RFF CMCC European Institute on Economics and the Environment

POLITECNICO MILANO 1863

Identifying characteristics of effective geoengineering coalitions

Pietro Andreoni

RFF, 09/03/2025

This work has received funding from the LAD climate fund and from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 870245 GEOCEP.

Introduction

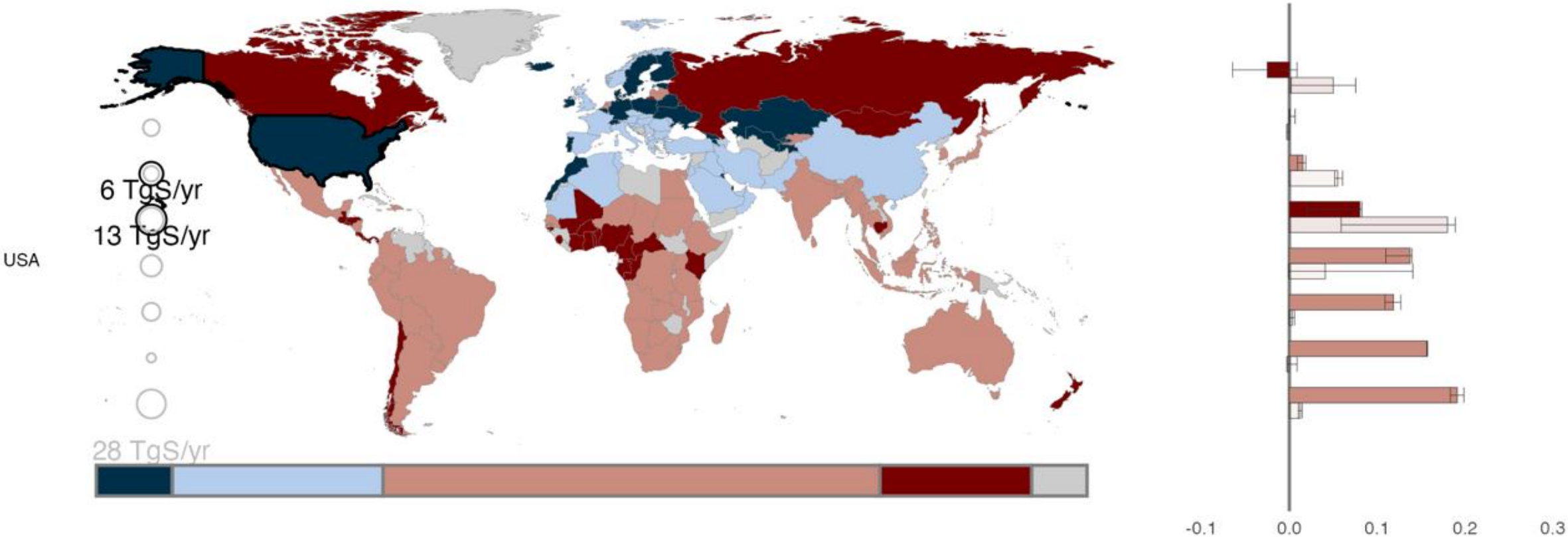
- For Stratospheric Aerosol Injection (**SAI**), not only how much, but also *where*, matters:
  - Injection in the northern hemisphere will cool more the north (and viceversa).
  - Injection in the northern hemisphere will increase precipitation in the southern tropics (and viceversa).

