Climate Change: The Ultimate Challenge for Economics

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Climate change looms over our future

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The circular flow of global warming science, impacts, and policy

Economic growth leads to CO₂ emissions (driving, heating and cooking, air travel, …)

Rising CO₂ concentrations and other forces lead to climate change (temperature, precipitation, sea-level rise, …)

Climate-change policies reduce emissions (cap-and-trade, carbon taxes, regulations, …)

Climate change imposes ecological and economic impacts (lower corn yields, coastal flooding, ocean acidification, …)
The mathematics of the DICE model

(1) \[ \max_{c(t)} W = \max_{c(t)} \left[ \int_0^\infty U[c(t)] e^{-\rho t} dt \right] \]

subject to

(2) \[ c(t) = M[y(t); z(t); \alpha; \varepsilon(t)] \]
**Alternative policies**

- Business as usual (minimal policies)
- Cost-benefit optimum (two damage functions)
- Limit temperature increase (to $1\frac{1}{2}$, 2, $2\frac{1}{2}$ °C) with hard cap
- Limit temperature increase (to $1\frac{1}{2}$, 2, $2\frac{1}{2}$ °C) over 100-year or 200-year averaging period
Temperature trajectories in different policies

![Graph showing temperature trajectories in different policies](image-url)
Abatement costs & damages, alternative policies

![Graph showing present value costs, damages (trillions)]

- **Future damages**
- **Present abatement**

Legend:
- Base
- Optimal
- \(T \leq 2.0\) (200 yr)
- \(T \leq 2.0\) (100 yr)
- \(T \leq 2.0\)
- \(T \leq 1.5\) (100 yr)
### Social cost of carbon, different policies and actual

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal</td>
<td>36</td>
</tr>
<tr>
<td>Optimal (alt dam)</td>
<td>91</td>
</tr>
<tr>
<td>T ≤ 2.0 (100 yr avg)</td>
<td>130</td>
</tr>
<tr>
<td>T ≤ 1.5 (100 yr avg)</td>
<td>236</td>
</tr>
<tr>
<td>T ≤ 2.0</td>
<td>225</td>
</tr>
<tr>
<td>T ≤ 1.5</td>
<td>Not feasible</td>
</tr>
<tr>
<td><strong>ACTUAL Price</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

SCC = societal damage from an additional ton of CO2 emissions.
Annual growth CO2: 1.8% per year
Annual growth CO2/GDP: -1.5% per year
Emissions trajectories in different policies

[Graph showing emissions trajectories for different policies from 1980 to 2050, including Base, Optimal, T 2.0 (200 yr av), T 1.5 (200 yr av), T 2.0 (100 yr av), and T 2.0 (No av).]
The Free Rider Problem

• Many public-goods issues are hampered by “free-riding.”
• Those who do nothing ride free, while those who undertake costly reductions pay dearly.
• The present rides free, while the future pays.
• Free rider problem is particularly severe for climate change.
• What to do? One proposal is to establish a Climate Club
**International Treaties as “Clubs”**

Clubs are agreements where:

- Have economies of scale or public goods
- Members pay dues
- Can exclude non-members (avoid free riders)

Important successful international clubs:

- Multinational trade negotiations (1930s to today)
- NATO
- European Union
A Climate Club to Overcome Free-Riding

• A climate club has incentives to overcome free-riding.
  – Club members “pay dues” through costly abatement.
  – Non-members are penalized through tariffs.

• Proposal here involves a regime with two features:
  – Target carbon price, say $50 per ton CO₂
  – Penalty tariff on non-participants, say 3% uniform

• So the “dues” to the club are expensive abatement, while the “penalties” for non-membership are tariffs on exports to the club region.
C-DICE model: Simulation of different penalty tariffs

Tariff rate (left to right):
- 0%
- 1%
- 2%
- 3%
- 4%
- 5%
- 6%
- 7%
- 8%
- 9%
- 10%

Number participating regions (0f 15)

Target carbon price ($/tCO2) = $50

No (zero) participants at 0% tariff
**Four steps for today**

1. People must understand the gravity of global warming. This involves intensive research and resisting false and tendentious reasoning.

2. Nations must raise the price of \( \text{CO}_2 \) and other greenhouse-gas emissions.

3. Policies must be global and not just national or local. The best hope for effective coordination is a climate club.

4. Rapid technological change in the energy sector is essential.