Climate Change:
The Ultimate Challenge for Economics

William D. Nordhaus, Yale University

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Climate change looms over our future

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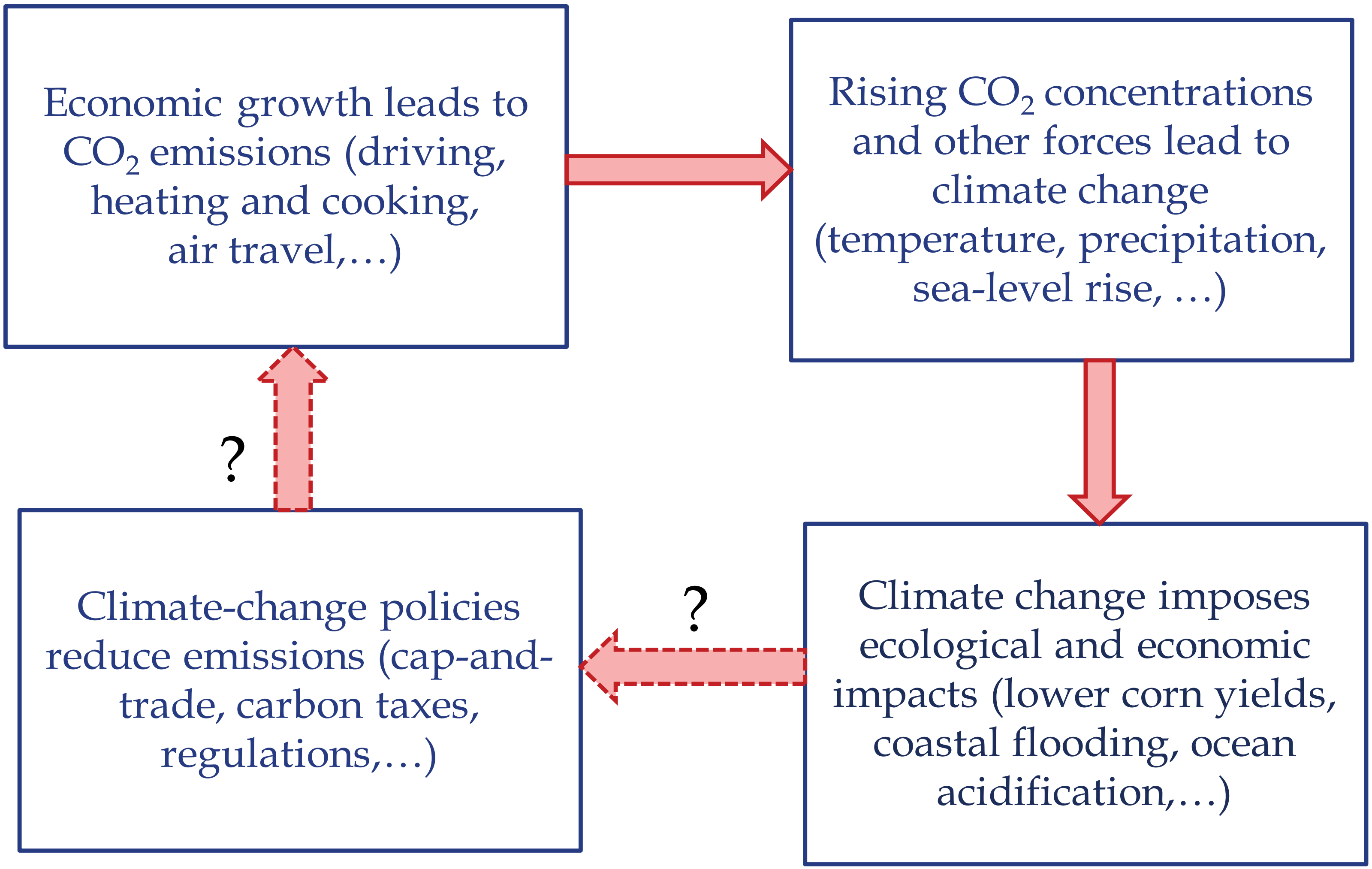
The circular flow of global warming science, impacts, and policy