Introduction

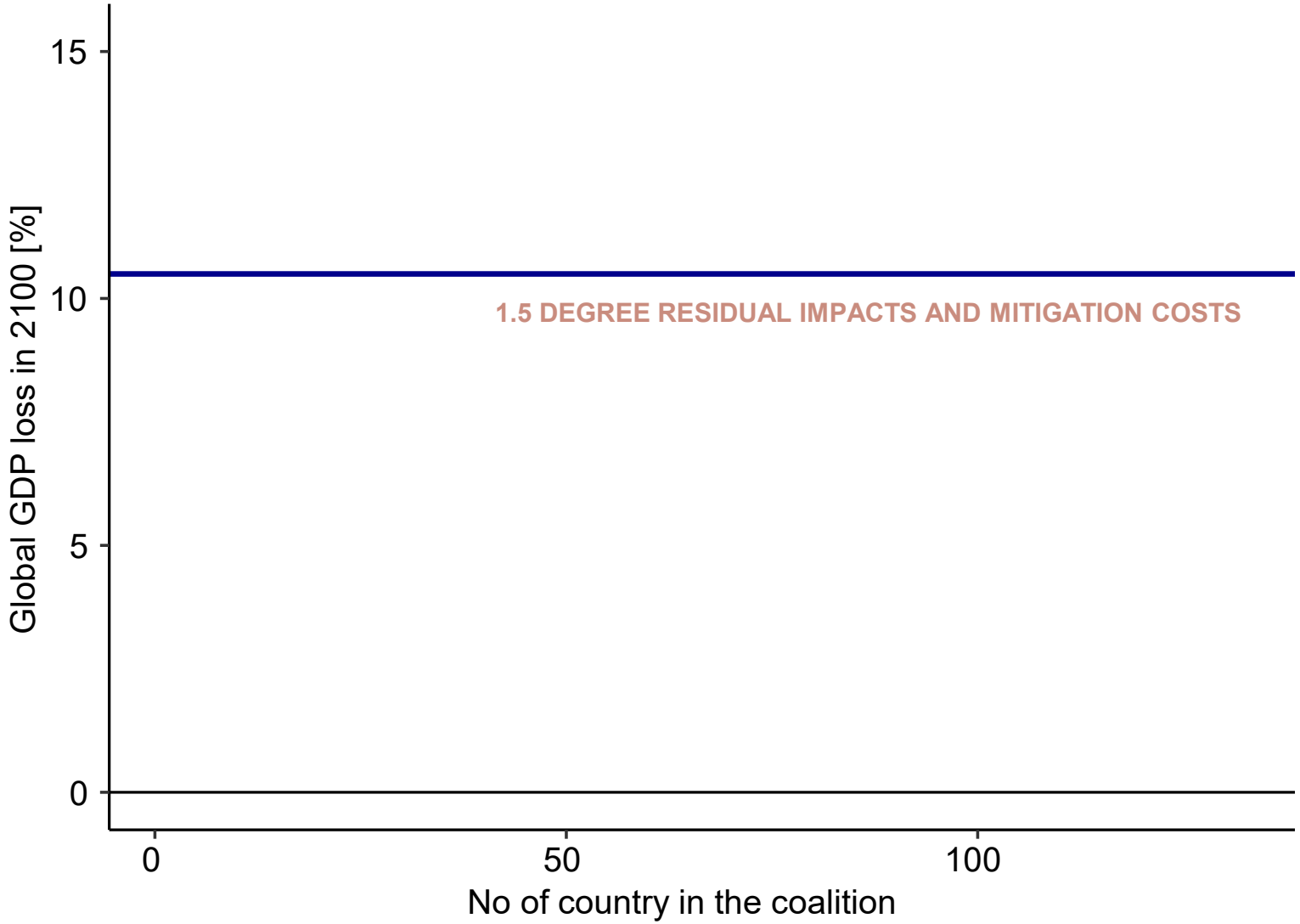
- In previous work (under review), we find that the **injection strategies** of countries acting unilaterally differ dramatically from a perfectly cooperative world.

