Research Cooperation and International Standards in a Model of Coalition Stability

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Overview

(1) Motivation: Issue Linking of
Technology-oriented and *International Environmental* Agreements

(2) Introduction to a model of coalition stability

(3) Results

   a. Research cooperation

   b. International technology standards

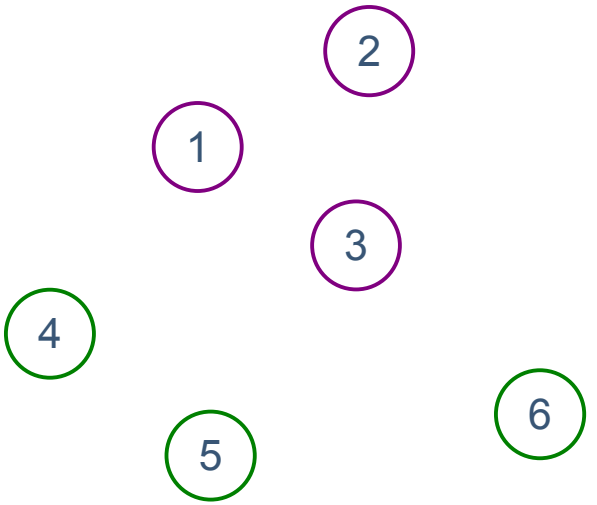
(4) Conclusions, outlook

Technology Oriented Agreements (TOA)

- De Coninck/Fischer/Newell/Ueno (2007):
  - all technology oriented agreement (TOA) have "potential to be valuable"
  - stress "supporting role" to emission reduction policies (IEA)
- Compare different TOAs in one model
- We focus on
  - **R & D (spillovers)**
    - Botteon/Carraro (1998): Production cost
    - Barrett (2003): Mitigation technology
    - Buchner/Carraro (2006): Productivity + Emission intensity
    - Nagashima/Dellink (2008): Mitigation costs
  - **Technology Standards**
    - Barrett (2003)

International Environmental Agreements

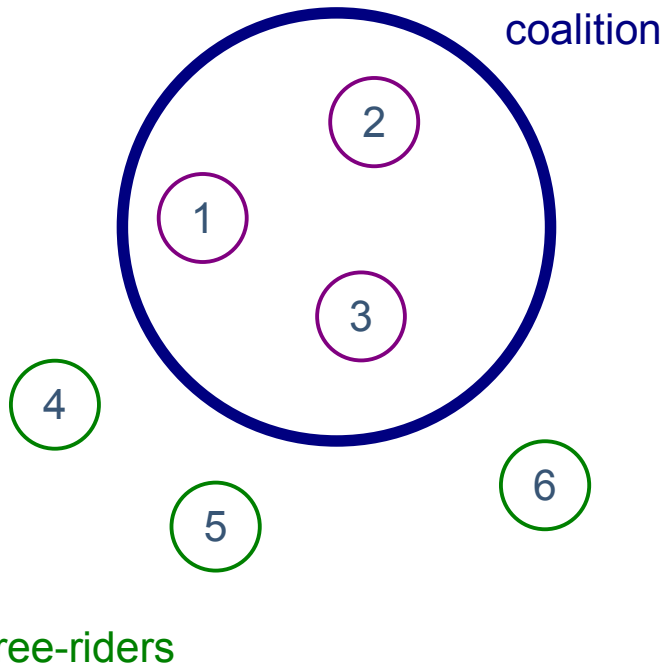
- Climate protection in a multi-actor world:
  - act selfish → no cooperation
  - cooperate → social optimum



International Environmental Agreements

- Climate protection in a multi-actor world:
  - act selfish → no cooperation
  - cooperate → social optimum
- Stable Coalition
  - no incentive to leave
  - no incentive to join

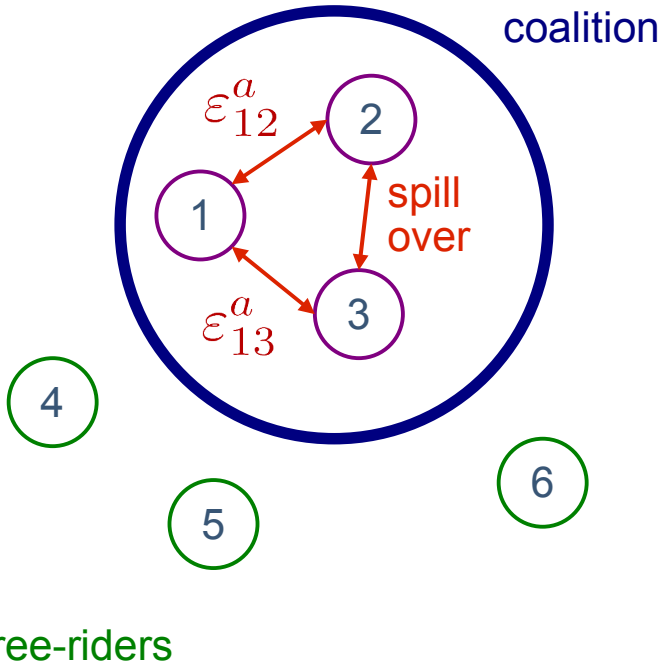
- «Issue Linking»
  Link cooperation on climate protection to something else, e.g.
    - trade sanctions
    - technology cooperation



Modeling Cooperative R&D

- R&D has spillovers
- Assumption: Cooperative R&D may
  - foster spillover
  - restrict spillover to coalition members

$$\tilde{a}_{it} = \sum_j \varepsilon^a_{ij} a_{jt}$$



- R&D in
  - mitigation technology
  - productivity

The Model: Economy equations

- Players maximize intertemporal welfare

$$\max_{\{c_{it},\, in_{it},\, im_{it}\}} \text{welfare}_i$$

$$\text{welfare}_i = \int_0^\infty e^{-\rho\, t}\; l_{it}\, U(c_{it}/l_{it})\; \mathrm{dt}$$

- ... by balancing investments and consumption:

$$GDP = c_{it} + in_{it} + ia_{it} + im_{it}$$

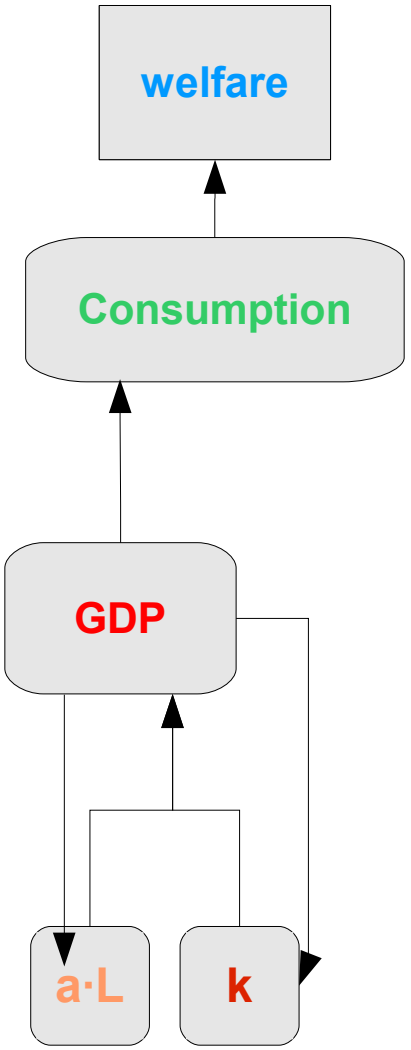
$$\frac{d}{dt} k_{it} = \xi_m\; in_{it}$$

$$\frac{d}{dt} a_{it} = \xi_a\; ia_{it}$$

$$\frac{d}{dt} km_{it} = \xi_m\; im_{it}$$

- Output is produced from capital and effective labor.

