Economic modeling of climate change impacts and adaptation: a review of global Integrated Assessment Models

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Abstract

IAM is a quite useful tool for understanding the issue of climate change and providing possible climatic policy suggestions, since the climate change problem not only relates to energy emissions, but also socio-economic development and natural climate science. The IAM helps to find all possible solutions with respect to climate change mitigation in last two decades, however, the climate change adaptation is paid attention to until recent years because people learn that climate change is most likely unavoidable due to the energy consumption and economy development around the world currently. Hence, this study makes a review of the impact assessment and adaptation modeling with respect to the global IAM. 19 influential or in active development IAMs are elected and evaluated in this review, in terms of specific modeling approaches and related results. The objective optimization IAM usually uses C-D or CES production function to integrate different factor inputs such as capital stock, labor, energy/energy services, knowledge, etc., with different nested structures in economic modeling. Recent IAMs use aggregated monetary economic losses or biophysical damages to represent the impacts from climate change. The monetized impacts are ready to be used in current economy based IAM and the biophysical damages, if considered in IAMs, are also usually converted to the monetary measurement units according to some assumed principles. The impact assessment focuses on agriculture, forestry, water resources, etc. As to the regional disparity, developing countries are more vulnerable to climate change than developed countries. The reactive adaptation is expressed as a flow expenditure while the proactive adaptation is treated as a capital stock formed by the investment periodically. Recent IAMs usually assess the relationship between mitigation and adaptation, the efficiency to reduce climate change costs or the impacts on GHGs emission path and atmospheric carbon concentration.

Several issues are highlighted according to the review of climate change impacts and adaptation modeling about IAM. First of all, for the objective optimization IAM, it is expected to provide detailed regional and sectoral information; however, it is often not the case actually. The compromise solution is to use global IAM with sectoral details or build regional IAM with similar climate change impacts and adaptation description for each region. Secondly, with respect to the long-term effects of proactive adaptation, an improvement for current modeling technique or new modeling technique is needed to describe the proactive adaptation appropriately. Thirdly, efforts should be made to distinguish the climate change adaptation from economic, population-related and technological "adaptation" to meet the needs of investment decision-makers. Fourthly, with respect to climate change impacts, a distinguish between sectors or impact endpoints would be helpful for model developers to provide additional detailed information about climate change mitigation and adaptation. Finally, in addition to climate change uncertainty, efficiency and equity among the regions, and the sub-optimal decision under uncertainty, the climate engineering including carbon dioxide removal and solar radiation management is expected to be involved in the IAMs, and fortunately, some tentative exploration about this climate engineering is in progress. The challenge IAM faces is also the challenge of the science of climate change. More communication is needed among economists, climatologists, environmentalists and model researchers and developers. Modeling of climate change with IAM is an interdisciplinary issue that it requires both empirical estimation from social science, and carbon cycle and atmospheric concentration principles from natural science. Current IAMs should integrate all the necessary information to find the solutions of climate change mitigation and adaptation, or even climatic geoengineering.