Central Banking Challenges Posed
by
Uncertain Climate Change

Lars Peter Hansen (University of Chicago)

NY Fed Financial Advisory Roundtable:

November 19, 2021

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, how should we acknowledge the limits to our understanding?

Confronting policy uncertainty

Tension:

- ▷ limited understanding of the mechanism by which policy influences economic outcomes
- ▷ demand for precise answers by the public and/or government policy-makers

Important Considerations

- hastily devised policy rules unsupported by quantitative modeling could backfire, harming reputations of central banks
- broadening the mission without well-defined mandates could compromise central bank independence

Uncertain climate economics

- physical risk
  - climate sensitivity - the temperature responses to changes in emissions
  - environmental tipping points - potentially dramatic consequences triggered after crossing a temperature anomaly threshold
- transition risk
  - damages and adaptation - economic and social consequences of climate change
  - green technology - development of new "clean" technologies
  - policy - private sector exposure to uncertain government action

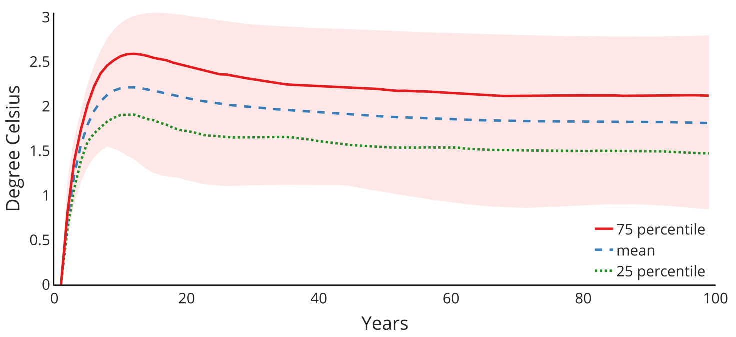
Modular approach to the SCC

Much of the quantitative research in climate economics has targeted the SCC (social cost of carbon) - fiscal policy

- socio-economic module - the projected future evolution of the economy, including emissions of CO_2, characterized without the explicit impact of climate change;
- climate module - the earth system response to emissions of CO_2 and other anthropogenic forcings;
- damages module - the economy's response to changes in the Earth system;
- discounting module - a time series of future damages is compressed into a single present value.

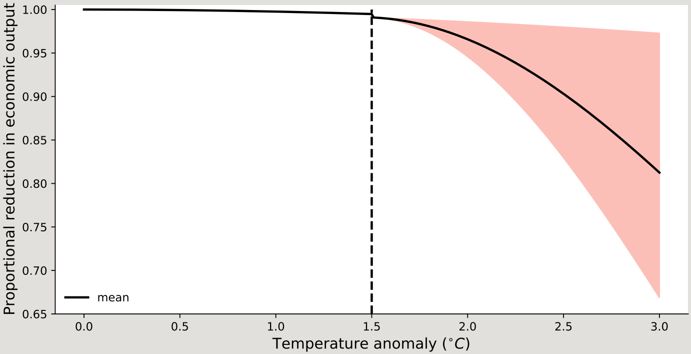
National Academies of Sciences, Engineering and Medicine Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017.

Divergent climate model predictions



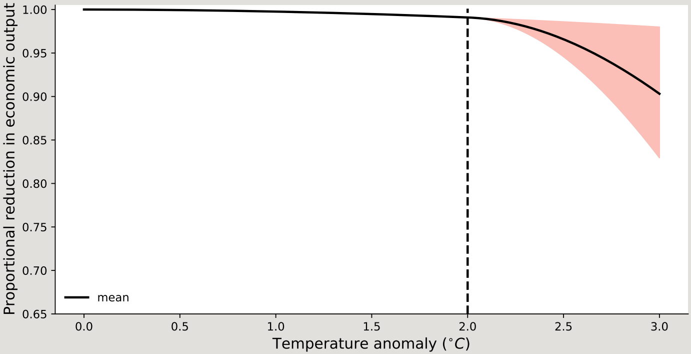
Percentiles for temperature responses to emission impulses. The emission pulse was 100 gigatons of carbon (GtC) spread over the first year. The temperature units for the vertical axis have been multiplied by ten. The boundaries of the shaded regions are the upper and lower envelopes based on 144 models.

A stochastic model of damages



Percentiles of possible proportional reductions of the productive capacity of the economy. Temperature anomaly threshold is 1.5 degrees celsius.

A stochastic model of damages



Percentiles of possible proportional reductions of the productive capacity of the economy. Temperature anomaly threshold is 2.0 degrees celsius.

Social Cost of Carbon

- asset price - emissions today have social costs in current and future time periods - price a social cash flow
- measurement framework: four modules
  i) emissions, ii) climate, iii) damages, iv) discounting;

  National Academies of Sciences, Engineering and Medicine
  Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017.
- observation: important interactions across the proposed modules

Discussion in "Climate Change Uncertainty Spillover in the Macroeconomy," Barnett, Brock and Hansen (2021), Macroeconomics Annual

Uncertainty tradeoffs

Use mathematical models informed by expert judgement and empirical evidence to:

- make best guesses
- determine potentially bad outcomes

Answer the following:

- How much weight do we assign to best guesses versus possible bad outcomes when constructing and designing policy?
- Do we act now, or do we wait until we learn more?