Introduction

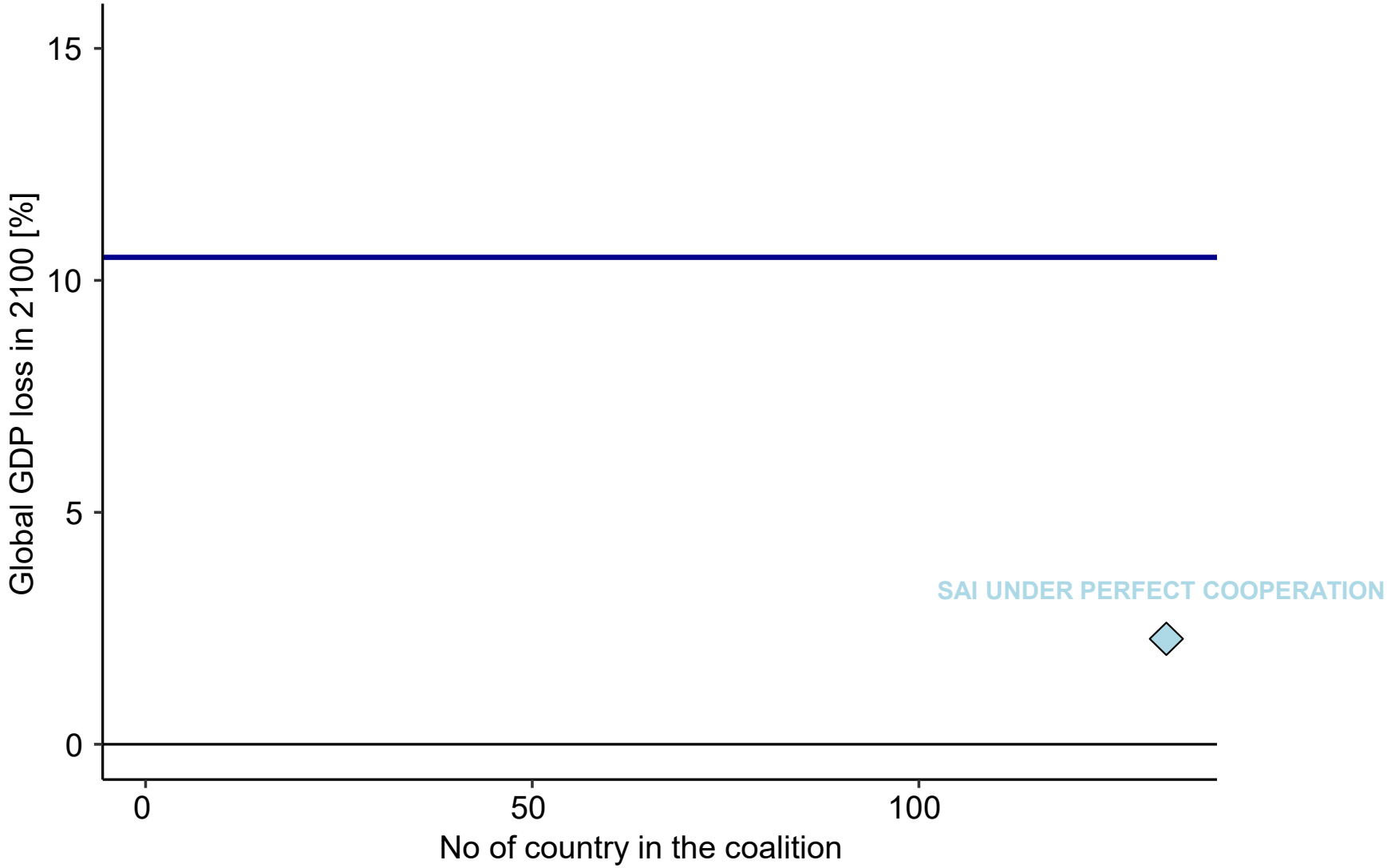
- In particular, single hemisphere injection (especially in the north) causes large adverse welfare impacts.



