Designing International Climate Agreements: An Economic Analysis Of Free-Riding Incentives

Wissenschaftliche Aussprache von Ulrike Kornek
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Technische Universität Berlin

Climate negotiations: where do we stand?

- **2°C** target → reductions to near zero emissions of greenhouse gases

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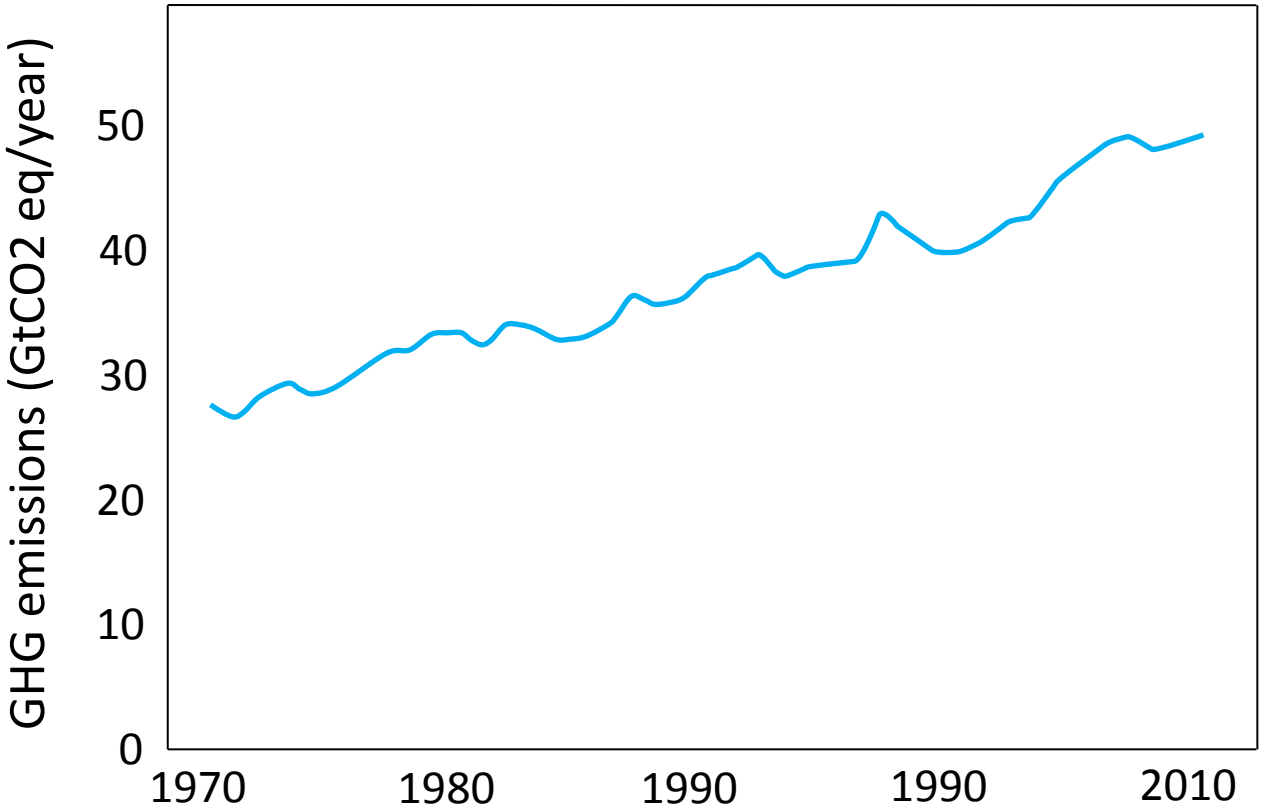
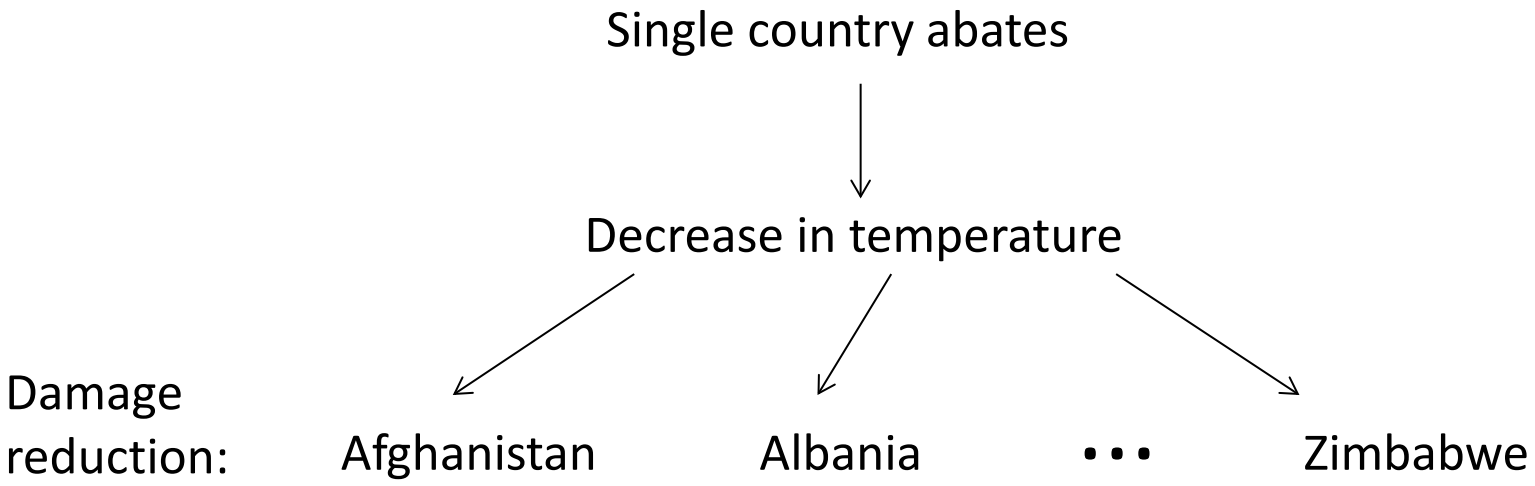
- **2°C** target → reductions to near zero emissions of greenhouse gases



Replicated from: IPCC, AR5, WGIII

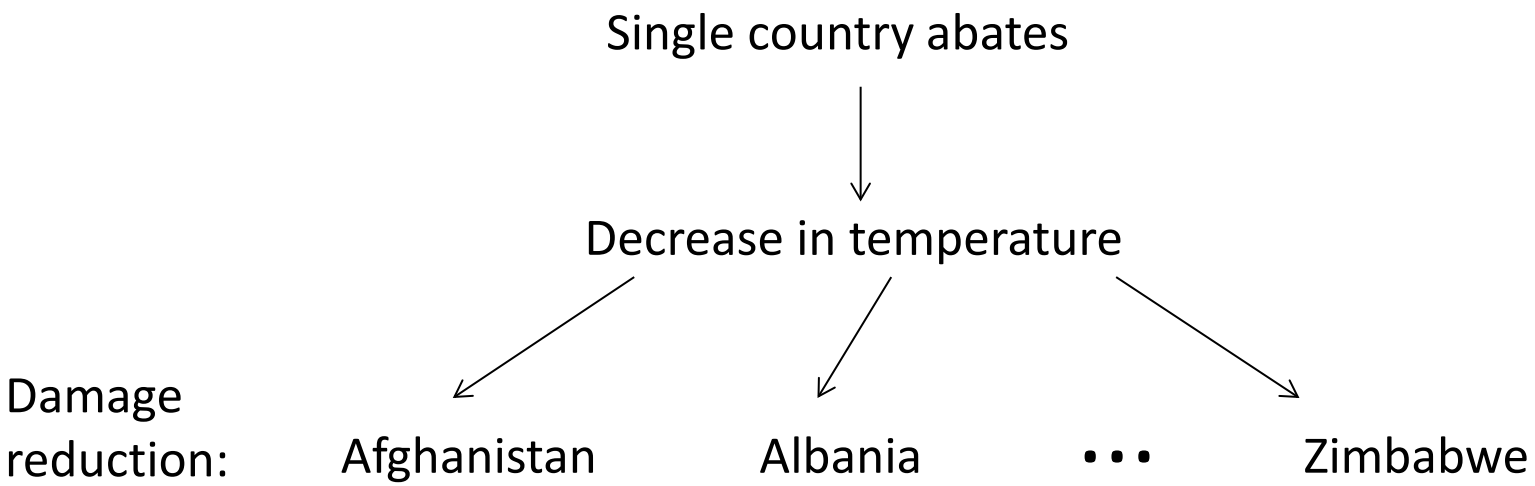
- Possibility of temperature increases until 2100 of up to **4.8°C**

Climate negotiations: abatement as a global public good



$$\underbrace{D1 + D2 + \ldots + D192}_{\text{Damage reductions of all countries}} - \underbrace{Costs}_{\text{Individual costs}} > 0$$

Climate negotiations: abatement as a global public good



D1 – Costs < 0

D2, ... , D192 > 0

Nash-equilibrium: inefficient **individually rational** choices compared to **collective optimum**

How can international climate agreements achieve ambitious collective abatement targets?

