COOPERATION ON CLIMATE CHANGE UNDER ECONOMIC LINKAGES

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Research Question

How do international macro-economic effects affect the possibility of a stable global climate agreement?

Motivation

Game-theoretic modeling using the core stability concept predicts the existence of a stable global climate agreement, in contrast to reality.

In the classical model, consumption loss from GHG emission reduction measures only depends on each region's own emissions:

$$C_i = C_i(E_i)$$

This assumption is unrealistic. Emission reduction measures in one region cause, inter alia:

- technological spill-overs,
- changes in international competitiveness,
- changes in fossil fuel prices.

We change the model to include these effects:

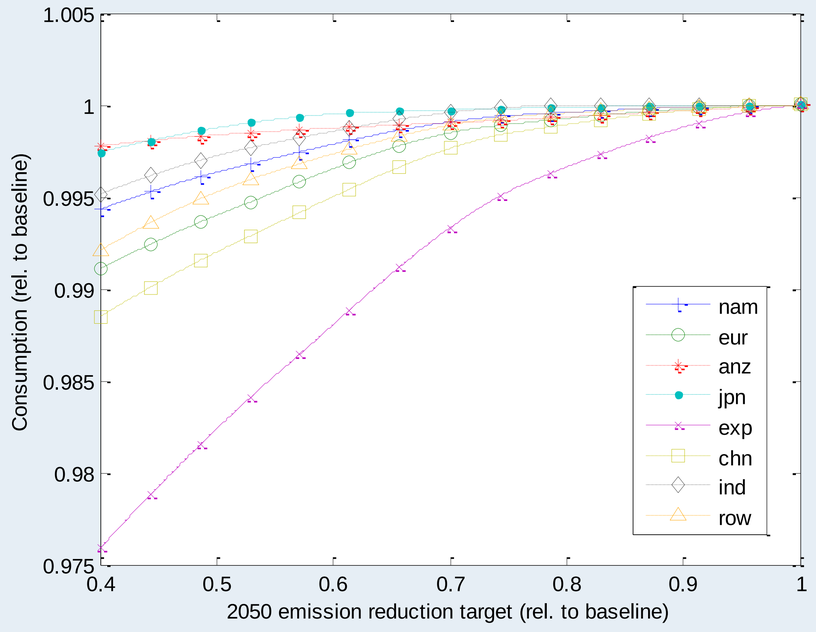
$$C_i = C_i(E), \quad E = (E_1, \ldots, E_n)$$

The revised model includes consumption functions for all possible **coalitions** of regions.

Methodology

The global CGE model DART computes consumption changes for each coalition, while damages are taken from the RICE model.

DART is a global computable general equilibrium (CGE) model consisting of eight world regions. It was used to compute **consumption** changes for all 255 possible coalitions.



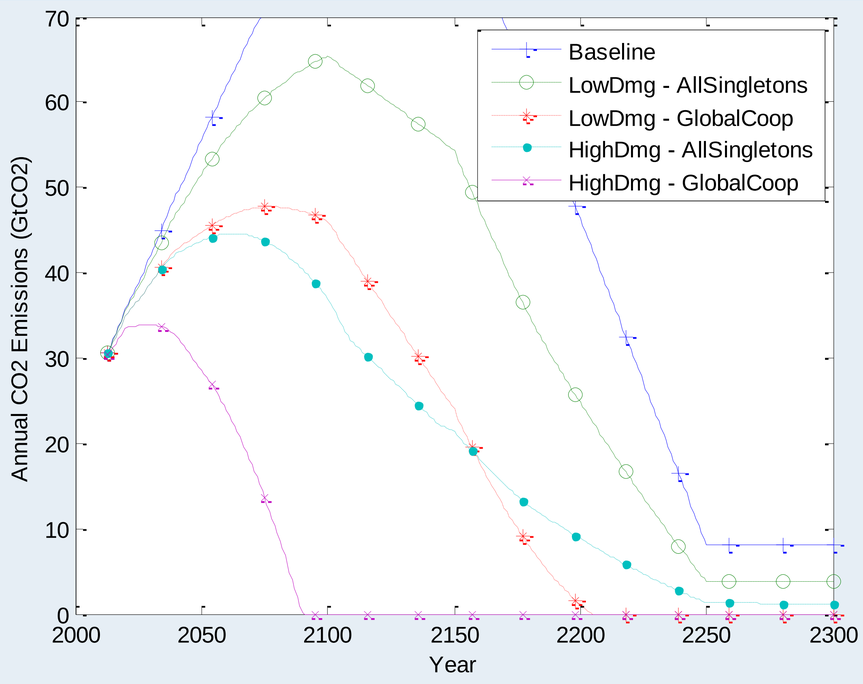
Damages from climate change are taken from the RICE model. We evaluate a **low damages** and a **high damages scenario**.
Regions choose their 2050 emission reduction target to optimize their **utility = consumption – damages**. Coalitions optimize joint utility, while outsider regions act individually.
The resulting **cooperative game** is evaluated by computing the **best partition** of the game. If the best partition is better than the grand coalition of all regions, the **core** of the game is empty and no stable agreement exists.

Results

Benchmark cases
In the low damages scenario, global emissions in the case of no cooperation ("All Singletons") peak only around 2100 and lead to global warming of 5.1°C. Global cooperation substantially reduces emissions and produces a temperature increase of 3.9°C. In the high damages scenario, global cooperation leads to an emissions peak in 2029 and global warming of 2.0°C.

Low Damages scenario
The best partition of the game is better than the case of global cooperation. The core of the game is **empty**, a stable global agreement is **not possible**, contrary to the classical model.
Why is stable global cooperation not possible?
Cooperation is blocked by **fossil fuel exporting regions**, specifically Australia / New Zealand, Former Soviet Union, Middle East and North Africa. If emission reduction measures were enacted globally, fossil fuel prices and consumption would fall, leading to revenue losses for these regions. Other regions can form a *coalition of the willing*, leading to only slightly higher damages than global cooperation. Therefore, other regions have no incentive to compensate fossil fuel exporters.

High Damages scenario
Global cooperation is the best partition of the game and a core-stable global agreement exists.
Why is stable global cooperation possible?
High damages imply high gains from global cooperation. The blocking regions from the low damages scenario, especially Middle East and North Africa, experience relatively high damages from climate change. Therefore, the benefits from global cooperation exceed the revenue losses from fossil fuel exports.



Utility Loss (tn$)		
	Low Dmg	**High Dmg**
All Singletons	16.66	127.85
Global Cooperation	16.65	98.56
Best Partition	16.17	98.56

Summary

- International macro-economic effects create new hurdles for a stable global climate agreement
- Fossil fuel exporters block cooperation, because it would reduce fossil fuel prices and consumption
- High damages from climate change create an incentive for cooperation
- Partial cooperation, excluding blocking regions, can almost reach optimal emission reduction levels

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*** Further Information**
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