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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Economic models of climate change

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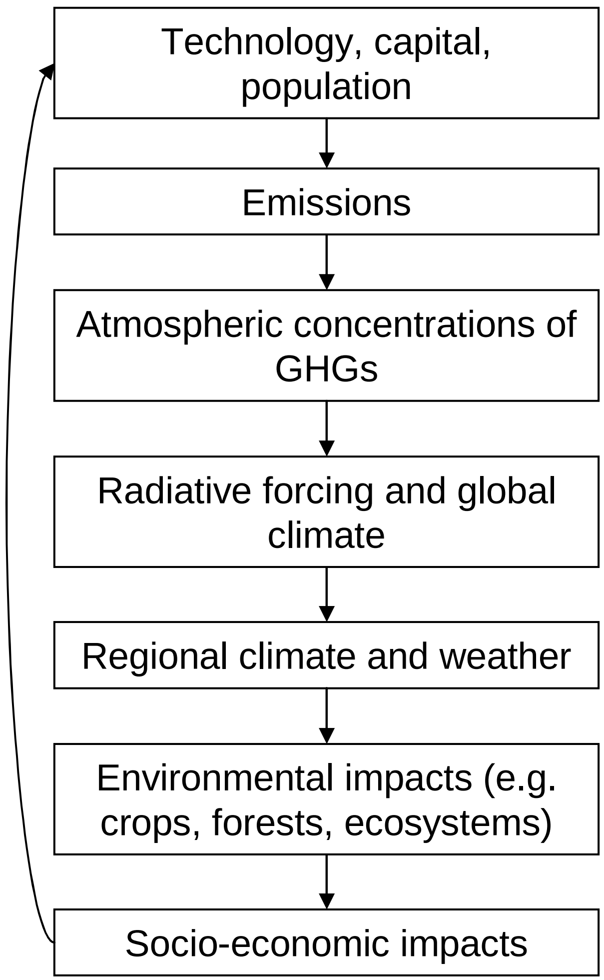
"All models are wrong, but some models are useful" (Box, 1979)

- Modelling the economics of climate change (as a whole) is a formidable challenge
- Most of the models we have were built primarily for understanding, rather than for prediction
- But that subtle distinction gets lost when model outputs are (ab)used in the real world
- Nevertheless these models are useful, principally in telling us what assumptions are necessary and sufficient to sustain a certain course of action
- In particular, we know that the economics of climate change depends both on environmental changes and on value judgements
- The benefits of reducing carbon emissions are probably higher than previously thought

What is an economic model of climate change?



- Actually there are many different kinds of economic model of parts of the system, e.g.:
  - Minimising the cost of hitting an emissions target
  - Valuing the loss of a species
- But here I just consider so-called ‘integrated assessment models’ of the whole system
  - Integrated in the sense of bringing together knowledge from economics, the sciences, and other social sciences
  - Applied, policy focus – able to answer the question, “what is the optimal climate policy?”

What does the typical model look like?

$$\text{(A.1)} \quad W = \sum_{t=1}^{Tmax} u[c(t), L(t)]R(t)$$

$$\text{(A.2)} \quad R(t) = (1+\rho)^{-t}$$

$$\text{(A.3)} \quad U[c(t), L(t)] = L(t)[c(t)^{1-\alpha}/(1-\alpha)]$$

$$\text{(A.4)} \quad Q(t) = \Omega(t)[1 - \Lambda(t)]A(t)K(t)^{\gamma}L(t)^{1-\gamma}$$

$$\text{(A.5)} \quad \Omega(t) = 1/[1 + \pi_1 T_{AT}(t) + \pi_2 T_{AT}(t)^2]$$

$$\text{(A.6)} \quad \Lambda(t) = \pi(t)\theta_1(t)\mu(t)^{\theta_2}$$

$$\text{(A.7)} \quad Q(t) = C(t) + I(t)$$

$$\text{(A.8)} \quad c(t) = C(t)/L(t)$$

$$\text{(A.9)} \quad K(t) = I(t) + (1-\delta_K)K(t-1)$$

$$\text{(A.10)} \quad E_{Ind}(t) = \sigma(t)[1-\mu(t)]A(t)K(t)^{\gamma}L(t)^{1-\gamma}$$

$$\text{(A.11)} \quad CCum \leq \sum_{t=0}^{Tmax} E_{Ind}(t)$$

$$\text{(A.12)} \quad E(t) = E_{Ind}(t) + E_{Land}(t)$$

$$\text{(A.13)} \quad M_{AT}(t) = E(t) + \phi_{11}M_{AT}(t-1) + \phi_{21}M_{UP}(t-1)$$

$$\text{(A.14)} \quad M_{UP}(t) = \phi_{12}M_{AT}(t-1) + \phi_{22}M_{UP}(t-1) + \phi_{32}M_{LO}(t-1)$$

$$\text{(A.15)} \quad M_{LO}(t) = \phi_{23}M_{UP}(t-1) + \phi_{33}M_{LO}(t-1)$$

$$\text{(A.16)} \quad F(t) = \eta\{log_2[M_{AT}(t)/M_{AT}(1750)]\} + F_{EX}(t)$$

$$\text{(A.17)} \quad T_{AT}(t) = T_{AT}(t-1) + \xi_1\{F(t) - \xi_2 T_{AT}(t-1) - \xi_3[T_{AT}(t-1) - T_{LO}(t-1)]\}$$

$$\text{(A.18)} \quad T_{LO}(t) = T_{LO}(t-1) + \xi_4\{T_{AT}(t-1) - T_{LO}(t-1)\}$$

