

Mercator Research Institute on  
Global Commons and Climate Change gGmbH

# The strategic dimension of financing global public goods

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Symposium for the High-Level Commission on Carbon  
Prices

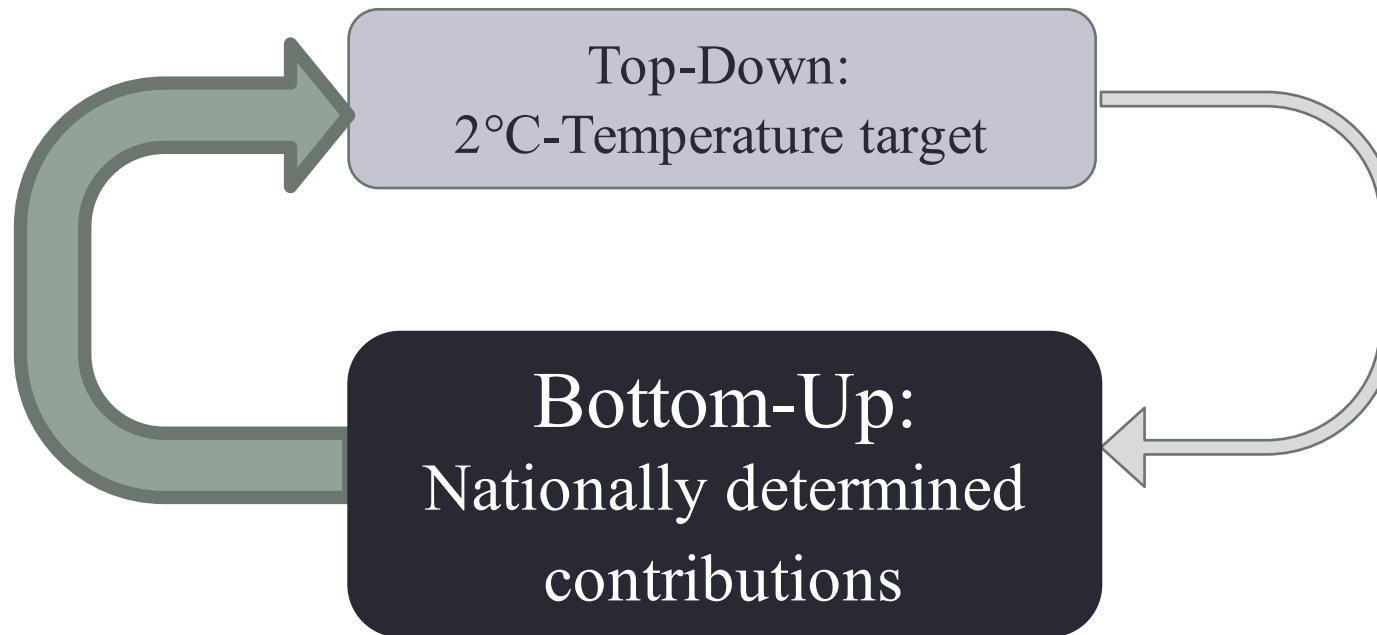
Paris, May 17<sup>th</sup> 2017

# Outline

1. The Paris Agreement and the public goods game
2. The public goods game with strategic transfers
3. Designing strategic transfers:
  - a) Transfers from a fund of fixed size
  - b) Transfers based on differences in prices
  - c) Transfers based on differences in costs
4. Conclusion

# The Paris Agreement and the public goods game

- Voluntary contributions to 2°C-temperature objective
- Only informal mechanisms as punishment/incentives
- Nationally determined contributions face free-riding incentives



