
2. **Firms own river.**
   - Firm charges swimmers for polluting less.

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     Equilibrium pollution is the same in 1. and 2.

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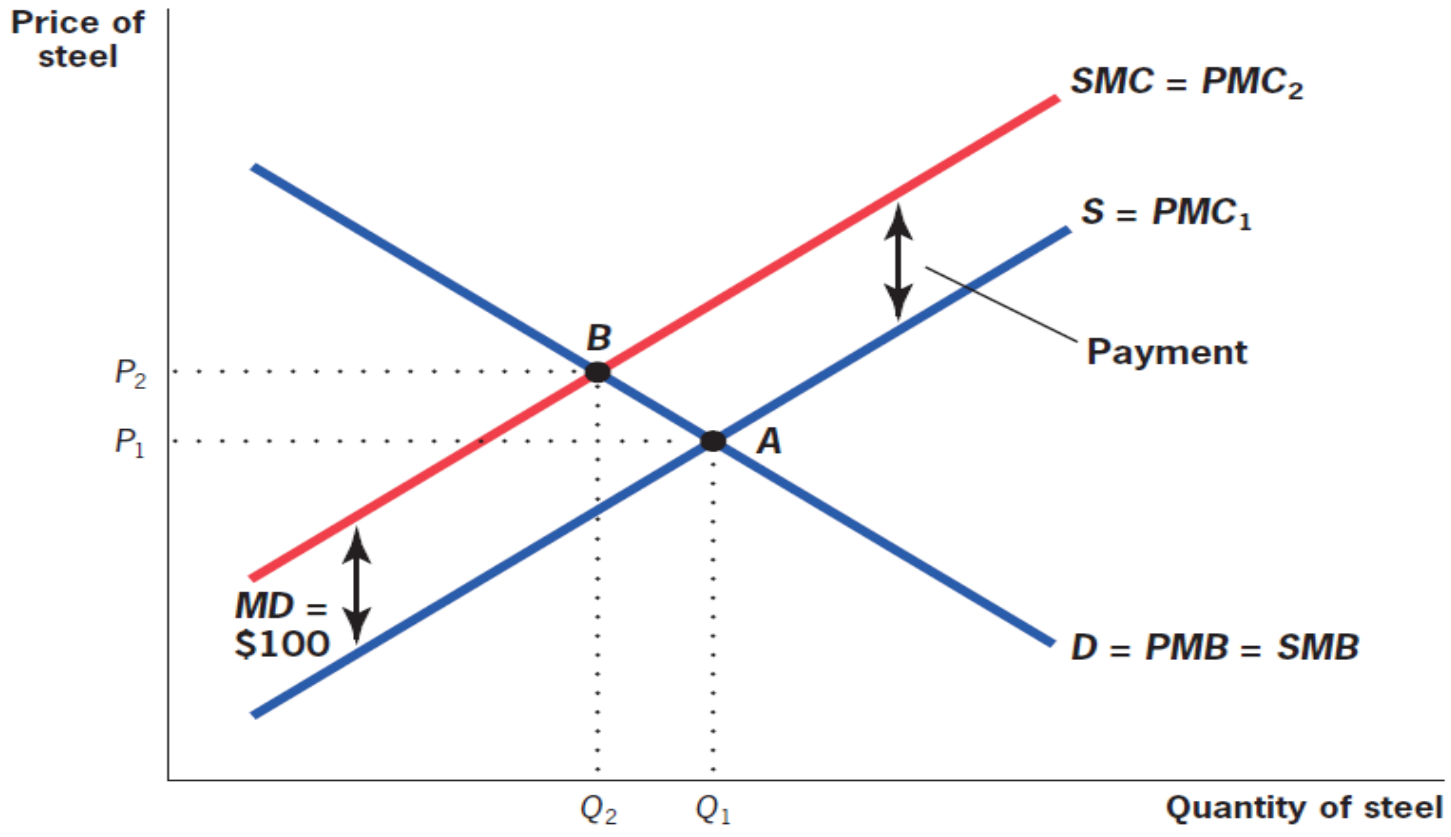
5.2

The Solution: Coasian Payments



Coase Theorem in Practice

- In reality, the Coase theorem is not solving many externality-problems.