$$GDP = (k_{it})^\beta\, (a_{it}\, l_{it})^{(1-\beta)}$$



Emission externality: Damages

- Emissions and abatement

$$e_{it} = \sigma_{it}\, y_{it}$$

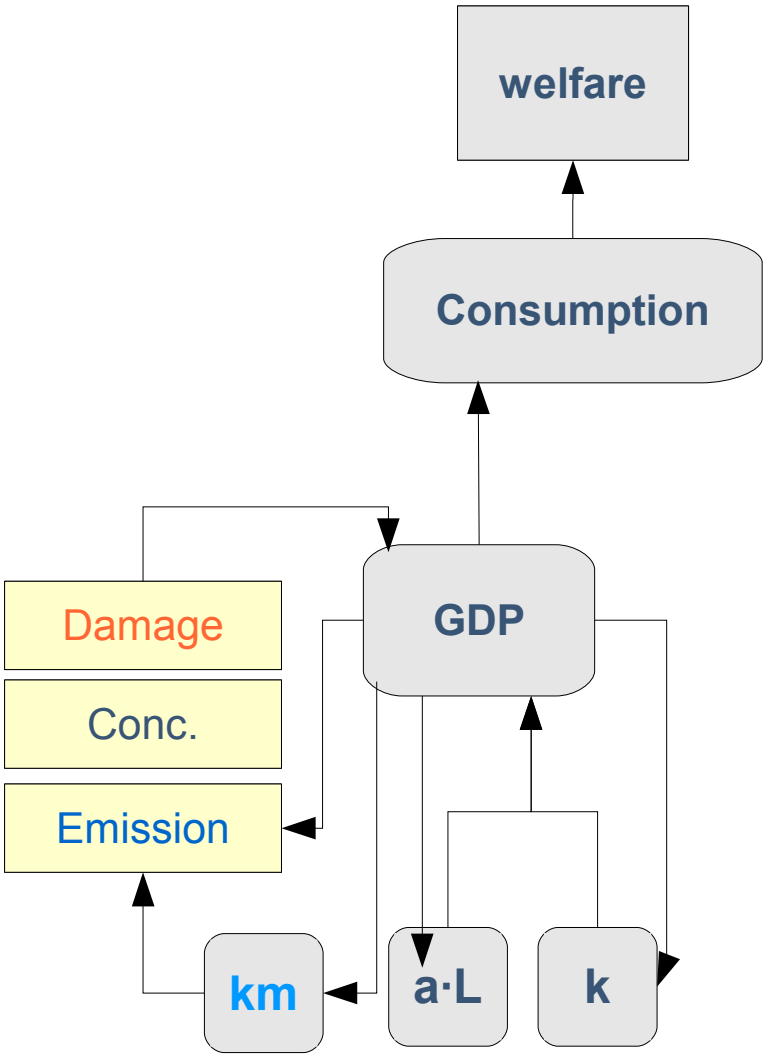
$$\sigma_{it} = (1 + km_{it})^{-\psi}$$

$$\frac{d}{dt} km_{it} = \xi_m \; im_{it}$$

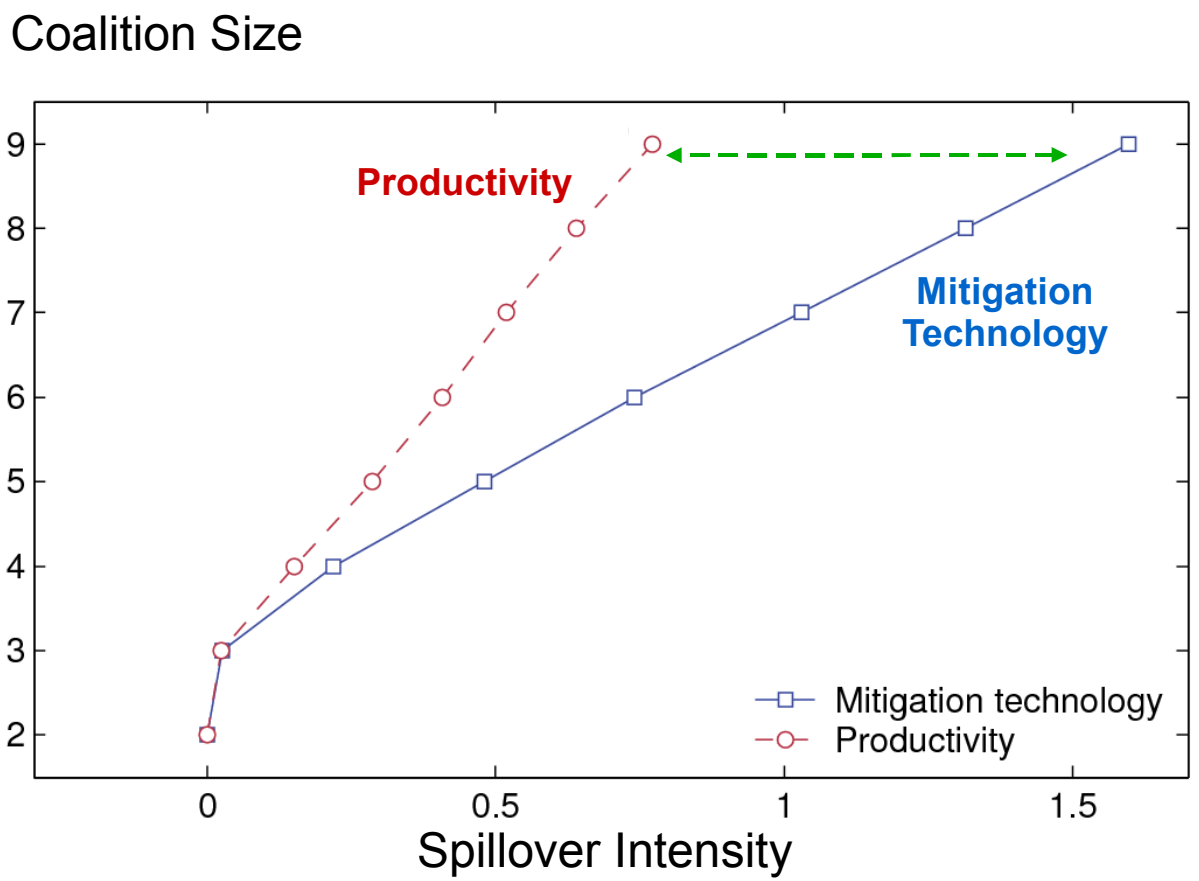
- Translation of emissions to
  - concentration to
  - temperature to
  - damages