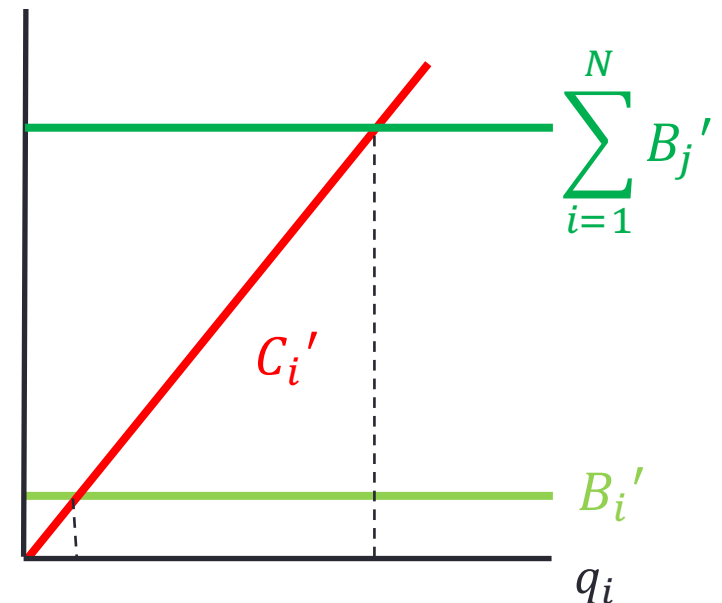
# The Paris Agreement and the public goods game

- Payoff structure:  $\pi_i = B_i(Q) - C_i(q_i)$ ,  $B_i' > 0, B_i'' \leq 0$   
 $C_i' > 0, C_i'' > 0$

Sum of individual contributions to public good  $q_i$   $Q = \sum_{j=1}^N q_j$

- Non-cooperative:  $B_i'(Q) = C_i'(q_i)$

- Cooperative:  $\sum_{i=1}^N B_j' = C_i'(q_i)$



# The Paris Agreement and the public goods game

- How to increase the incentive to voluntarily provide the public good?
- Set up of a **compensation fund** that disburses transfer payments as reward for costly abatement

- Individual decisions:

1. Voluntary provision of public good → strategic transfers:

$$\frac{\partial}{\partial q_i} \mathcal{T}_i \geq 0$$

2. Participation in the compensation fund:

Constraint from International Environmental Agreements literature

# The Paris Agreement and the public goods game

- Limit cheating: cost-efficient emission reductions through carbon price

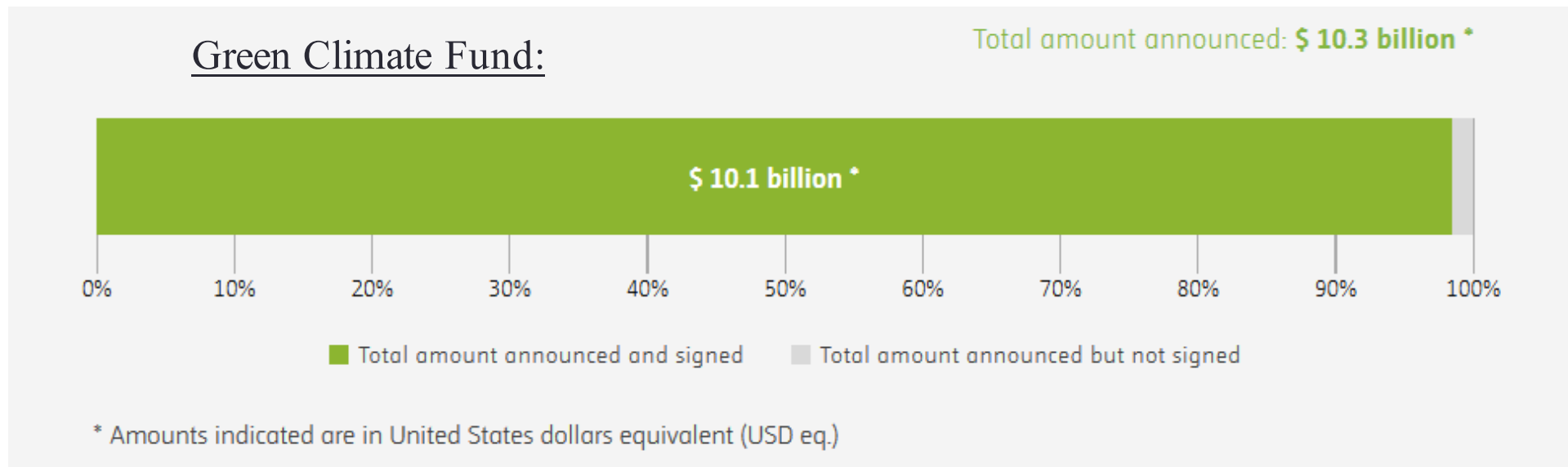
$$p_i = C'_i(q_i) \rightarrow \mathcal{T}_i(p_i)$$