Stable climate agreements

- Formal game-theoretic analysis

Stable climate agreements

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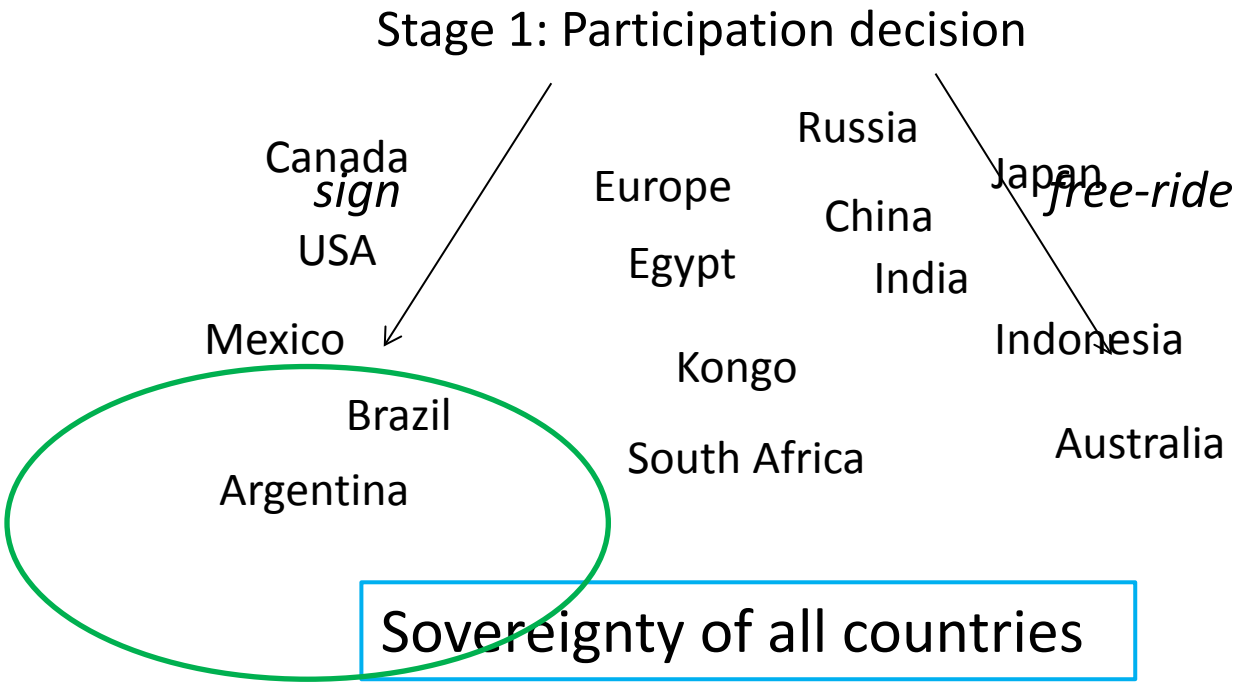
- Two-stage, one-shot participation game (Hoel 1992, Carraro and Siniscalco 1993, Barrett 1994)



Stable climate agreements

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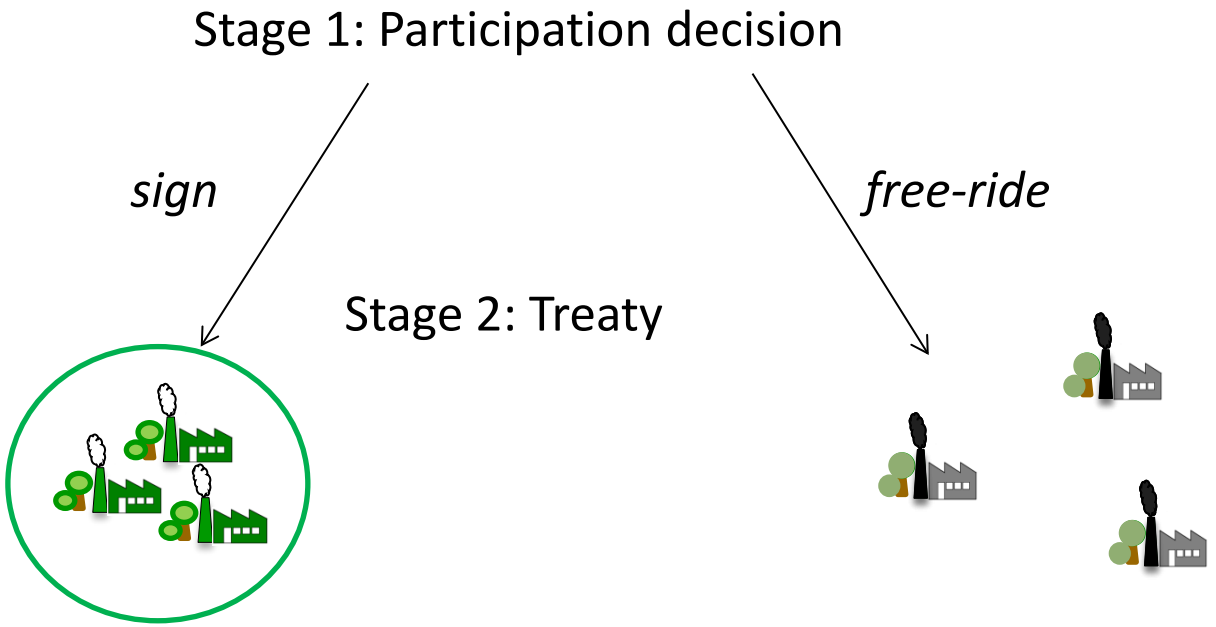
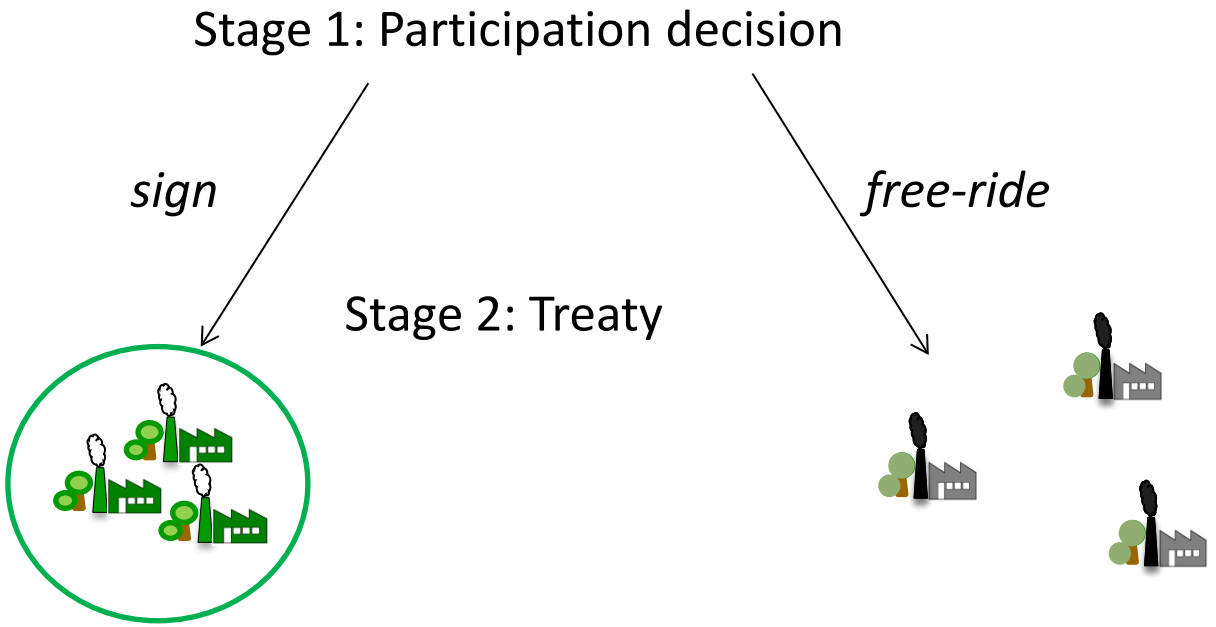


- Equilibrium ⇒ member: payoff is reduced when leaving coalition
  free-rider: payoff is reduced when joining coalition