The mathematics of the DICE model

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

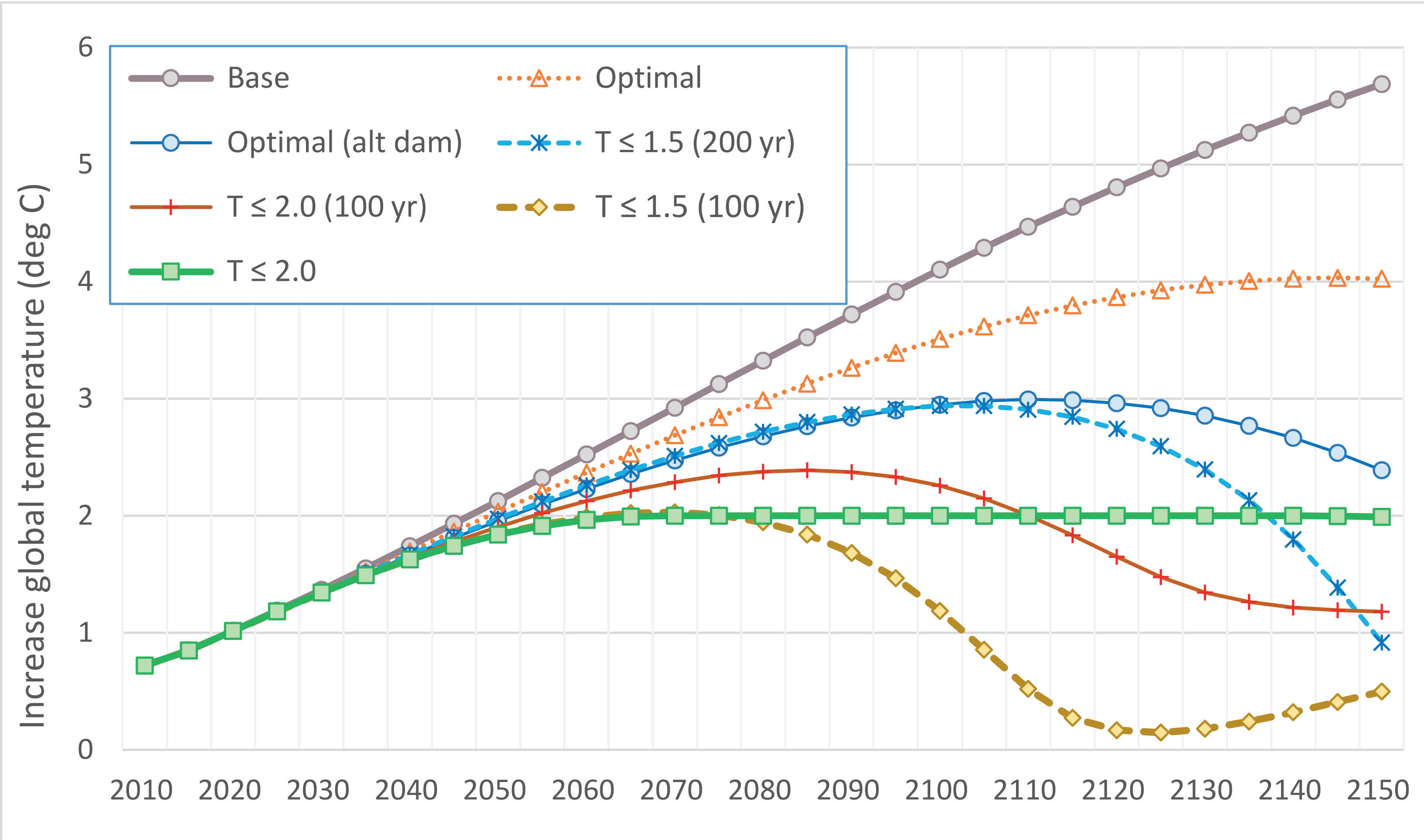
subject to

$$(2) \quad c(t) = M[y(t); z(t); \alpha; \varepsilon(t)]$$

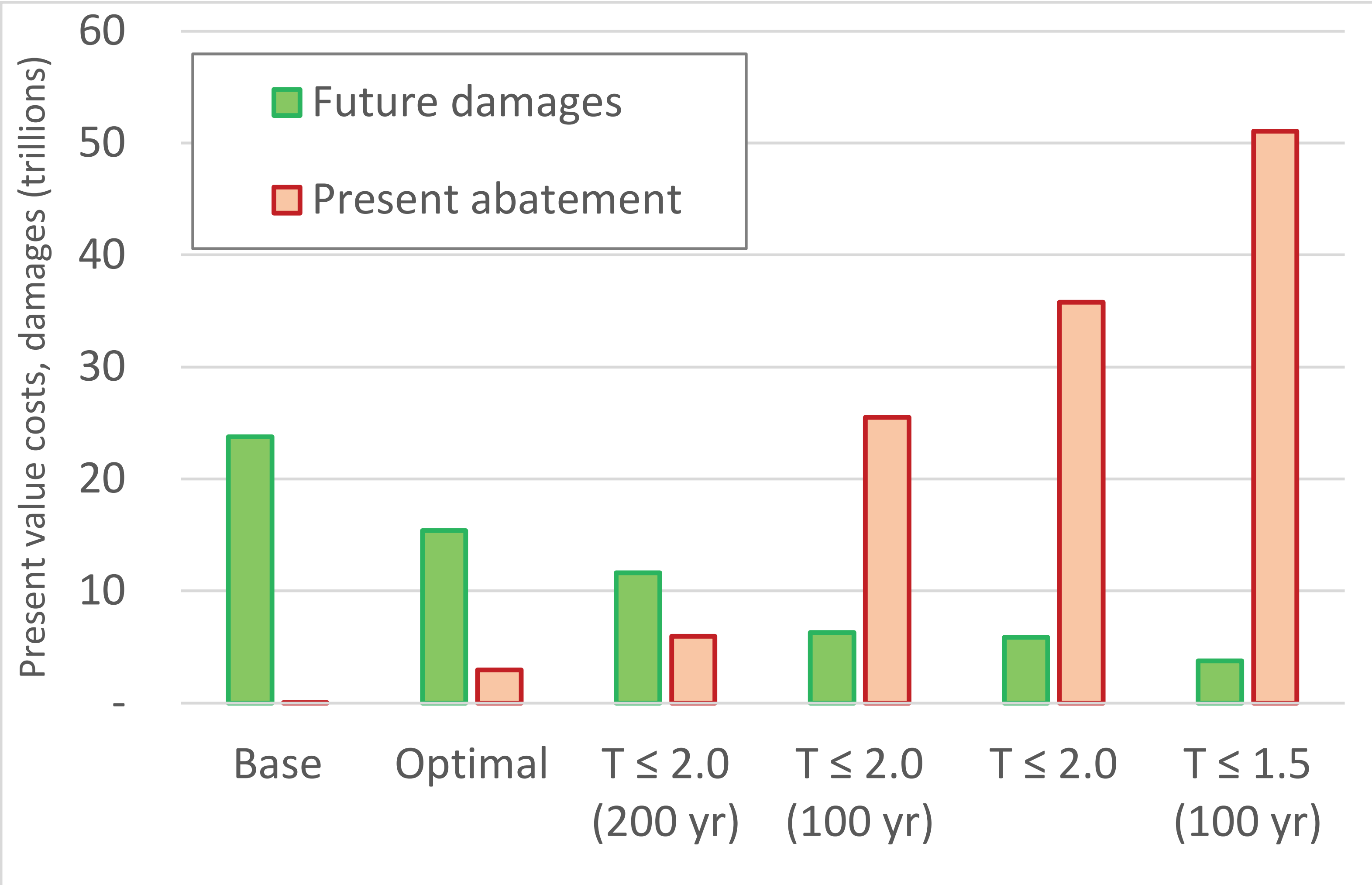
Alternative policies

- Business as usual (minimal policies)
- Cost-benefit optimum (two damage functions)
- Limit temperature increase (to 1½ , 2, 2½ °C) with hard cap
- Limit temperature increase (to 1½ , 2, 2½ °C) over 100-year or 200-year averaging period