- Strategic transfers:

$$\frac{\partial}{\partial p_i} \mathcal{T}_i \geq 0$$

# The Paris Agreement and the public goods game

- Prime example: climate finance
  - 100 bln USD North to South flow
  - Recipients and donors have to have an incentive to participate



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# The public goods game with transfers

3 stage game for setting up compensation fund

1. **Countries set up fund and decide on magnitude of compensation through the fund**
2. **Countries decide whether to participate**
3. **Countries decide on individual level of public good provision**

→ 2<sup>nd</sup> and 3<sup>rd</sup> stage voluntary basis (Paris setting)

→ 1<sup>st</sup> stage: collective decision

# The public goods game with transfers

## The 3rd stage

- Given from the second and first stage of the game:
  - $S$ : set of countries participating in the fund
  - $t$ : magnitude of compensation
- Payoff structure:  $\pi_i = B_i(Q) - C_i(q_i) + \mathcal{T}_i$
- Compensation fund:  $\sum_{k \in S} \mathcal{T}_k = 0$ ,  $\mathcal{T}_k = 0, k \notin S$ 
  - Multilateral payments among  $S$ ,  $\mathcal{T}_k \leq 0$

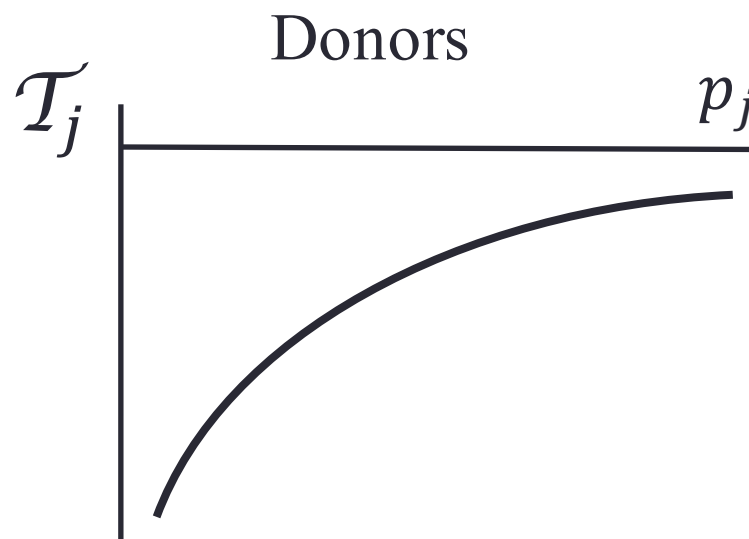
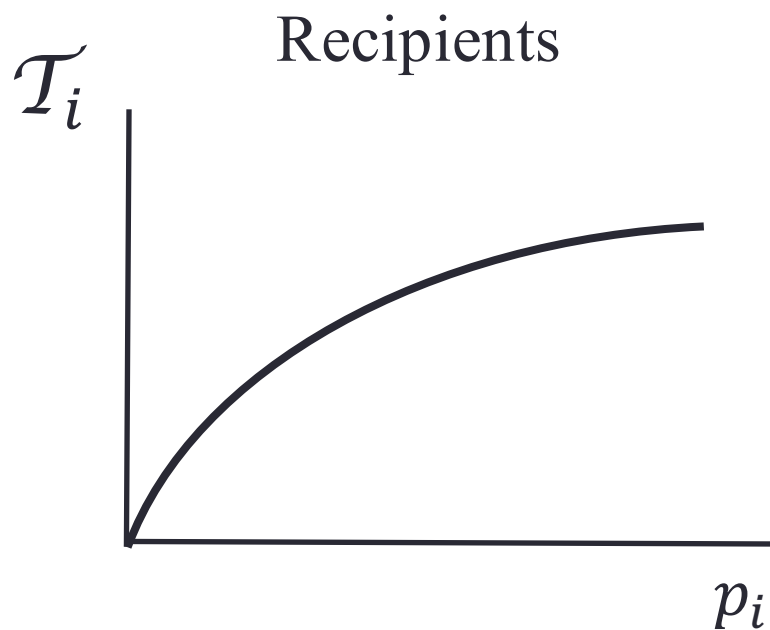
# The public goods game with transfers

