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Mitigation, technological change and international technology spillovers

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International Energy Workshop

Stanford, 8th July 2011

Outline

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Technological change and climate mitigation

Technological change

→ Important role in climate change mitigation

→ 3 processes:

- Learning-by-doing
- Learning-by-searching
- Technology spillovers

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Integrated assessment models

→ Exogenous technology learning

→ Two parameter learning curves: "learning-by-doing" and "learning-by-searching"

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Integrated assessment models

→ Exogenous technology learning

→ Two parameter learning curves: "learning-by-doing" and "learning-by-searching"

→ Generally do not account (Bosetti et al. (2008) modeled international R&D spillovers WITCH) or overestimate technology spillovers

MERGE-ETL

- Enhanced version MERGE [Magne, Kypreos, Turton (2004)]
- Collective evolutionary process: technology clusters
  - Key components often used across different technologies

		Gasifier	Gas turbine	Coal balance of plant	Carbon capture		Wind	Solar
					Pre	Post		
Electricity	gas-r		x					
	NGCC		x					
	NGCC (ccs)		x			x		
	IGCC	x		x				
	IGCC(ccs)	x		x	x			
	Solar							x
	hydro							
	wnd						x	

  - Experience with one technology may benefit other technologies
- Learning global process:
  - Key components learn from global cumulative production and R&D expenditures.
  - Technologies are assumed to have full spillovers between all world regions.

Two factors learning curve

For the y-key component:

Learning by doing

$$inv_y \propto CC_y^{-b_y}$$

where CC_y is the cumulative capacity; and b_y is the learning-by-doing index

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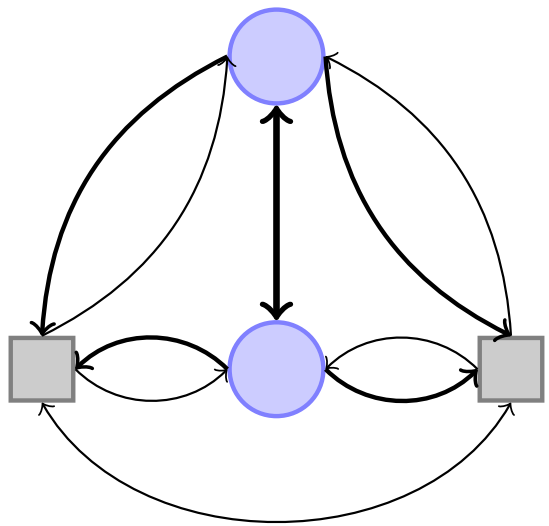
Assumes 100% spillovers among the regions

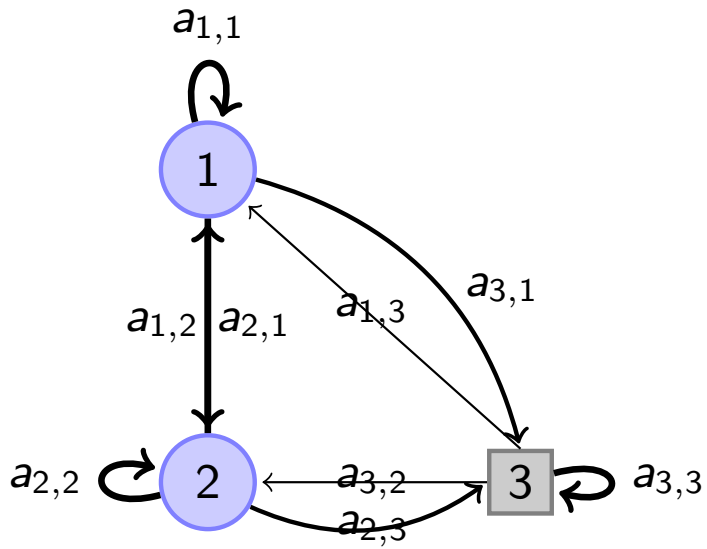
Technology spillovers in MERGE

- Region-to-region spillovers.
- International transfers of experience and knowledge using exogenous absorption parameters
- Innovators and imitators



Two factors learning curve with spillovers

- Absorption parameter



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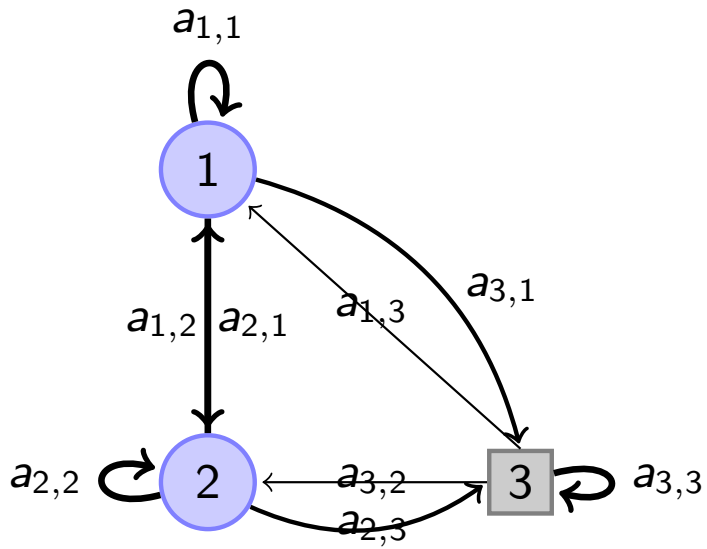
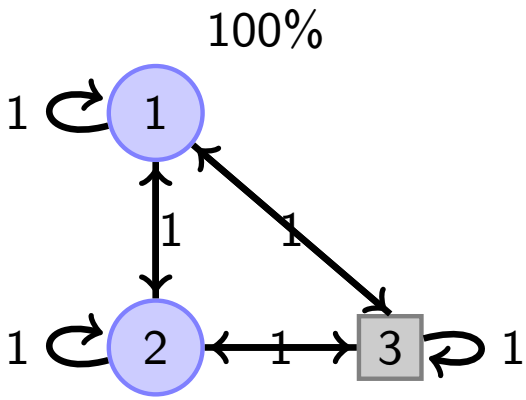
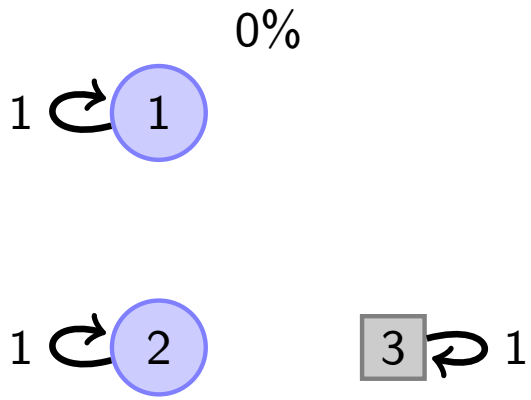


