Climate Change: Uncertainty and Economic Policy

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Confronting Policy Uncertainty

Tension:

▷ Limited understanding of the mechanism by which policy influences economic outcomes
▷ Demand for precise answers by the public and/or governmental policy makers

Examples:

▷ Monetary Policy
▷ Financial Market Oversight
▷ Climate Change
Haunted by Hayek’s Forewarning

“Even if true scientists should recognize the limits of studying human behaviour, as long as the public has expectations, there will be people who pretend or believe that they can do more to meet popular demand than what is really in their power.”
(From Hayek’s Nobel address, 1974)

For quantitative policy analysis, we should not “throw in the towel,” but should acknowledge the limits to their understanding.
Quantitative Storytelling

Use mathematical models with numerical inputs to further our understanding and support policy analysis.

Ingredients:

▷ substantive knowledge
▷ formal models
▷ empirical evidence
Where does Uncertainty emerge?

Quantitative storytelling with multiple stories

- multiple models give rise to multiple “stories” with different implications
- each model has random impulses and requires numerical inputs
- each model is an abstraction: stories not intended to be detailed recordings of actual histories or complete descriptions of reality
Dangers of Being Naive

The Cheat, Georges de La Tour
Conceptual Tools

▷ decision theory under uncertainty
  ◦ statistics
  ◦ control theory
  ◦ economics

_How do we make “sensible” or “rational” decisions?_

▷ asset valuation under uncertainty
  ◦ “assets” include financial, physical, human, organizational and environmental “capital”
  ◦ associated with each asset is a prospective sequence of net payoffs to investments

_How do we assess the investment opportunities in the face of uncertain future net payoffs?_

decision-making and valuation are symbiotically linked
Navigating Uncertainty

Probability models we use in practice are misspecified, and there is ambiguity as to which among multiple models is the best one.

- Aim of robust approaches:
  - use models in sensible ways rather than discard them
  - use probability and statistics to provide tools for limiting the type and amount of uncertainty that is entertained
- aversion - dislike of uncertainty about probabilities over future events
- implementation - target the uncertainty components with the most adverse consequences for the decision maker
Uncertainty, climate change and economic valuation

▷ market valuation fails to account for the full social impact of human inputs on the climate

▷ uncertainty can have a big impact on the measurement of the social cost of carbon - an idealized target defined formally as a socially efficient (Pigouvian) tax

▷ two interacting sources of uncertainty
  ○ impact of CO2 emissions on temperature changes - geophysics
  ○ impact of temperature changes on well being - economics
Climate Science and Uncertainty

... the eventual equilibrium global mean temperature associated with a given stabilization level of atmospheric greenhouse gas concentrations remains uncertain, complicating the setting of stabilization targets to avoid potentially dangerous levels of global warming.

Citation: Allen et al: 2009
Climate Impacts

Climate literature suggests an approximation that simplifies discussions of uncertainty and its impact.

▷ Matthews *et al* and others have purposefully constructed a simple “approximate” climate model:

\[ T_t - T_0 \approx \beta \int_0^t E_\tau d\tau. \]

▷ Abstract from transient changes in temperature.

Emissions today have a *permanent impact* on temperature in the future where \( \beta \) is a *climate sensitivity parameter*. 
Climate Sensitivity Uncertainty

Histograms and density for the climate sensitivity parameter across models. Evidence is from MacDougall-Swart-Knutti (2017).
Carbon Budgeting

Many in the climate concerns community and policy community argue for a **carbon budgeting approach** as a simplified way to frame the discussion of environmental damages.

- exploit the Matthews approximation linking emissions to temperature
- design policy to enforce a Hotelling-like restriction on cumulative carbon emissions because of climate impact

Still must **confront uncertainty**: constraint depends on the **unknown** climate sensitivity parameter.
Beyond Carbon Budgeting

▷ explicitly model economic dynamics
▷ incorporate economic “damages” to measure the social cost of climate change on the economic environment
▷ treat formally uncertainty and its interconnected components
Modeling Framework
Modeling Framework
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Modeling Framework
Proportional Damage Uncertainty: Reconsidered

Temperature Increment over Pre-Industrial Levels (°C)
The initial weighting is the same for both the low- and high-damage specifications. The ambiguity-adjusted probabilities remain very close to this at year 50, but are tilted towards the high damage specification (probability .59) at year 100.
Social Cost of Carbon Decomposition

Years vs. Dollars per Ton of Carbon

- Total
- Uncertainty

0 20 40 60 80 100

0 200 400 600 800 1000

Dollars per Ton of Carbon

Years
Emissions Comparison

Years

Gigatons of Carbon

Ambiguity Neutral

Ambiguity Averse
Future Responses to Climate Change

Opens additional channels with uncertain consequences

credit: United Nations
Education is the path from cocky ignorance to miserable uncertainty

- Mark Twain
Complementary References

▷ Cai, Judd, and Longtzek (2017), *The Social Cost of Carbon with Climate Risk*
▷ Hambel, Kraft, and Schwartz (2018), *Optimal Carbon Abatement in a Stochastic Equilibrium Model with Climate Change*
▷ Lemoine and Traeger (2016), *Ambiguous Tipping Points*
▷ Millner, Dietz, and Heal (2013), *Scientific Ambiguity and Climate Policy*
▷ Nordhaus (2018), *Projections and Uncertainties About Climate Change in an Era of Minimal Climate Policies*
▷ Weitzman (2012), *GHG Targets as Insurance Against Catastrophic Climate Damages*