## The 3rd stage

- Payoff structure:  $\pi_i = B_i(Q) - C_i(q_i) + \mathcal{T}_i(p_i, p_{-i}, t, S)$

- Strategic transfers:

$$\frac{\partial}{\partial p_i} \mathcal{T}_i \geq 0$$



# The public goods game with transfers

## The 3rd stage

- Payoff structure:  $\pi_i = B_i(Q) - C_i(q_i) + \mathcal{T}_i(p_i, p_{-i}, t, S)$

- donors pay into fund, resources fixed

- recipients receive a share of resources proportional to their

public good provision:

$$\mathcal{T}_i = \underbrace{t \sum_{j \in S} GDP_j}_{\text{Total resources in fund}} \cdot \underbrace{\frac{p_i}{\sum p_j}}_{\text{Transfers proportional to individual public good provision}}$$

Total resources in fund

Transfers proportional to individual public good provision

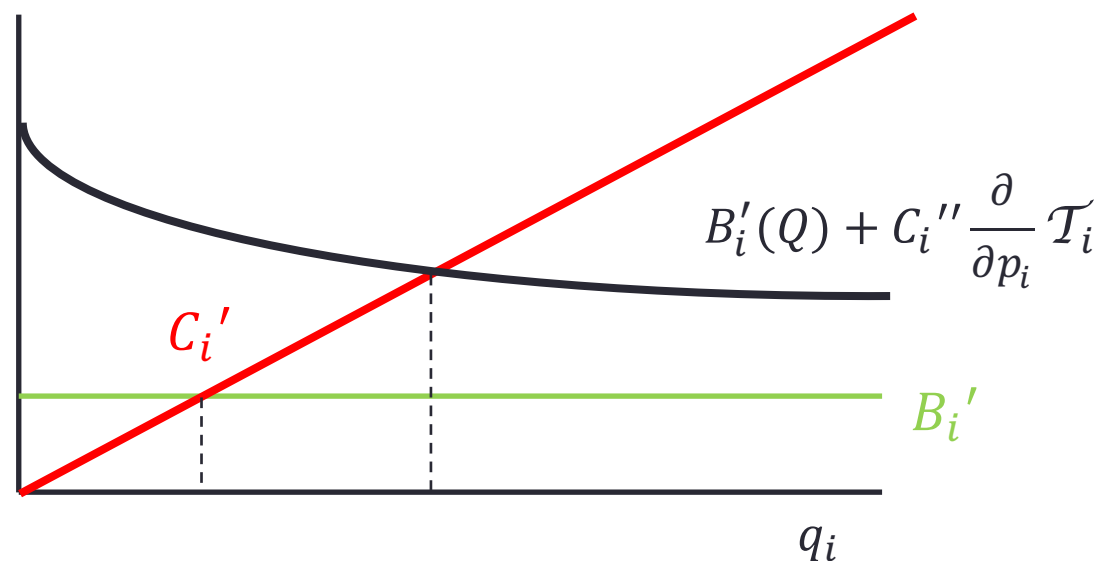
# The public goods game with transfers

## The 3rd stage

- Payoff structure:  $\pi_i = B_i(Q) - C_i(q_i) + \mathcal{T}_i(p_i, p_{-i}, t, S)$

- Strategic transfers enhance voluntary contribution to public good:

$$B_i'(Q) + C_i'' \frac{\partial}{\partial p_i} \mathcal{T}_i = C_i'(q_i)$$



# The public goods game with transfers

- Participants: provide more of the public good
- BUT: free-riding incentives
  - A country can stay out of the compensation fund: no extra payments, enjoy higher public good provision by others
- 2<sup>nd</sup> stage: studies the incentive to actually take part in fund and provide more of the good
  - We explicitly look into fragmented regimes