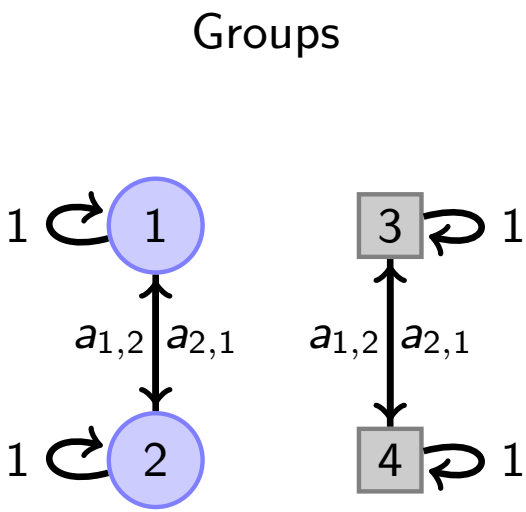
- For the r region and y-key component:

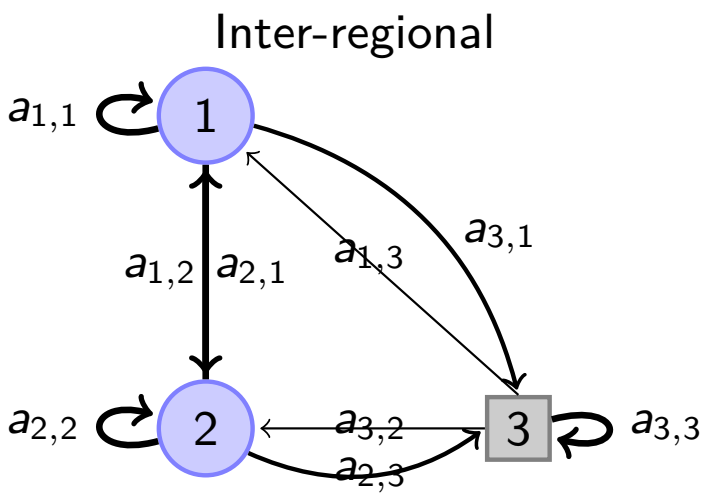
$$inv_{y,r} \propto \left(\sum_{i \in R} a_{i,r} CC_{y,i} \right)^{-b_y} \left(\sum_{i \in R} a_{i,r} CRD_{y,i} \right)^{-c_y}$$