Stable climate agreements

- Formal game-theoretic analysis
- Two-stage, one-shot participation game (Hoel 1992, Carraro and Siniscalco 1993, Barrett 1994)



- Assuming **symmetric countries** and treaty solely addressing **abatement**:
  → small and ineffective agreements

Overview

This thesis:
1. Heterogeneous countries
2. Other policy instruments

Synthesis:
- Modesty within treaty can decrease burden on members
- Trade-off between participation and welfare possible

Overview

Numerical climate coalition models	**Kornek**, Lessmann, Tulkens: Conceptual Implemen-tation of stabilities and transfers	Lessmann, **Kornek**, et al.: • Role of heterogeneity and transfers	**Kornek**, Steckel, Lessmann, Edenhofer: • Implementation of transfers under adverse effects
Design of abatement targets	Lessmann, Marschinski, Finus, **Kornek**, Edenhofer: Including CDM trade in climate treaty	**Kornek**, Marschinski: • Instrument choice under uncertainty	

Comparison of numerical climate coalition models

Numerical climate coalition models

Kornek, Lessmann, Tulkens:

Conceptual Implemen-tation of stabilities and transfers

Lessmann, **Kornek**, et al.:

- Role of heterogeneity and transfers

Kornek, Steckel, Lessmann, Edenhofer:

- Implementation of transfers under adverse effects

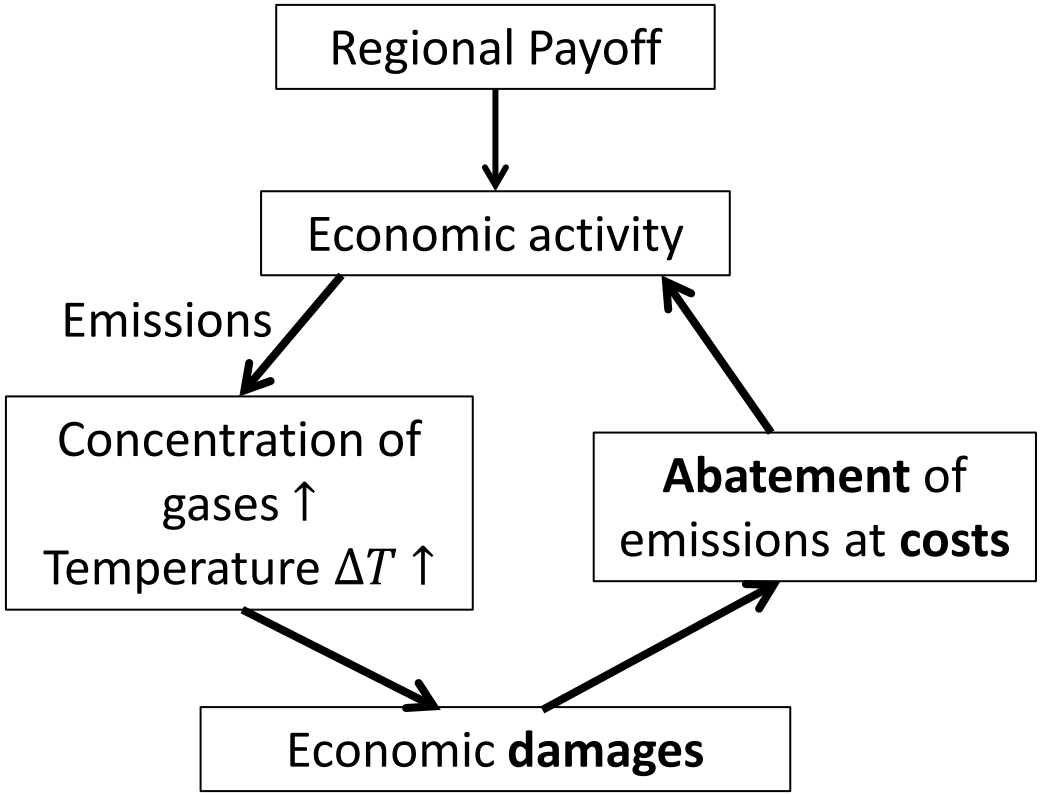
Lessmann, K., U. **Kornek**, V. Bosetti, R. Dellink, J. Emmerling, J. Eyckmans, M. Nagashima, H.-P. Weikard, Z. Yang (2015):
The stability and effectiveness of climate coalitions: A comparative analysis of multiple integrated assessment models.
Environmental and Resource Economics (online first)

Comparison of numerical climate coalition models

Numerical models:

- Calibration based on data from the literature
- Order of magnitude
- Robust findings and differences

MICA, STACO, CWS, WITCH, RICE



Comparison of numerical climate coalition models

Numerical models:

- Calibration based on data from the literature
- Order of magnitude
- Robust findings and differences

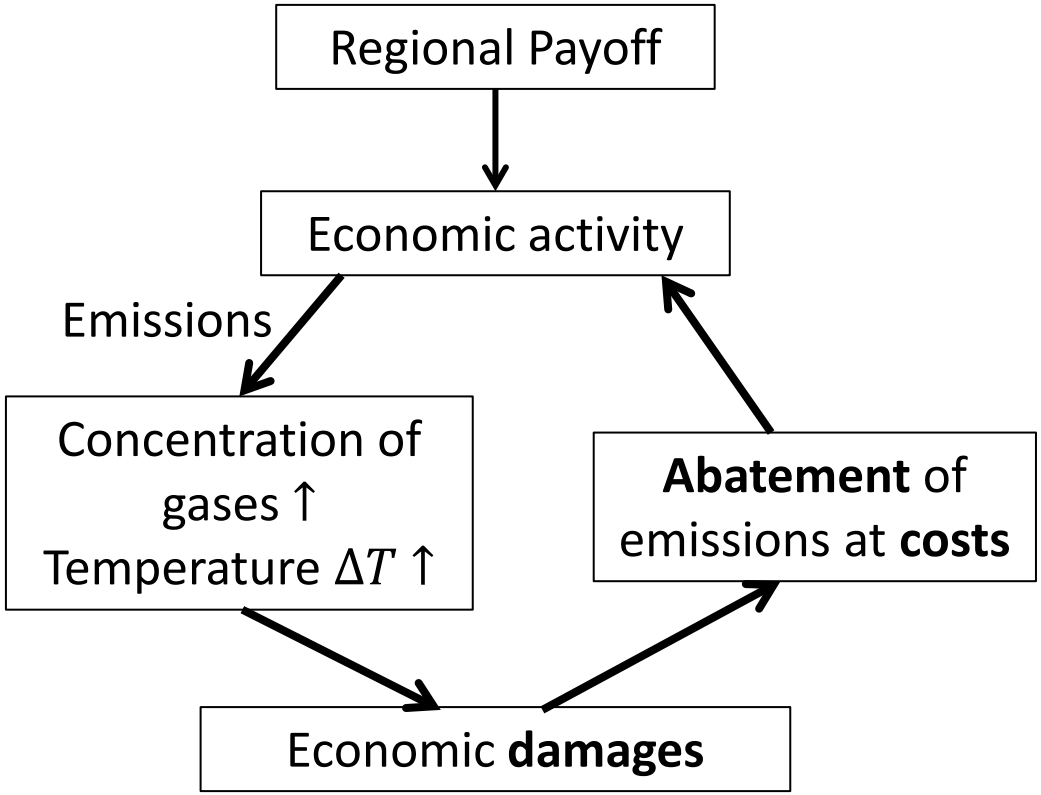
Objectives:

- What are the incentives of different regions to sign?
- What are the characteristics of potential of transfers mechanisms?

