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Recalculating the Social Cost of Carbon

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Recalculating the Social Cost of Carbon

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Summary

Over the last few decades, integrated assessment models (IAM) have provided insight into the relationship between climate change, economy, and climate policies. The limitations of these models in capturing uncertainty in climate parameters, heterogeneity in damages and policies, have given rise to skepticism about the relevance of these models for policy making. IAM community needs to respond to these critics and to the new challenges posed by developments in the policy arena. New climate targets emerging from the Paris Agreement and the uncertainty about the signatories' commitment to Nationally Determined Contributions (NDCs) are prime examples of challenges that need to be addressed in the next generation of IAMs. Given these challenges, calculating the social cost of carbon requires a new framework. This can be done by computing marginal abatement cost in cost-effective settings which provides different results than those calculated using constrained cost-benefit analysis. Here we focus on the areas where IAMs can be deployed to asses uncertainty and risk management, learning, and regional heterogeneity in climate change impacts.

Keywords: Integrated Assessment Models, Climate Policy, Carbon, Uncertainty

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1 Introduction

Over the last few decades, integrated assessment models (IAM) have provided insight into the relationship between climate change, economy, and climate policies. The limitations of these models in capturing uncertainty in climate parameters, heterogeneity in damages and policies, have given rise to skepticism about the relevance of these models for policy making [1]. IAM community needs to respond to these critics and to the new challenges posed by developments in the policy arena. New climate targets emerging from the Paris Agreement and the uncertainty about the signatories' commitment to Nationally Determined Contributions (NDCs) are prime examples of challenges that need to be addressed in the next generation of IAMs. Given these challenges, calculating the social cost of carbon requires a new framework. This can be done by computing marginal abatement cost in cost-effective settings which provides different results than those calculated using constrained cost-benefit analysis. Here we focus on the areas where IAMs can be deployed to asses uncertainty and risk management, learning, and regional heterogeneity in climate change impacts.

2 Carbon pricing with a moving target

The Paris agreement calls for "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" [2]. This has introduced new sources of uncertainties for the economic models of climate change. Temperature policy targets in turn, have been translated into cumulative emission targets by the IAM community to create a link between economic output and climate conditions [3, 4]. The main source of uncertainty facing policy makers that wish to stick to the Paris agreement is the uncertainty about the transient response to cumulative emissions. This uncertainty significantly curbs the available carbon budget to keep temperature below the target, and more so if policy makers are willing to accept less risk than the two third chance of not hitting the Paris target mentioned by the IPCC [5]. The price of carbon that guarantees this probabilistic target is pinned down at the end by the cost of full decarbonization of the global economy and in the preceding period grows at a rate equal to the rate of interest. To put it in the IAM language, the constrained, welfare maximizing carbon price equals the social cost of carbon (SCC, the marginal

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damage cost of increasing GHGs), plus a Hoteling premium that ensures intertemporal efficient use of the scarce emissions budget created by the binding temperature constraint. This has led to emergence of 'cost-effective' analysis versus the traditional 'cost-benefit' analysis to find the optimal carbon price. By ignoring damages, the cost-effective method sets a carbon price that guarantees global mean temperature to stay below the 2°C following the Hoteling rule. This leads to a carbon price that is lower initially and grows faster over time.

3 Averting climate risks

Conventional cost-benefit IAMs such as DICE tend to maximize welfare taking account of the global warming damages to aggregate production. Unless very low discount rates are used, these typically lead to temperatures above 2°C target with moderate carbon prices. If instead, the effects of temperature on output growth rate (and not level) are being considered, the carbon prices can be much higher if damages are presumably severe [6, 7, 8].The relationship between risk aversion attitudes of policy makers and presumed damages from higher temperatures can have significant implications for climate policy making [9, 10]. If the damages are more convex in temperature, the price of carbon increases substantially compared to traditional assumed prices.

4 Learning unknowns

Uncertainties about the extend of climate change and its socioeconomic impacts will resolve as future generations live under altered climatic conditions. Today's climate policies must be designed with these climatic (and related) uncertainties in mind to avoid misleading advice from deterministic averages. An optimal response to uncertainty depends a priori on: (1) the distribution of the uncertain parameter and how this quantity affects our welfare, for example, how climate sensitivity translates into climate damages; (2) society's attitude to uncertainty; and (3) the anticipation of learning, or the resolution of uncertainty. To understand how these aspects interact, one needs an explicit model of uncertainty and learning. Such a model can give a comprehensive understanding of the channels through which uncertainty affects the social cost of carbon, helping us to better understand the important contributions that require more research. Earlier, deterministic integrated assessments insinuate a level of certitude that does not exist. Current Monte-Carlo assessments are unable to guide decisions under uncertainty and lead to a misunderstood sense of understanding the impacts of uncertainty on policy. For decision support, we need comprehensive dynamic models that account for uncertainty already in the formulation of the dynamic equations.

5 Recognizing heterogeneity

Analysis of carbon price and the SCC that captures the global economic impacts of climate change have been traditionally computed at the global level, with limited geographical differentiation. Recent development of the New Climate Economy literature [11] has made it possible to account for the distribution of climate impacts across countries and regions. These impacts are expected to be unequal, and most likely regressive, with poorer countries being hit the most [12, 13]. Regional IAMS have improved the consideration of spatially distributed impacts. More recently, the within-region income distribution has been taken into account but the use of much disaggregated data on spatial impacts, notably regional temperature changes, sea-level rise and other biophysical impacts [14], and their linking to economic costs should be substantially improved. Furthermore, other dimensions of social heterogeneity such as human capital accumulation, demographic change, and migration [15] are importantly linked to the distribution of impacts and should be part of the assessment of climate impacts and the computation of the SCC. Moreover, spatial resolution matters for computing the global aggregate values, since it can provide additional accuracy and a better estimate of the uncertainties. Estimating the heterogeneity of regional SCC is important for quantifying non-cooperative behavior. Beside climate damages, there is a high level of heterogeneity in the GHG emissions with some countries more than others. This leads to a significant free-rider problem that makes it enormously hard to achieve any global agreement on this matter. Even when an agreement is reached, countries have always strong incentives to defect from it as it was recently demonstrated by the US government's decision to pull out of Paris agreement. This requires IAMs to capture the game-theoretical aspect of the problem. Furthermore, dealing with climate change requires continuous efforts of all countries and therefore, a non-cooperative repeated-game framework could be a promising way to capture these heterogeneities over time.

6 Engaging in policy

The nature of the problem of climate change has also severe policy implications. Since stable global agreements are challenging to reach, one might additionally aim for incremental steps complementing the international efforts to make fundamental progress. Besides, policies involving incremental steps can typically be faster implemented (in particular in democracies). To cope with uncertainties in our climate and socioeconomic systems, policy makers will need to build portfolios of strategies (among which pricing carbon might be one), starting from those which are more robust (e.g. policies favoring renewables in those countries which are not rich in fossil fuels, or disfavoring polluting combustion engine for personal mobility) and then adding to this chore set of policies new ones, as the political environment allows them to (e.g. when the cost of solar energy or batteries have been drastically lowered by first movers). Will SCC metric be still relevant in future? It may still be useful, in international contexts, in order to study the relative exposure to climate change impacts of various regions of the world, as long as the many elements we are leaving out are not proven biased in favor of one region versus the other [16]. In a more practical way, IAM analysis needs to take aboard climate risks and implications for finance. This means a richer set of asset menus consisting of carbon-free risky assets, carbon-intensive risky assets and safe assets and detailed study of how institutional investors can decarbonize their portfolios in an efficient manner taking full account of the wide range of economic, climatic and damage risks facing them.

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