1. **The assignment problem:**
   - If externalities affect many agents – e.g. global warming – it is impossible to assign property rights.
   - How can we assign value to the damage?

2. **The holdout problem:** Shared ownership of property rights ⇒ Power of all the others, because everyone have to agree to Coasian solution.

3. **Transaction costs and negotiations:** Coasian solution ignores that it is hard to negotiate when there are many agents involved.

- Bottom line:

1. Coasian solution more effective for small, local externalities.
2. Coasian solution does not solve large-scale, global externalities, such as global warming (which must include the government).

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Government solutions

- Three typical types of remedies:

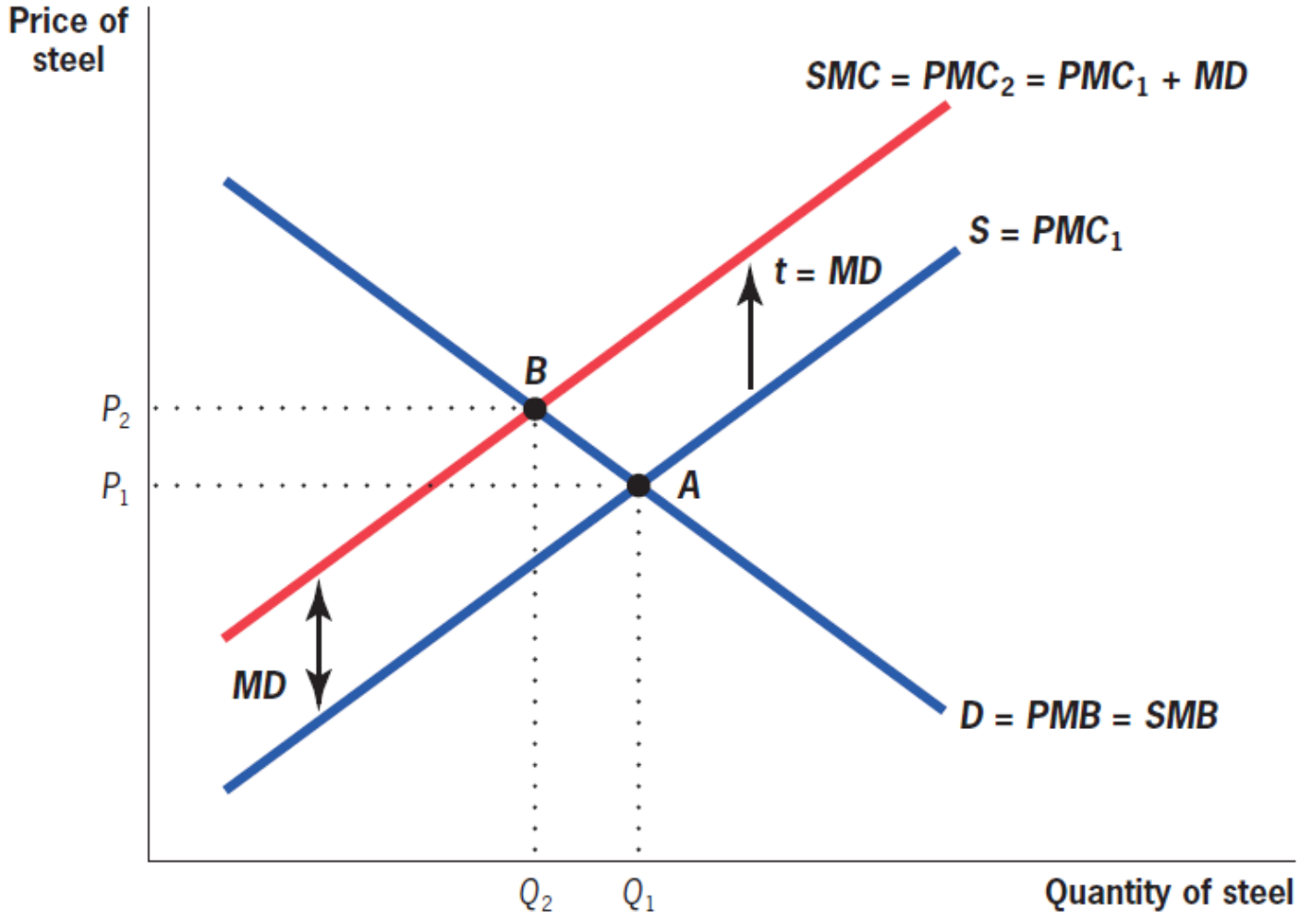
1. **Corrective taxation:** Corrective tax / subsidy that equals the marginal damage (MD).
   - Example: Carbon tax to fight CO2-emissions.