$$\Omega_{it} = 1/(1 + dam1_i (temp_t)^{dam2_i})$$

$$y_{it} = \Omega_{it}\, GDP(k_{it}, l_{it})$$



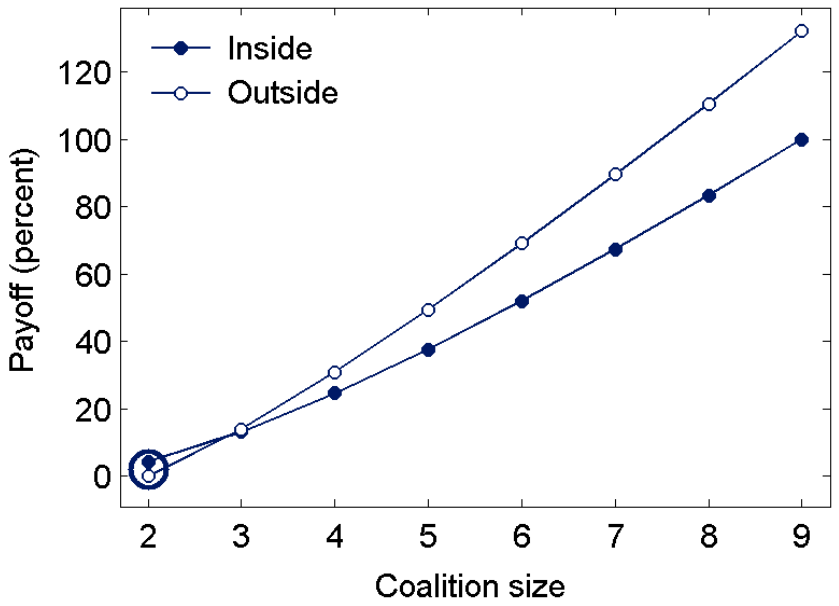
Results: Cooperative R&D



- Full cooperation achieved
- Cooperation on Productivity R&D is stronger as an incentive

- Spillover Intensity: *consumption gains from spillovers* in percent

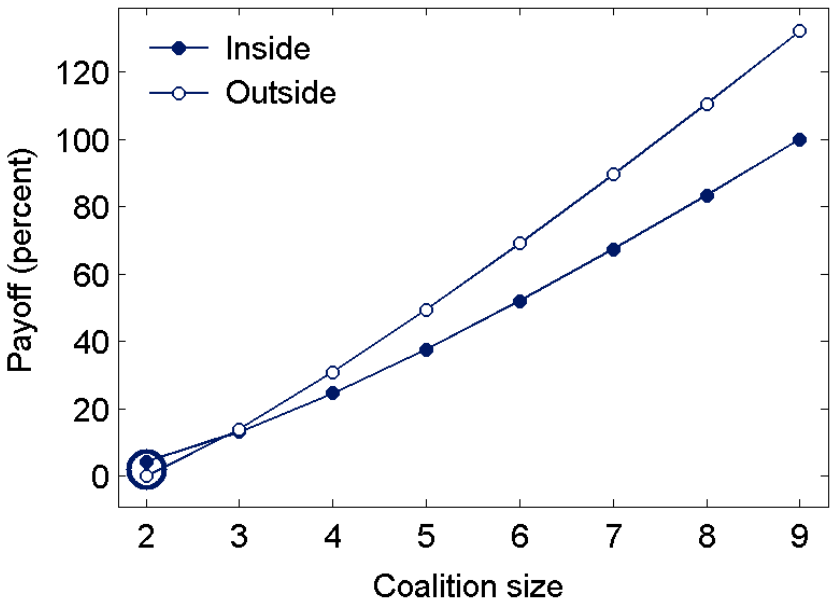
Inside payoff and outside payoff



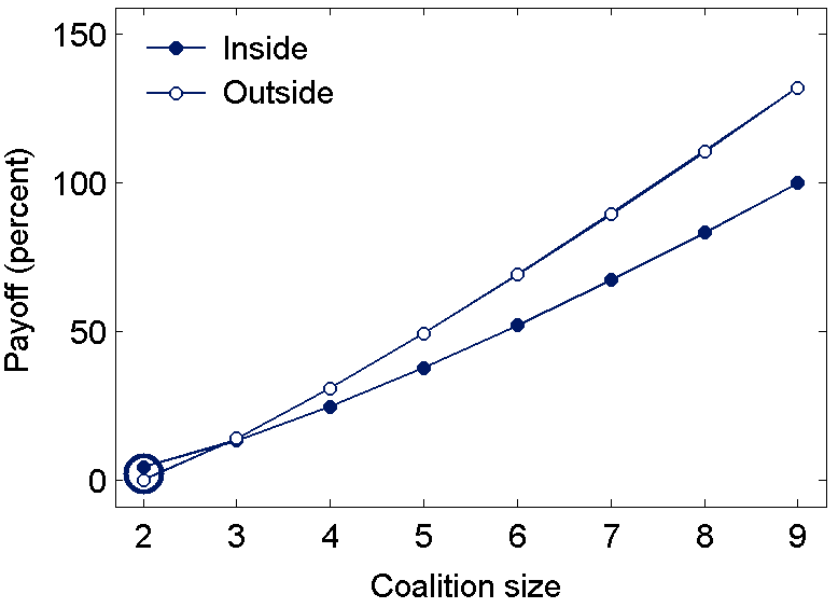
- Member of a Coalition, Size n:
  - *Remain a member → receive inside payoff*
  - *Leave the coalition → receive outside payoff (Coalition Size $n-1$)*
- Coalition *stable* when inside payoff > outside payoff