Role for decision theory under uncertainty

- allows for a broad perspective on uncertainty
  - risk - unknown outcomes with known probabilities
  - ambiguity - unknown weights to assign to alternative probability models
  - misspecification - unknown ways in which a model might give flawed probabilistic predictions
- includes formulations that are dynamic and recursive

Better ways to do uncertainty quantification for dynamic economic models used for private sector planning and governmental policy analysis

Financial stability mandate

Promoting financial stability is a key element in meeting the Federal Reserve's dual mandate for monetary policy regarding full employment and stable prices. In an unstable financial system, adverse events are more likely to result in severe financial stress and disrupt the flow of credit, leading to high unemployment and great financial hardship. Board of Governors of the Federal Reserve (2020).

Financial stability challenges

- What is systemic risk? - modeling successes have been largely qualitative
- How do we integrate climate change into our current understanding?
- Over what time scale should we seek to quantify climate change uncertainty?

Quantifying Exposures to Climate Uncertainty

Well-articulated mandate for the regulatory/supervisory role for the banking sector.

- ▷ systematic uncertainty in contrast to systemic risk.
- ▷ historical measurement is of limited value - push advanced economies in realms that we have yet to experience.
- ▷ concern that the private sector collectively under-estimates magnitudes of their exposure to climate change.

Productive initial steps

- Work collectively (regulators and regulated) on methods and models for quantifying climate change exposure over alternative horizons
- Embrace a broad notion of uncertainty using decision theory as a guide
- Come up with agreed upon and prudent ways to measure climate change exposure

Caution: whose models do we use for assessing the exposure of financial institutions to climate change: regulators' or the ones of those who are regulated? - see Behn, Haselmann, and Vig, "The Limits of Model-Based Regulation."

Scenario-based stress tests

Aims:

- ▷ confront "extreme uncertainty" connected to climate change without resort to probabilities
- ▷ explore events through a small number of well-defined scenarios that can extend over three decades
- ▷ investigate tail events that stress the financial system

Scenario based stress tests

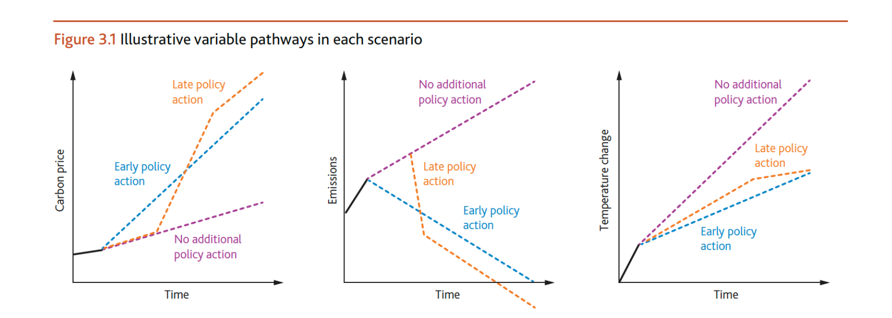


Figure taken from the Bank of England report: The 2021 Biennial Exploratory Scenario on the Financial Risks from Climate Change

Limits to stress tests

Static with no uncertainty along a path.

- miss or disguise two important lessons from decision theory:
    - tradeoff between guarding against possible bad outcomes that could happen versus performing well over more likely outcomes
    - decisions respond recursively to state dynamics and information revelation
- provide potentially misguided paths for economic outcomes and environmental outcomes without explicit dynamic modeling
- open the door to stress test answers that condition on the entire path

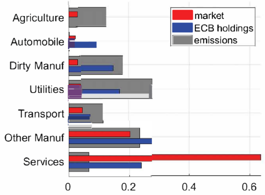
Shunting probabilities and dynamic information revelation to the background is counter-productive.

Tilting portfolios green

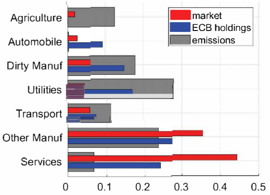
What is the role of central banks embracing sustainability in the construction of their own portfolios and certifying ESG (environmental, social and governance) portfolio standards for other investors?

- at best, a weak substitute for fiscal policy which can impose taxes on carbon emissions and subsidize research and development in green technology
- central bank expertise in green venture capital is currently very limited
- runs the danger of pushing central banks closer to political arena

Green versus market neutrality in asset purchases



(a) Market measured by capital income



(b) Market measured by total assets to revenues

Figure 1: Sector shares of the market portfolio, ECB holdings, and emissions

This figure is constructed the year-end 2017 data. In figure (a) market shares are measured as capital income by sector (capital income = value added - wages). In figure (b) market shares are measured as output (from Eurostat) times the ratio of total assets to revenues (from Orbis) by sector. Emission intensity is measured by Scope 1 air emissions by sector. The ECB portfolio includes only securities held under the corporate sector purchase programme (CSPP) that was initiated in March 2016.

Source: Papoutsi, Piazzesi, Schneider, 2021

Conclusion/Summary

- The time horizon over which climate change uncertainty plays out is different than in other forms of turbulence on the radar screen of central banks creating unique challenges for oversight and regulation
- Rules-based policy is most compelling when supported by quantitative models that reflect our understanding based on insight and evidence.
- Understanding the sources of subjective uncertainty in models used by both the regulated and regulators will make oversight more effective.