2. **Quantity regulation:** Government limits the use of production.
   - Example: CFCs (Chlorofluorocarbons), present in cooling systems, deplete ozone layer.

3. **Cap-and-trade:** Give / sell emissions rights.

5.3

Corrective Taxation



Empirical Example: Acid Rain and Health

- How large are environmental externalities in the real world?

- Key Question: How does acid rain (or SO_2) affect health outcomes? (Chay and Greenstone, 2003.)

(i) Naive approach: Correlation between health outcomes (e.g. mortality) and level of particulates in the air.

- Problem: Areas with more particulates different in many ways, not just in the amount of particulates in the air.

(ii) Chay and Greenstone (2003) use **1970 Clean Air Act:** First major federal legislation in the US to regulate air pollution.

- Mainly regulating emissions of sulfur dioxide (SO_2; *svaveldioxid* in Swedish) and nitrogen oxide (NO_x; *kväveoxid* in Swedish).

- Reform assigned US counties into:
  1. Non-attainment status (**TREATMENT**) – Total Suspended Particulates (TSPs) $>$ threshold.
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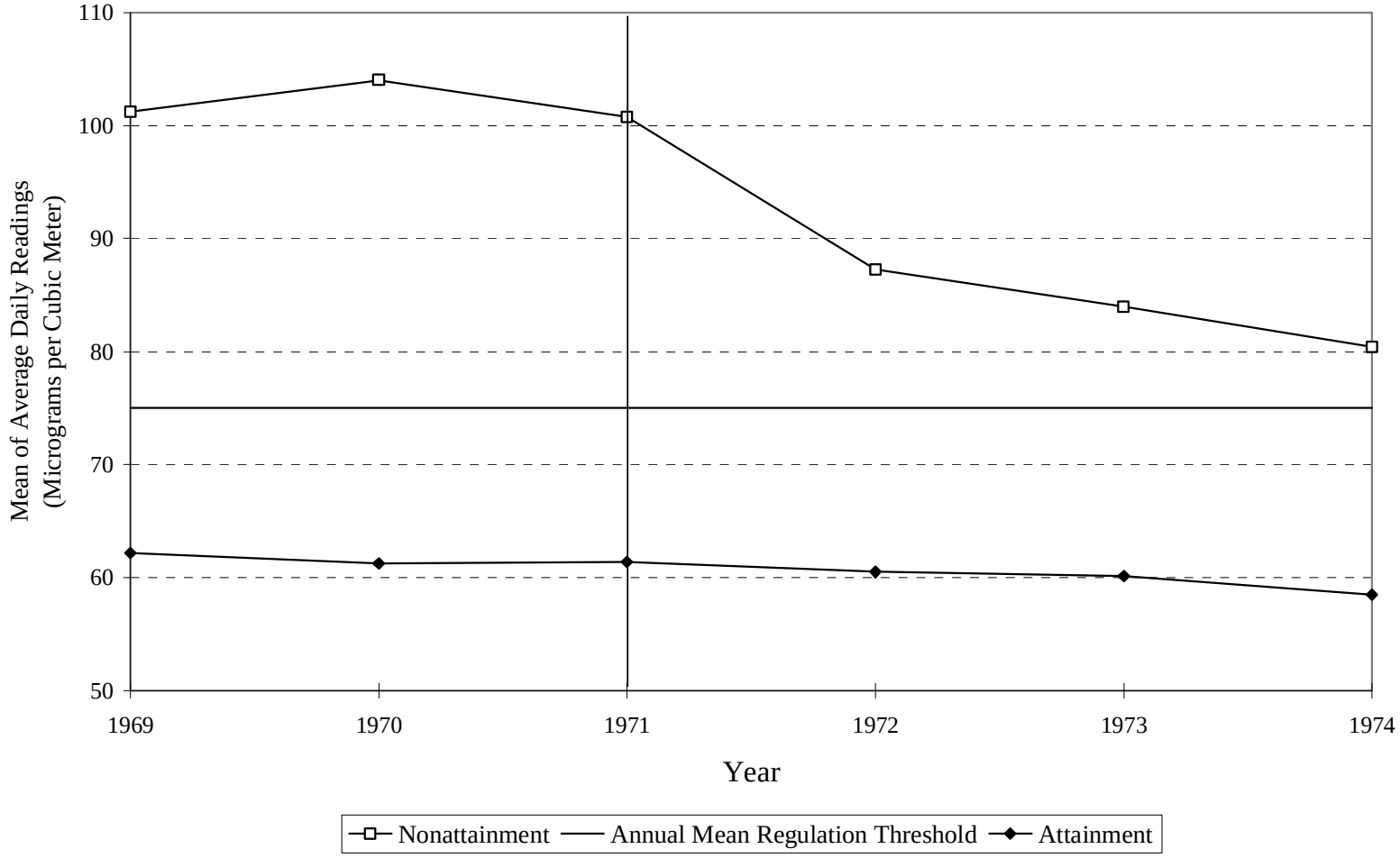
Figure 2: Trends in TSPs Pollution and Infant Mortality, by 1972 Nonattainment Status

