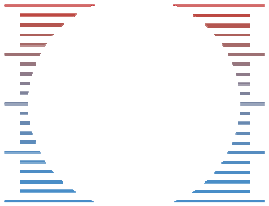

Centre for
Climate Change
Economics and Policy

The Munich Re Programme: *Evaluating the Economics of Climate Risks and Opportunities in the Insurance Sector*

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Using Economic Models and Coping with their Uncertainties

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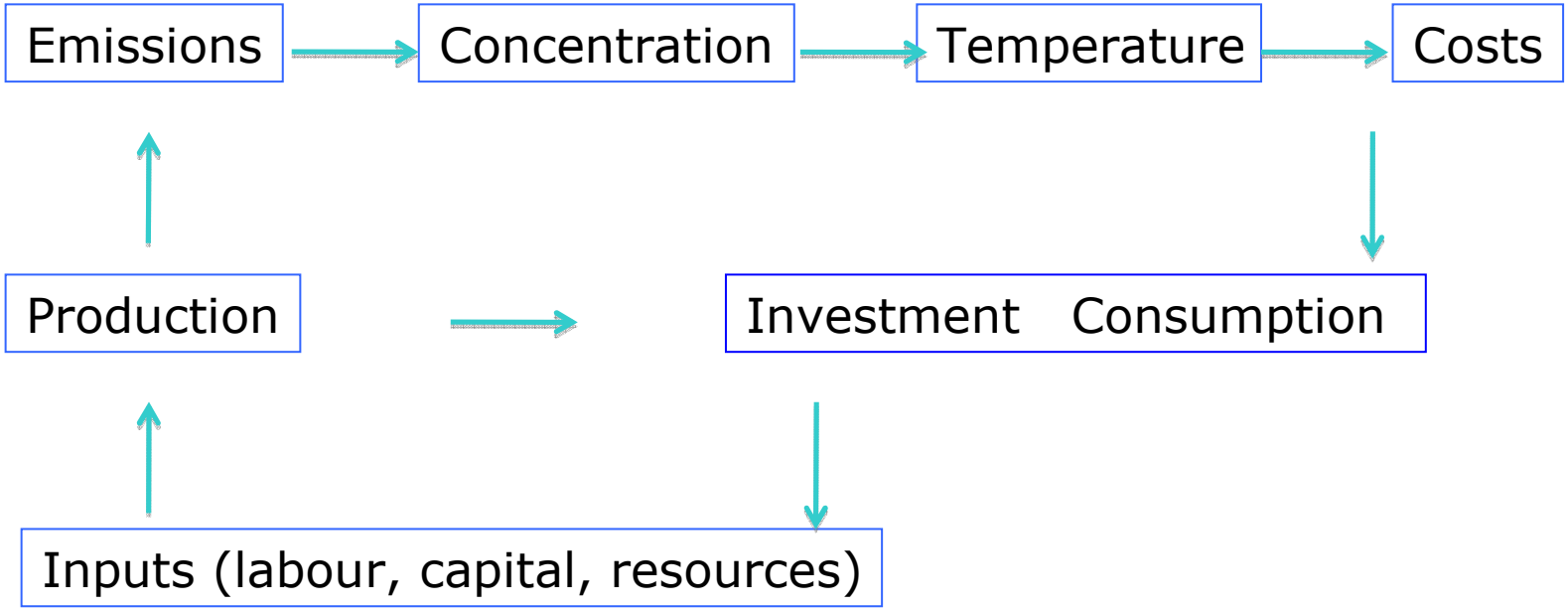
Categories of model

- Integrated assessment models
- Theoretical models
- Econometric models

What is an IAM?

- Climate Loop
  - Emissions – concentration – temperature – economic costs as loss of output
- Economic Loop
  - Inputs [labor, capital] - emissions, output – investment, consumption
- Economic consequences appear as loss of output, never directly as impact on welfare.

Typical IAM


Emissions
Concentration
Temperature
Costs
Production
Investment
Consumption
Inputs (labour, capital, resources)

How do we use models?

- How do we use and construct models?
- We have forecasting models – econometric models with statistical validation –
- and theoretical models designed to generate insights into how complex systems fit together and how their components interact.

