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Climate cooperation with technology investments and border carbon adjustment

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ABSTRACT

A central question in climate policy is whether early investments in low-carbon technologies are a useful first step towards a more effective climate agreement in the future. We introduce a climate cooperation model with endogenous R&D investments where countries protect their international competitiveness via border carbon adjustments (BCA). BCA raises the scope for cooperation and leads to a non-trivial relation between countries' prior R&D investments and participation in the coalition. We find that early investments in R&D render free-riding more attractive. Therefore, with delayed cooperation on emission abatement and ex-ante R&D investments, the outcome is often characterized by high participation but inefficiently low technology investments and abatement.

1. Introduction

Countries have been struggling for over 20 years to reach an effective international agreement to reduce emissions of greenhouse gases. Still, it is uncertain whether a global treaty that encompasses a large number of participating countries and deep emission cuts for its members can be reached in the future. In the meantime, countries have to make important decisions regarding their technology policy. A central research question is, thus, whether early efforts to bring down the costs of abatement may help to improve the future prospects of cooperation.

In this paper, we analyze the interaction of abatement efforts, R&D investments, and countries' participation decisions in a climate treaty. We treat climate stability and knowledge as two global public goods, and assume that each country can contribute to both of them. In line with Barrett (1994), Carraro and Siniscalco (1993) and other authors from the climate cooperation literature (see, e.g., Finus, 2008, for a survey), we assume that countries decide individually and non-cooperatively whether they want to join a coalition or not. Furthermore, R&D investments are determined *before* countries play the membership game. Intuitively, the development of low-carbon technologies is a time-consuming process. Therefore, strategic effects upon later abatement arise when countries determine their R&D investments.

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Buchholz and Konrad (1994), Beccherle and Tirole (2011), and Harstad (2015) have shown that these strategic effects can negatively affect welfare. The reason is that countries that reduce their abatement costs more than others by R&D investments will be assigned a higher abatement target at the cooperation stage. This motive for strategic underinvestment is absent in our model because R&D affects all countries' abatement cost functions equally due to its public good nature. However, the positive effect of R&D investments on abatement targets leads to a different problem. It makes *participation* in a future climate coalition less attractive. This effect arises even if countries can determine their R&D efforts cooperatively, as long as there is a delay.[1]

An important feature of our model is that it allows for border carbon adjustments (BCA). This reflects the importance that the topic has received in recent discussions of climate agreements (see, e.g., Böhringer et al., 2012). BCA is a policy instrument designed to prevent competitive disadvantages for firms located in countries that implement unilateral climate policies. Based on a simple trade model, we assume that firms in signatory countries that export their output to non-signatories are partially exempted from the emissions tax in their home country. Furthermore, import tariffs adjust the total emissions price of firms located in non-signatory countries to the tax raised by signatories.

The introduction of BCA substantially changes the outcome of the climate cooperation game. Similar to R&D, it reduces the abatement cost of signatories (due to export exemptions), which leads to more ambitious abatement targets. One might expect that this makes participation in a coalition less attractive. However, BCA has additional effects that lead to the opposite result. Specifically, the import tariff induces further abatement efforts by the non-signatories and, thus, raises their costs. In combination with the export exemptions, this effectively allows the signatories to 'shift' some of their abatement costs to the non-signatories. Furthermore, signatories receive transfers from non-signatories via the BCA-tariff. These effects make the option to become a signatory more attractive. The endogenous coalition size can, thus, be higher than in a standard cooperation model without BCA. We show that when countries' export shares are large, then often a grand coalition forms in equilibrium. Intuitively, if a single country drops out of a grand coalition, all its exports still go to the remaining signatories. Under BCA, these exports are then subject to import tariffs. This 'cost' of leaving the coalition is large when countries' export shares are large, whereas the benefit of lower abatement costs incurred by the firms that serve the domestic market is then small.

This stabilizing effect of BCA upon cooperation motivated us to integrate BCA into the coalition model. In particular, it allows us to derive a non-trivial relation between countries' R&D efforts and the endogenous coalition size, which is the main focus of this paper. By contrast, we do not explore the effects of climate policies with and without BCA on trade patterns, and the latter will be modeled in a very stylized way.

In our analysis we treat the participation level as a continuous variable and skip the usual integer constraint when countries decide whether to join or leave a coalition. It turns out that this substantially facilitates the determination of the coalition size. This allows us to use a non-parametric approach, and to carry out most of the analysis without closed form solutions or numerical simulations, on which much of the existing literature has relied. Moreover, we show that this approach is conservative in the sense that it (weakly) underestimates equilibrium participation as obtained in the 'standard' coalition model. Indeed, without BCA the continuous approach would always lead to zero participation. Intuitively, all countries benefit equally from abatement, but costs of abatement are larger for coalition members. Hence, they would always prefer the position of a non-signatory. Accordingly, in the standard approach it is the discontinuity from the integer effect that gives individual countries leverage on the coalitions' abatement target and, thereby, leads to a non-empty coalition. In contrast, in our continuous participation model it is BCA that allows for a positive coalition size.

Our stylized model enables us to tackle the following questions regarding the relation between R&D and coalition formation: assuming that climate cooperation is currently not feasible – how do countries' prior investments in R&D affect the endogenous participation in a future climate agreement and the amount of emissions reductions achieved? And how do countries – in anticipation of these effects – adjust their R&D efforts?

We show that early R&D efforts are often detrimental to welfare – even if R&D costs are neglected. Intuitively, if the coalition size were fixed, higher R&D investments would lead to a higher abatement target implemented by a coalition. However, this makes it less attractive to become a coalition member in the first place. As a result, participation decreases, which in turn has a negative effect on the coalition's abatement target and welfare. Countries, therefore, have an incentive to reduce their R&D efforts as long as they anticipate that not all countries will participate in a future climate coalition. This underinvestment persists even if countries can cooperate in the R&D dimension (despite the public good nature of R&D in our model). The outcome is thus often characterized by full participation in the climate coalition, but the welfare improvements that this grand coalition achieves are limited due to technology underinvestments.

In an extension of our model (see Section 4), we further show that an alternative outcome may exist, where the free-rider effect manifests itself in the membership game. In this case, countries invest more in R&D, but the welfare gains are now limited due to low participation (as in the classical model by Barrett, 1994). Hence, although our model demonstrates that BCA can significantly improve the prospects of cooperation, a free-rider effect is still present, and it can show up *either* in the R&D-dimension, *or* in the participation dimension.

[1] Past climate negotiations focused primarily on the issue of emission reductions, and to a lesser extent on the development of low-carbon technologies. A possible reason is that the latter are more difficult to monitor than emission levels.