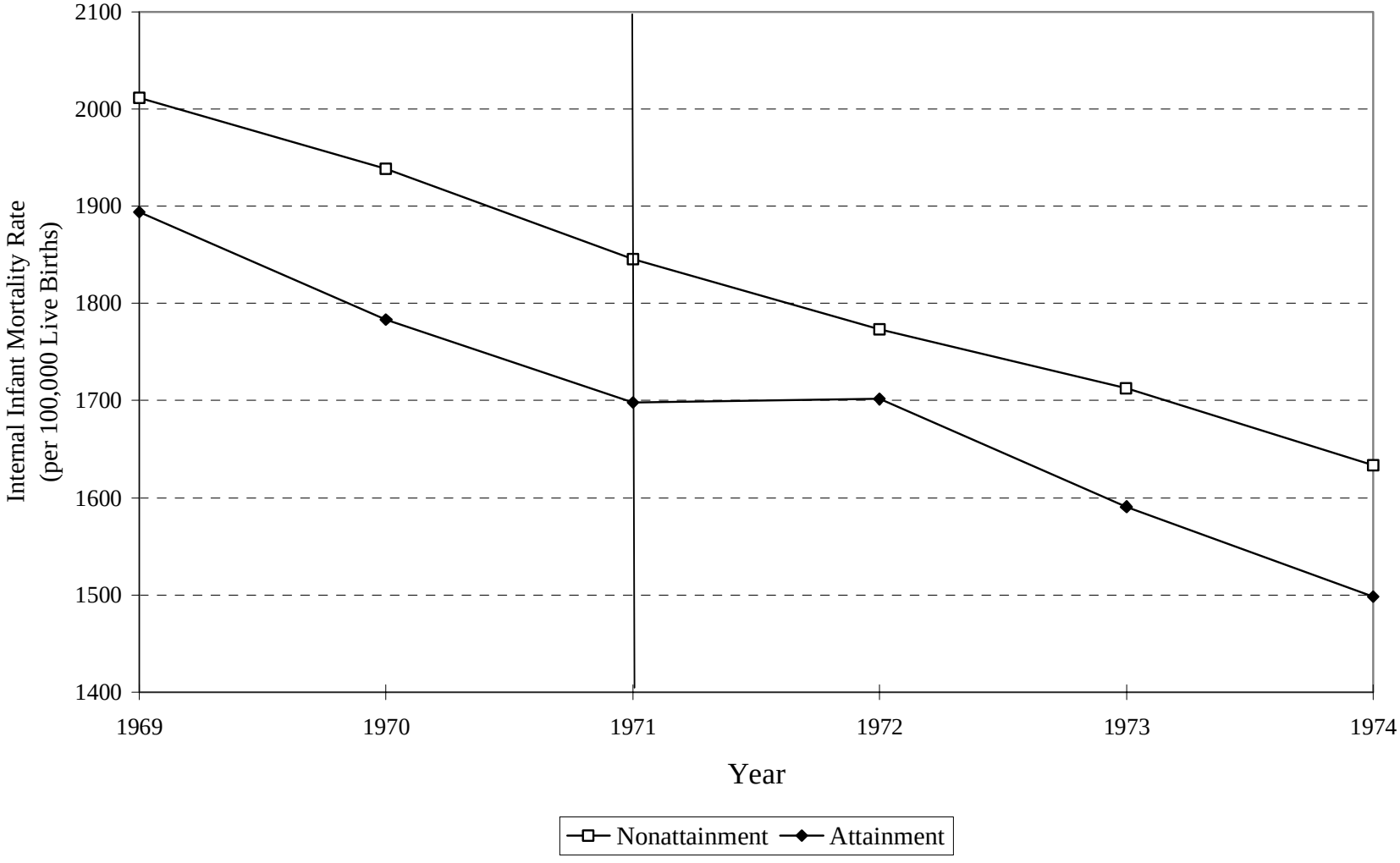
A. Trends in Mean TSPs Concentrations, by 1972 Nonattainment Status



