

Regional total climate change costs for different burden sharing regimes and concentration targets

Introduction

Many studies have assessed cost implications of different burden sharing regimes or allocation schemes for post-2012 regional emission reductions. These studies analysed the implications of emission allocation rules on the regional costs of abatement. Adaptation costs and residual damages are generally analysed separately from the burden sharing regime. This can lead to a distorted view of the regional burdens of climate change policy and to the principle of common responsibilities. In our study, we look at the implications of several burden sharing regimes on the total climate change costs, i.e. abatement costs, adaptation costs, and residual damages, using an integrated model.

Method

For the analysis we use the integrated model FAIR (den Elzen and van Vuuren, PNAS, 2007, 104 (46): p.17931-17936; Hof, den Elzen and van Vuuren, Global Environmental Change, 2008, in press) with adaptation and residual damage estimates from the AD-RICE model (de Bruin and Dellink, Climatic Change, 2008, in press). The FAIR model describes the interactions between multi-gas emissions pathways, greenhouse gas concentrations and the climate system, as well as the interaction between the climate system and the economy through climate change damages and abatement costs on a global as well as regional scale. Furthermore, FAIR analyses the implications of emissions trading for different international burden sharing regimes. The AD-RICE model separates the regional damage functions of the RICE model by Nordhaus and Boyer (MIT Press, 2000) into a residual damage (i.e. damages not avoided by adaptation measures) and adaptation cost component.

More specifically, the FAIR model consists of the following six sub-modules: 1. the scenario module, calculating the GDP growth projection until 2250 for different scenarios; 2. the emissions pathway module, calculating multi-gas emission pathways for the six greenhouse gases covered under the Kyoto Protocol; 3. the MAGICC 4.1 climate model is used to calculate the temperature implications of the emission pathways; 4. the abatement costs module, calculating the direct abatement costs; 5. the damage model, calculating the direct damages and adaptation costs, and 6. the macroeconomic growth model, calculating the direct and indirect consumption loss of abatement and damages.

Analysis

We have analysed two global multi-gas emission pathways, corresponding with stabilising long-term greenhouse gas concentrations at 450 ppm and 550 ppm CO₂-eq. The regional emission reductions are calculated based on the burden-sharing regimes, i.e.: Contraction & Convergence (C&C) with convergence year 2050, the Multi-Stage regime, or according to the Triptych 7.0 approach (den Elzen, Höhne and Moltmann, Energy Policy, 2008, 36, p. 1107-1124). In the C&C regime, emission reductions are allocated over the regions so that per capita emissions converge from their current values to a global average by 2050. In the Multi-Stage regime, an increasing number of regions accept commitments over time based on per capita income and per capita greenhouse gas emissions. Allocation by the Triptych approach is based on technological criteria at the sector level, and accounts for structural differences. In our default calculations, the amount of adaptation is set at the optimal level according to

AD-RICE (meaning that the sum of adaptation costs and residual damages are minimised). We have analysed the effect of sub-optimal adaptation on the total climate change costs as well, by setting the amount of adaptation at 50% of this optimal level.

We have used the medium projection for population, GDP and emissions. In our economic growth model, the savings rates per region in 2005 are taken from the World Development Indicators database and are assumed to converge linearly to the current world average of 21% in 2100 in every region. The initial capital stock in every region is based on the IIASA growth study datasets and depreciation is set at 5% annually. Finally, we adopted the UK Green Book discounting method for computing the net present value of income losses.

Conclusions

We show that assessing the burden sharing regimes on the total climate change costs instead of abatement costs only leads to very different results. The reason is that potential damages, and with that adaptation costs, are distributed unevenly among regions. Most developing regions are projected to incur relatively high climate change damages. Even with burden sharing regimes with small or even negative abatement costs for developing regions, total climate change costs are relatively high for most of these regions. This means that current proposals for burden sharing regimes that are beneficial for developing regions still cannot compensate the higher damages in these regions. This is even more so the case if the adaptation measures of these developing regions are inadequate.