On welfare frameworks and catastrophic climate risks

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Uncertainty and climate policy

- Climate Science:
  - Broadbrush physical principles well understood, but detailed empirical predictions highly uncertain
- Climate-Economy Interactions
  - MORE uncertain than the science
- Integrated Assessment Modeling (IAM)
  - Combines two things we understand less well than we'd like: Climate Science, Economic Growth
  - Common view pre-Weitzman:

    'Time' dominates 'Risk' in determining policy prescriptions from IAMs

Weitzman's Dismal Theorem (DT)

- DT places uncertainty at the heart of Climate Policy analysis
- Assumptions:
  1. **Fat tailed risk** of a global consumption catastrophe is a generic feature of the climate problem
  2. The coefficient of relative risk aversion (CRRA) is **bounded above zero** as consumption tends to zero
- Result:
  - The stochastic discount factor (the value of a marginal unit of future consumption in today's consumption units) is **infinite.**
- Common Interpretation:
  - We should pay a large amount today to offset future fat-tailed risks

3 CRITICISMS OF DT

Marginal vs. Total Willingness to Pay

- *Infinite marginal willingness to pay does not imply total willingness to pay is infinite* (Horowitz & Lange, Karp, Nordhaus)

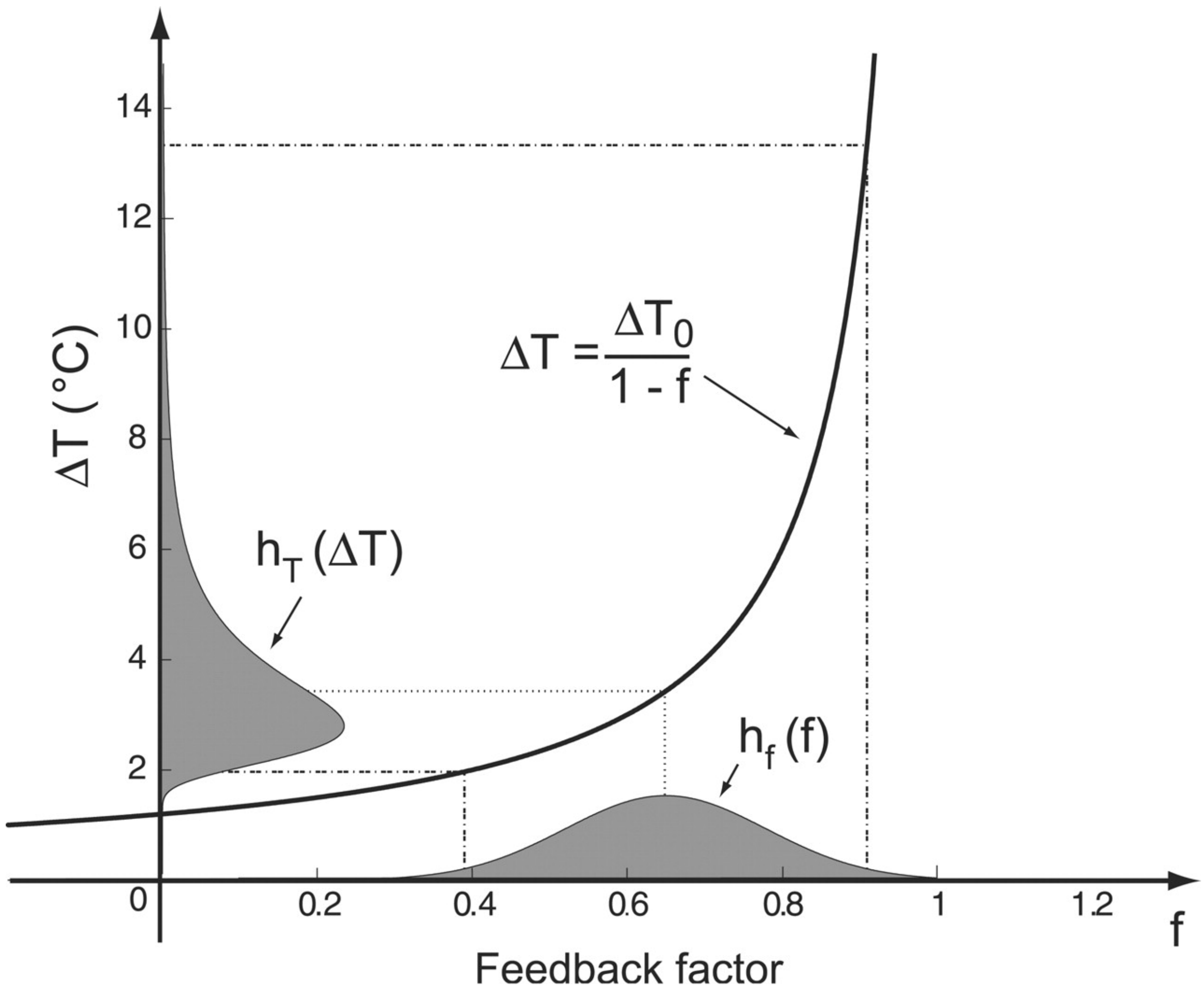
- TRUE, but relies on assuming certain transfers between the present and the future exist.

