

Agreement Formation with Heterogeneous Agents in International Public Goods Provision

Christine Gutekunst
Kaj Thomsson

Maastricht University

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The Idea

Provision of international public goods (e.g. climate change abatement)

- *Public good*: non-excludeability, non-rivalry
 - Free riding incentive
- *International aspect*: no enforcement instance
 - No coercion
 - Agreements

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Heterogeneity

- Countries are heterogeneous
- Literature so far is limited:
 - Barrett (1997), Botteon and Carraro (2001), Mc Ginty (2006): Simulations
 - Kolstad (2010): Heterogeneity over size and marginal damage for two types of countries

The Idea

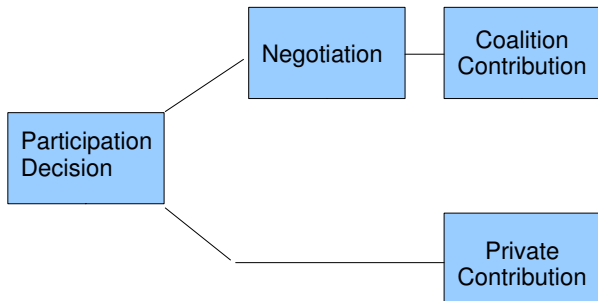
We add:

Tractable N country model of agreement formation, taking into account heterogeneity over costs, valuation, endowment and political power

- Cost or valuation heterogeneity make agreement formation more difficult
- Endowment heterogeneity might make it easier
- Weighted voting re-enforces the effect of endowment heterogeneity

The Setup

- Three stage, non-cooperative game theory setup
- Solution concept: subgame perfect equilibrium



The Setup

① *Participation:*

Countries decide simultaneously and independently whether to participate in negotiations.

② *Negotiation:*

Participants negotiate over the fraction of their endowment to be provided: $t \in [0, 1]$. Vote by *majority rule*.

③ *Contribution:*

Agreement members provide the agreed upon amount. Non-members provide zero.

The Setup

Utility of a representative agent in country i is given by

$$U_i = \ln \left(\frac{w_i - (1+c_i)g_i}{n_i} \right) + a_i \ln \left(\sum_{j=1}^N g_j \right) - K \mathbf{1}_{\{g_i > 0\}} + B \mathbf{1}_{\{coalition\}}$$

where

w_i is endowment

c_i are costs

a_i is valuation

n_i is the number of citizens

g_i is a country's contribution

Baseline Case: Homogeneous Countries

Proposition

*If countries are homogeneous, there exists a unique number of countries that can form a **stable agreement** in equilibrium.*

Follows from considering internal and external stability of a coalition:

- Internal stability holds for $S \leq \bar{S}$
- External stability holds for $S \geq \underline{S}$

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Corollary

*If $N \leq \bar{S}$ a **grand coalition** forms.*

Cost Heterogeneity

- Costs are **equidistantly distributed** across countries
⇒ Countries can be lined up according to the fraction of endowment they wish to contribute:

$$t_i^* = \frac{a}{(1+a)(1+c_i)}$$

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The country with the highest costs in any conjectured coalition is the least likely to participate

Cost Heterogeneity

→ **Median preserving increase in cost heterogeneity:**

- ① pull on low cost side
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- a pull on *low cost side* induces a stronger **political effect**: shift in t_M
- a pull on the *high cost side* induces a stronger **private consumption effect**: difference between median costs and country with largest costs in a conjectured coalition

Endowment Heterogeneity

Consider **heterogeneity over endowment** while costs are the same for all countries:

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Consider **heterogeneity over endowment** while costs are the same for all countries:

- Endowment heterogeneity has no direct influence on t_i^*
- But it has an indirect influence on willingness to participate:

$$\ln\left(1 - \frac{a}{1+a}\right) + a \ln\left(\sum_{j \in S} w_j\right) \geq a \ln\left(\sum_{j \in (S-1)} w_j\right)$$

⇒ Difference in utility is larger for a country with high endowment
⇒ **A player with a large endowment is more likely to be in a coalition**

Cost and Endowment Heterogeneity

Combined effect of cost and endowment heterogeneity:

Proposition

An increase in the degree of endowment heterogeneity makes coalition formation

- *less difficult if endowment heterogeneity increases in the **same direction** as cost heterogeneity*
- *more difficult if endowment heterogeneity increases in the **opposite direction***

Cost and Endowment Heterogeneity

	low	Costs	high	
low	Agreement formation more likely		Agreement formation less likely	
Endowment				
high	Agreement formation less likely		Agreement formation more likely	

Weighted Voting

Consider the case where one country has all weight:

- **High cost dictator** in coalition: number of members of the coalition weakly increases while t decreases (\rightarrow effect on aggregate contributions not clear)
- **Medium cost dictator** in coalition: number of members of the coalition weakly increases while t is the same as in unweighted case (\rightarrow aggregate contributions increase)

Consider a group of countries sharing voting weights:

- A **larger group** of countries being relevant might make coalition formation more difficult if the degree of cost heterogeneity is non-decreasing.

\Rightarrow *Montreal Protocol vs. Kyoto Protocol*

Conclusion

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- ② **Endowment** heterogeneity can make it easier, depending on the relation between costs and endowment.
- ③ **Weighted voting** makes coalition formation easier if countries with high costs or lower valuation have greater political power.