Temperature trajectories in different policies



Abatement costs & damages, alternative policies

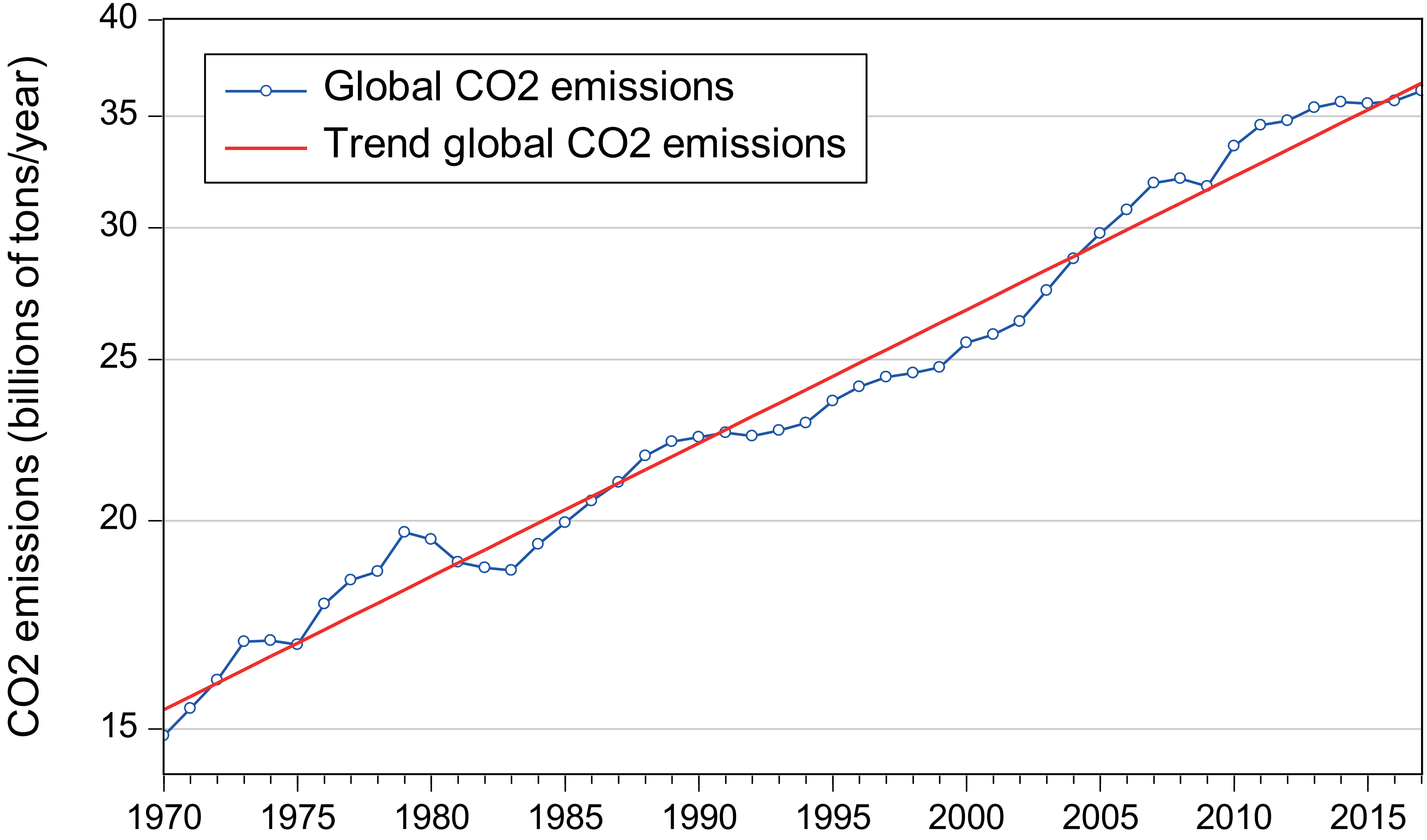


Social cost of carbon, different policies and actual

	Social Cost of Carbon (SCC) [2018 $ per ton of CO2]
Year	2015
Optimal	36
Optimal (alt dam)	91
T ≤ 2.0 (100 yr avg)	130
T ≤ 1.5 (100 yr avg)	236
T ≤ 2.0	225
T ≤ 1.5	Not feasible
ACTUAL Price	**3**