Methods:

- Scenario design
- Common data evaluation

MICA, STACO, CWS, WITCH, RICE



Treaties solely defining abatement

- Stable agreements are **small** and **ineffective**

Model	Number of stable coalitions	Number of members	Closing of welfare gap non- vs. fully-cooperative outcome
MICA	1	3	0.09
STACO	1	2	0.03
CWS	1	2	0.77
WITCH	1	2	0.05
RICE	0	0	0.00

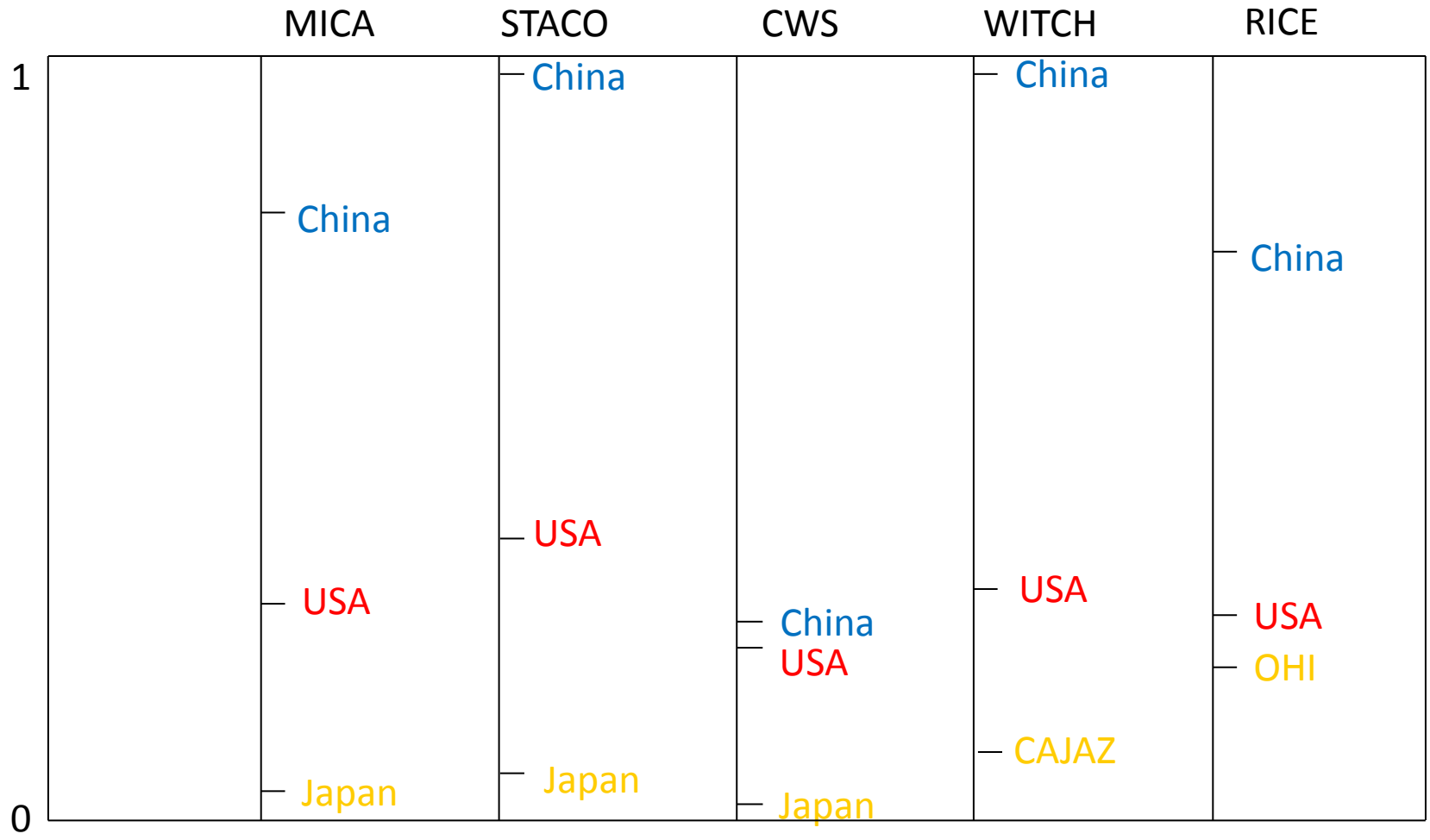
Characterization of regions

1. Common measure of abatement costs
2. Common measure of damages from climate change

Characterization of regions

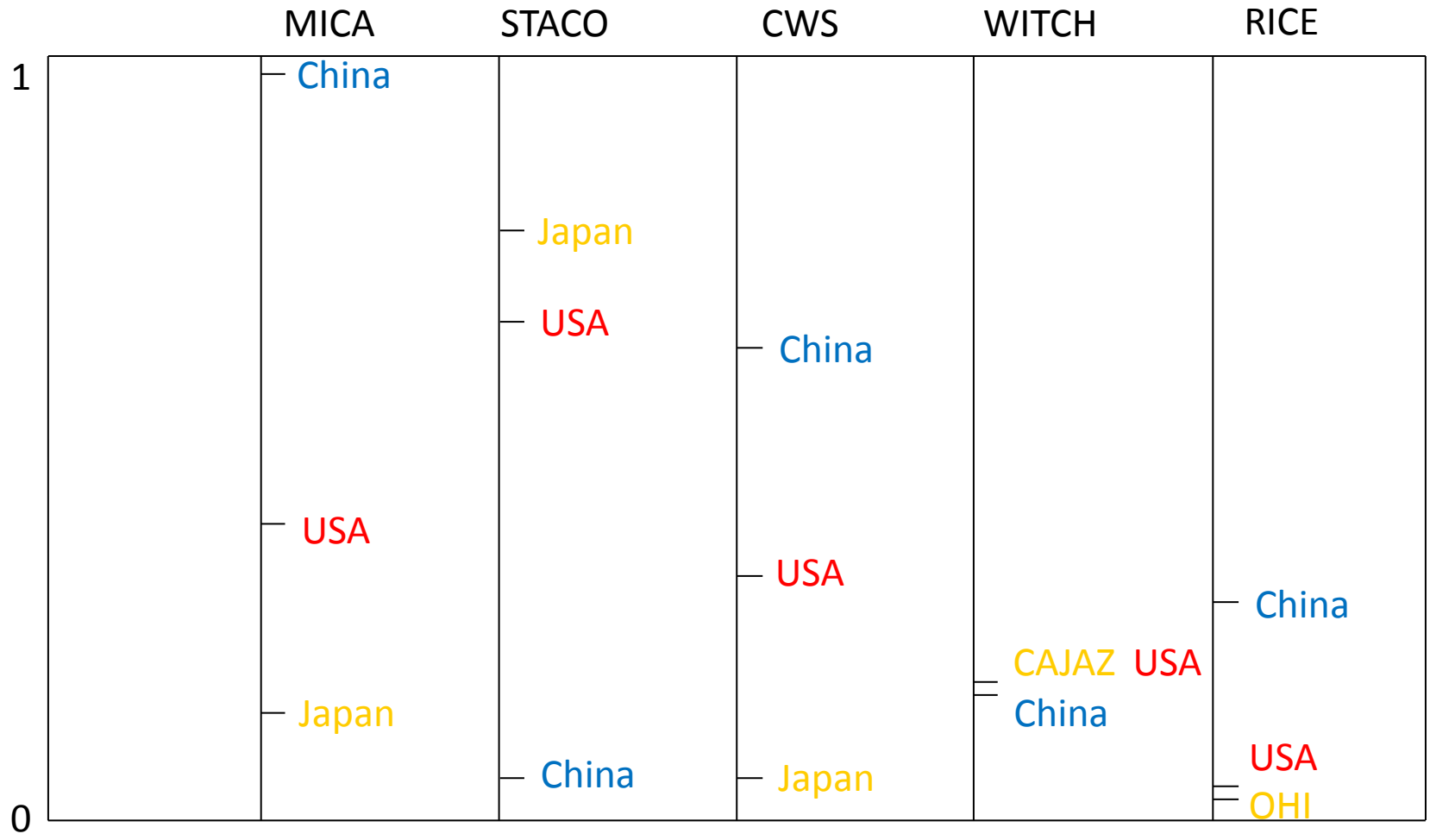
Characterization of regions: abatement costs

Abatement costs represented rather similarly across models



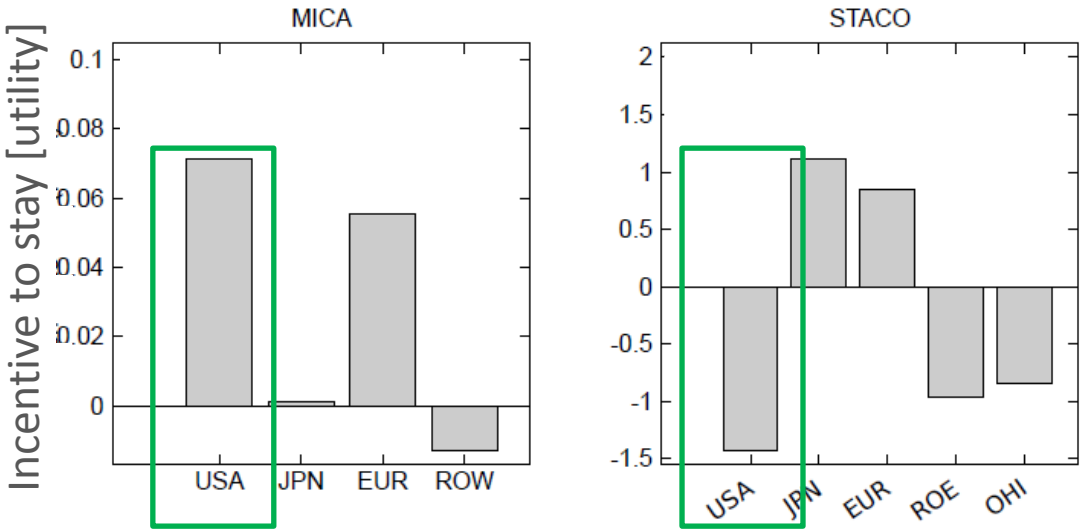
Characterization of regions: damages

Variation in damages large



Incentive to stay inside coalition: OECD-example

- Incentives for common regions differ



Incentive to stay inside coalition

- Incentives for similar regions alike
  - ➢ High damages from climate change
  - ➢ Low abatement costs