Scenario description





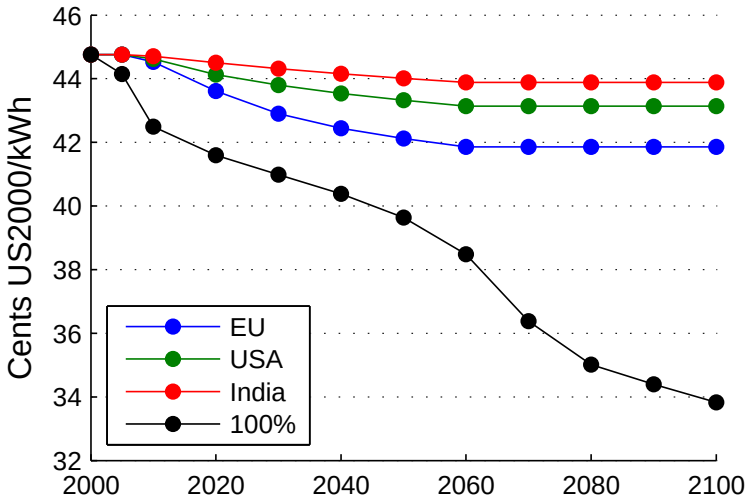




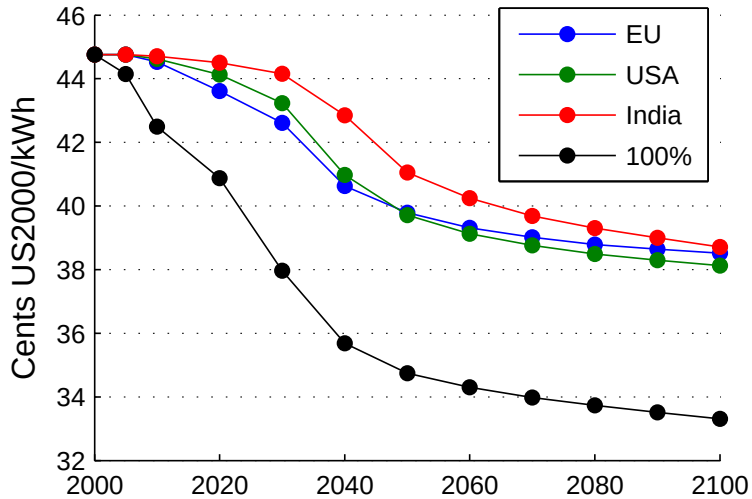
Wind technology cost

0% spillovers

BAU



400ppm

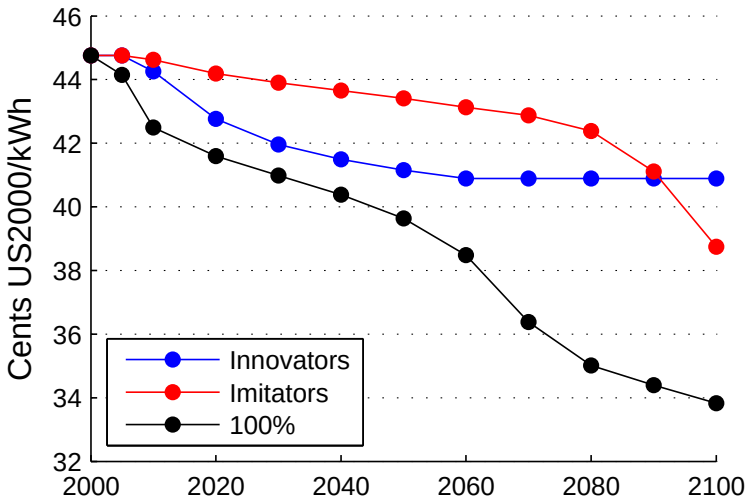


- BAU: 24-30 % higher cost, large regional differences
- 400ppm: 15 % higher cost, smaller regional differences

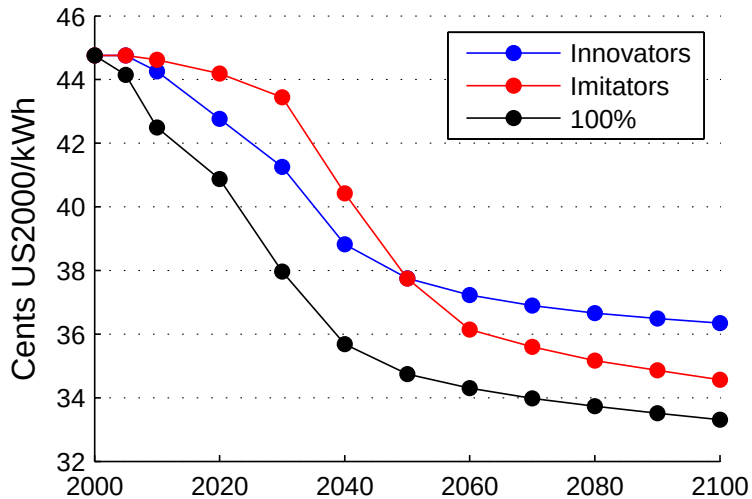
Wind technology cost

Spillovers within each group

BAU



400ppm

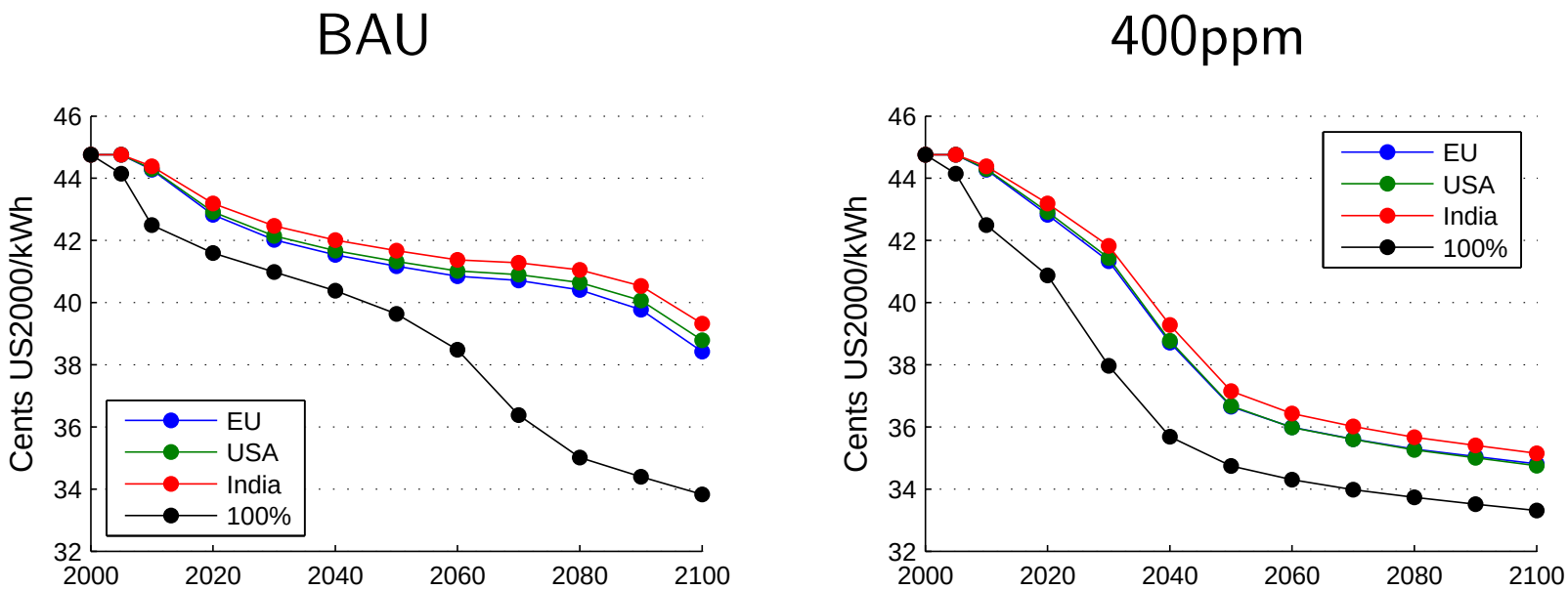


Cross point imitators and innovators:

