Limitations of Integrated Assessment Models of Climate Change

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Introduction

- Integrated assessment models (IAMs) provide important insights into the economics of climate change

- All models, however, rest on simplifications. Our paper points to three main weaknesses in the current generation of models:

  1. Information on climate damages is structurally incomplete. Current models do not adequately handle decision-making under uncertainty

  2. IAMs can overstate mitigation costs unless they account for endogenous technical change and market failures in technology adoption and diffusion

  3. The treatment of discounting abstracts away from the key role of risk in savings/investment decisions

The Discount Rate Controversy

- IAMs commonly assume that decision-makers aim to maximize a Ramsey social welfare function given perfect foresight:

$$W = \sum_t N_t u(c_t)/(1+\rho)^t \qquad u(c_t) = c_t^{1-\alpha}/(1-\alpha)$$

- This implies that the net monetary benefits of climate change policies should be discounted at the rate:

$$r = \rho + \alpha g$$

- Cline (1992) and Stern (2007) argue that $\rho \approx 0$ based on principles of intergenerational fairness

- Nordhaus (1992 and 2007) argues that r should be based on the market rate of return: $r = 0.06$, $\alpha = 1$, and $g = 0.03 \Rightarrow \rho = 0.03$

Discounting and Uncertainty

- In financial economics ***risk*** is the key factor that determines returns on investment. Average returns vary from 1% for safe investments to 7% for U.S. stocks

- Under uncertainty, the Ramsey setup implies that:

$$r_f = \rho + (\alpha g - \alpha^2 \sigma^2 / 2) \qquad E(r_r) = r_f - \frac{Cov[u'(c_{t+1}), r_r]}{E[u'(c_{t+1})]}$$

- The problem: No set of plausible parameter values ρ and α is consistent with observed data (Mehra and Prescott, 1985; Kocherlakota, 1996)

- Mehra and Prescott (2003): ***"using this class of models for any quantitative assessment, say, for instance, to gauge the welfare implications of alternative stabilization policies, is thrown open to question"***

Better Models?

- Two ways to resolve this paradox (the "equity premium" puzzle):

  1. Work with models that distinguish between intertemporal substitution and risk aversion (Epstein and Zin, 1989; 1991)

  2. Assume that people attach high subjective weight to low-probability "disasters" (Weitzman, 2007; Barro, 2006)

- For a broad class of models:

  1. The discount rate is set equal to the risk-free rate plus a risk premium (Howarth, 2009; Howarth and Borsuk, 2009)

  2. The risk premium is negative for precautionary actions that reduce perceived risks to future social welfare

Discounting and Climate Change

- Weitzman (2009) argues that climate catastrophes with low but unknown probabilities and very high damages should dominate discounting

  – Metaphorically, climate stabilization is like buying an insurance policy

- Cochrane (2005): "Insurance pays off exactly when wealth and consumption would otherwise be low—you get a check when your house burns down. For this reason, you are happy to hold insurance, even though you expect to lose money—even though the price of insurance is greater than its expected payoff discounted at the risk-free rate"

  – These effects are not adequately addressed in the current generation of IAMs. We need better models of time and risk preferences and a better characterization of climatic uncertainty