  Higher incentive to join
- Different to symmetric case:
  - ➢ Incentive to sign also for large and ambitious agreements

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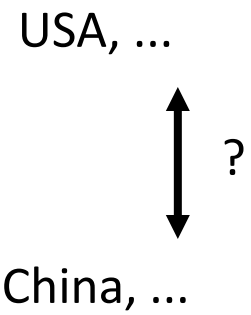
- Small island states:

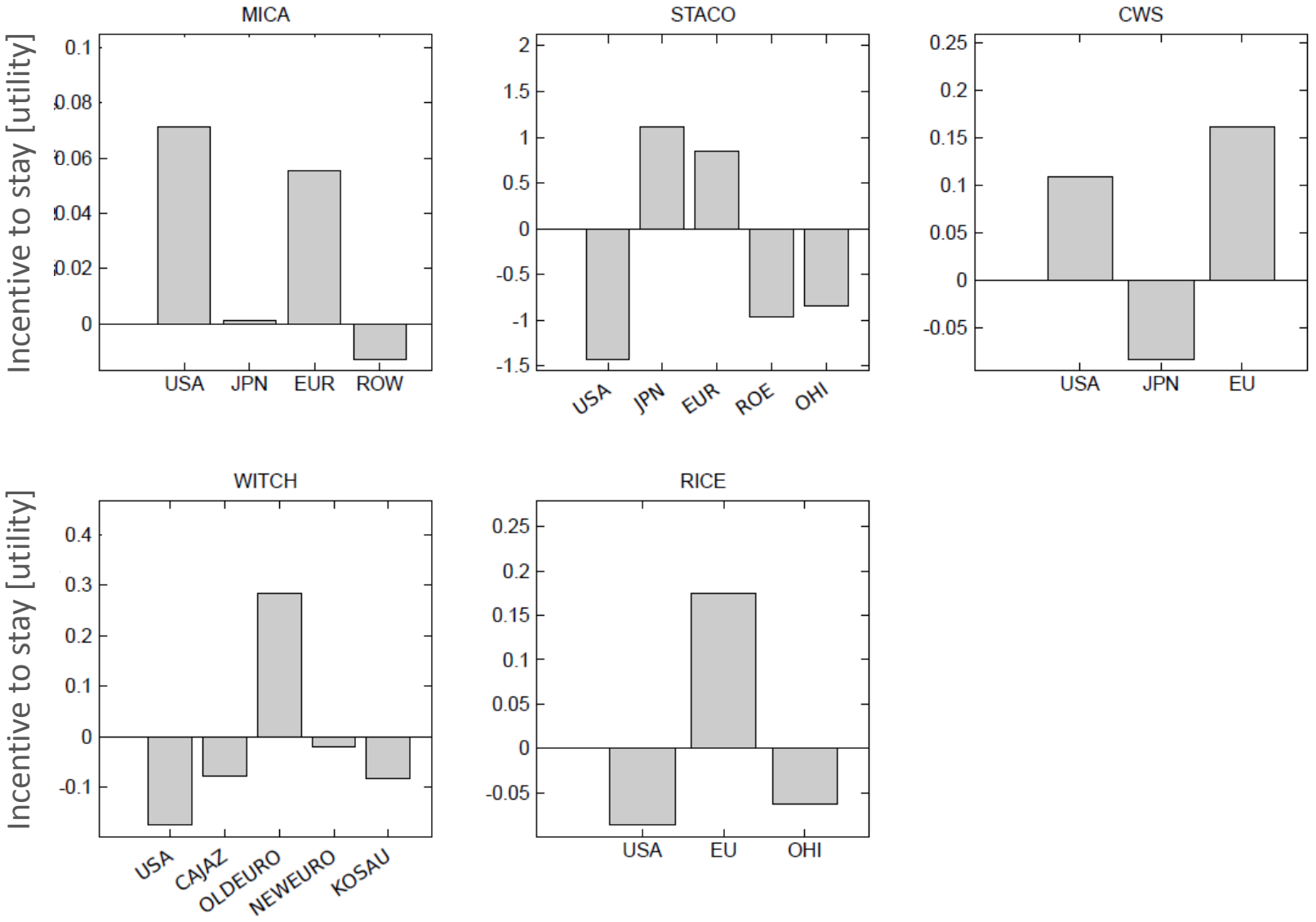
  High damages, low costs



- Russia:

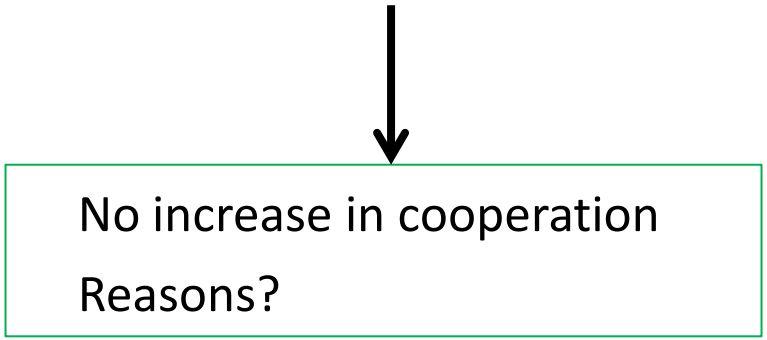
  Small damages, high costs

Transfers: distribution between winners and losers



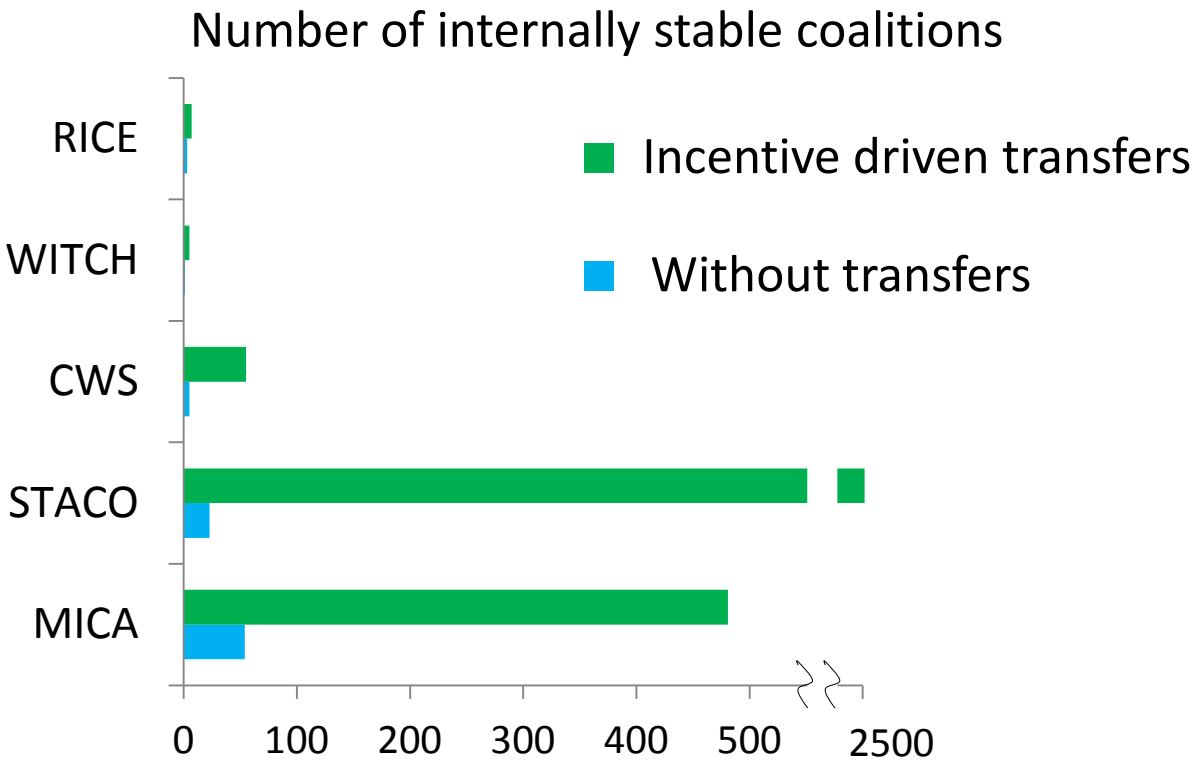
Transfers: normative or incentive driven