Econometric models

- Forecasting/Econometric – models of oil market, commodity markets, macroeconomy, ….. Statistically complex.
  - Track record of forecasting models is poor.
- Econometrics probably better used for testing hypotheses than for forecasting –
  - e.g. do pollution taxes cause firms to migrate? Does outsourcing reduce wages?

Theoretical models for insights

- Theoretical models –
  - Solow 1956 growth model, Ramsey model, general equilibrium models of Arrow and Debreu, …….
- Solow: $Y = a(t)F(K,L), {dK}/{dt} = I, C + I = Y, {dL}/{dt} = n$
- Dasgupta/Heal maximize $\int_0^\infty u(c)e^{-\delta t}\,dt$
-
- subject to $c + I = F(K,L,R), I = {dK}/{dt}, \int_0^\infty R \le S_0$
- Provide basis for Nordhaus's DICE model

Theoretical models for insights

- Forecasting and hypothesis testing are irrelevant: issue is to get **robust qualitative** insights into the behavior of the economy.
  - EG how does the rate of technical progress affect the economy's long-run growth?
  - How does resource scarcity affect growth in the long run? Is growth sustainable in the face of resource scarcity?
  - Robust means not sensitive to small changes in specification
- Big qualitative questions. Models are good if they capture important interactions and if conclusions are robust to specification changes, so we need to study the sensitivity of the model in a topological not a numerical sense.

Back to IAMs

- Where do they fit in this typology?
- Based on theoretical models for insights – but often claiming some numerical precision
- No econometric component – calibrated rather than estimated
- Probably means that numerical estimates are suspect and that we should pay attention to qualitative rather than quantitative features

Back to IAMs

- When they say “Costs of climate change are 1% or 14% of GDP” what are they saying?
- My interpretation is that they are saying “negligible” or “significant” but no more than this.
- The difference between 10% and 20% is not significant, though the difference between 1% and 20% probably is.
- In other words, only very robust features of outputs merit confidence.
- Lots of sensitivity analysis is crucial
- I have more confidence in simple calculations than in some of these complex models – e.g. cost of reducing CO2 emissions 80% = CO2 output *0.8*$40

Back to IAMs

- Miss the non-market effects of CC, which according to many scientists may be the most important.
- Also don't model direct welfare impacts of climate change and changes in biosphere
- Arguably temperature, concentration should affect welfare directly because of impacts on B/D, fisheries, natural capital or ecosystem services.
- How does state of environment affect human welfare? Is there a minimum of ESS required for any level of wellbeing?
- Status of IAMs highly unsatisfactory on all these counts.

Uncertainty

- Normal approach – take a PDF over space of possible outcomes and work with EV and with moments as measure of risk
- Don’t have a PDF
  - Could work with subjective probabilities and be Bayesian (Weitzman, Pindyck).
  - Or could drop idea of a PDF altogether and work with non-expected utility frameworks, e.g. Henry.

Subjective probabilities

- Over both climate science and socio-economic impacts we don't have a PDF based on observation or on knowledge of data generation process
- Can instead elicit subjective PDFs from experts, which is roughly what IPCC does today
- Revise according to Bayesian updating as more data becomes available – Weitzman, Pindyck
- As good or bad as the subjective estimates of the experts, many of whom are not trained to think probabilistically

Non-EU approaches

- Alternative – recognize we don't have PDFs over outcomes but do nevertheless have some information about the relative likelihoods of different regions of outcome space
- Not complete enough or integrated enough to give PDF – probabilistic information even when we don't have a PDF
- Several approaches – most common, work with all PDFs consistent with the data available
- One axiom set says we look for such PDFs that give best and worst outcomes and evaluate with a weighted average – almost a scenario-based approach – Henry
- Leads to precautionary behavior, precautionary principle

Fat tails

- IPCC focuses on most likely range of outcomes – 2-4 deg.
- But greatest damage is in extreme outcomes in tails of distribution – 6 deg temperature rise
- These are low but not zero probability and the losses may be so massive that even with low probabilities these outcomes should dominate our calculations
- Point recently emphasized by Weitzman, who suggests that with subjective probabilities and Bayesian updating and a non-informative prior over climate sensitivity then tail outcomes should dominate our thinking about the economic costs of climate change
- Non-EU approach also suggests extreme caution in such cases

The end ……..

- Questions?