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

Source: Chay and Greenstone (2003)

B. Trends in Internal Infant Mortality Rate, by 1972 Nonattainment Status



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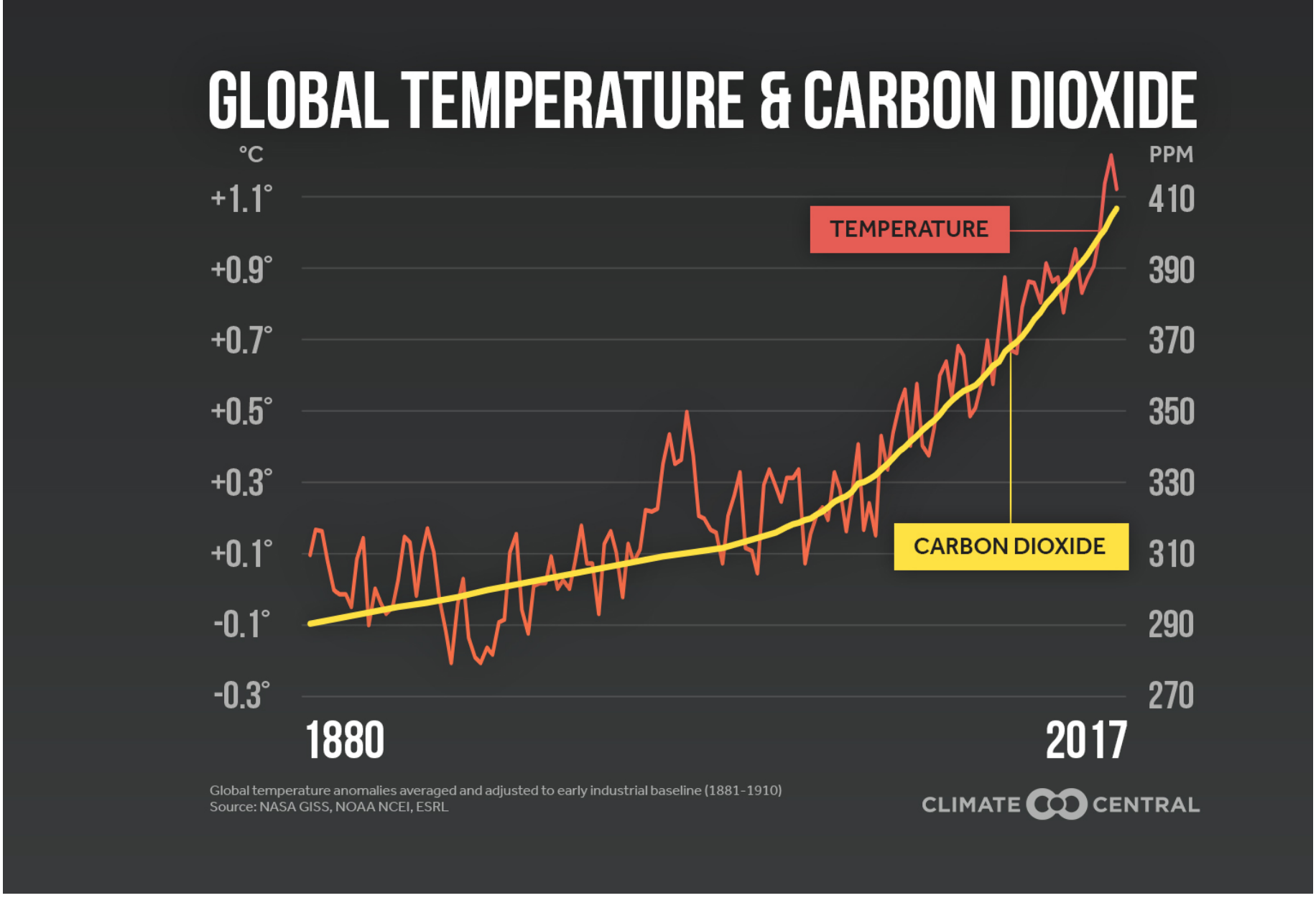
GLOBAL TEMPERATURE & CARBON DIOXIDE
°C
PPM
+1.1°
+0.9°
+0.7°
+0.5°
+0.3°
+0.1°
-0.1°
-0.3°
410
390
370
350
330
310
290
270
TEMPERATURE
CARBON DIOXIDE
1880
2017
Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910)
Source: NASA GISS, NOAA NCEI, ESRL
CLIMATE CENTRAL