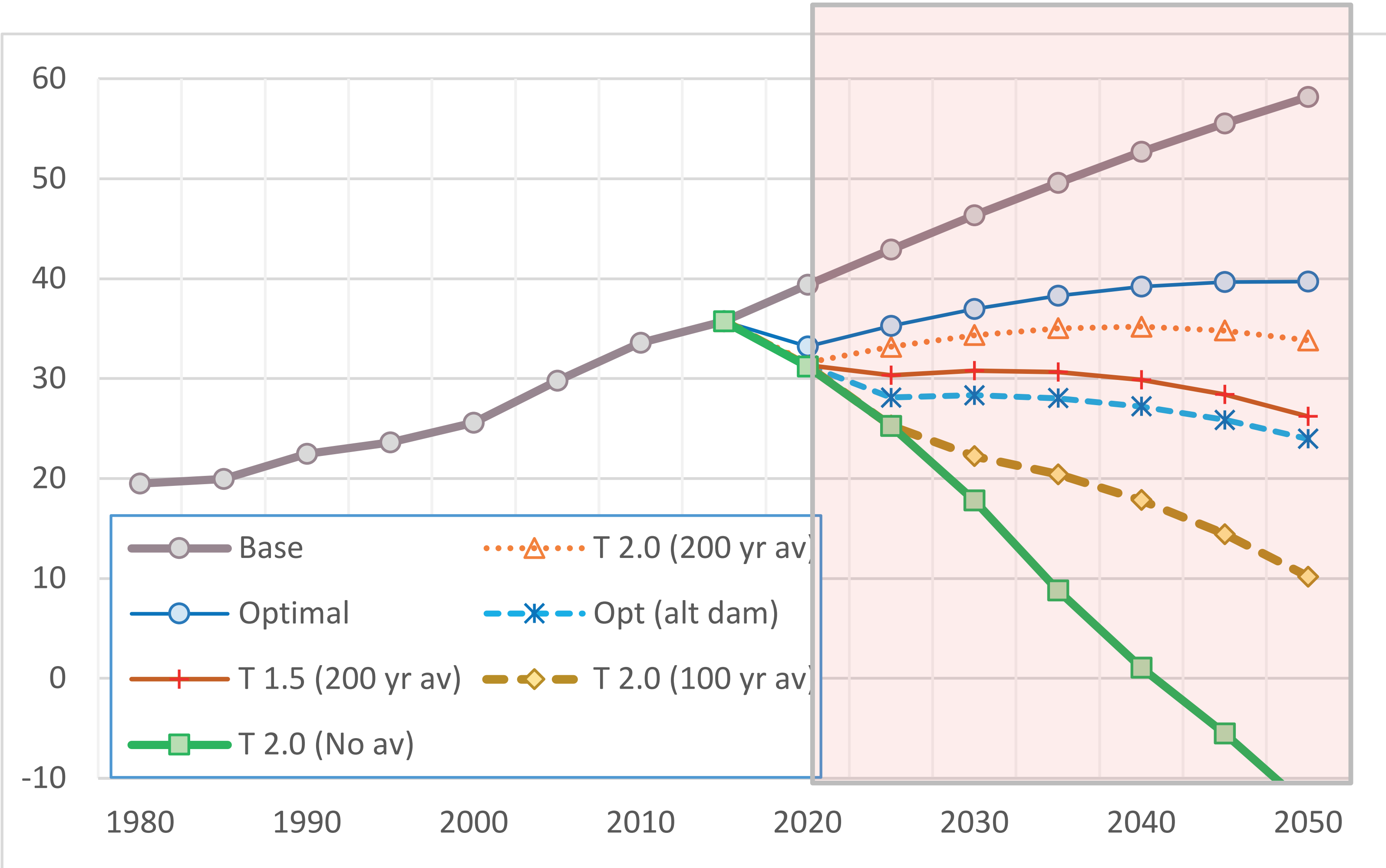
SCC = societal damage from an additional ton of CO_2 emissions.