Inside payoff and outside payoff

Productivity



Mitigation technology



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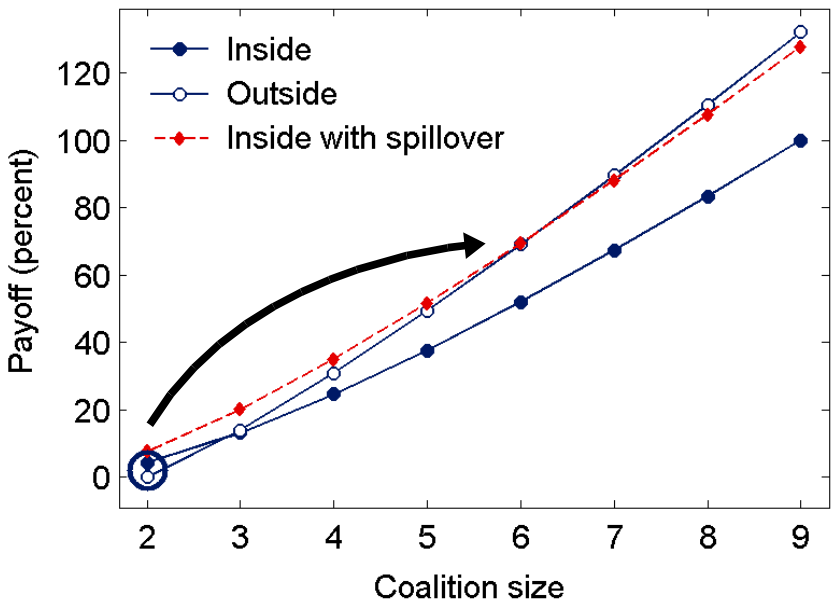
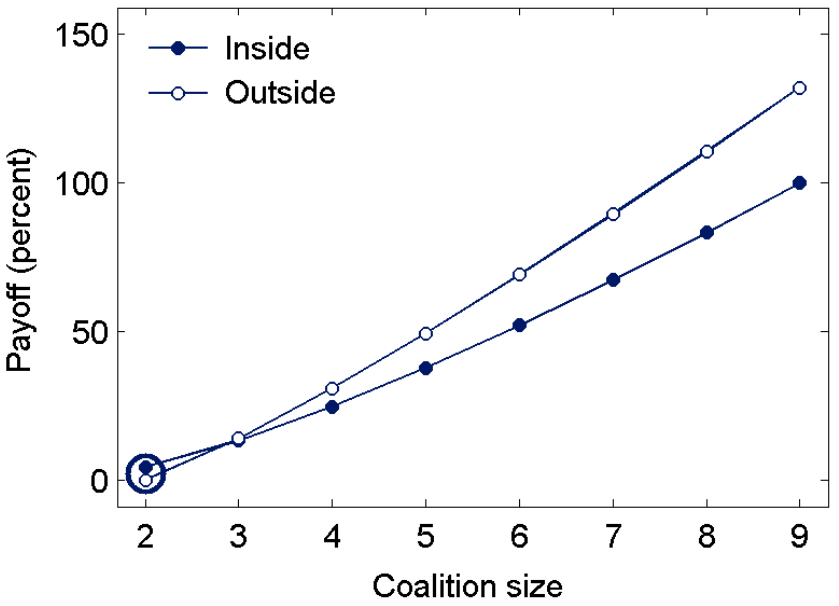


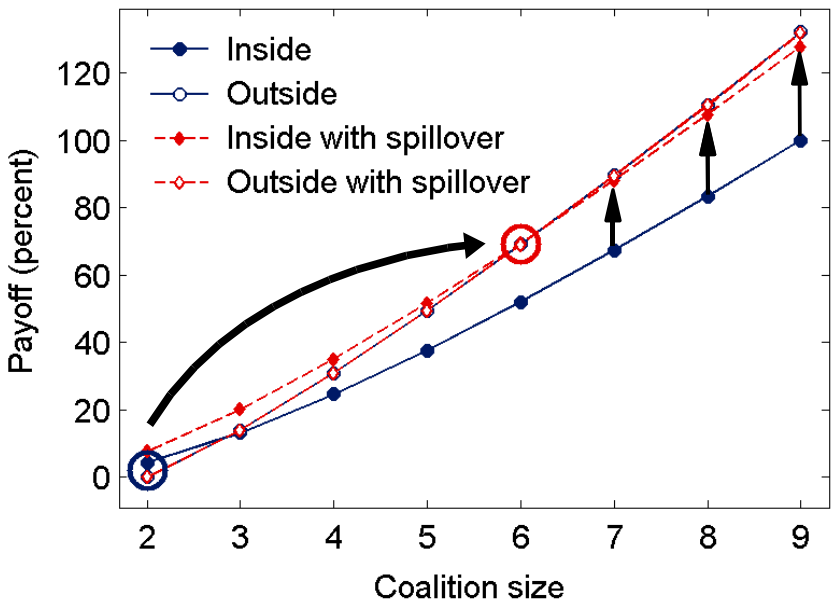
Mitigation technology



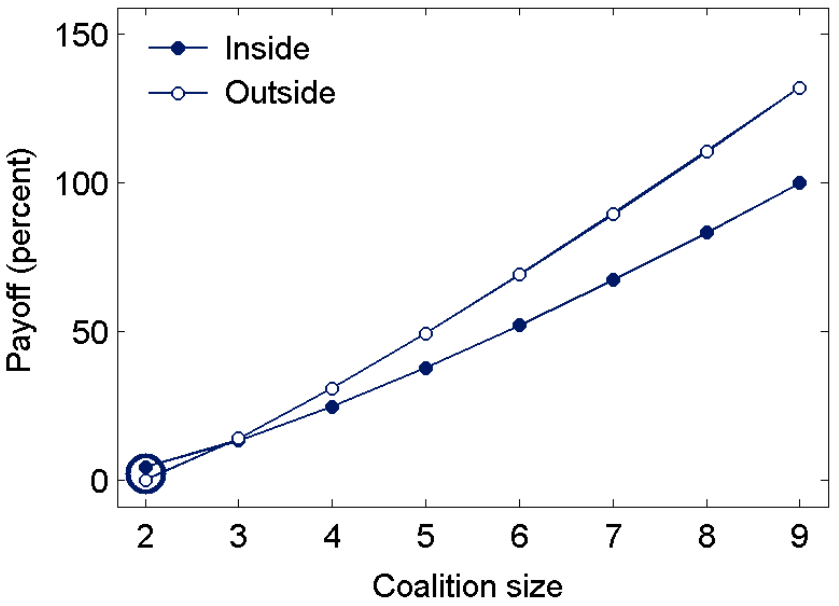
- Introducing spillovers in...
  - productivity: moves inside payoff curve ...