Climate change and CO2 Emissions

- Industrialization has increased CO2-emissions dramatically. This generates global warming.
- How can we address it?

- Four challenging factors (Wagner-Weitzman, 2015):
  1. **Global:** Emissions in one country affect the world.
  2. **Irreversible:** Atmospheric CO2 has long life (centuries).
     - Absent carbon capture techn.
  3. **Long-term:** Costs of global warming last decades / centuries. How should we discount future costs?
  4. **Uncertain:** Great uncertainty in costs of global warming.
- How fast should we cut emissions? Stern-Weitzman argue for fast path, Nordhaus wants slower reduction.

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Point 3: How to discount future costs?

- **Social cost of carbon (SCC):**

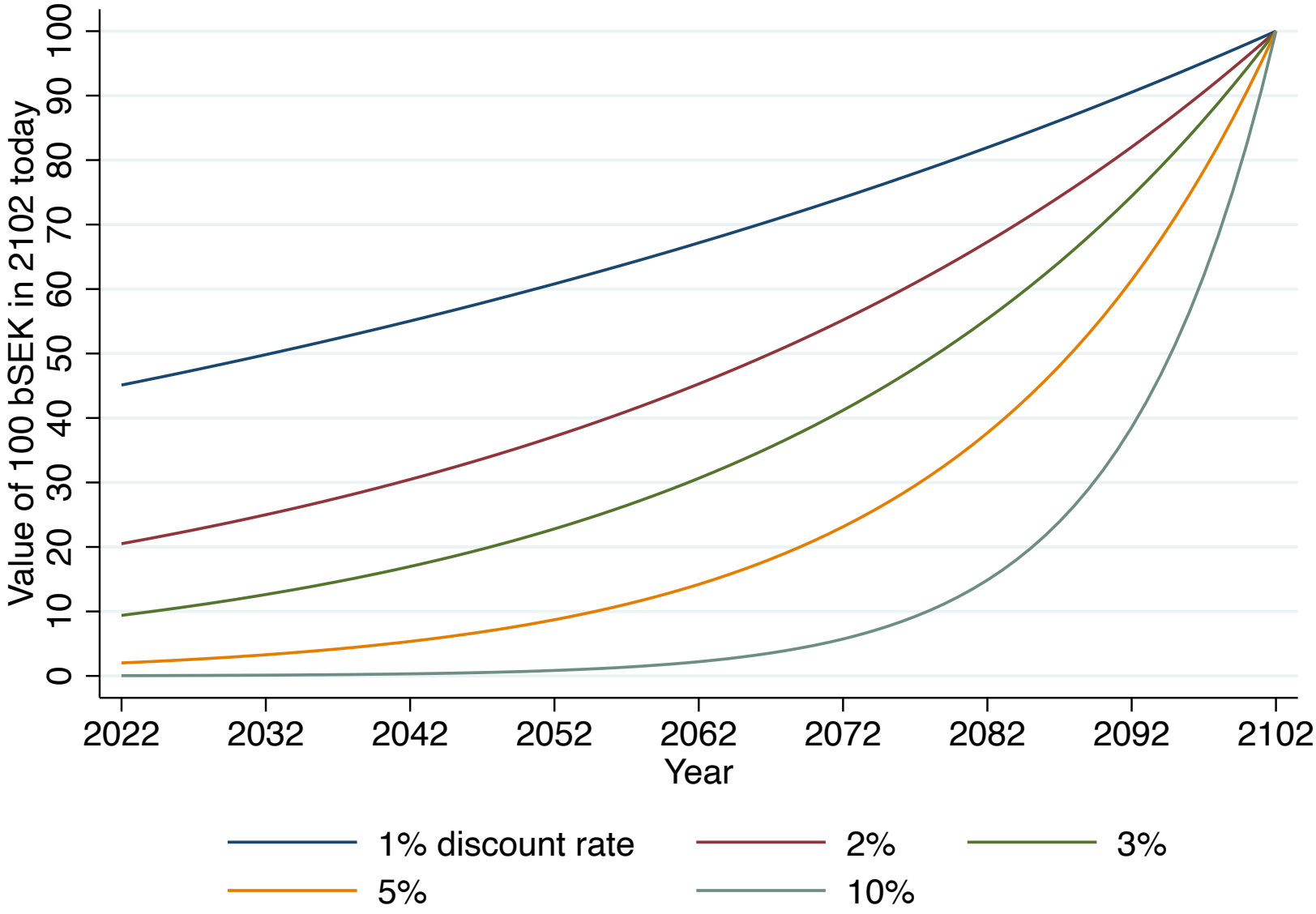
  The expected present discounted value of future damage caused by releasing one more ton of CO2 today.

  If I dont care that much about the future – if I discount the future more – SCC $\downarrow$.

- In general, getting X SEK today is worth $Y = (1+r)^T$ SEK in T years.
