Abstract

Climate change, the *21st* centuries challenge for cooperative human decision making, is surrounded by large uncertainties concerning the scientific understanding of the climate system, of climate change induced changes of natural and social systems and of the impacts of those changes on human economic activities and human welfare in general. Parts of these uncertainties will be resolved as science advances and new observations are made. This learning will allow to refine the decisions undertaken to cope with the climate problem.

This thesis is dedicated to examine the role of uncertainty and future learning in the formal assessment of optimal global mitigation strategies for global warming. The central contributions of this study are contained within three research articles.

The first article investigates the validity of the cost-effectiveness framework when applied to the case of climate targets under uncertainty and future learning. The study highlightens two major conceptual problems of this formalism, namely the possibility of negative value of information and infeasibility of the whole decision criterion. As a consequence an alternative decision framework is proposed, the so called cost-risk analysis, that avoids those conceptual problems but still remains based on climate targets.

The second article is motivated by the clash between the general scientific intuition that epistemic uncertainties about the climate system and climate damages should play a major role in determining optimal mitigation policies (and the resulting welfare gain compared to doing nothing) and the results from the integrated assessment models that show only insignificant influence of those uncertainties. We introduce a method of assessing the importance of uncertainty both in its impact on optimal policy and in its impact on the welfare gain from acting upon climate change. We then use a representation of the integrated assessment model MIND that allows to link the decomposed value of climate policy to the structural form of the functions representing the climate cause-effect chain, thereby understanding the negligible effect of uncertainty from the model structure. Finally we propose some changes to the model structure that result in large impacts from including uncertainty.

The third article investigates the circumstances under which the anticipation of future learning about tipping-point-like threshold climate damages would be important for the determination of near term mitigation decisions. We show that this is only the case if the learning occurs within a narrow *anticipation window*. In this case far stronger near term mitigation is optimal to keep the option open to avoid the threshold in case it turns out to lead to severe damages. The location and width of this window is found to be sensitive to the DM's flexibility to reduce emissions. If reducing this flexibilitiy in the MIND model, may this represent political or social barriers, the anticipation window moves towards the present and broadens considerably, thereby increasing the importance of including future learning into the analysis of climate change.

The articles are put into perspective by an introduction into the field that lays out the general linking research questions and general conclusions.