- Transfers: Allocation of emission permits to address distributional questions (Altamirano-Cabrera & Finus 2006)
  - Transfers based on normative/pragmatic principles
  - Selection: grandfathering, equal-per-capita, historic responsibility



Transfers: normative or incentive driven

- Transfers based on incentives:
  - large number of internally stable agreements
  - close cooperation gap about half



Transfers: normative or incentive driven

Reasons for transfers failing:

1. Pragmatic/normative transfers often flow in the wrong direction

   → Not designed along incentives

2. Equity-based transfers too large in magnitude also when direction right

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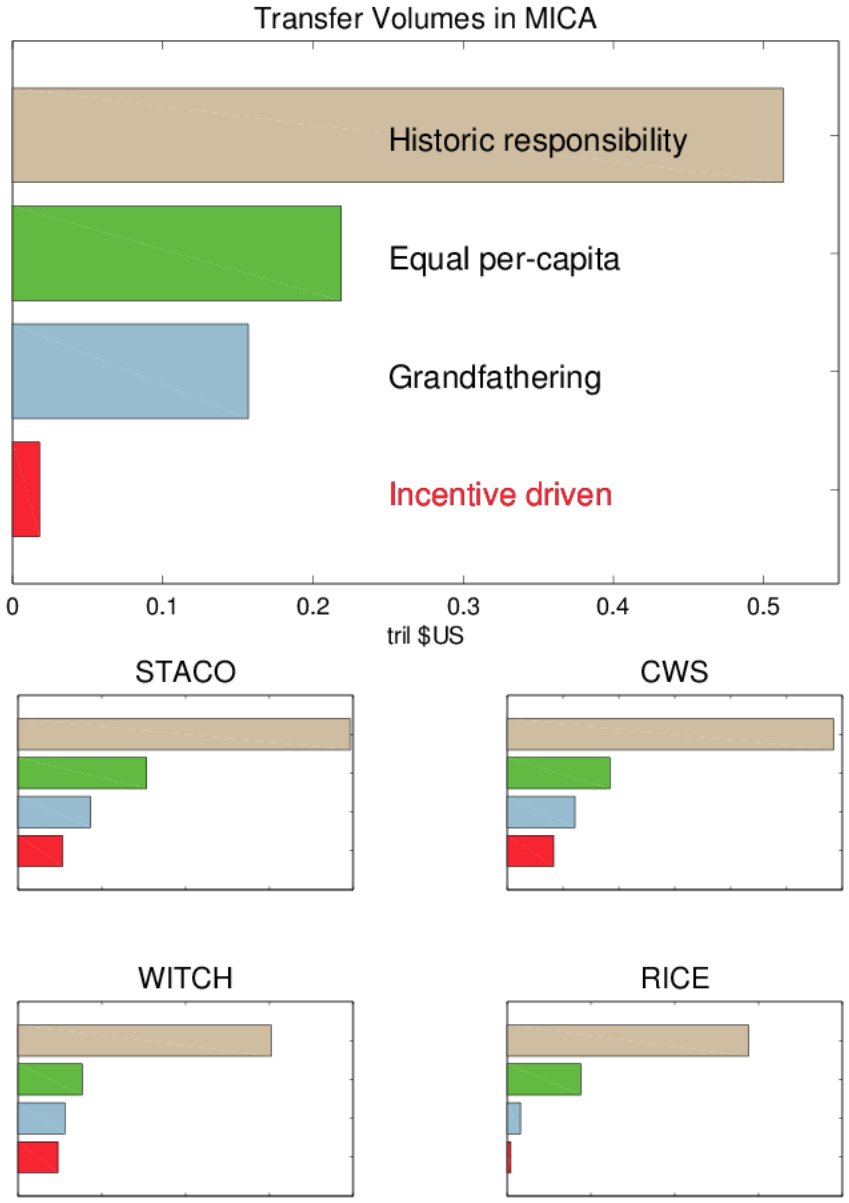

The climate rent curse

Numerical climate coalition models	**Kornek**, Lessmann, Tulkens: Conceptual Implemen-tation of stabilities and transfers	Lessmann, **Kornek**, et al.: • Role of heterogeneity and transfers	**Kornek**, Steckel, Lessmann, Edenhofer: • Implementation of transfers under adverse effects

Kornek, U., J. Steckel, K. Lessmann, and O. Edenhofer:
The Climate Rent Curse: New Challenges for Burden Sharing
Under review at Climate Change Economics

The climate rent curse

- Nordhaus 2007:

"emissions-trading system creates **valuable assets in the form of tradable emissions permits**"

- Scarce resource creating rents
- Large monetary flows between countries
- Effects like a **resource curse** possible:
  - Adverse effects of natural resource rents on growth prospects
  - Dutch Disease/Rent Seeking/ Volatility

The climate rent curse

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- Scarce resource creating rents
- Large monetary flows between countries
- Effects like a **resource curse** possible:
  - Adverse effects of natural resource rents on growth prospects
  - Dutch Disease/Rent Seeking/ Volatility

- Similar characteristics of a climate rent

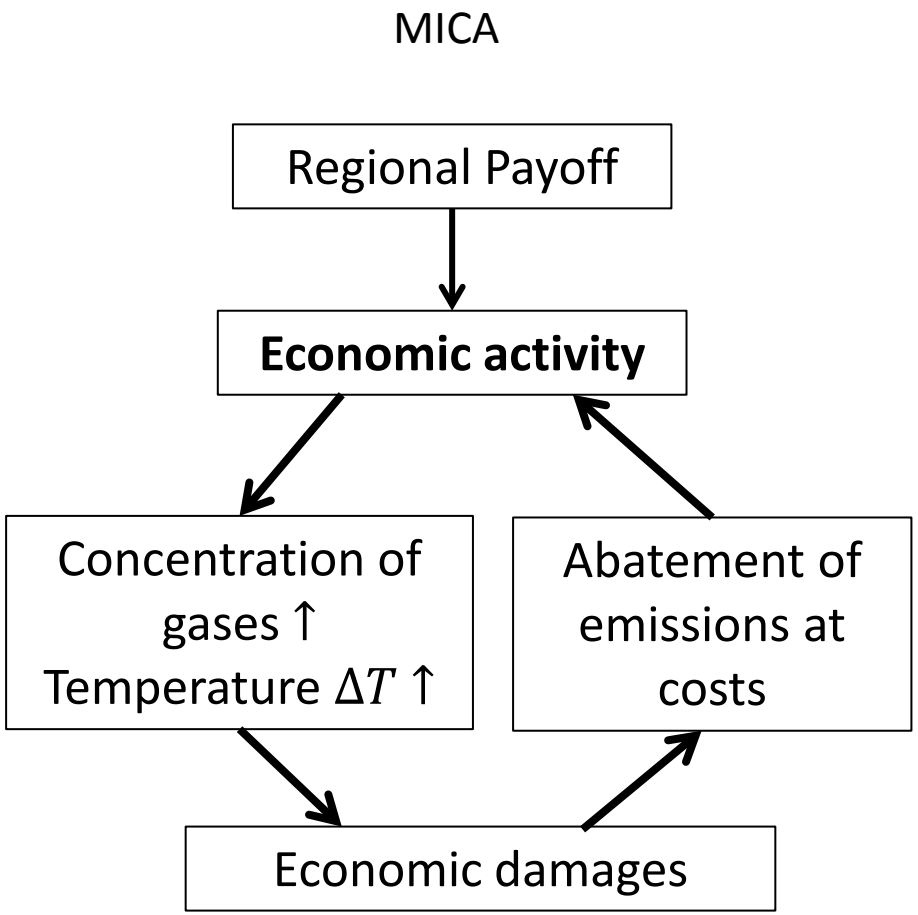
The climate rent curse

Objectives:

- What are the characteristics of potential transfer mechanisms with and without adverse effects?

