Climate Policy Analysis

• What long-term stabilization target?
• How strong a mitigation effort to undertake NOW?
  – Quantity target, say for 2008-2015?
  – Social cost of carbon?
• Need more information?
  – What specifically?
  – How to frame the issue for public/policy discussion?
Path for Today

• Structure of the assessment task
  – The handling of uncertainty
  – Representation of decision-making process
  – Areas of policy choice

• Examples under Certainty
  – Benefit-cost analysis
  – Cost-effectiveness analysis
  – Tolerable windows analysis

• Examples under Uncertainty (preview)
  – Probabilistic forecasts
  – Sequential decision
Certainty vs. Uncertainty

• Assuming certainty
  – Once-and-for-all decision now
    • Near-term choice  (e.g., Kyoto-type analyses)
    • Path over time  (e.g., B/C, stabilization studies)

• Considering uncertainty
  – Once-and-for-all decision now
    • Scenario analysis
    • With probability distributions
  – Sequential choice, with learning

How important to include uncertainty?
Representation of the Decision-Maker or Process

- Single decision-maker
- Multiple decision-makers and gaming behavior
- Negotiation among parties

What is the value/limits of single-actor analysis?
Areas of Policy Choice

- Emissions control (what to do now?)
  - Single decision-maker (global welfare)
  - [Multiple parties and negotiation]
- Anticipatory adaptation
- Actions to open options
  - R&D & technology push
  - “Architecture” of climate negotiations
- Geo-engineering
Examples under Certainty

(1) B/C

(2) Climate target (Article 2)

(3) CE

(4) TWA

Who does what?

What control to take today?

Climate target (Article 2)
Benefit-Cost Analysis

• Cost function & benefit relationship

• Alternative applications
  – Calculate optimal path, unconstrained
  – Constrain by long-term target
  – Apply policy scenarios (e.g., burden sharing)

• Difficult issues
  – Valuation & aggregation
  – Discounting
  – Institutional assumptions
Example: Nordhaus DICE Model

- Growth, emissions, and $\Delta T$
  - Like Homework's 2 & 3
- Climate change effects
  - A damage function of form in last lecture
- Forward-looking, optimizing model
- Policy assumptions
  - Optimal path (by their valuations)
  - Stabilize concentrations at $2xCO_2$
  - Hold $\Delta T$ to 2.5°C
  - Stabilize emissions at 1990 levels (E90)
Efficient Policies

Emission control rates: Alternative policies

- **Optimal**
- **E90**
- **2xCO₂**
- **T < 2.5 deg C**

Figure by MIT OpenCourseWare.
Social Cost of Carbon

Figure by MIT OpenCourseWare.
Insights/Evaluation?

- What think of the analysis?
- Insights gained?
  - About paths of stringency?
  - Other?
- What assumptions dominate?
- What is missing?
- US EPA task under Court ruling on CO$_2$
- Debates surrounding Warner-Lieberman
Cost Effectiveness Analysis

- Who does what?
- What control to take today?
- Climate target (Article 2)

B/C

CE

(?)
Stabilization

- Forcing trajectories are similar across the models
- 550 and 650 ppmv cases stabilize in next century
- 450 case must stabilize with 50 to 75 years
To stabilize, emissions must decline to the rate of natural removal ($E \rightarrow 0$).

Higher stabilization targets only delay this ultimate condition.

Monotonic increase in effort over time, with only technology to moderate.
% Loss in Global World Product

550 ppmv case (MER)

COPrice Paths

% Loss in Gross World Product

Origin of the Differences

- Required CO₂ reduction
- Assumptions about post-2050 technology
Cost-Effectiveness Analysis

• Maybe no direct benefit estimate
  – Least-cost path in stabilization studies
  – Examples: CCSP & HW #3
• Explore what, where & when flexibility
• Input to “meta” benefit-cost analysis
  – Combine with benefits of stabilization level
  – Example: Stern Review
• Difficult issues
  – Aggregation
  – Discounting
  – Institutional assumptions
Tolerable Windows

• No explicit benefit function
  – Represented in form of constraints

• No explicit cost function
  – Represented by some limit on effort

• Question: what must we do to preserve the option of some future climate state?
  – Capable of multiple attributes
Sequence of Windows

Figure by MIT OpenCourseWare.
Figure 2.