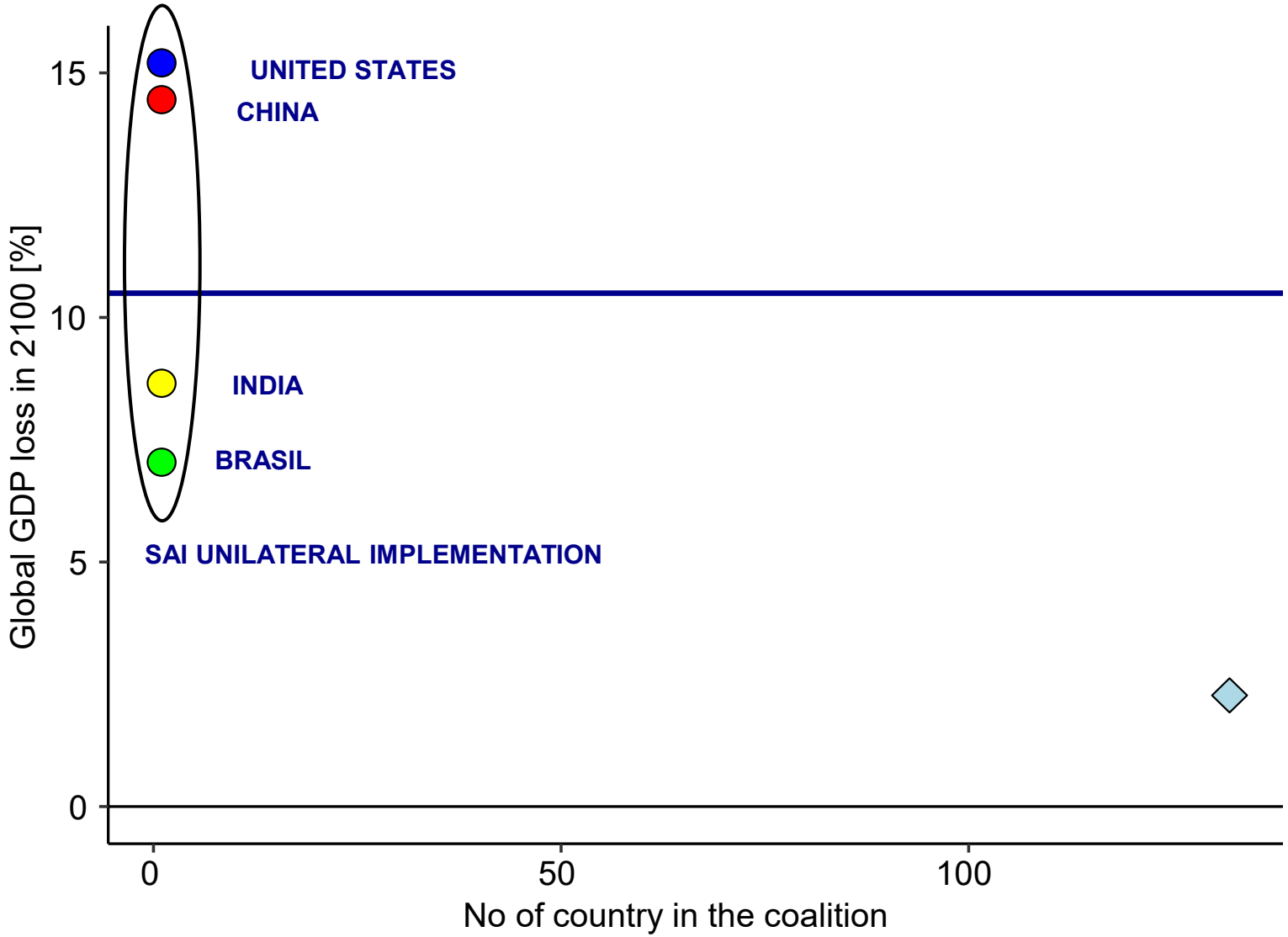
Motivation


15
10
5
0
Global GDP loss in 2100 [%]
1.5 DEGREE RESIDUAL IMPACTS AND MITIGATION COSTS
0
50
100
No of country in the coalition