Trend in global emissions



Annual growth CO2: 1.8% per year
Annual growth CO2/GDP: - 1.5% per year

Emissions trajectories in different policies



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)

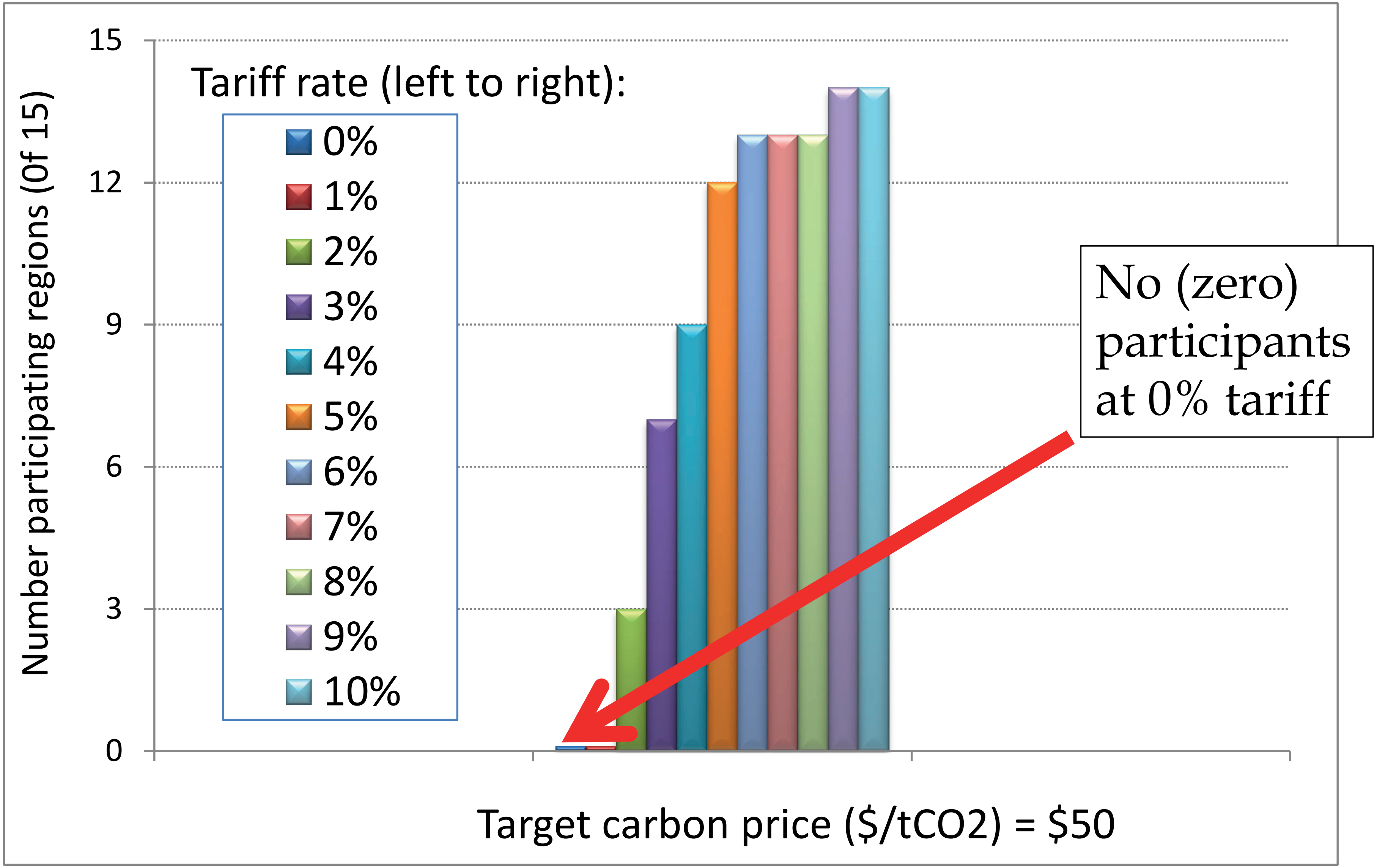
Important successful international clubs:

- 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 CO_2
  - 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



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 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.