Methods:

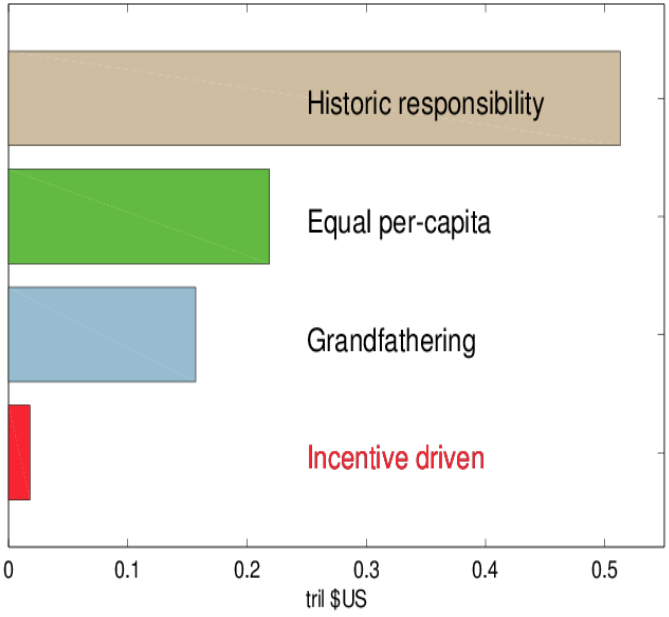
- Introduction of adverse effects in economic activity



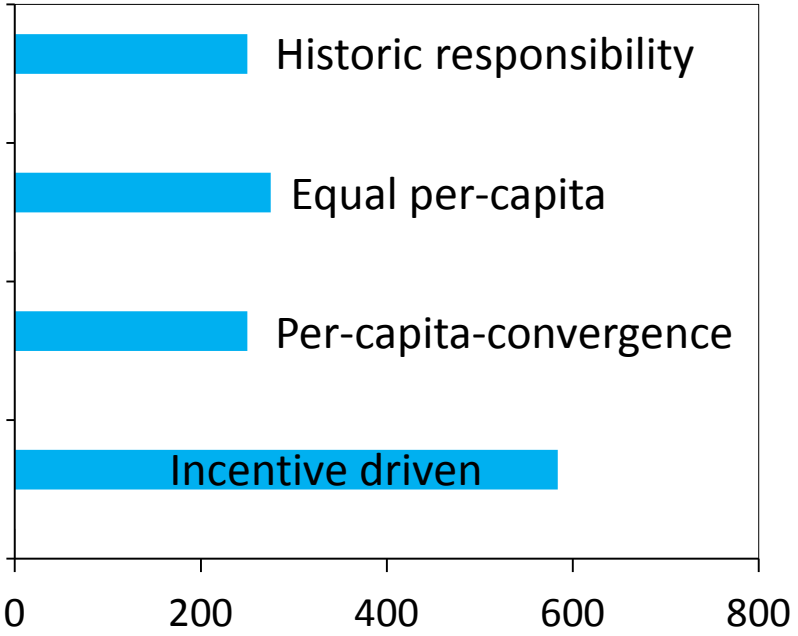
Performance of transfers

- Large number of regions encouraged to participate
- Equity-Based transfers: 97%-99% developing regions

Transfer Volume



No. of regions encouraged to cooperate

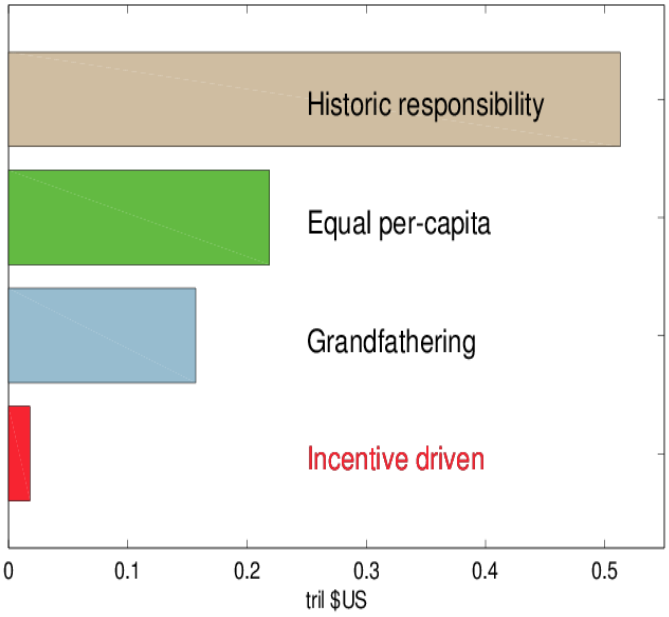


inside potentially internally stable coalitions

Performance of transfers under adverse effects

- When regions anticipate the adverse effects of the transfer received, no incentive to join anymore

Transfer Volume



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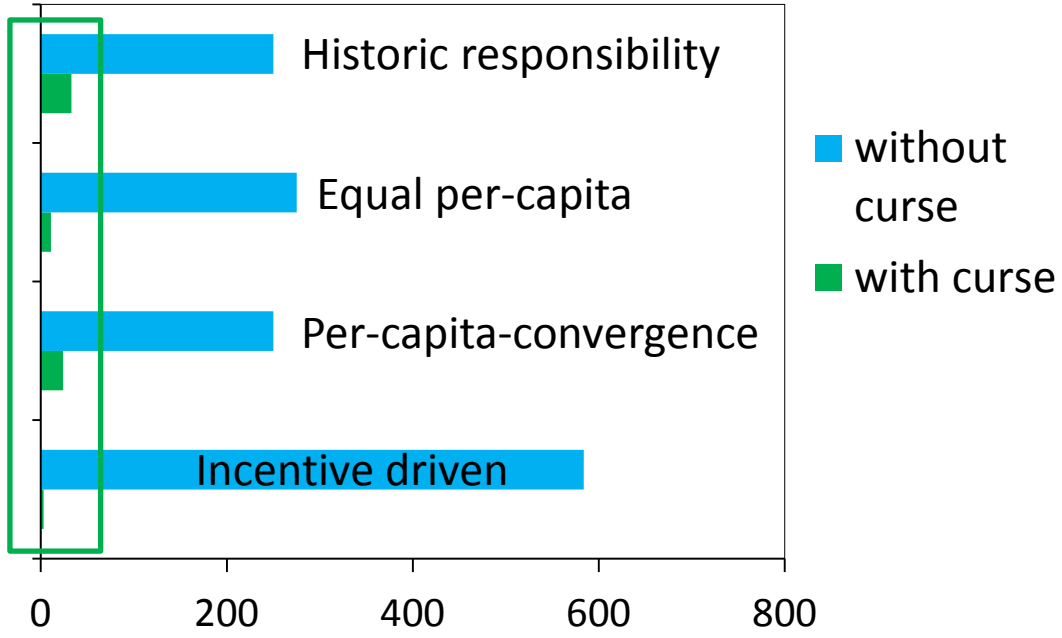
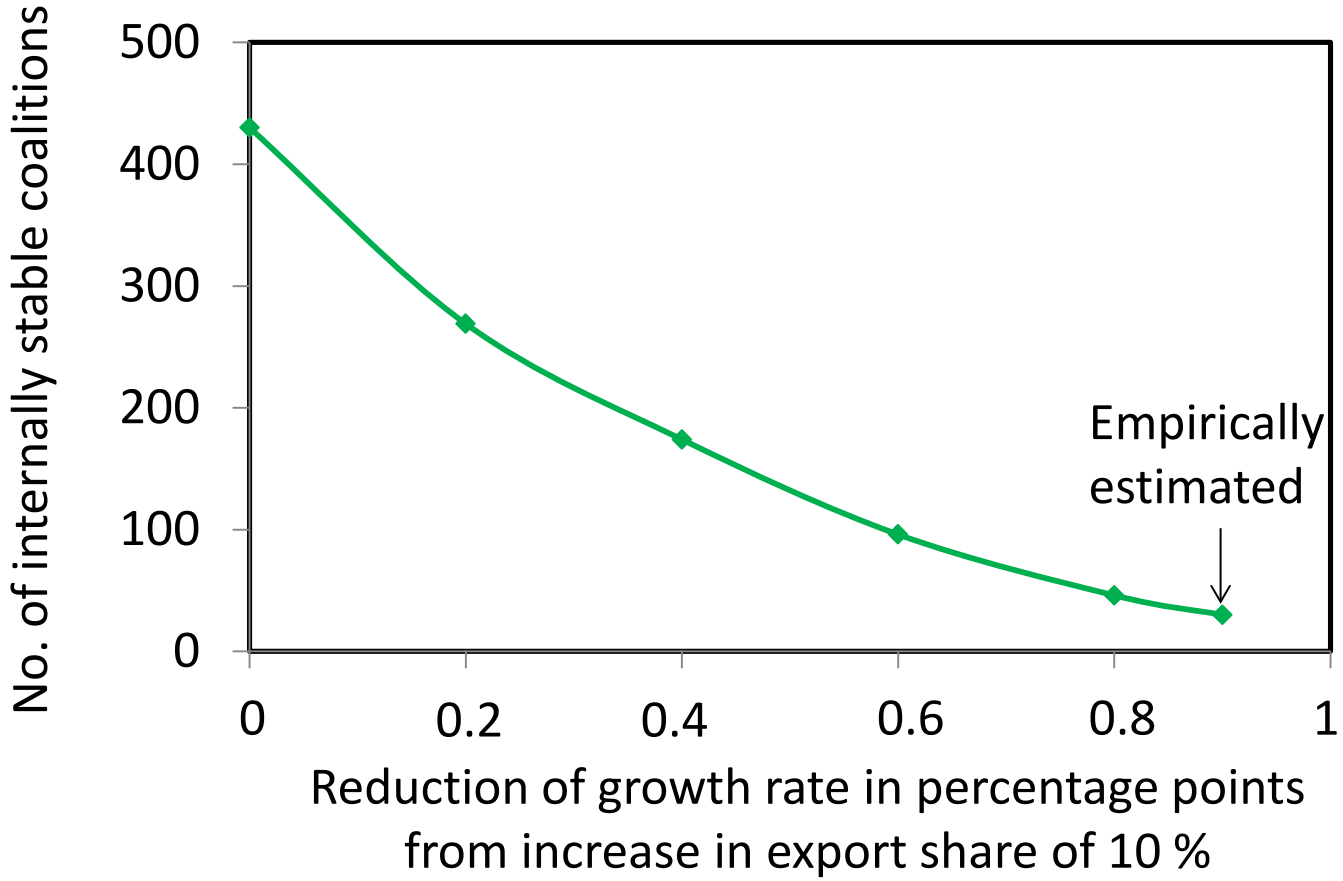