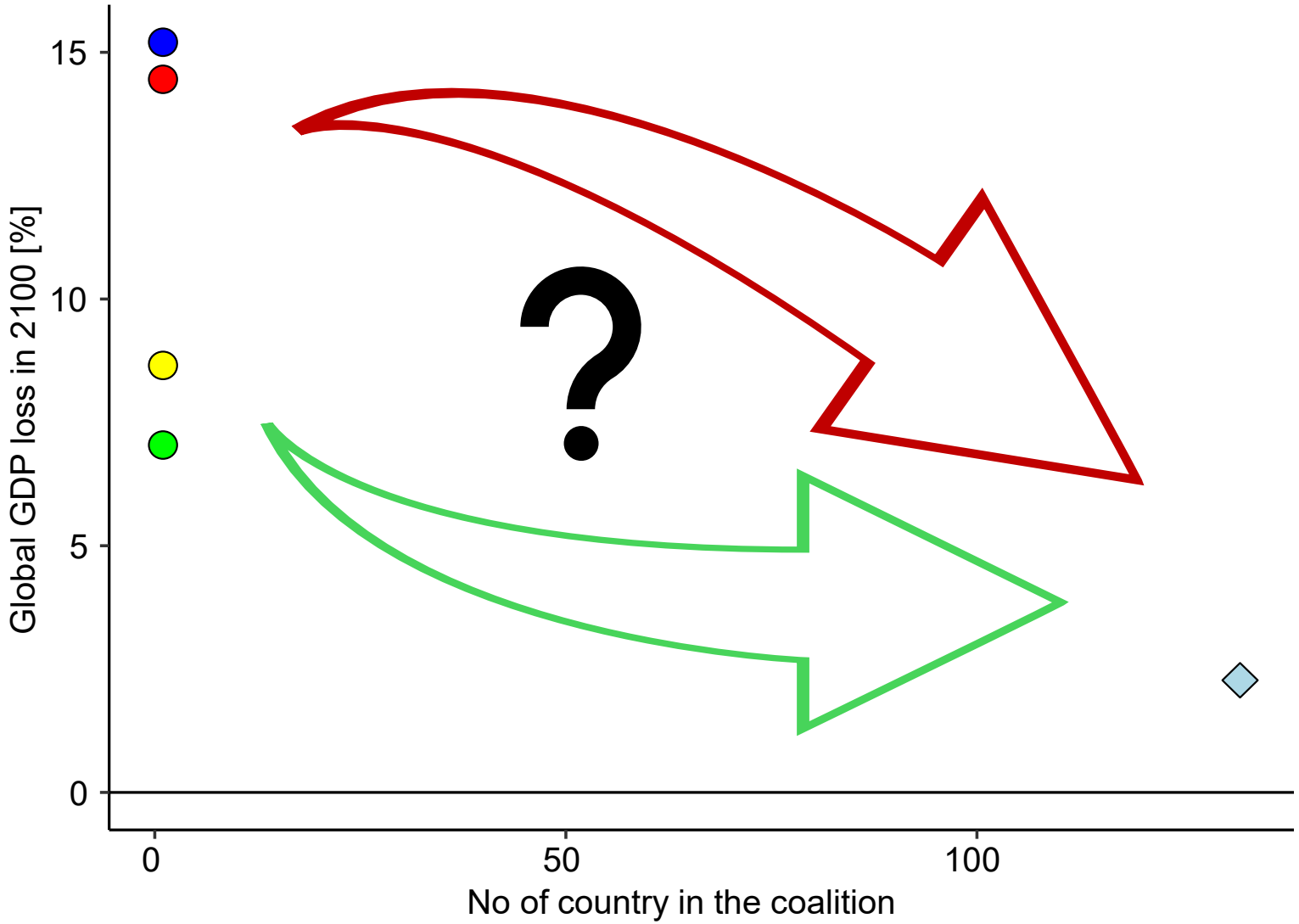
Motivation


15
10
5
0
Global GDP loss in 2100 [%]
SAI UNDER PERFECT COOPERATION
0
50
100
No of country in the coalition

Motivation


UNITED STATES
CHINA
INDIA
BRASIL
SAI UNILATERAL IMPLEMENTATION
Global GDP loss in 2100 [%]
15
10
5
0
0
50
100
No of country in the coalition

Motivation


15
10
5
0
Global GDP loss in 2100 [%]
?
0
50
100
No of country in the coalition

Methods

- **Cost-benefit climate economic model** (RICE50+):
  - 155 countries/regions
  - Empirically calibrated temperature and precipitation economic impacts
  - Emulator of multi-latitude SAI injection

Methods

- Cost-benefit climate economic model.