- Therefore, getting Y SEK in T years is worth, $X = \frac{Y}{(1+r)^T}$ today.

  If $r \uparrow$, $X \downarrow$.

Examples with different discount rates



Main Costs of Global Warming

- Enormous variation across geographical areas and economic development.

1. Sea rise $\Rightarrow$ floods low-lying coasts and population centers.

2. Biodiversity $\Downarrow$ (mass extinctions).

3. Agriculture production $\Downarrow$.

   Demand for food inelastic $\Rightarrow$ Large variation in prices.

4. Draughts and heat waves $\Uparrow$ $\Rightarrow$ Many places become impossible to live in.

   $\Rightarrow$ Mass migration movements.

Empirical Example: Cost of Global Warming

- Estimating the costs of global warming is difficult b/c society adapts and reduces costs.

- Example: Heat waves and mortality (Barreca et al., 2016).

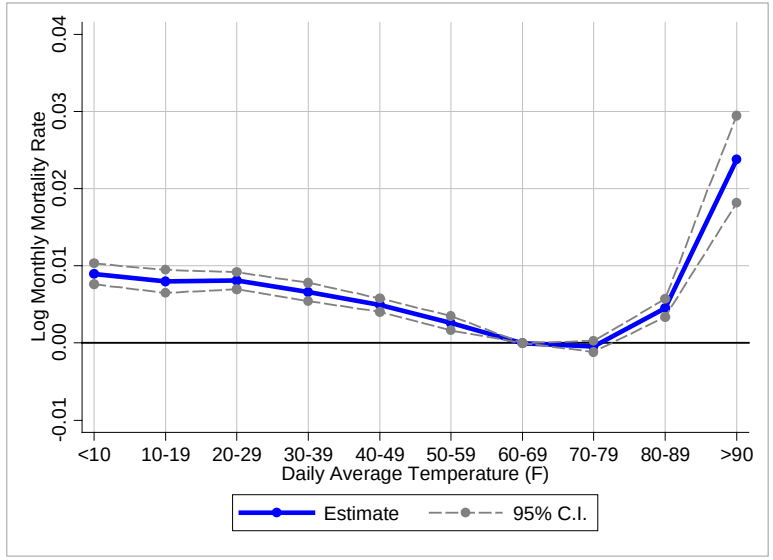
1. The effect of an extremely hot day (80+ degrees Fahrenheit / 27+ degrees Celsius) on mortality declined by **75%** between 1900 – 1959 to 1960-2004.