- learning-by-searching vs. learning-by-doing
- Earlier in the 400ppm case

Wind technology cost

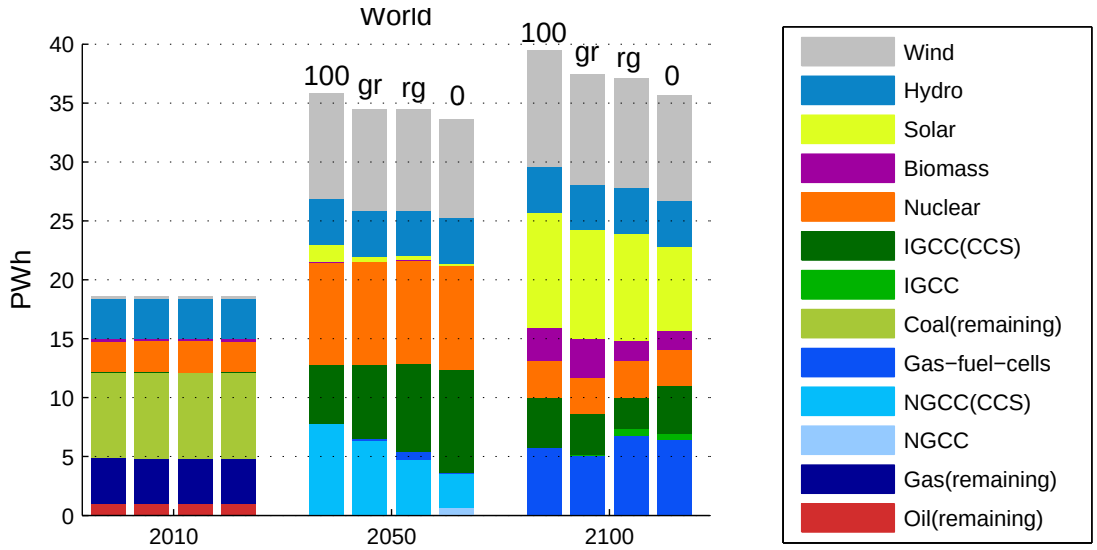
Inter-regional spillovers



- BAU: 15% difference; 400ppm: 6%
- No cross point: importance of spillovers from learning-by-doing from imitators to innovators

Technology mix

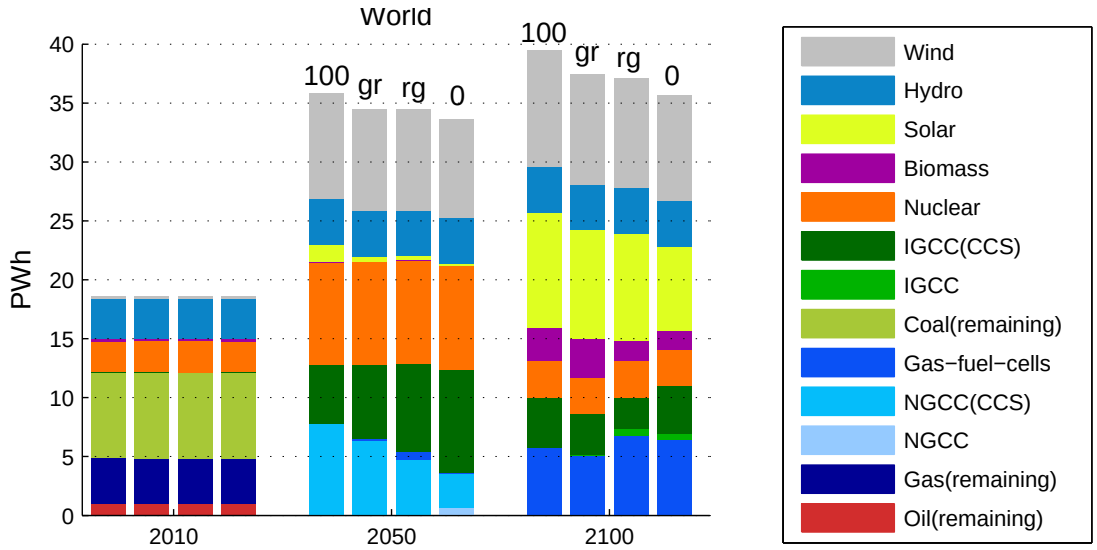
400ppm



- Reduction electricity demand: efficiency improvements

Technology mix

400ppm



- Reduction electricity demand: efficiency improvements spillovers?