- **Montecarlo analysis of possible small coalitions** (~1000):
  - Max 5 countries, sampled to provide representation of the possibility space over several variables of interest.
  - Three possible injection rules: free, symmetric, sovereign.
  - IN PROGRESS: filter for stable coalitions

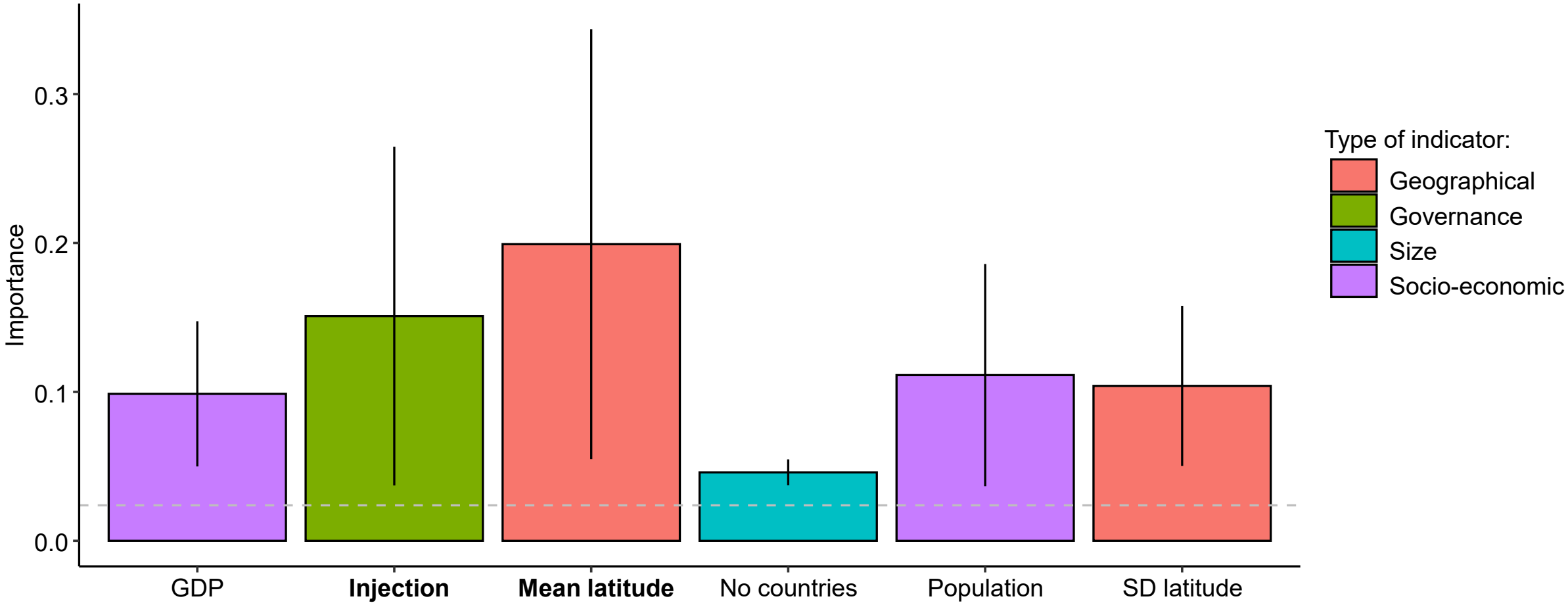
Methods

- Cost-benefit climate economic model.
- Montecarlo analysis of possible small coalitions.

