Possibilities for international cooperation in different negotiation environments

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11 October 2013

Outline

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Situation of the climate negotiations

- Greenhouse Gas emissions affect all countries, irrespective of origin
- Negotiations process moves away from global UNFCCC framework, to smaller fora
  - G20
  - Major Economies Forum on Energy and Climate (MEF)
  - Climate and Clean Air Coalition (CCAC)
- Differentiation between Annex I and non-Annex I still occuring under UNFCCC

Consequences for game-theoretic model

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- In the usual game-theoretic models, all countries are treated the same
- Division of countries in two groups
  - Countries which are supposed to agree on binding emission reduction commitments among themselves (*negotiators*)
  - Countries which benefit from emission reductions, but do not make commitments themselves (*outsiders*)
- This division will be central in our model.

Some definitions

- A *cooperative game* (N, v) consists of a set of players N and a *characteristic function* $v : 2^N \to \mathbb{R}$.
- $v(S)$ is called the *value* of coalition $S \subseteq N$.
- An *allocation* is a vector $x \in \mathbb{R}^n$ with $\sum_{i \in N} x_i = v(N)$.
- In the case of cooperation on greenhouse gas emissions, this allocation can be realised in different ways
  - Monetary transfers
  - Initial allowances of an emission trading system

Some definitions II

The *core* of the game is the set of all allocations from which no coalition has an incentive to deviate.

$$\mathcal{C}(N, v) = \{x \in \mathbb{R}^n \mid \sum_{i \in S} x_i \geq v(S) \ \forall S \subsetneq N\}$$

A *subgame* of a cooperative game (N, v) is a game (T, v^T) where $\emptyset \neq T \subseteq N$ and $v^T(S) = v(S)$ for all $S \subseteq T$. The subgame (T, v^T) will also be denoted by (T, v).

The model

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- We use the subgame concept to define a game on the set of the *negotiators*, T. The set of the remaining countries is called R.
- For the underlying game, we use the setup by Chander and Tulkens (1997). This means that
  - Countries optimize their utility, consisting of production and benefits from emission abatement.
  - Coalitions of countries optimize joint utility, resulting in a cost-effective distribution of emission abatement.
  - If a coalition forms, all other countries split up into singletons and optimize individual utility ("γ-assumption").
- Consequences for the subgame
  - Interaction between the two groups (T and R) is non-cooperative.
  - R benefits from cooperation in T, as utility of R depends on emissions of T.

Theoretical analysis

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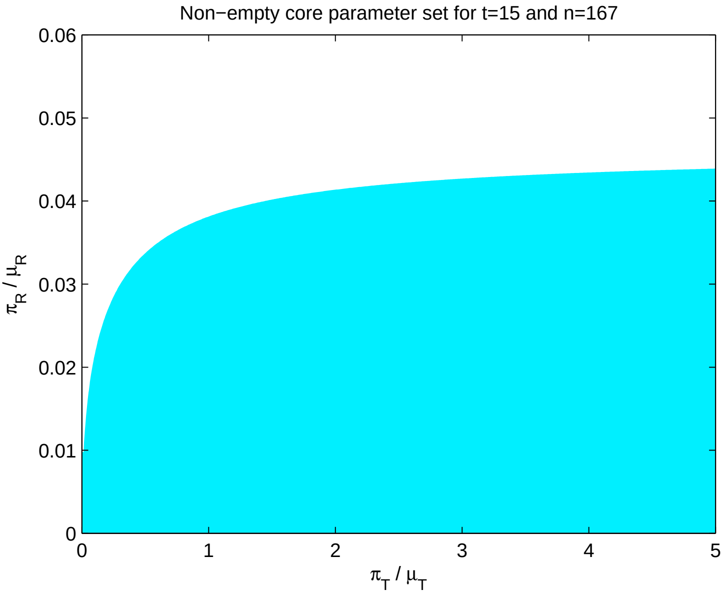
- Central question of the analysis: under which circumstances is the core of the subgame (non-)empty?
- Assumptions
  - Quadratic production and benefit functions
  - Countries inside a group are symmetric
- Pivotal parameters
  - μ_T, μ_R: abatement cost parameters
  - π_T, π_R: damage cost parameters

Key results

- (Non-) emptiness of the core only depends on value of single countries ("singleton coalitions"). Intermediate coalitions ($S \subset T$ with $|S| > 1$) do not matter.
- Ratio of abatement and damage cost parameters crucially influences (non-)emptiness of the core. Parameters of the two groups work in opposite ways.

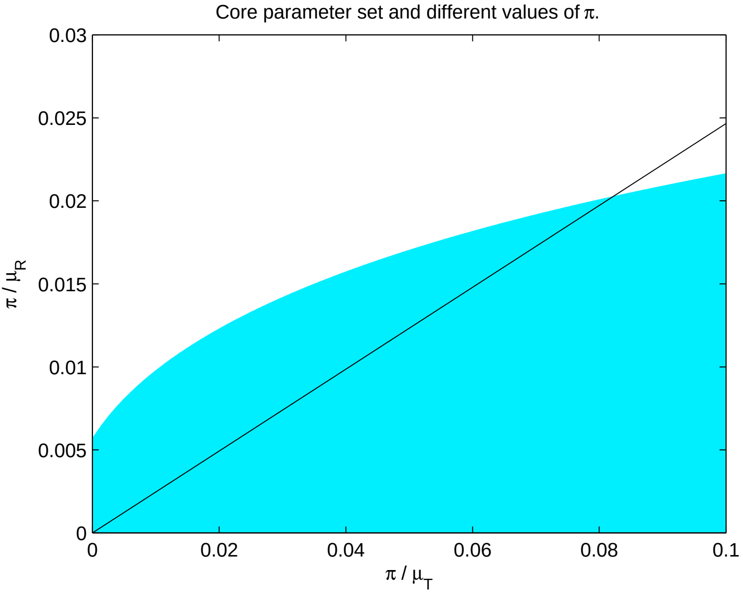
Visualisation



Application to UNFCCC process

- Application of the model to the "Kyoto situation": only Annex I countries make binding commitments.
- There are currently 15 Annex I and 152 Non-Annex I parties to the UNFCCC.
- Therefore, we analyse the game with $n = 167$ and $t = 15$.
- Abatement cost parameters are estimated by using marginal abatement cost curves from POLES.
- By setting the damage cost parameter π equal for both groups, we can estimate an upper bound $\bar{\pi}$, under which the core of the game is non-empty.

Visualisation of the "Kyoto situation"



Upper limit for existence of a stable agreement

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- This upper limit can be transformed into marginal damage cost of
$$308.24 \frac{EUR}{tCO_2eq} = 1130.21 \frac{EUR}{tC}.$$
- According to the meta-analysis by Tol (2008), this approximately corresponds to the 98-percentile of estimates of marginal damage cost.
- If all countries in T assume that the "real" damage cost parameter is smaller than this value, the core of the game is not empty.
- Therefore, in this highly stylized scenario, a stable agreement among Annex I countries exists.
- Importance of the assumption of symmetric countries: Na and Shin (1998) showed that cooperation is easier among similar countries.

Conclusion and outlook

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- This model captures the special structure of the climate change negotiations.
- Existence of a stable agreement crucially depends on abatement and damage cost parameters.
- In a stylized application to the "Kyoto situation", a stable agreement exists.
- Improvements of the model
  - Non-symmetric countries
  - Uncertainty about the parameters

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Thank you for your attention!