Inside payoff and outside payoff

Productivity



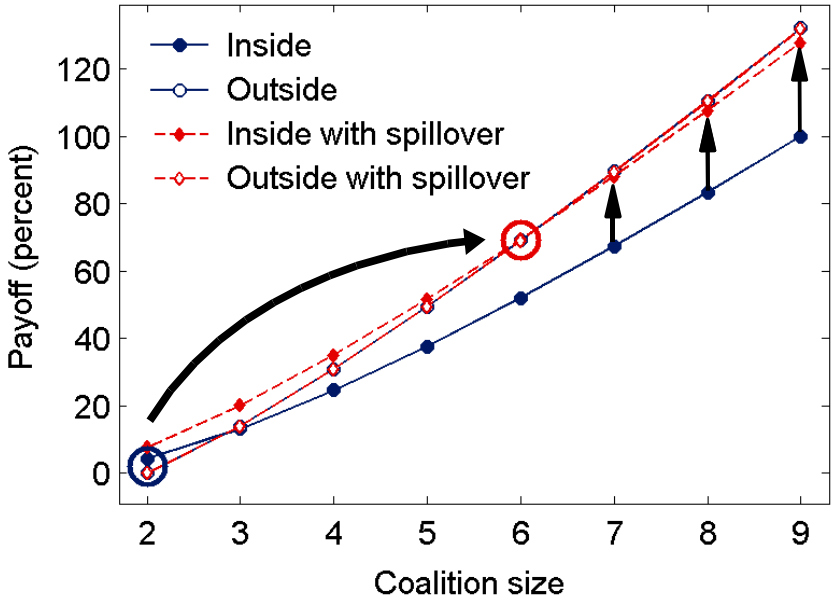
Mitigation technology



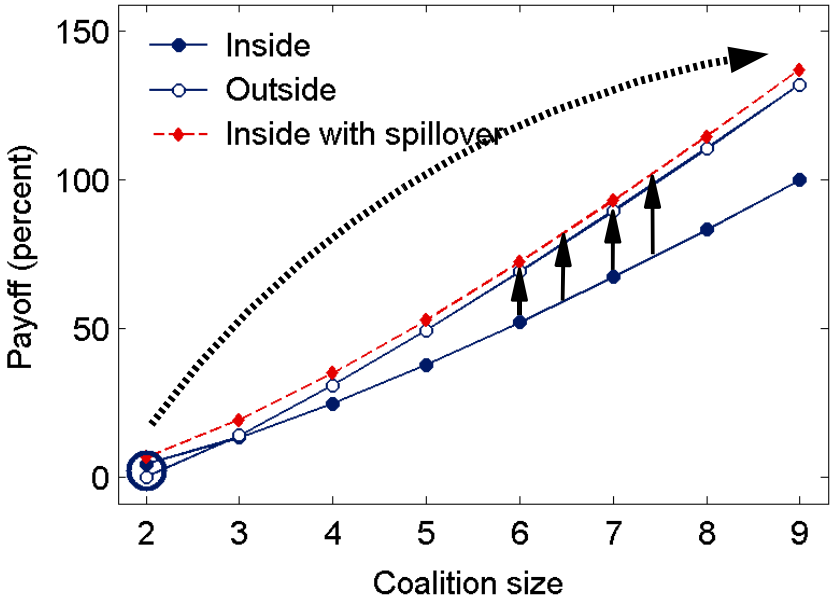
- Introducing spillovers in...
  - productivity: moves inside payoff curve ... *only!*

Inside payoff and outside payoff

Productivity



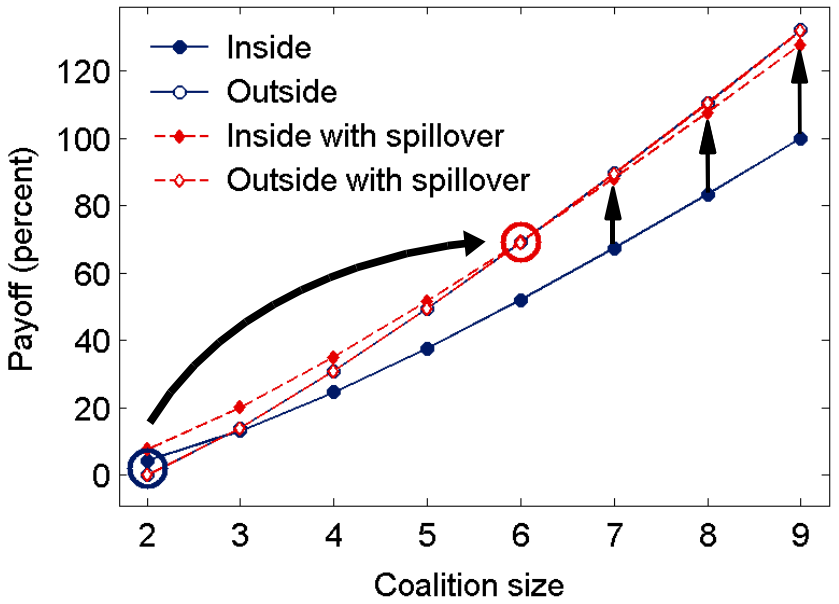
Mitigation technology



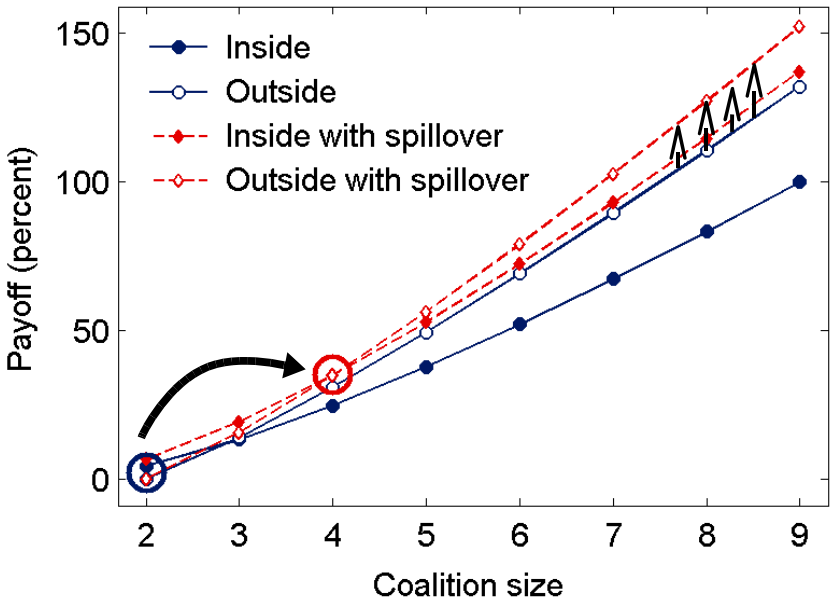
- Introducing spillovers in...
  - productivity: moves inside payoff curve ... *only!*
  - mitigation: moves inside ...

Inside payoff and outside payoff

Productivity



Mitigation technology

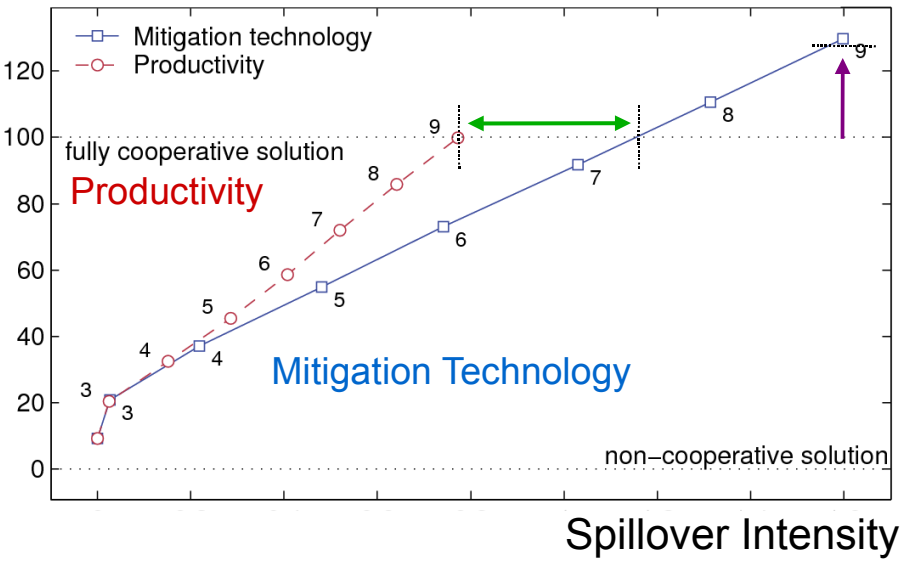


- Introducing spillovers in...
  - productivity: moves inside payoff curve ... *only!*
  - mitigation: moves inside ... *and outside payoff curves*
- Rationale: benefits from “cheap mitigation” spill over to outsiders via reduced emissions / damages