# The public goods game with transfers

## The 2nd stage

- Comparison of payoffs:

$$\Delta \pi_i = \pi_i(S) - \pi_i(S \setminus \{i\})$$

↑  
Payoff when  
participating

↑  
Payoff when  
free-riding

# The public goods game with transfers

## The 2nd stage

- Comparison of payoffs:

$$\Delta \pi_i = \pi_i(S) - \pi_i(S \setminus \{i\})$$

→ Take the example of a donor country: **Why would it join?**

$$\pi_i = B_i(Q) - C_i(q_i) + \mathcal{T}_i(p_i, p_{-i}, t, S)$$

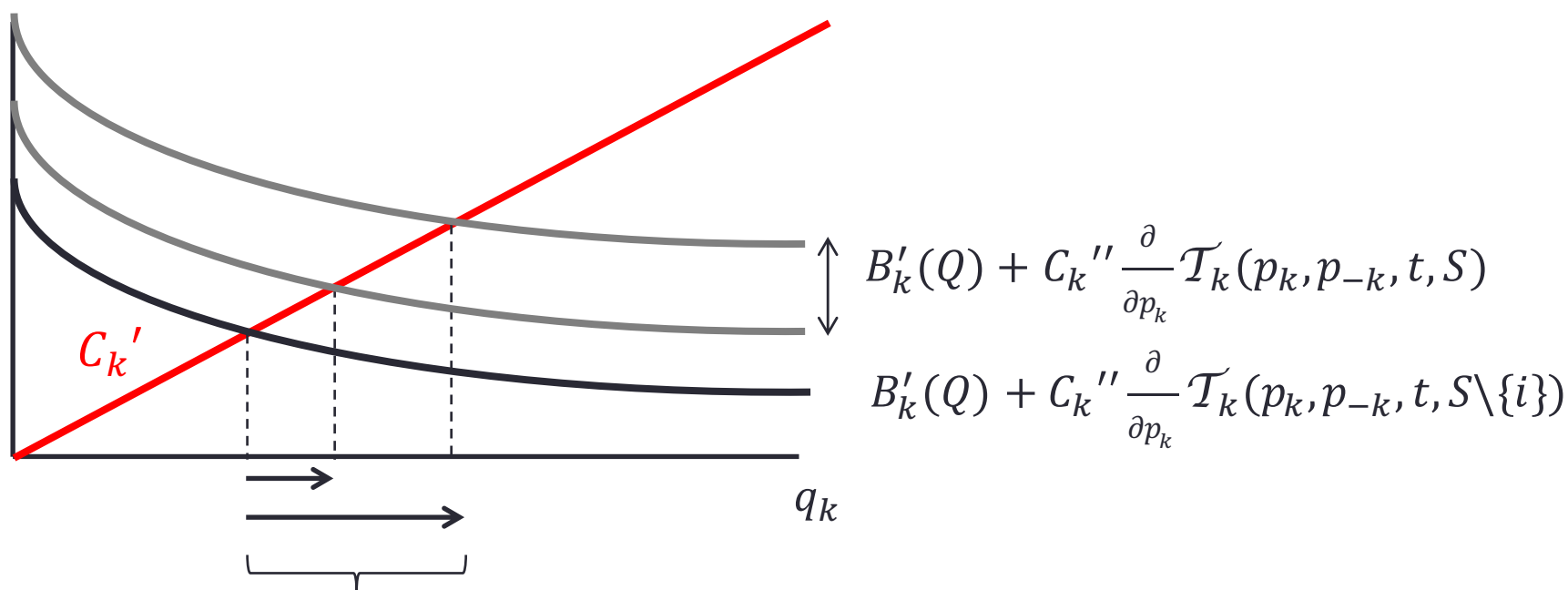
- $\mathcal{T}_i < 0$  → Transfer decrease incentive to join
- $C_i \geq C_i^{Non-coop}$  → costs increase as strategic transfers increase level of public good provision
- $B_i(Q)$  → benefits provide **only gain** for donor countries if other participants increase their level of public good provision!



