On the Economics and Politics of Climate Change

Challenges for the Science-Policy Interface

Advancing Sustainability in a Time of Crisis

Oldenburg ISEE 2010, 23 August 2010
Tipping Points in the Earth System

Potential policy-relevant tipping elements that could be triggered by global warming this century, with shading indicating their uncertain thresholds. For each threshold, the transition from white to yellow indicates a lower bound on its proximity, and the transition from yellow to red, an upper bound. The degree of uncertainty is represented by the spread of the colour transition.

World Map of Wealth

Capital stock per person
- very low
- low
- medium
- high
- very high

Source: Füssel (2007)
World Map of Carbon Debt

Carbon emissions per person from fossil fuel burning (1950-2003)

- very low
- low
- medium
- high
- very high

Source: Füssel (2007)
Carbon Dept and Wealth

Fitting line: \( \ln P = 0.987 \ln K + c \)

Source: Füssel (2007)
The Economics of Atmospheric Stabilisation

3 stabilisation targets with different probabilities to reach the 2° target:
550ppm-eq, 450ppm-eq, 400ppm-eq

Energy-related CO$_2$ emissions

- Baseline
- 550ppm-eq
- 450ppm-eq
- 400ppm-eq

Negative emissions
- ~15% prob.
- ~50% prob.
- ~75% prob.

Knopf, Edenhofer et al. (2009)
Driving Forces

- Population
  - Per Capita Production
    - GDP / Pop

- Energy Intensity
  - E / GDP

- Carbon Intensity
  - CO2 / E

- CO2 Released
  - CO2(A)/CO2

- CO2 Emissions
- Carbon Cycle
- Ocean Acidification

- Other GHG Emissions
- Radiative Forcing
- Climate Change

Impacts
Assessing the Solution Space

- Population
  - Per Capita Production
  - Energy Intensity
  - Carbon Intensity
- Energy
  - CO₂ Emissions
  - CO₂ Capture at Plant (CCS)
- Other GHG Emissions
  - Agricultural Practices etc.
- Radiative Forcing
- Climate Change
- Ocean Acidification
- Impacts
- Adaptation
- Life-Style Change Technologies
- Non-Fossil Energy
  - CO₂ Released
  - CO₂(A)/CO₂
- Carbon Cycle
- Carbon Management
- Radiation Management
- Radiation Management
Assessing the Solution Space

- Population
  - Per Capita Production
    - GDP / Pop
  - Energy Intensity
    - E / GDP
  - Carbon Intensity
    - CO₂ / E

- CO₂ Capture at Plant (CCS)

- Life-Style Change Technologies
- Non-Fossil Energy

- CO₂ Released
  - CO₂(A)/CO₂

- CO₂ Emissions

- Other GHG Emissions
  - Agricultural Practices etc.

- Carbon Cycle
  - Carbon Management

- Radiative Forcing

- Ocean Acidification
- Climate Change

- Impacts
- Adaptation

2º/ 3º/ 4º Policies
The Great Transformation

Primary Energy Consumption [EJ]

REMIND-R, ADAM 450ppm-eq, 4/6/2009, Steckel/Knopf

Based on IEA Data (1971-2005) and REMIND-R results for 450ppm-eq (ADAM); Graphic by Steckel/Knopf (PIK)
There is more than one path towards a carbon-free economy

Knopf, Edenhofer et al. (2009)
There is more than one path towards a carbon-free economy

MERGE  
TIMER  
POLES  
REMIND  
E3MG

Baseline

550 ppm

400 ppm

⇒ 400ppm can be achieved by all models
⇒ Different possibilities to reach low stabilisation

Knopf, Edenhofer et al. (2009)
Technology Options for Low Stabilisation

- **high biomass potential**
- **with all options**
- **no nuclear beyond baseline**
- **low biomass potential**
- **no CCS**
- **no renewables beyond baseline**

**550ppm-eq**

**400ppm-eq**

*Knopf, Edenhofer et al. (2009)*
Technology Options for Low Stabilisation

- 400 ppm neither achievable without CCS nor without an extension of renewables
- Biomass potential dominates the mitigation costs of low stabilisation
- Nuclear is not important beyond its (high) use in the baseline

Knopf, Edenhofer et al. (2009)
Statistical Analysis for Assessing Second Best Worlds

Green: with BECS
Blue: w/o BECS

Statistical Analysis

Increasing strictness of target

Tavoni and Tol (2010)
The Technocratic Model

• The technocratic model:

• Max Weber predicts that this model will abolish democratically legitimized policy making. (Policy makers ask for practical constraints, science offers inherent necessities to legitimize policy making.)

• What does consensus among WGI, II, and III relate to respectively?

• Question not answered in technocratic model, consensus is mostly pretended.
The Decisionistic Model

- The decisionistic model:

  - This division of labour presumes: *Distinction of facts and values and of targets and means always always feasible.*
  
  - Goals and possible conflicts and synergies among them are usually re-assessed ex-post in the light of their intended and unintended consequences. This requires a continued dialogue between science and policy makers.
The Pragmatic-Enlightened Model

Legend:
- Policy Makers
- Science
- Outcome

Data → Targets → Mean 1 → Mean n → Qualifier 1 → Decision 1

Justification

Qualifier m → Decision j

Backing

Rebuttal that reduces the plausibility of footings, justifications or means.

intended

unintended

counter-productive?