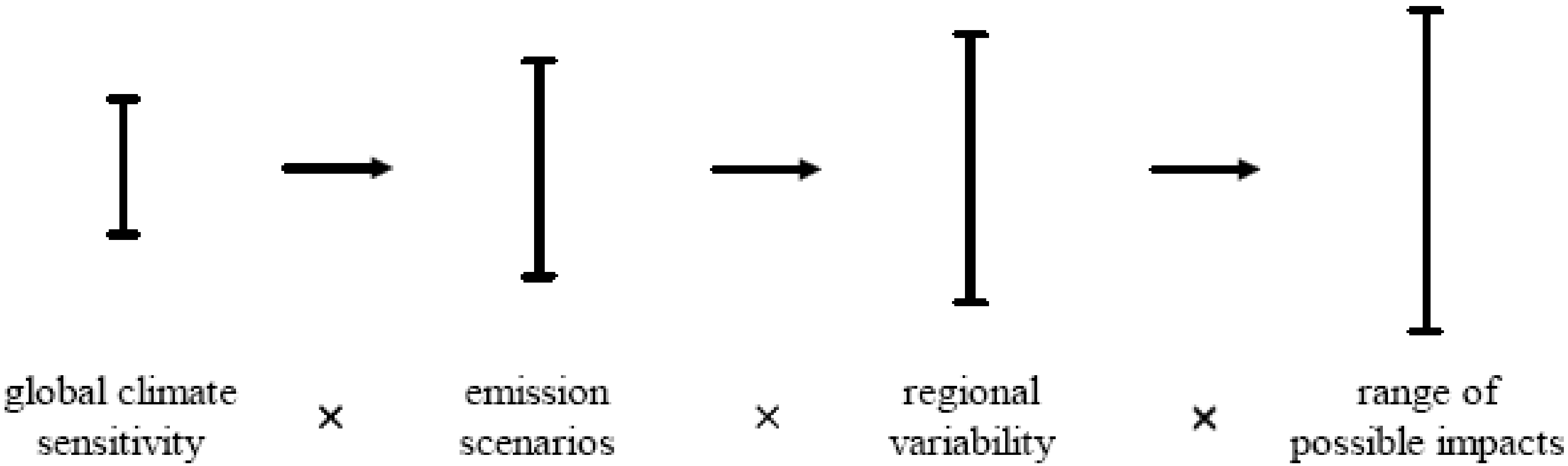
$$\text{(A.19)} \quad \pi(t) = \varphi(t)^{1-\theta_2}$$

- Highly aggregated, procedurally (fairly) simple
- Standard model of economic growth, which produces emissions
- Simple climate model
  - Model in itself
  - But calibrates model parameters on other climate models (interesting)
- Damages
  - Are either enumerated from sector to sector (e.g. agriculture, malaria)
  - Or are a simple polynomial function
- Social welfare
  - Embodies standard economic philosophy (welfarism)
  - So compare costs and benefits

What do the models tell us?

- All agree to reject the extremes of no action on emissions and total cessation, but beyond that big differences
- William Nordhaus
  - “efficient emissions reductions follow a “policy ramp” in which policies involve modest rates of emissions reductions in the near term” (from *A Question of Balance*, 2008, p 14)
- Nicholas Stern
  - “Our actions now and over the coming decades could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20^{th} century…So strong and prompt action is clearly warranted.” (from *The Economics of Climate Change: The Stern Review*, 2007, p xv.)

Why the disagreement? Reason I: uncertainties over the ‘facts’ of the system



- Many of the model’s parameters have huge ranges, so plenty of room for disagreement
- And very big difference in economics (where you are risk-averse) between a deterministic model, with a best estimate of each parameter, and a stochastic model, with ranges

Why the disagreement? Reason II: disagreement over values

- What is the present value of a £1 trillion benefit in 100 years
  - £249 billion with the Stern Review's c. 1.4% discount rate
  - £3 billion with a 6% discount rate
- And another issue is how much weight to put on costs and benefits in other regions

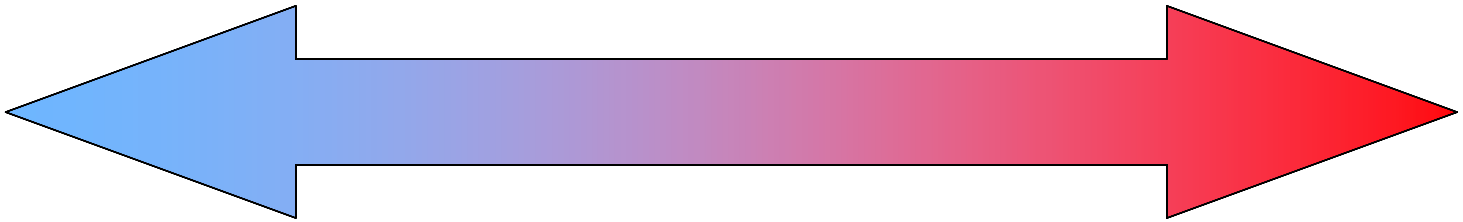
So what are the models good for?

Diagnostic models

- "models for understanding"

Prognostic models

- "models for prediction"



- Economic models of climate change were built primarily for understanding, but have become used as models for prediction, without substantially changing in character
- There are other examples of this in the history of economic thought (e.g. the 'Solow' growth model gave birth to growth accounting)

When understanding becomes prediction

- From the *Stern Review*, chapter 6:
  - “The large uncertainties in this type of modelling and calculation should not be ignored”
- From the *Observer*, front page, on publication of the *Stern Review*


£3.68 trillion
The price of failing to act on climate change
Landmark report reveals apocalyptic cost of global warming

Main points repeated

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