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A Game-Theoretic Approach to Global Warming

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ABSTRACT

Global warming is now recognized as a significant threat to sustainable development on an international scale. We model the global warming process as a dynamic commons game in which the players are countries who can at each date, at a cost, reduce their emissions of greenhouse gases and improve their emissions-producing technologies. The state variables are the current global stock of greenhouse gases and the current energy-producing technologies of the respective countries. The model accommodates exogenously growing populations and capital stocks in each country. For a transnational issue like global warming, the "standard"approaches of mechanism design theory are inadequate in the absence of a world government or equivalent institution for enforcing cooperative agreements. Hence we look for *self-enforcing* agreements (treaties), i.e., Nash equilibria of the game. We show that there is a large multiplicity of noncooperative equilibria of this game, which creates a role for analysts to discover equilibria that are superior to the status-quo ("business-as-usual") equilibrium. We characterize the business-as-usual equilibrium and the set of global Pareto optimal outcomes. We provide information about the set of equilibria, as well as particular (subgame-perfect) Markov equilibria, and show that if the players' discount factors are not too small, there may be Markov equilibria that sustain outcomes that are Pareto-superior to the business-as-usual equilibrium. Furthermore, if the players' discount factors are sufficiently close to unity, it may be possible to sustain Pareto-optimal (first-best) outcomes.

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