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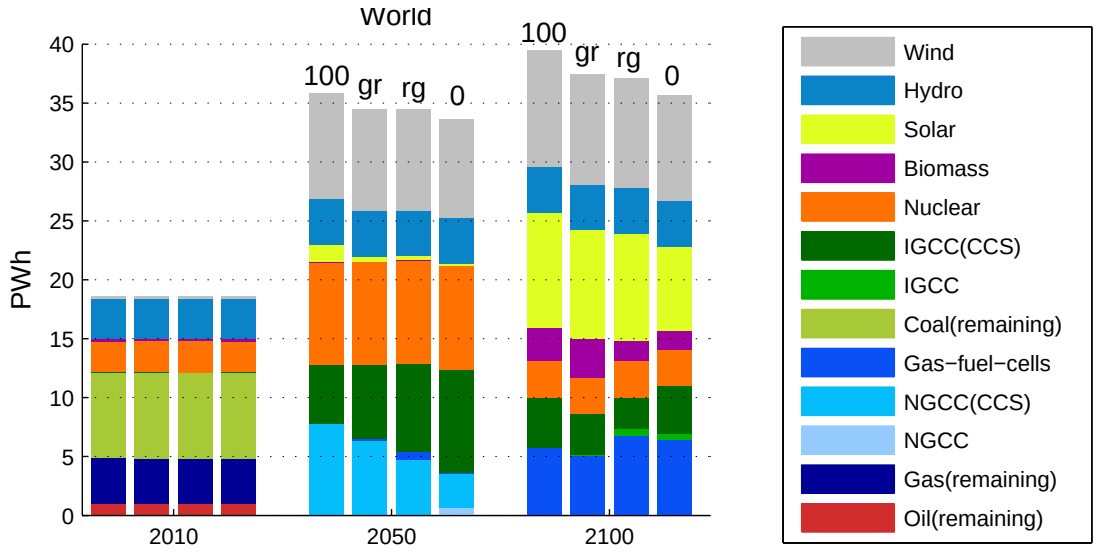
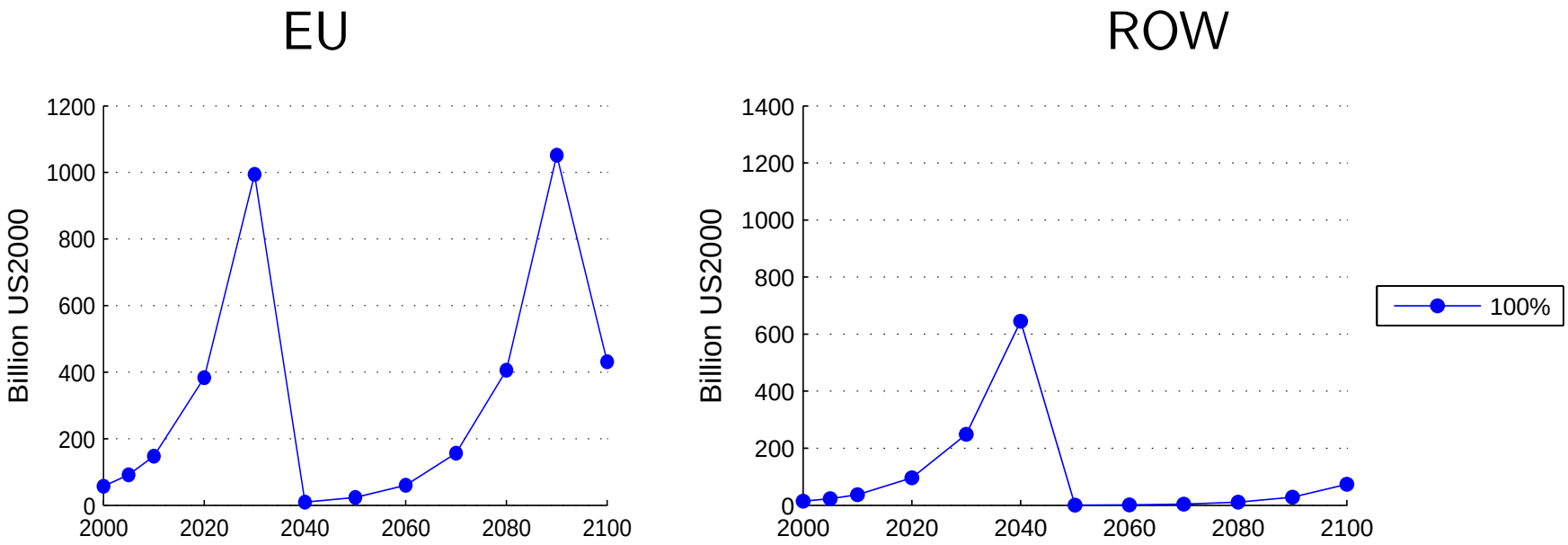


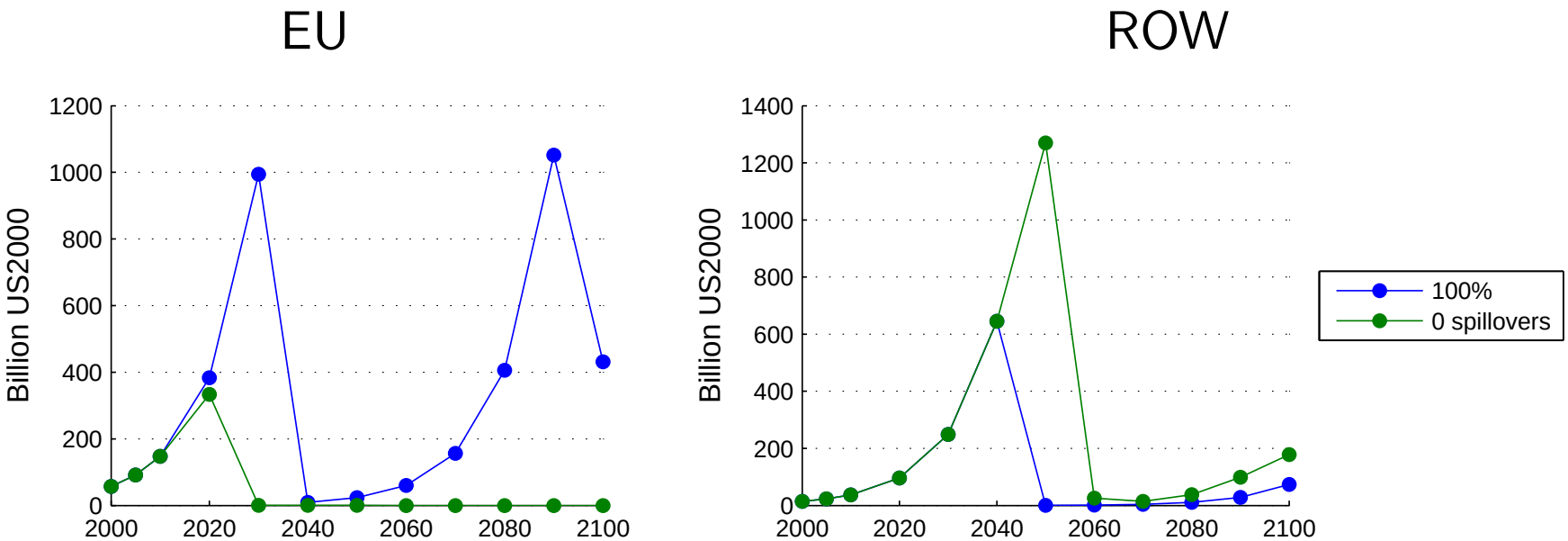
- Reduction electricity demand: efficiency improvements spillovers?
- Technologies with high share of learning component (wind vs. CCS)

