



A mechanism for coalition formation for international climate change mitigation?

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- Game theory can help us understand strategic behaviour in this situation, and find mechanisms to address this problem

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- "A surprisingly large number of individuals facing collective action problems do cooperate" [Ostrom, 2009]
- "The principal theoretical and practical drawbacks of Nash equilibrium as a solution concept are far less troublesome in problems of mechanism design than in most other applications of game theory" [Maskin, 2011]

Climate Change Game

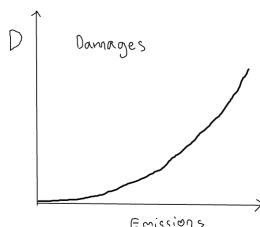
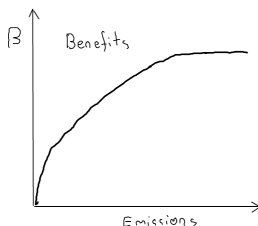
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- Each player i represents a country that is choosing its level of greenhouse gas emissions e_i
- Each player has an emissions *benefit function* B_i satisfying $B'_i > 0$ and $B''_i \leq 0$; and an emissions *damage function* D_i satisfying $D'_i > 0$ and $D''_i \geq 0$.



Climate Change Game

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- The Nash equilibrium involves significantly less emission reductions and less net benefits than the socially optimal outcome – but does involve some emission reductions

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- Boadway, Song and Tremblay (2011) apply Guttman's mechanism to pollution abatement

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Stage 2 Countries choose their direct abatement level, a_i

- The total abatement of each country is given by

$$A_i = a_i + \sum_{j \neq i} m_{ij} a_j$$

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- This game achieves the efficient level of pollution abatement
- If a third stage is added where countries trade permits, marginal abatement costs are equalised
- This game requires that countries can *commit* to their matching rates
- Helps explain the significance of conditional targets.
- But what if only some countries can commit?

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- If a subset of all countries match each other's commitments, will they behave like a coalition?

The Mechanism

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- Each non-member $i \notin S$ reduces emissions by $A_i = a_i$

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- We calculate the subgame perfect equilibrium using backwards induction.
- So we treat Stage 2 (choosing direct abatement) as a subgame and calculate the Nash equilibrium for this subgame.
- Then we calculate the Nash equilibrium for Stage 1 (choosing matching rates), assuming the Nash equilibrium for Stage 2. This is the subgame perfect equilibrium.

Properties of the Subgame Perfect Equilibrium

- When $S = N$,
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 - there is more than one equilibrium choice for each a_i , but only one equilibrium choice for A_i ;
 - this equilibrium implements the social optimum (equivalent to a grand coalition).
- When $S \subset N$, this is not necessarily the case.

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- It could possible to achieve international cooperation from the “bottom-up”, even if participation is not full.
- This mechanism assume that countries cannot ‘backtrack’ from their conditional commitments. Backtracking could be reduced by
 - ① Incorporating commitments into a legally binding treaty
 - ② Passing domestic legislation to make backtracking difficult

References

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