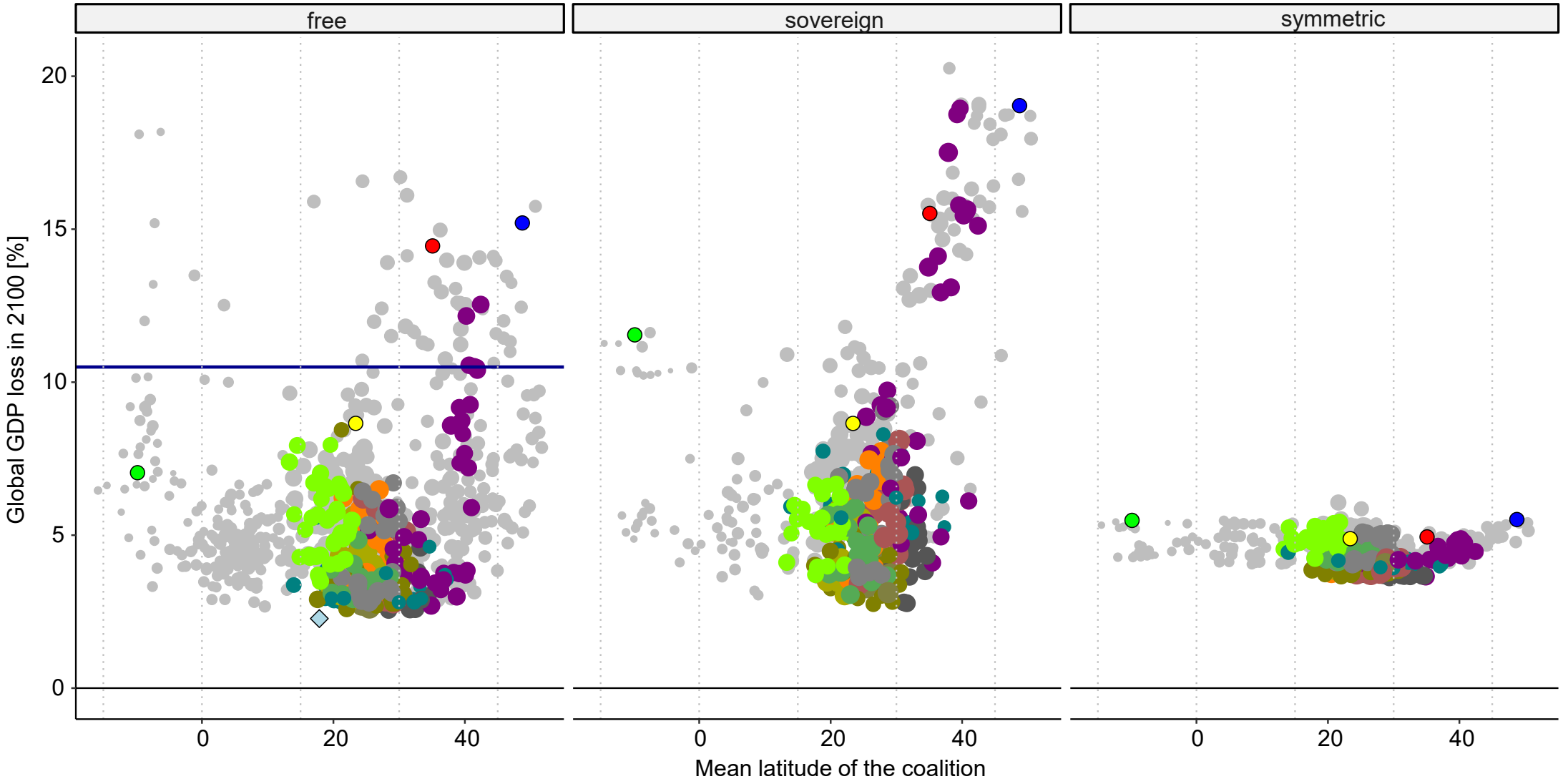
- **Global Sensitivity Analysis Indices Using Optimal Transport** (Chiani et al, 2024):

  - What are the most important charateristics that define a globally desirable coalition?

Results


Importance
0.3
0.2
0.1
0.0
GDP
Injection
Mean latitude
No countries
Population
SD latitude
Type of indicator:
Geographical
Governance
Size
Socio-economic

Results


free
sovereign
symmetric
Global GDP loss in 2100 [%]
20
15
10
5
0
0
20
40
Mean latitude of the coalition

Results

- The «center of population» of the coalition is important because coalitions skewed to the global north (or south) tend to inject only in one hemisphere, causing large damages on the opposite.

- The injection strategy is important because, if symmetric injection is forced, only difference is the quantity injected, which reduces risk.

Preliminary conclusions

- «Geographically balanced» coalitions are conductive to desirable SAI outcomes.

- Small (or very small) coalitions exist that produce outcome similar to the «idealized» solution.

- Forcing a symmetric injection strategy significantly decreases SAI risk stemming from imperfect governance.

- Are these desirable coalitions also stable? Likely **efficiency-stability** trade-off

Thank you!

This work has received funding from the LAD climate fund and from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 870245 GEOCEP.