R&D expenditures



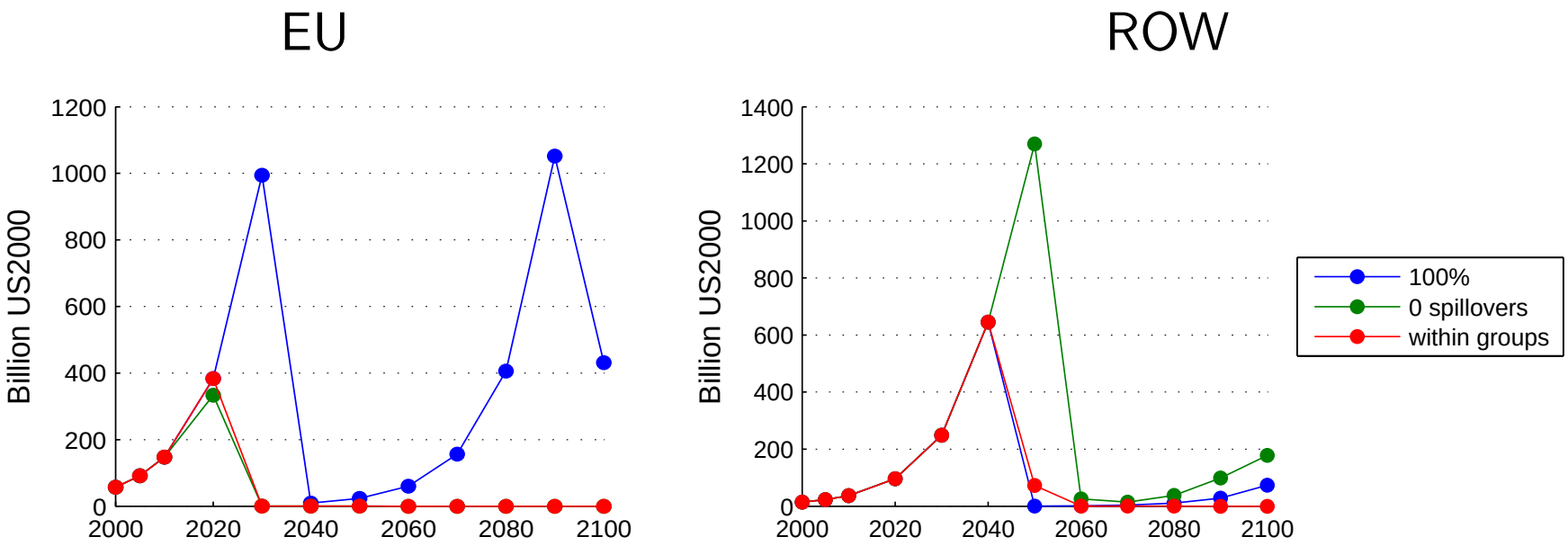
- Mostly of the R&D done by the innovators

R&D expenditures



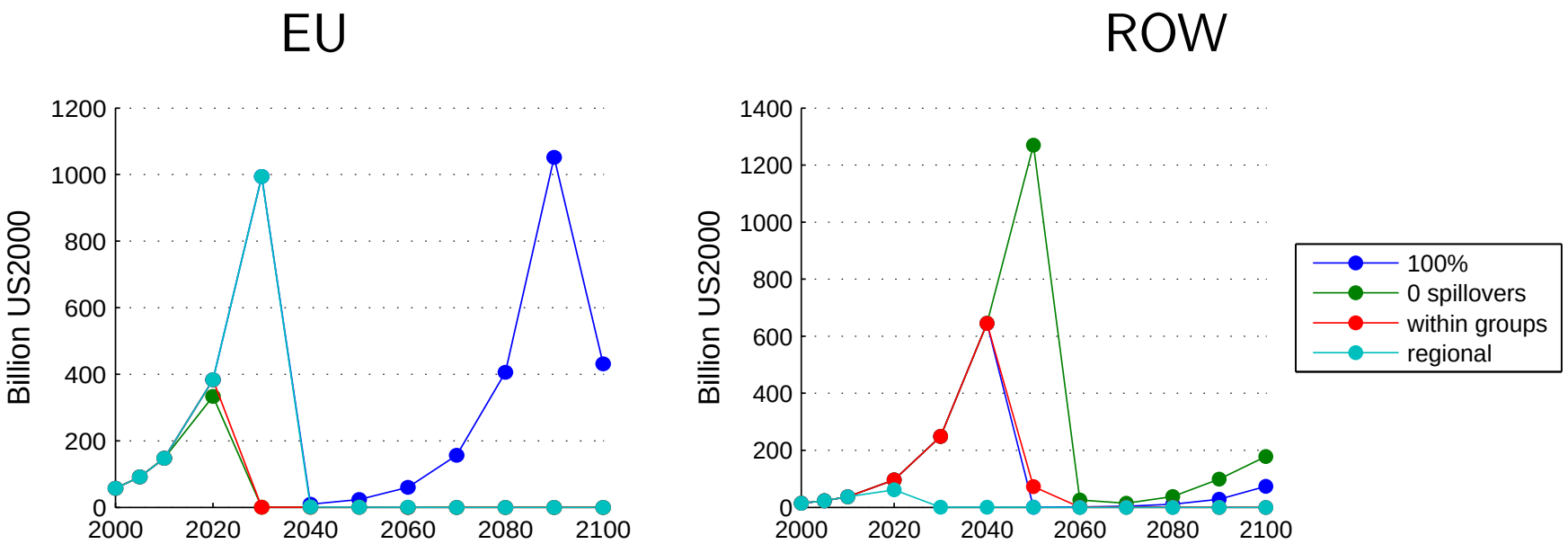
- Imitators do their own research

R&D expenditures



- Innovators behave like 0% scenario: not need to help imitators
- Imitators behave like 100% case: spillovers from the other regions (learning-by-doing)