Corridors for energy-related CO₂ emissions

(a) Variation of the impact constraint

Maximum regional income loss: 2.0%

Maximum global ecosystem transformation

50%
45%
40%
35%
30%

Inner structure (for 35% limit)

Max. 2035
Min. 2035
Max. 2065
Min. 2065
Max. 2100
Min. 2100

Cost-effective emission path

Figure by MIT OpenCourseWare.
Insights/Evaluation?

• What think of the analysis?

• Insights gained?
  
• What assumptions dominate?
  – Structure of solution algorithm

• What is missing?
  
  
  


Assessing an Atmospheric Target Under Uncertainty

What control action today?

Climate target (Article 2)

Meta B/C
What would we gain with stabilization & 550 ppm?

Low probability, high consequence events?
Benefit-Cost Under Uncertainty

- What control action today?
- Climate target (Article 2)

The “Wait to Learn” Debate
April 23 & 28
Ongoing Research

• Upper tail the distribution of outcomes
  – Missing (extreme) events
• Methodology
  – Elicitation of parameter PDFs
  – Cascading uncertainties through models of several stages of the climate issue
• The real (sequential) decision problem
  – Partial learning
  – Institutions and path dependency
  – Capturing risk aversion (precaution)
  – Multiple players & “who does what?”
• Lay communication
Final Thoughts

• At best, gain rough insight to today’s decision
  – Damage functions are inadequate to the task
  – Necessary simplification of choices
  – Thus far: single decision-maker model, or very simple decision theory representations

• Much work needed to do better, even for “expert” understanding

• Lay audiences deserve our sympathy
**Exhibit B**

**U.S. MID-RANGE ABATEMENT CURVE – 2030**

- **Cost basis**
- **Discount rate**
- **What is in baseline?**
- **What use?**

Source: McKinsey analysis

Courtesy of McKinsey & Company. Used with permission.
Explaining Why Technologies Are Not Used

• Market failures: decision-makers don’t see correct price signals
  – Lack of information
  – Principal-agent problems (e.g., landlord-tenant)
  – Externalities & public goods

• Market barriers
  – Hidden costs (e.g., transactions costs)
  – Disadvantages perceived by users
  – “High” discount rates
Alternative Views of the Options

Alternative Notions of the Energy Efficiency Gap

- **Technologists' optimum**: Eliminate "market barriers" to energy efficiency, such as high discount rates and inertia; ignore heterogeneity.

- **Theoretical social optimum**: Eliminate environmental externalities and market failures in energy supply; set aside corrective policies that cannot be implemented at acceptable cost.

- **Economists' narrow optimum**: Eliminate market failures in the market for energy-efficient technologies.

- **True social optimum**: Net effect of corrective policies that can pass a cost-benefit test.

Figure by MIT OpenCourseWare, adapted from Resources for the Future.
Thinking about Technology

• What is technology, and tech. change?
• What leads to change?
  – Does change tend to economize on one factor or another, in response to prices?
  – What is the role of R&D expenditure?
  – To what degree is it *ad hoc* or random?
• Role of “learning by doing”

• How to distinguish tech change from
  – Change in inputs (in response to price)
  – Economies of scale
“New” Technologies

- Carbon capture and storage
  - From electric power plants
  - From the air
- Renewables
  - Wind & solar
  - Biomass
  - Tidal power
  - Geothermal
- New generation of fission, and fusion
- Solar satellites
- Demand-side technology
  - Fuel cells and H$_2$ fuel
  - Other? (lighting, buildings, ind. process, etc.)

What determines the likely contribution of each?