# The public goods game with transfers

## The 2nd stage

- Marginal transfers:  $\frac{\partial}{\partial p_k} \mathcal{T}_k(p_k, p_{-k}, t, S)$
- Change in *marginal transfers*:



Magnitude depends on design of transfers

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# Designing strategic transfers

- Linear quadratic example:  $\pi_i = b_i Q - \frac{c_i}{2} q_i^2$
- Assumption on heterogeneity:
  - a) **Transfers from a fund of fixed size:** symmetric donors, symmetric recipients
  - b) **Transfers based on differences in prices:** full symmetry
  - c) **Transfers based on differences in costs:** full symmetry
- Results also for other heterogeneity

# Designing strategic transfers

- **Fixed magnitude**
- **Proportional to price**

Transfer  
equal  
 $\mathcal{T}_i =$

$$t \sum_{j \in S} GDP_j \cdot \frac{p_i}{\sum p_j}$$

If a  
donor  
joins

- Magnitude of compensation  $\uparrow$   
 $\rightarrow$  public good  $\uparrow$
- Recipients anticipate fixed resources have to be shared

Outcome

- Large participation
- Small additional abatement

# Designing strategic transfers

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Fixed magnitude</li> <li>• Proportional to price</li> </ul> | <ul style="list-style-type: none"> <li>• Endogenous magnitude</li> <li>• Proportional to price</li> </ul> |
|--|---|

Transfer equal  
 $\mathcal{T}_i =$

$$t \sum_{j \in S} GDP_j \cdot \frac{p_i}{\sum p_j}$$

$$t \sum_{j \in S} GDP_j \cdot \left( p_i - \frac{1}{|S|} \sum p_j \right)$$

If a donor joins

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Magnitude of compensation <math>\uparrow</math><br/><math>\rightarrow</math> public good <math>\uparrow</math></li> <li>• Recipients anticipate fixed resources have to be shared</li> </ul> | <ul style="list-style-type: none"> <li>• Magnitude of compensation <math>\uparrow</math><br/><math>\rightarrow</math> public good <math>\uparrow</math></li> <li>• Transfers increase linear, costs to larger degree</li> </ul> |
|---|---|

Outcome

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Large participation</li> <li>• Small additional abatement</li> </ul> | <ul style="list-style-type: none"> <li>• Full participation</li> <li>• Moderate additional abatement</li> </ul> |
|---|---|

# Designing strategic transfers

	<ul style="list-style-type: none"> <li>• Fixed magnitude</li> <li>• Proportional to price</li> </ul>	<ul style="list-style-type: none"> <li>• Endogenous magnitude</li> <li>• Proportional to price</li> </ul>	<ul style="list-style-type: none"> <li>• Endogenous magnitude</li> <li>• Proportional to costs</li> </ul>
Transfer equal $\mathcal{T}_i =$	$t \sum_{j \in S} GDP_j \cdot \frac{p_i}{\sum p_j}$	$t \sum_{j \in S} GDP_j \cdot \left( p_i - \frac{1}{ S } \sum p_j \right)$	$t \sum_{j \in S} GDP_j \cdot \left( C_i - \frac{1}{ S } \sum C_j \right)$
If a donor joins	<ul style="list-style-type: none"> <li>• Magnitude of compensation <math>\uparrow</math> <math>\rightarrow</math> public good <math>\uparrow</math></li> <li>• Recipients anticipate fixed resources have to be shared</li> </ul>	<ul style="list-style-type: none"> <li>• Magnitude of compensation <math>\uparrow</math> <math>\rightarrow</math> public good <math>\uparrow</math></li> <li>• Transfers increase linear, costs to larger degree</li> </ul>	<ul style="list-style-type: none"> <li>• Magnitude of compensation <math>\uparrow</math> <math>\rightarrow</math> public good <math>\uparrow</math></li> <li>• Transfers increase with costs <math>\rightarrow</math> full compensation</li> </ul>
Outcome	<ul style="list-style-type: none"> <li>• Large participation</li> <li>• Small additional abatement</li> </ul>	<ul style="list-style-type: none"> <li>• Full participation</li> <li>• Moderate additional abatement</li> </ul>	<ul style="list-style-type: none"> <li>• Full participation</li> <li>• Social optimum</li> </ul>

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# Conclusion

- Strategic transfers can implement social optimum between countries in **Paris-agreement** setting including
  1. Voluntary decision on contribution
  2. Voluntary decision on participation
- Important characteristics:
  - Transfers need to be strategic → **depend on price**
  - Transfers based on price: compensation only increases with marginal costs not total costs → moderate additional incentive to abate
  - Transfers based on costs: countries anticipate to be compensated for extra costs through **endogenous transfers**
- Ambitious targets between donors with large benefits and recipients with flat marginal costs



**Thank you for your attention!**