- One can show that DT holds for total as well as marginal WTP if, for all abatement levels:

$$\textit{Temp distribution exponent} > 1 + (\textit{Damage Steepness})(\textit{CRRA}-1)$$

- For common parameter values, require *CRRA < 1.5* for convergence

Uncertainty in Climate Sensitivity



G H Roe, M B Baker Science 2007;318:629-632

Climate sensitivity and adjustment times

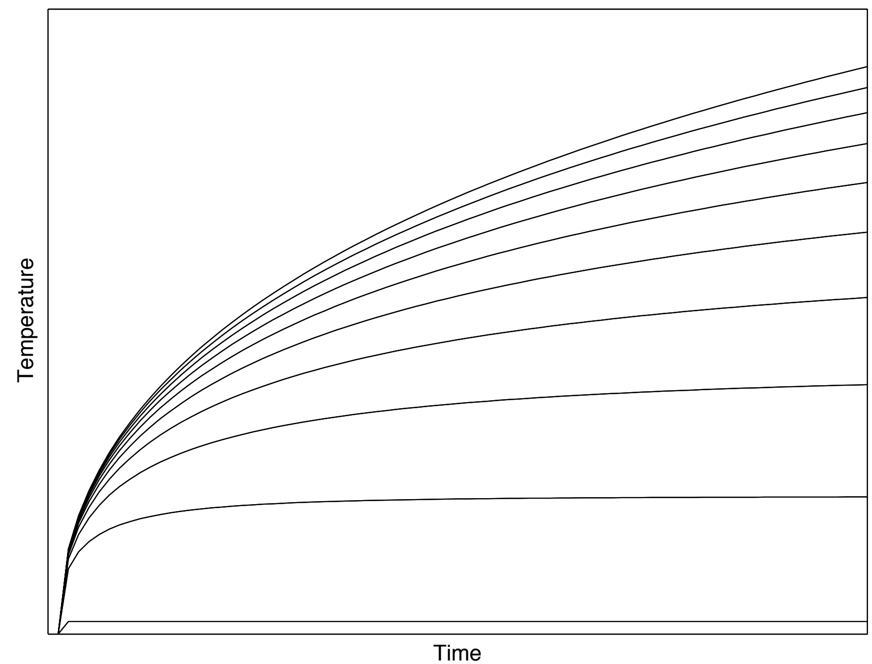
Several papers criticize DT by **bounding the distribution of future temperature change**: Nordhaus, 2009; Costello et al, 2010; Newbold and Daigneault, 2010; Roe and Bauman, 2010

Very general argument by Hansen et. al. (1985) suggests time to reach equilibrium proportional to S^2.

$$T(t) := S\left[1 - \exp\left(-\frac{K\sqrt{t}}{S}\right)\right]$$

$$\lim_{t\to\infty} T(t) = S$$

$$\lim_{S\to\infty} T(t) = K\sqrt{t}$$



But is *consumption* bounded above zero?
Multiplicative damage functions not designed to account for extreme temp change.

The role of the utility function

- Arrow (1974): Expected Utility exists for all finite mean risks only when:
  - U is increasing and concave.
  - U(0) is bounded below!

- For the existence of the stochastic discount factor, the relevant quantity is U'(0), which does not exist for ANY positive value of the CRRA.

- Policy choice vs. Policy Evaluation:

  "Expected Utility theory is insensitive to small probability events." (Chichilnisky, 2000)

The key question…

How should we ‘value’ catastrophes as a society?

- A counterintuitive result from social choice:
  - Applying Harsanyi’s aggregation theorem to this problem: Even if every individual has a bounded utility function, the social utility function may be unbounded below.
  - Revealed preference arguments for bounded social utility function based on samples of the population may be flawed.

Accounting for Population Change

- Weitzman and commentators implicitly assume an ‘average utilitarian’ approach to the population change that invariably accompanies catastrophes.
- Average Utilitarianism heavily criticized by social choice theorists.
- A more attractive alternative, Critical Level Utilitarianism:

$$\text{Welfare} = \int \bar{N}(c)\,(U(c) - \alpha)\,p(c)dc$$

- This welfare function is much less sensitive to catastrophes even if the social utility function is unbounded below.

Conclusions

- The real message of Weitzman's DT:
  Our traditional welfare frameworks are not suitable for evaluating policies with potentially catastrophic outcomes.
- There are viable alternatives available.
- These require both new *empirical inputs*, and new *ethical choices*.
- These choices are unavoidable, and should be made explicitly and transparently, rather than implicitly.