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

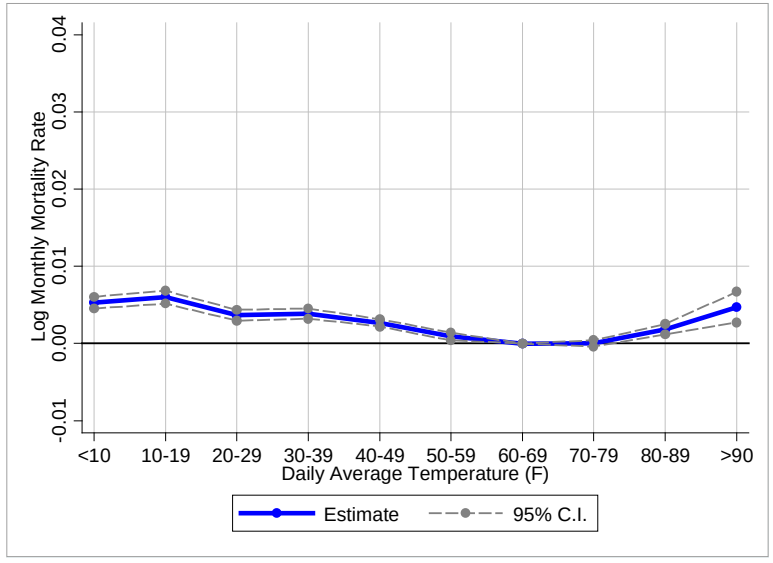
3. Worldwide adoption of AC speeds up climate change.

Figure 2: Estimated Temperature-Mortality Relationship (Continued)

(c) 1929-1959



(d) 1960-2004



Notes: Figure 2 plots the response function between log monthly mortality rate and average daily temperatures, obtained by fitting Equation (1). The response function is normalized with the 60°F – 69°F category set equal to zero so each estimate corresponds to the estimated impact of an additional day in bin j on the log monthly

Source:Barreca, Alan, et al (2013)

Remedies: How to Decarbonize?

- Carbon tax set equal to marginal damage.
- Encourage research on renewable technologies (both public and private).
- **Industrial Policy:** Plan phase-out of carbon in various sectors. Weaken fossil fuel industry power, Sachs (2020).
  - Cost of decarbonization: 1-2 % of GDP per year until 2050.
  - Cost of WWII: up to 43 % of GDP per year.
  - Start with easy-to-adjust sectors, such as electricity and cars. Wait with aviation, steelmaking.
- Compensate low-income losers (avoid yellow-vests)
- Impose tariffs on carbon-content of imported goods.

National Policy Framework (Sachs, 2020)

1. End energy-based emissions of CO2 by 2050.

2. A low-cost pathway for this transmission.

3. Compensate vulnerable groups and regions.

REFERENCES

- Barreca, Alan, et al. "Adapting to Climate Change: The Remarkable Decline in the US Temperature-Mortality Relationship over the 20th Century." Journal of Political Economy 124(1), 2016, 105-159. (link).
- Chay, K. and M. Greenstone "Air Quality, Infant Mortality, and the Clean Air Act of 1970," NBER Working Paper No. 10053, 2003. (link).
- Jonathan Gruber, Public Finance and Public Policy, Sixth Edition, 2019 Worth Publishers, Chapter 5. "Externalities: Problems and solutions"
- Sachs, Jeffrey. 2019. "Getting to a Carbon-Free Economy: The urgent is attainable, and at entirely affordable cost.", The American Prospect. (link).
- Wagner, Gernot and Martin L. Weitzman. "Climate Shock: The Economic Consequences of a Hotter Planet." Princeton University Press 2015.