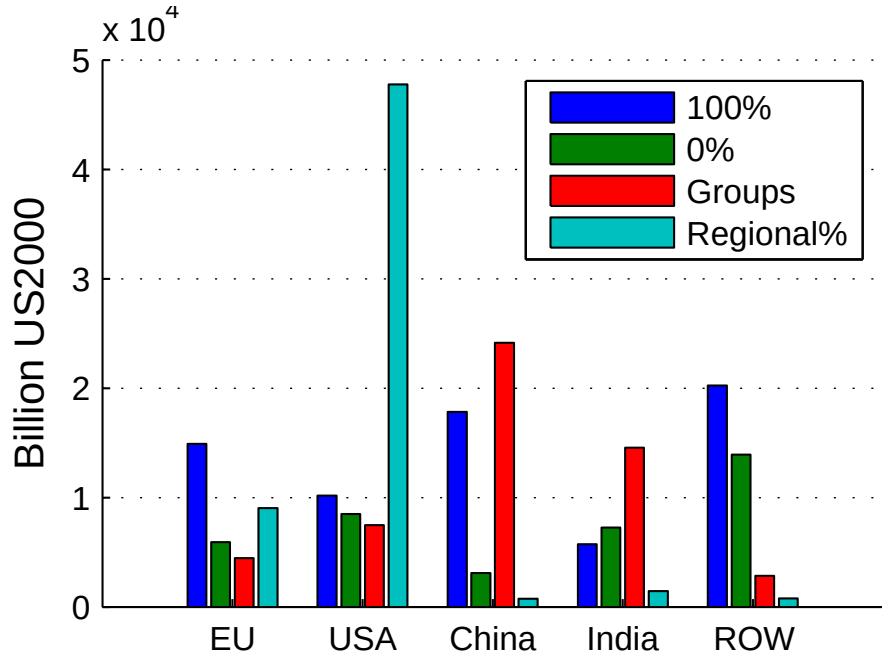
R&D expenditures



- Innovators reduce their R&D efforts compared to the 100% scenario
- Imitators do not have an incentive to research: spillovers from innovators and small effect on global learning

