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Energy Policy 31 (2003) 1033–1044

ENERGY POLICY

www.elsevier.com/locate/enpol

Equity and carbon emissions trading: a model analysis

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Abstract

Carbon emissions trading is a key instrument of climate policy. It helps to bring about emission reductions in that place where they are least costly. However, fair burden sharing is about more than just cost-efficiency. While focussing on the instrument of emissions trading, this paper touches upon equity issues that frame decisions on emission rights allocation. The analysis is based on the ICLIPS model. The model study gives new insights on how the equal per capita allocation principle influences the intertemporal emission paths and about the distribution of mitigation costs in the long run. Apart from the intuitive economic evaluation of model results, this paper also attempts to provide an evaluation from an equity point of view. For a variety of assumptions, model results show that several developing countries could benefit considerably from joining an international emissions trading system, thereby becoming potential collaborators in post-Kyoto climate agreements.

Keywords: Climate policy; Emissions trading; Equity; Integrated assessment

1. Introduction

In climate policy decision-making, pure economic decision criteria are superimposed by fairness issues. This applies in particular to the instrument of emissions trading. Both the question of whether to restrict the amount of emission permits traded and the question about the principle of emission rights allocation can in part only be answered by looking at equity and other non-economic factors. Most climate policy models are not able to reflect such non-economic factors and their influence on decision-making in an appropriate formalized way. Since they are not equally represented in the models, economic and non-economic factors cannot be traded off against each other. They are of rather different dimensions. Consequently, existing models fall back on economic analysis and handle equity issues by means of exogenous normative assumptions. This is the point of departure in the present analysis too. However, model results will be subject to supplement evaluation focussing on interregional equity.

The international literature has discussed the equity issue in the context of climate policy burden sharing and emissions trading for some years (e.g., Rose and Stevens, 1993; Manne and Richels, 1995; Ridgley, 1996; Ringius et al., 1998; Gupta and Bhandari, 1999; Azar, 1999; Helm, 1999; Aaheim, 1999; Metz, 2000; Carraro, 2000). I focus on a prominent allocation-based equity criteria—the equal per capita emission right—which follows from the egalitarian approach (see Rose et al., 1998). The equal per capita entitlement to emission permits is not the only method of allocation that can be justified by equity concerns and it fails where different individual needs arise due to existing natural and cultural living conditions. Therefore a combined allocation principle is probably more equitable (Müller, 2001). Nevertheless, the moral superiority of the equal per capita allocation of emission permits follows from the global commons property of the atmosphere as a sink for anthropogenic greenhouse gases and its limited sink capacity. There are no property rights to the atmosphere, so anyone is eligible to use it. This is the current legal situation as long as international agreements are not violated. However, overproportional per capita emissions today restrict the future emission opportunities of others. Hence the argument against the equal per capita allocation, that the others are unable to use a surplus of emission rights anyway, is unconvincing. Overproportional use thus only seems fair if the others are compensated, which is something that could efficiently be implemented by means of an emissions trading regime.

Most model studies analyze the impacts of an equal per capita allocation of emission rights in a rather limited form, e.g. without the tradeable permit market

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0301-4215/03/$ - see front matter
PII: S0301-4215(02)00180-5

being explicitly modeled (Edmonds et al., 1995) or by fixing the emission reduction targets ex ante, which not only applies for studies that aim to model the consequences of the Kyoto Protocol, but also for studies with a time horizon that goes beyond Kyoto (e.g., Rose et al., 1998; Böhringer and Welsch, 1999). Buonanno et al. (2001), who analyze the impact of emission trade restrictions on equity and efficiency, implement the allocation of emission permits by assuming that the Kyoto targets apply for the whole century. While focusing on long-term climate policies, the model study presented here goes beyond this rather unlikely Kyoto-for-ever scenario. It resembles the 'contraction and covergence' approach (Meyer, 2000) and derives the global as well as regional emission reduction targets from the model analyses based on a permit market and on ambitious climate goals. Due to this, I am able to give new insights on how the equal per capita allocation principle influences both the distribution of mitigation costs and intertemporal emission paths ("when flexibility"). Moreover, I will demonstrate the phenomenon of the "equity dent", which arises under a particular model setting.