Results: Cooperative R&D

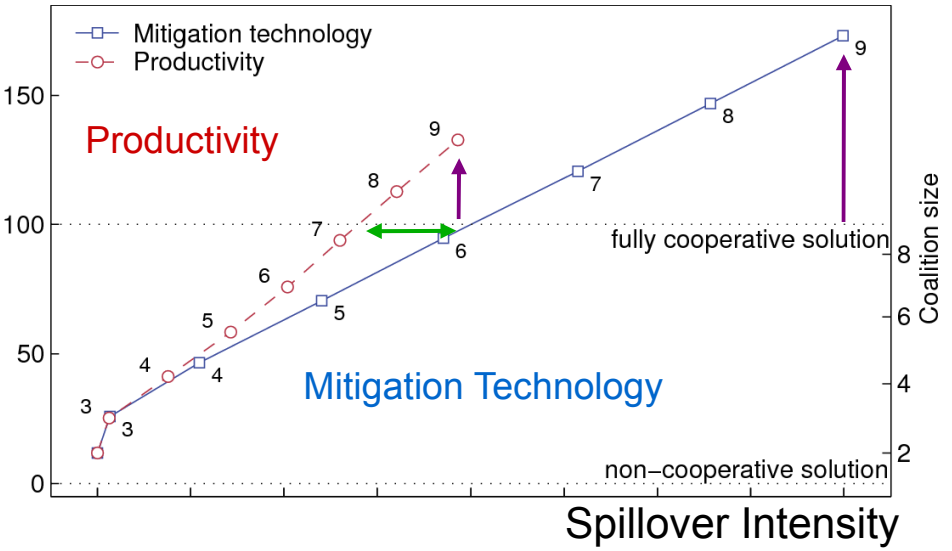
- Environmental Effectiveness
  - Mitigation case exceeds 100%
  - but Productivity still more effective

Environmental Effectiveness



- Welfare effects
  - both exceed 100%
  - and Productivity *still* more effective

Global Welfare



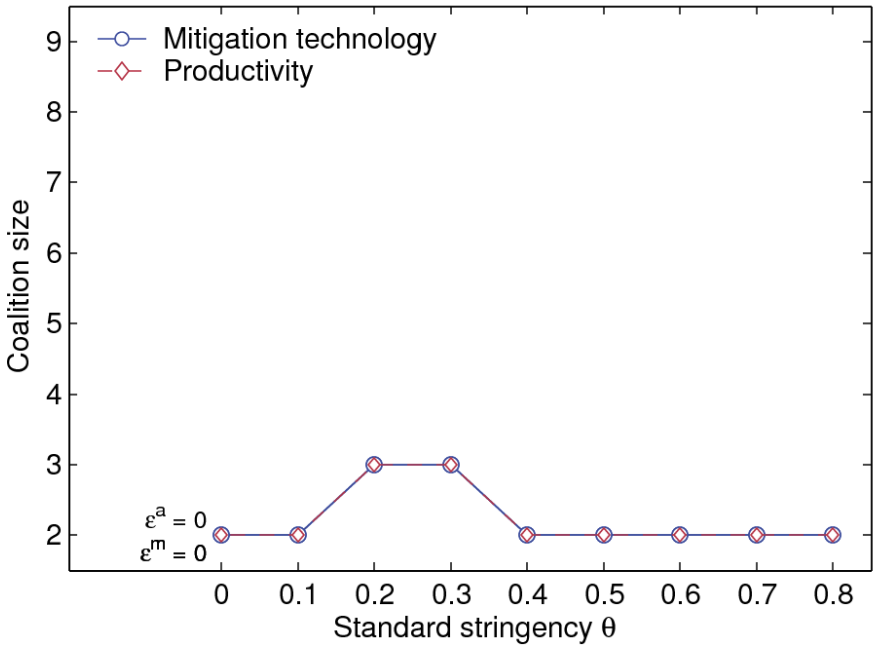
International Technology Standards

- Idea: Combine Cooperative R&D (*push*) and Standards (*pull*), Barrett's *Technology-centered Approach* (2003)
- It's easier to agree on standards than on abatement (*network externalities, economies of scale, implicit trade ban, ...*)

- Modeling assumptions about standards:
  - global adoption *ad hoc* due to incentives
  - performance standard to approximate the effect of a technology standard
  - standard on emission intensity σ_{it} : reduction relative to the Nash Equilibrium

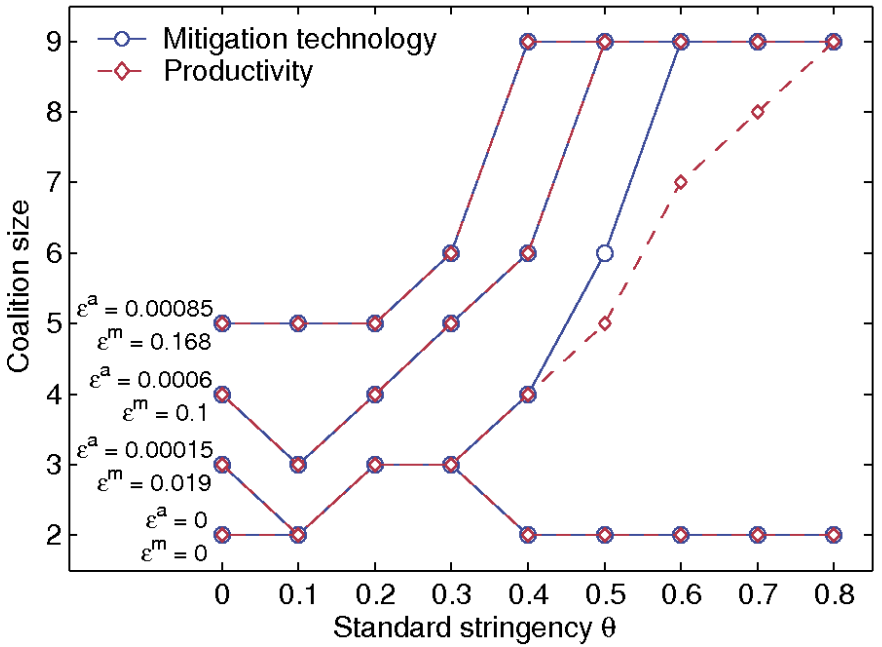
$$\sigma_{it} \leq (1 - \theta)\, \sigma_{it}^{NE}$$