Policy Makers
Science
Outcome
“Policy relevant but not policy prescriptive“

Science: Scope of options

Science

Goal-setting by politics

Data

1.5°C Target

2°C Target

Such as impacts from excessive use of biomass or geoengineering

Consideration of unintended side-effects of BECS / Geo-engineering
Implications for the Scenario Process

WG I
Extreme events
Sea level rise

WG II
Differential impacts:
\[\Delta(2^\circ C/3^\circ C)\]
\[\Delta(3^\circ C/4^\circ C)\]

WG III
Differential mitigation costs:
\[\Delta(2^\circ C/3^\circ C)\]
\[\Delta(3^\circ C/4^\circ C)\]

Complete picture of impact and mitigation costs for policy relevance

\[\Delta(2^\circ C/3^\circ C), \Delta(3^\circ C/4^\circ C)\]

Policies
International Environmental Agreements

• In many cases global climate policy implicitly assumes full international cooperation
• In reality: lack of a global authority instead: international environmental agreements (IEA)
• Participation is low whenever IEA (Barrett 1994) actually achieve something

Bali 2007
• Provision of a Global Public Good:
  • (Same) benefits for everyone, say e.g. 5 (per contributing party!)
  • (Same) costs to contribute, say e.g. 7

• Game Structure of the Prisoners’ Dilemma:
  • Individual rationality for players to act selfishly
    → Incentive to free-ride
    → Suboptimal outcome

• If abating global warming resembles a Public Good, then climate negotiations will face a Prisoners’ Dilemma
Reward: Technology Cooperation and Punishment: Import Tariffs

• Tuning incentives by treaty design:
  
  – Positive incentive: *Research Cooperation*
    • R&D spill-over within coalition
    • Participation rises with spill-over intensity
    • Improving *productivity* by R&D shown to be a stronger incentive than improving *abatement*
  
  – Negative incentive: *Import Tariffs*
    • Coalition levies tariffs on imports from free-riders
    • Tariffs induce up to full cooperation
    • Tariffs are individually + socially rational

• Polycentric Governance

For details see
  
  – Lessmann et al. (2009), Economic Modelling
  – Lessmann and Edenhofer (2010), Resource and Energy Economics
Development Policy

Avoided Deforestation

Climate-friendly Technologies

Limiting and Trading of CO₂

Global Deal

Effectiveness – Efficiency – Equity

Adaptation

Development Policy
Regional Mitigation Costs: Winners and Losers

Edenhofer et al., 2009

REMIND-R, Version 11/09, K. Bright Knopf
The Supply-side of Global Warming

Cumulative historic carbon consumption (1750-2004), estimated carbon stocks in the ground, and estimated future consumption (2005-2100) for business-as-usual (BAU) and ambitious 400-ppm-CO$_2$-eq. scenario.

Source: Kalkuhl, Edenhofer and Lessmann, 2009
The Supply-side of Global Warming

• Atmosphere is a scarce resource – fossil carbon is not
• Economic approach to deal with scarcity in an efficient way:
  – Establish prices on scarcities
• Who should determine scarcity prices?
  – Regulator (establish prices on the use of scarce resources – carbon tax)
  – Market (assigning property rights according to the scarcity of the atmosphere – ETS)
“The European Commission is preparing to call on the United States to create a trans-Atlantic system of carbon trading”

- Herald Tribune, Friday, January 23<sup>rd</sup>, 2009
The Representative Clients of AR5 in WG III

- International level: Negotiators, NGO’s

- National Policies: Parliaments, governments, national agencies

- Regions: e.g. EU

- Sub-National Level: Cities
Global Deal

Effectiveness - Efficiency - Equity

- Limiting and Trading of CO₂
- Climate-friendly Technologies
- Avoided Deforestation
- Adaptation
- Development Policy
R&D-Investment in Energy Technologies

Source: Updated version of IPCC (2007), AR4
Global Deal

Effectiveness – Efficiency – Equity

Avoided Deforestation

Limiting and Trading of CO₂
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CO₂ emissions per person and year, 1950 - 2003

CO₂ emissions from fossil fuel combustion and cement production, and including land use change (kg C per person and year from 1950 - 2003)

-1000 - 0
0 - 100
100 - 1000
1000 - 2000
2000 - 5000
5000 - 15000

Ratio

Emissions per year from fossil fuel combustion and cement production
Emissions per year from land use change
Global Deal

Effectiveness – Efficiency – Equity

Limiting and Trading of CO₂
Climate-friendly Technologies
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Development Policy
Change in Agricultural Production

Climate-induced changes in agricultural production between 1990 and 2050

Füssel et al., 2010
Multilevel and polycentric governance

- Nation state
- Pressure groups
- Science
- Voters/consumers
- Municipalities
- Investment funds
- Voluntary treaty with self-enforcing cooperation
- International firms
- Federal states
- Media