e-axes FORUM

Modelling uncertainty in climate economics

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The impact of climate change on social and economic systems is deeply uncertain. There are knowledge gaps over the precise effect greenhouse gas emissions have on the climate system, i.e., scientific uncertainty. Scenarios about the evolution of carbon emissions and society's response to climate change are equally riddled with unknowns, i.e., socioeconomic uncertainty. Finally, lack of normative knowledge over how to value the relative interests of people today and the interests of future generations, as embodied in discount rates, complicates the picture further. How then should we make policy decisions in such an uncertain environment?

Decision-making frameworks under uncertainty

Developing meaningful quantitative models that guide science-based and prudent policymaking requires methods that quantify the pertinent uncertainty as well as a framework to assess alternative courses of action. The literature discussing decision-making under uncertainty dates back decades but has picked up pace in the past ten years in the context of climate policy.

Geoffrey Heal and Antony Millner (2014), in "Uncertainty and decision making in climate change economics," explore the different sources of uncertainty in climate change economics and decompose them into categories to assess their relative importance for climate policy. They then argue that the standard framework for decision making under uncertainty (i.e., the expected utility model) may be of limited use for analyzing the climate problem.

Berger et al. (2017), in "Managing catastrophic climate risks under model uncertainty aversion," propose an alternative, robust, risk management approach to deal with the presence of deep uncertainty in the context of a specific catastrophic climate event. They propose both an analytical framework and a numerical application which makes explicit the distinction between uncertainty within models and across models, and allow for distinct attitudes towards them. In their application, model uncertainty is accounted for by a simple measure capturing the disagreement between scientific experts. In this way, they disentangle the contribution of preferences and the structure of model uncertainty on the level of abatement, with the latter having the largest effect. They find that in most cases, "a robust climate strategy implies stronger mitigation policies."

Ivan Rudik (2020), in "Optimal climate policy when damages are unknown," develops a recursive Integrated Assessment Model (IAM) to take into account climate damage uncertainty. Incorporating parametric uncertainty into the damage function of the standard DICE IAM and accounting for concerns that the damage functional form is misspecified, he finds that this concern for robustness tends to increase the carbon tax through a channel that parallel insurance motives in the savings literature. Moreover, if the damage function is misspecified as widely believed, robust control and learning can achieve higher welfare than accounting for parametric damage uncertainty alone.

Michael Barnett et al. (2021), in their working paper "Climate Change Uncertainty Spillover in the Macroeconomy," structure model uncertainty into three categories (carbon dynamics; temperature dynamics; and damage functions) and integrate them into the analysis of a social planner determining the optimal carbon tax. They offer a computational example of their approach, showing which impact the future availability of information "about environmental and economic damages, triggered by temperature anomaly thresholds, should have on current policy."

Finally **Berger and Marinacci** (2020), in "Model Uncertainty in Climate Change Economics: A Review and Proposed Framework for Future Research," review recent models of choices under uncertainty that have been proposed in the economic literature and show how different concepts and methods of decision theory can be directly useful for dealing with uncertainty in climate change. To illustrate, they provide a simple application in the context of an optimal mitigation policy under climate change, which consists in choosing the level of GHG emissions maximizing the economy's net output.

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The E-axes Forum is an independent nonprofit, nonpartisan research organization on macroeconomic policies and sustainability. The Forum is dedicated to aggregating knowledge from around the globe with the aim to catalyze the engagement of economists and decision makers who are working on policies towards achieving a sustainable economy.

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