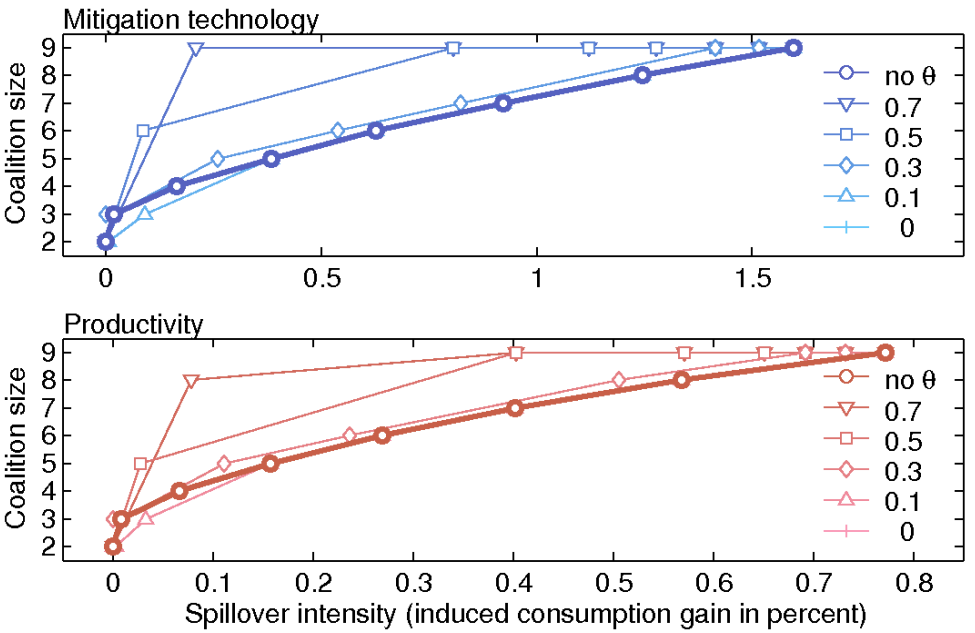
Results: Standards



- Without R&D, standards fail to induce participation

Results: Standards

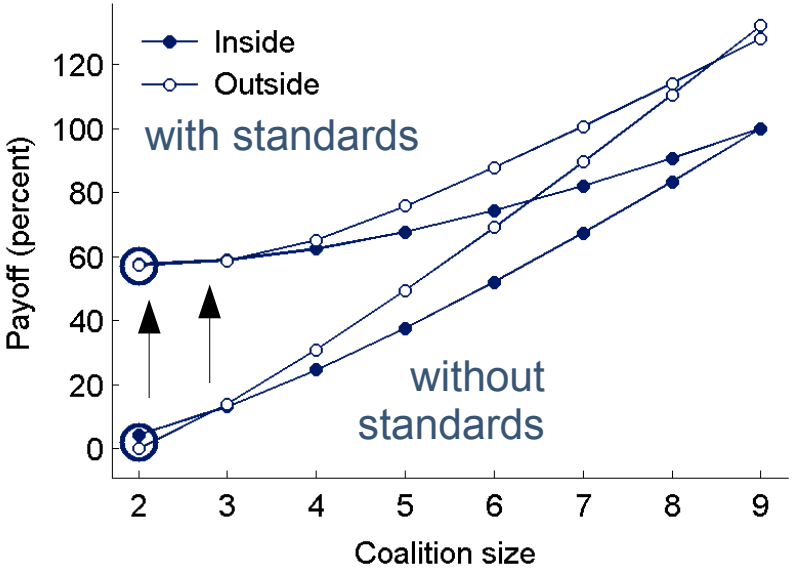




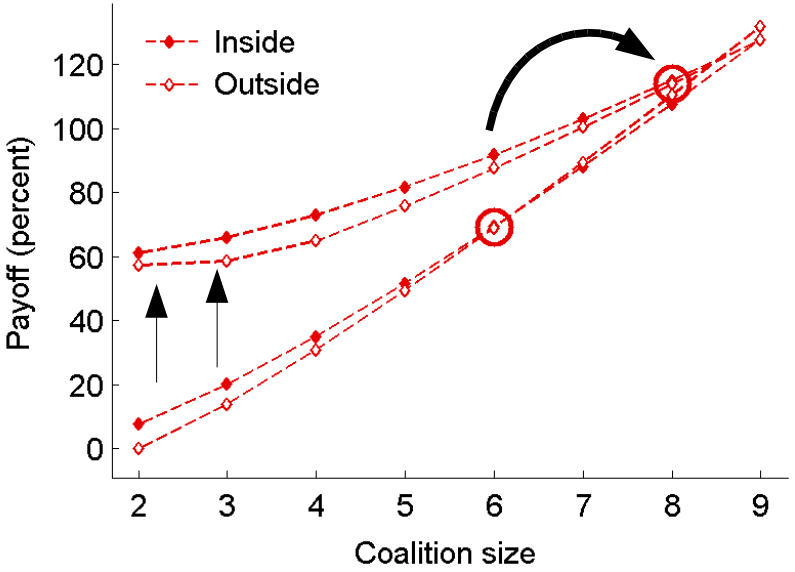
- Without R&D, standards fail to induce participation
- Combined with R&D cooperation, standards facilitate cooperation
  - Interaction of spillover and standards?

Inside payoff and outside payoff

No R&D cooperation



With R&D cooperation

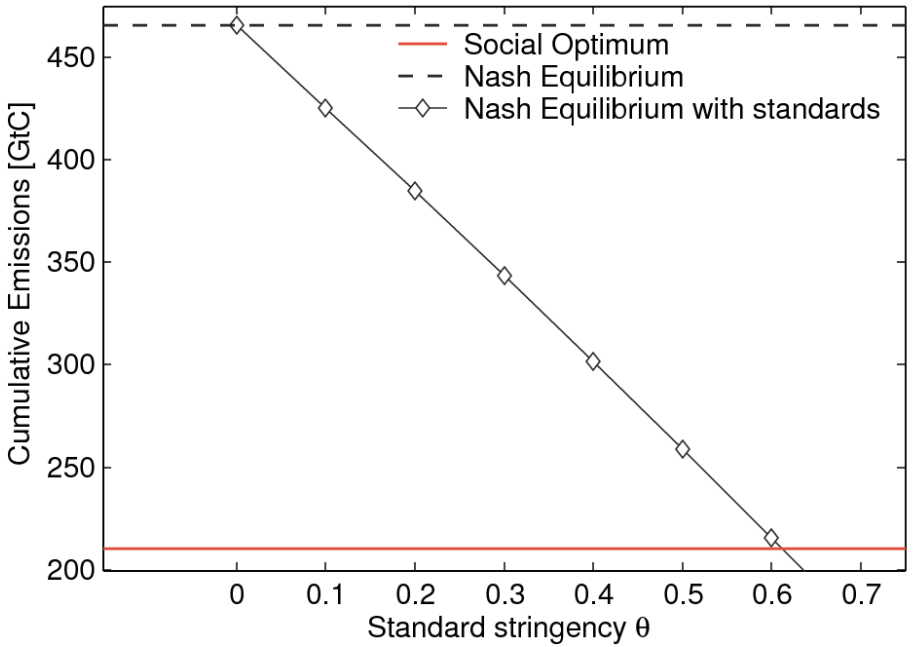


- Standards enforce minimum abatement → raise payoffs
  - No R&D cooperation: small coalitions, similar behavior inside and out
    members + nonmembers similarly affected
  - With R&D cooperation: larger coalitions,
    standards affect nonmembers more strongly
    → additional advantage for members