Performance of incentive driven transfers

Decrease in the magnitude of adverse effects:

- Large number of coalitions again stable: positive effect of transfers restored



Prices vs quantities for climate agreements

Design of abatement targets

Lessmann, Marschinski, Finus, **Kornek**, Edenhofer: Including CDM trade in climate treaty	**Kornek**, Marschinski: • Instrument choice under uncertainty

Kornek and Marschinski.
Prices vs. Quantities for International Environmental Agreements.
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Prices vs quantities for climate agreements

- Treaty design under different policy instruments

  Quantities ⇒ precise emission target
  Prices ⇒ emissions tax

Prices vs quantities for climate agreements

- Treaty design under different policy instruments

  Quantities ⇒ precise emission target
  Prices ⇒ emissions tax

Objectives:

- What instrument will the members base the treaty on?
- What is the participation rate and global overall welfare level?

Methods:

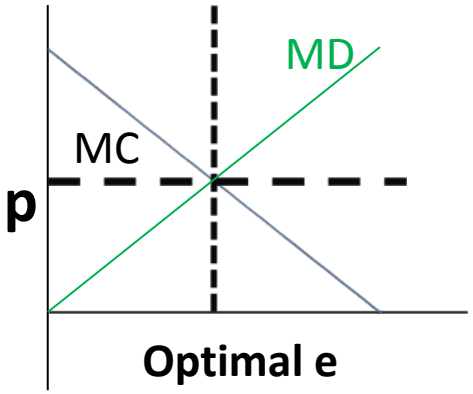
- Analytical study

Prices vs quantities for climate agreements

- Treaty design under different policy instruments

  Quantities ⇒ precise emission target

  Prices ⇒ emissions tax



Abatement costs Damages

Previous studies: total costs under instrument-symmetry

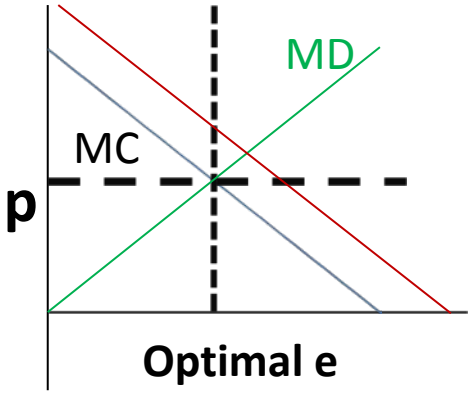
$$\boldsymbol{TC} = C\ (E = \Sigma_i e_i) + D(e)$$

Prices vs quantities for climate agreements

- Treaty design under different policy instruments

  Quantities ⇒ precise emission target
  Prices ⇒ emissions tax

- **Regulation under uncertain baseline emissions**



Abatement costs Damages

Difference between individually and collectively preferred instrument

$$\boldsymbol{TC} = C_{\boldsymbol{\varepsilon}}(E = \Sigma_i e_i) + D(e)$$

Prices vs quantities for climate agreements

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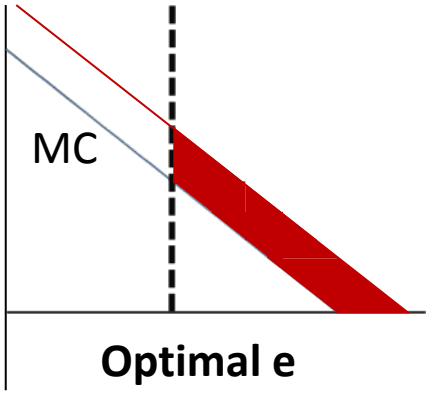


Abatement costs

- Increase in expected abatement costs

Damages

- No emission uncertainty
- Secures damage target

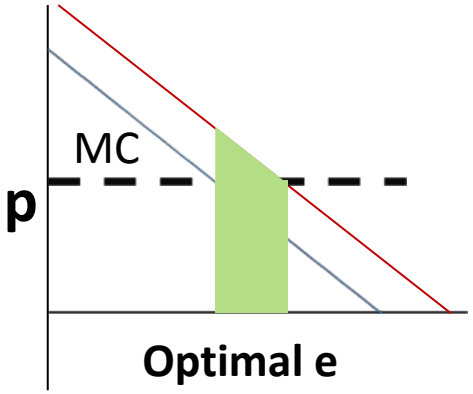
Prices vs quantities for climate agreements

- Treaty design under different policy instruments

  Quantities ⇒ precise emission target

  Prices ⇒ emissions tax

- **Regulation under uncertain baseline emissions**



Abatement costs

- Decrease in expected abatement costs

Damages

- Emisson uncertainty
- Increase in expected damages

Prices vs quantities for climate agreements

- First study to consider instrument choice for several regulators

$$\boldsymbol{TC_i} = C_{\boldsymbol{\varepsilon}}(E = \Sigma_i e_i) + D(e_i)$$

Saving in individual abatement costs	**vs**	Higher global emission uncertainty Higher global expected damages

- Price-regulation leads to **individual** benefits
- Quantity-regulation leads to **global** benefits

1. Result: incentives on instrument choice

Members choose treaty based on emission targets
- Internalize increased expected damages

- Non-members regulate via emission tax
- Welfare maximizing coalitions are ambitious

2. Result: quantities reduce participation

Uncertainty decreases size of the coalition

1. Non-members save additional costs
2. Coalition provides certain amount of public good

3. Result: prices increase participation

Uncertainty decreases size of the coalition

1. Non-members save additional costs
2. Coalition provides certain amount of public good

Treaty restricted to emission taxes decreases free-riding

1. Burden on members decreased
2. No extra free-riding incentive

3. Result: prices increase participation

Either treaty design may increase global welfare

- Higher participation vs higher emission uncertainty

	Size of the coalition	
	Treaty in Quantities	Treaty in Prices
Parameter set A	5	18
Parameter set B	3	15

3. Result: prices increase participation

Either treaty design may increase global welfare

- Higher participation vs higher emission uncertainty

	Welfare losses in utility	
	Treaty in Quantities	Treaty in Prices
Parameter set A	95.43	98.83
Parameter set B	93.02	87.38

Summary

Numerical climate coalition models	**Kornek**, Lessmann, Tulkens: Conceptual Implemen-tation of stabilities and transfers	• High damage/low cost regions cooperate • Transfers of **moderate** magnitude increase cooperation	• Adverse effects on recipient countries impede cooperation • Transfers of **moderate** magnitude preferable
Design of abatement targets	Lessmann, Marschinski, Finus, **Kornek**, Edenhofer: Including CDM trade in climate treaty	• **Ambitious formulation** in emission targets collectively optimal • **Taxes decrease burden** on signatories • welfare trade-off	

Conclusions

- Treaty design influences success
- Transfers crucial for heterogeneous countries
- Well-designed transfers potentially beneficial
- Modesty in treaty design may prefereable for participation

Thank you for your attention.