

## Towards a Self-Enforcing Climate-Change Treaty

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### Abstract

In the absence of some form of world government, an effective treaty to control global climate change must be self-enforcing. The theory of noncooperative equilibria of a dynamic game provides a good model for such a treaty. These notes will sketch an approach to such a model, in which the players are the approximately 180 sovereign countries of the world, and the goal of the treaty is to control the emissions of greenhouse gases, primarily generated in the production and use of energy. Assume that each country is interested in maximizing its total discounted net production of goods and services in the foreseeable future, measured, e.g., by gross national product (GDP). The emission of greenhouse gases (GHGs) can be reduced by (roughly speaking) three groups of activities: (1) reducing the output of goods and services; (2) increasing the efficiency of the use of energy in the production of goods and services, and the efficiency of the production of energy; and (3) shifting to technologies of producing energy that emit less GHG per unit of energy used.

Other things being equal, Category 1 activities directly reduce a country's GDP, Category 2 activities increase GDP if the expenses of research and development and other fixed costs are not too high, and Category 3 activities probably decrease GDP, at least in the short run. On the other hand – and this is the point of the treaty – the reduction of GHGs by one country reduces the total global damage due to climate change, and hence increases the total discounted world GDP (although there are some regions of the world that might benefit from climate change). Thus the world is faced with the problem of dealing with a classic externality.

Extending the analysis in (Dutta and Radner, 2004, 2006, 2009, 2012), we formulate a dynamic game in which the actions of each player (country) in each period include: (1) the total quantity of energy devoted to the production of goods and services; (2) the allocation of the energy requirements among a set of energy sectors (fossil fuels, nuclear, solar, wind, etc.); (3) the addition of capacity in each energy sector; (4) possible contributions to a foreign aid escrow fund used to subsidize increases in the outputs of GHG-free energy by poorer countries; (5) possible trade sanctions against countries that defect from the treaty. We characterize a set of (Nash) equilibria of the game, which include “business-as-usual” (no treaty), and Pareto superior treaties with caps on GHG emissions sustained by trade sanctions and cuts in foreign aid. We illustrate these theoretical results with numerical calculations.

### References:

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