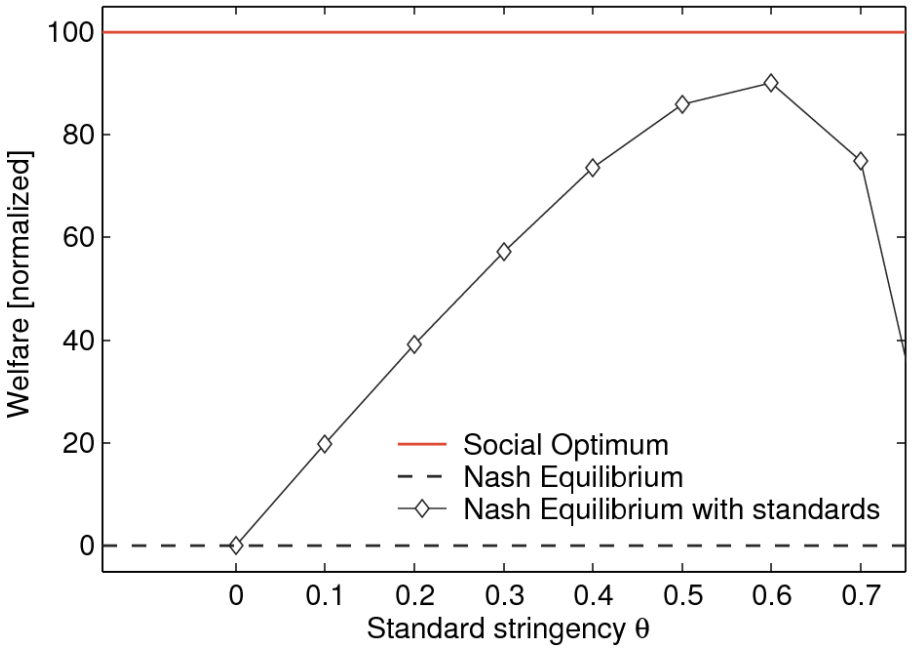
Interaction of Standards and Spillovers

- Standards by themselves:
  - approach and exceed optimum emissions
- Inefficiency of Standards:
  - Standards alone never optimal welfare level

Cumulative Emissions



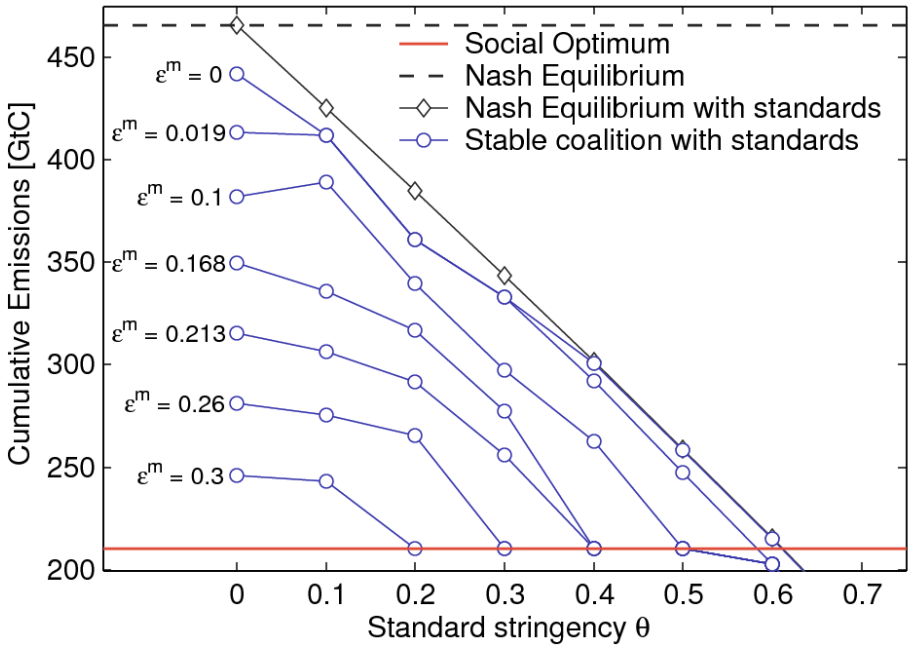
Welfare



Interaction of Standards and Spillovers

- Standards by themselves:
  - approach and exceed optimum emissions
- Inefficiency of Standards:
  - Standards alone never optimal welfare level
  - Combination becomes efficient
  - Possibility of two-step approach

Cumulative Emissions



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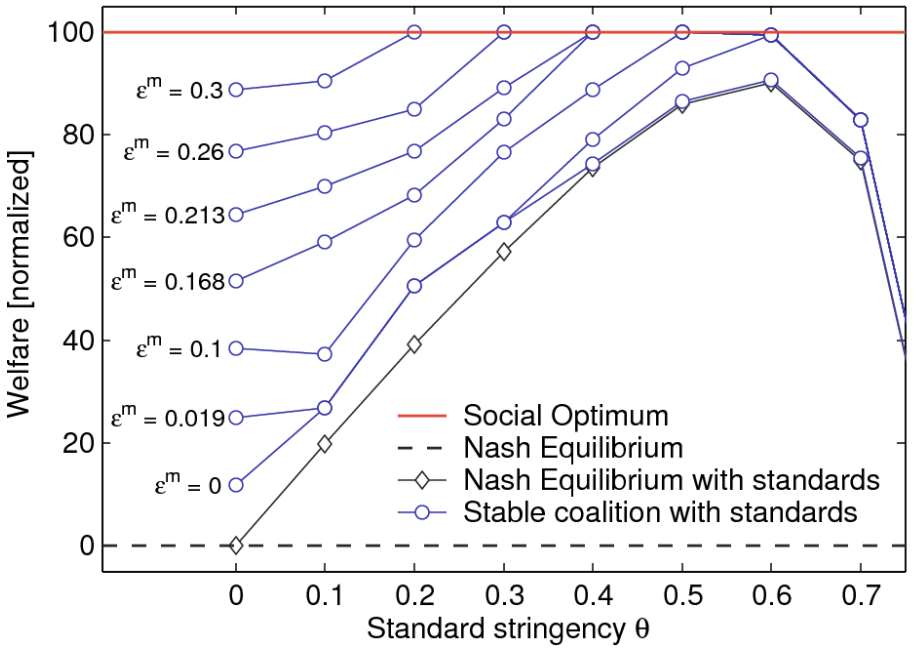

Conclusions, Outlook

- R&D Spillovers + Standards
  - "Supportive role" confirmed
  - Stronger incentive from cooperation on technology unrelated to climate change
  - Separate standards agreement allows splitting coalition building into two steps
- Extensions
  - Heterogeneous regions
  - Technology level standards

References

- De Coninck/Fischer/Newell/Ueno (2007): International technology-oriented agreements to address climate change, *Energy Policy*
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