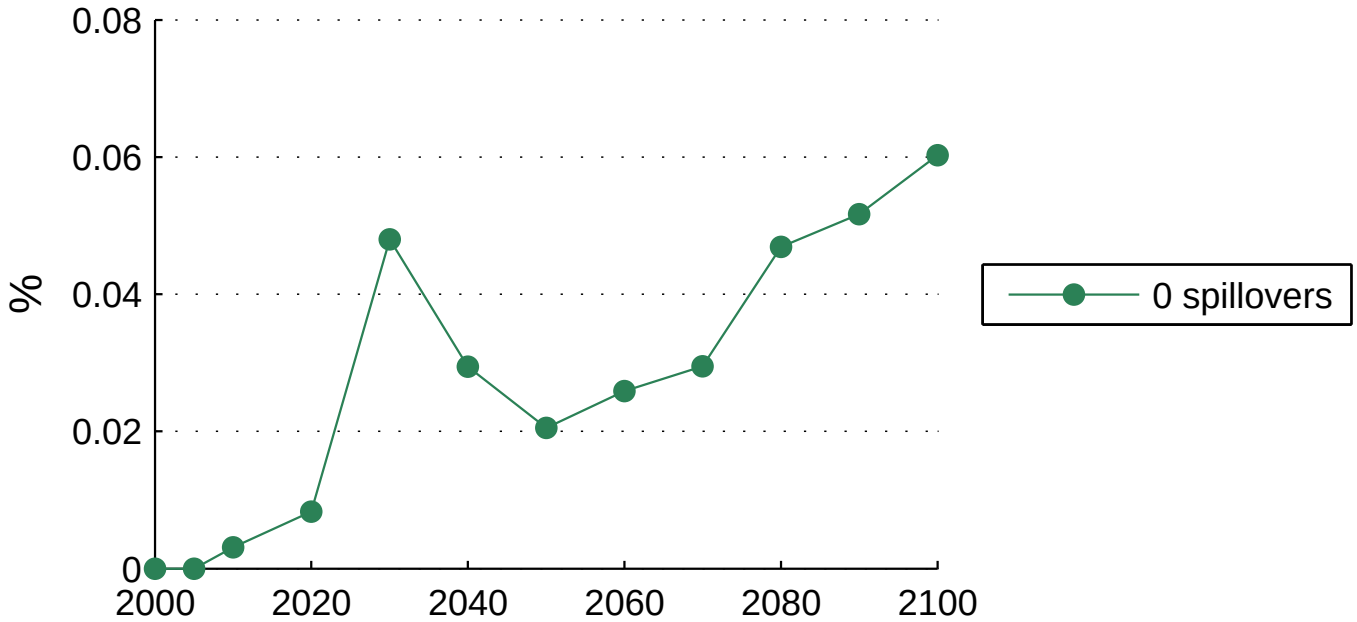
Discounted R&D expenditures

400ppm



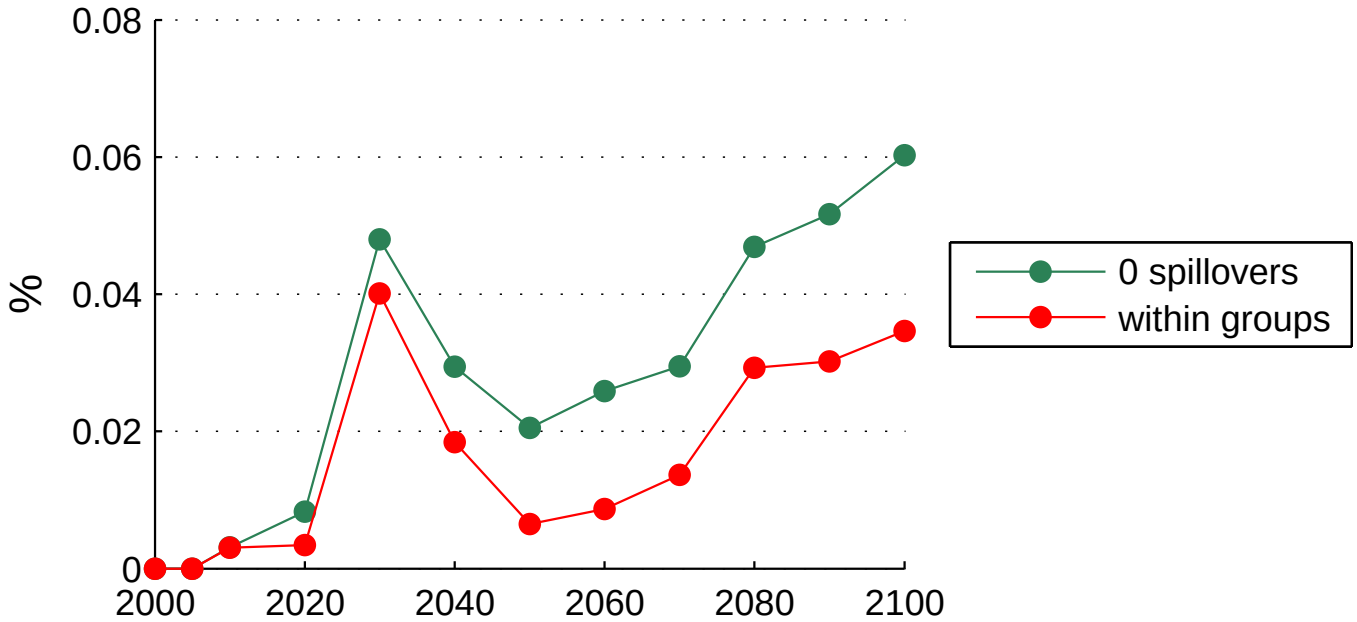
- Innovators all R&D efforts with 100% and regional spillovers
- China and India: research development in regional case
- Need of technology transfer to accomplish the needed R&D spillovers

GDP losses



- No learning spillovers → higher GDP losses

GDP losses



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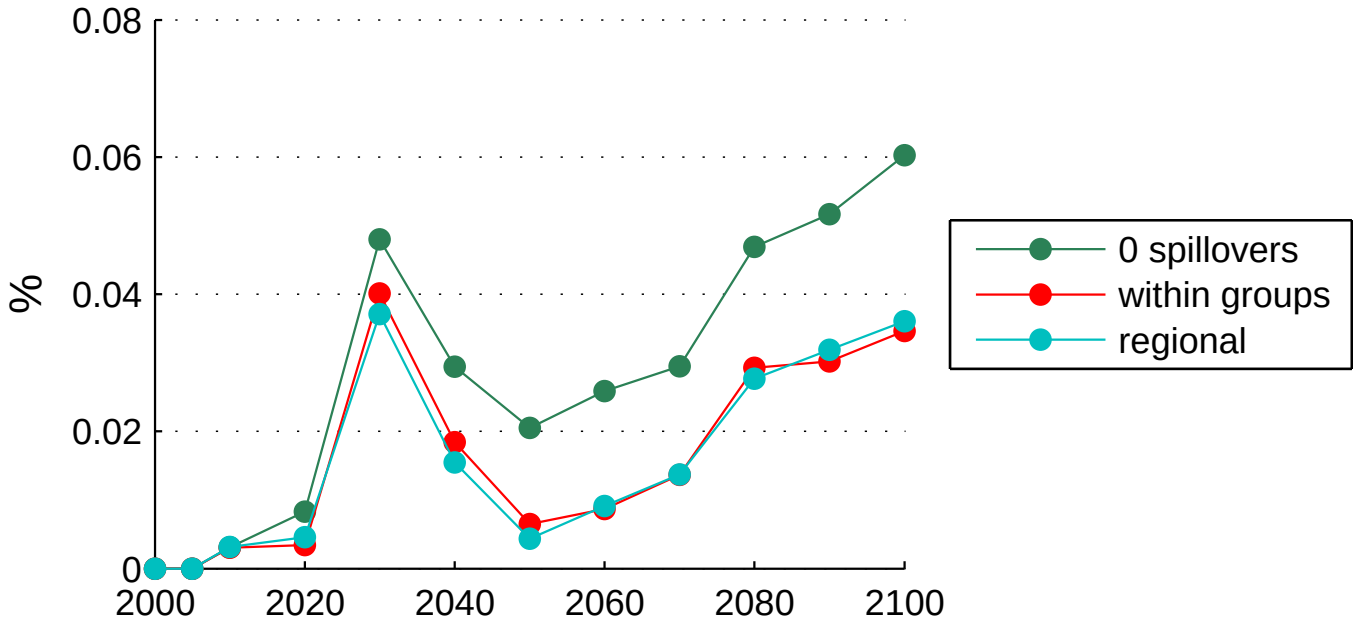

- No learning spillovers → higher GDP losses
- Less GDP losses when regional spillovers

Discussion

Overall

Important linkages between learning spillovers, technology deployment and climate change mitigation.

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- Less technology cost reductions due to learning when using regional instead of global spillovers

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Important linkages between learning spillovers, technology deployment and climate change mitigation.

- Less technology cost reductions due to learning when using regional instead of global spillovers
- Learning-by-doing has a crucial role for imitators
- Global climate mitigation target
  - → Lower energy demand. Important role for energy efficiency
  - → Global technology learning might overestimate spillover effect
    Importance of technology transfer

Outlook

- Different absorption parameters: LBD and LBS

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- Costs or benefits of getting/giving knowledge to the pool
  incentives for technology transfer
- Spillovers in energy efficiency measures

Thank you for your attention