With a given reduction target and under common assumptions on rationality and competition, model studies yield a market solution according to which all regions have to reduce greenhouse gas emissions up to the point where the marginal abatement costs reach the same level. While neglecting any equity aspects, Nordhaus and Boyer (2000) based their analysis about efficient climate-change policies on an emission rights allocation that follows that market solution (they call it a revenue-neutral allocation). Emissions trading will hardly occur in such a model setting. Above all it implies different reduction amounts (in absolute as well as percentage terms) for each region, while the responsibility of major emitters is not taken into account. It is far from being a realistic option to expect that African countries undergo emission reductions because of their low mitigation costs without any compensation. A differentiated burden sharing as demanded by the Kyoto Protocol is required. Nevertheless, the efficiency potential offered by the market can yet be used thanks to flexible instruments like emissions trading.

There are two approaches to starting the emissions trading system. With the first approach, a given amount to emission rights is auctioned, whereas according to the second approach emission rights are allocated on the basis of a fixed allocation rule. While in the second case the discussion is centered around the allocation rule, the same applies to the problem of recycling the revenues from auction in the first case. In the present model, I start with an initial allocation of emission rights. But differently to other studies, I do not derive this allocation from fixed regional emission reduction targets. Only the regions' share in the pool of emission rights is given. The absolute level of allocated emission rights is endogenously determined.[1]

2. Model framework

The analysis is based on the version 1.0 of the ICLIPS model (Toth et al., 2003). The ICLIPS model serves to integrated assessments of climate protection strategies. The core model, that is used for this analysis, couples an economic submodel (cf. Leimbach and Toth, 2003) and a climate submodel (cf. Bruckner et al., 2003).[2] The economic submodel (ICEMODE) is illustrated in Fig. 1, a technical description is presented in Appendix A. ICEMODE is a multi-region, single-sector economic growth model. In the following I describe the most important assumptions that frame the model analysis.

The starting point is a definition of guard-rails[3] which should exclude intolerable developments of the climate system. In a cost-effectiveness analysis, the model determines that emission path which keeps the system within the guard-rails at least costs. The chosen guard-rail is a climate window that restricts the increase in global mean temperature to 2°C (relative to the preindustrial level) and the rate of change in global mean temperature to 0.2°C per decade.

Drastic emission reductions within each region are required to meet this guard-rail which was originally defined by the German Environmental Council on Global Change (WBGU, 1995). In an economic growth model, emission abatement is optimally allocated regionally and temporally. Emissions trading makes the system more flexible and thus increases economic performance. The actual level of trading, however, depends on the initial allocation of emission rights. Regarding the allocation principle I will focus on the equal per capita distribution. Although representing a fair principle in the long run, in the short term the per capita distribution seems to have hardly any chances of implementation. The underlying argument is that of the economic cost. I carried out a series of experiments in which I calculated these costs while varying the model setting in two directions. First, I combined the equal per capita allocation with a status quo rule (see Eq. (A.27)), and second, I analyzed the impact of emission trade restrictions.

[1] The intended long-term analysis goes far beyond the time horizon of the Kyoto Protocol. Short-term adaptation and mitigation measures are not the focus here. Hence, I do not attempt to base the analysis on the specific reduction targets as announced by the Kyoto Protocol.

[2] The submodels of ICLIPS are also elements of PIAM (Potsdam Integrated Assessment Modules) which represent a highly innovative framework of modularized model integration. PIAM activities were started at the Potsdam Institute for Climate Impact Research recently.

[3] See Bruckner et al. (1999) for a detailed discussion of the guard-rail approach.