A methodology to investigate the diversity of socio-economic pathways with similar outcomes

Céline Guivarch
guivarch@centre-cired.fr
with Julie Rozenberg (World Bank and Cired)
and Vanessa Schweizer (University of Waterloo)

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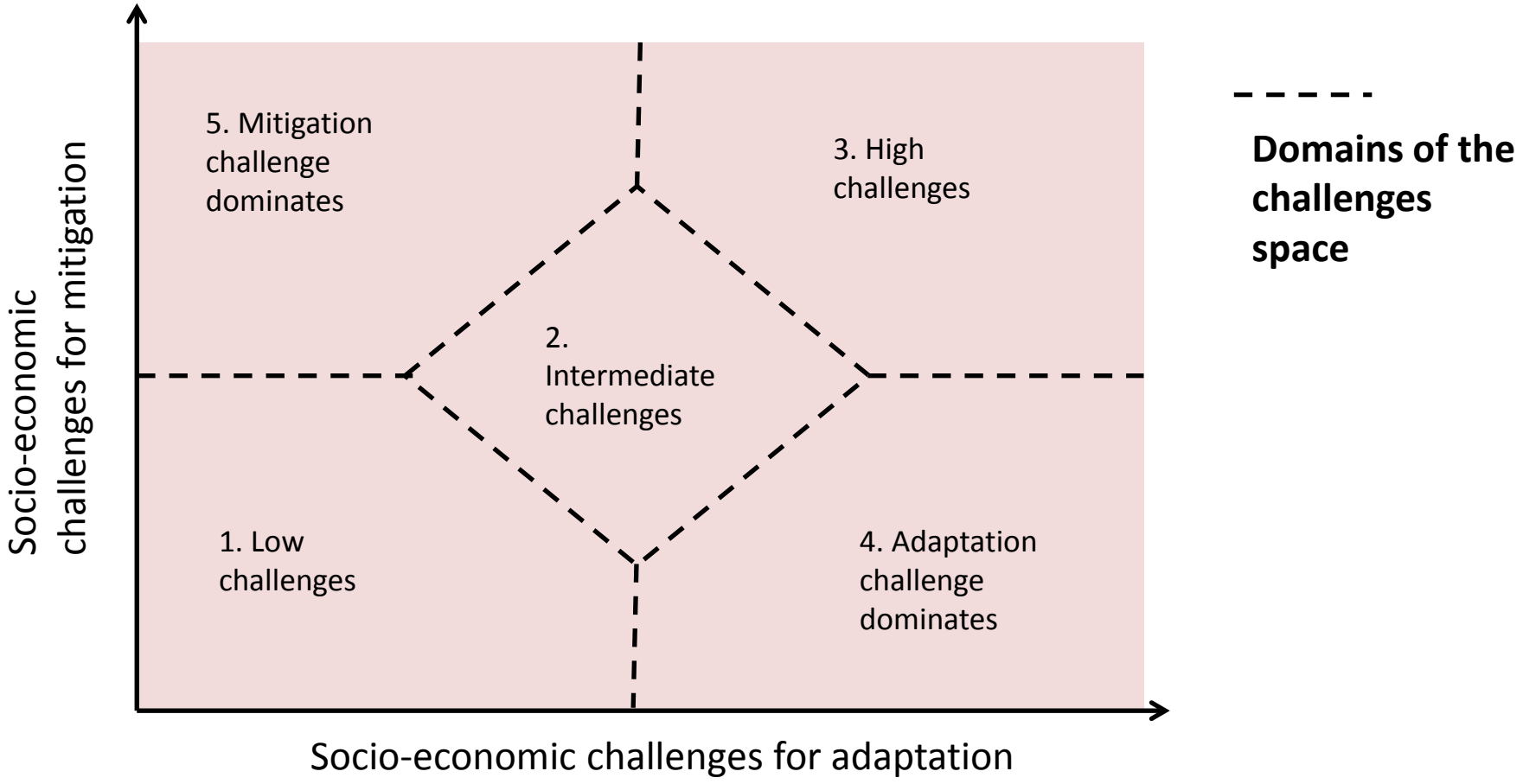
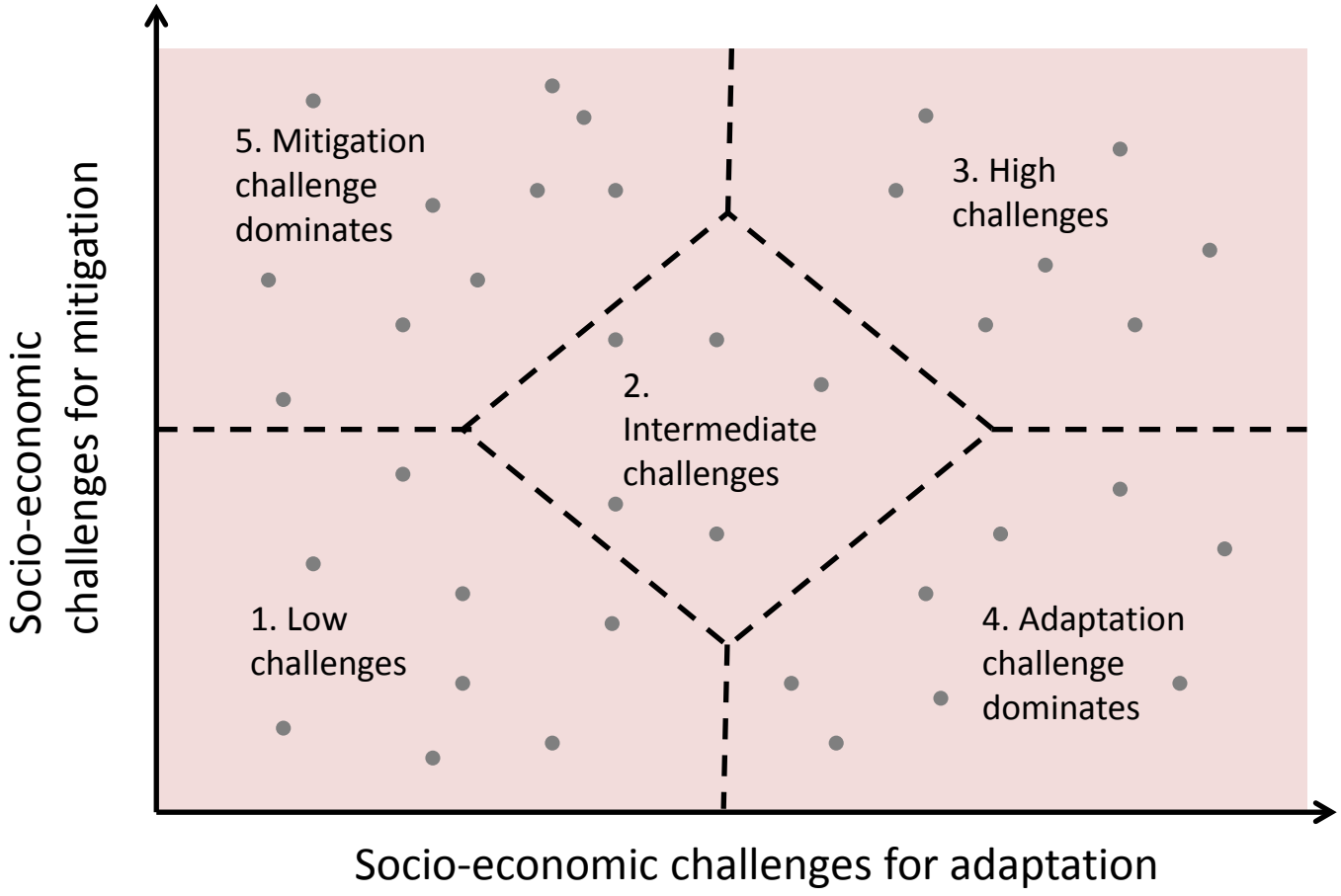
Motivation


Socio-economic challenges for mitigation
Scenarios to explore the « uncertainty space », the « challenges space»
Socio-economic challenges for adaptation

Motivation


5. Mitigation challenge dominates
3. High challenges
2. Intermediate challenges
1. Low challenges
4. Adaptation challenge dominates
Socio-economic challenges for mitigation
Socio-economic challenges for adaptation
Domains of the challenges space

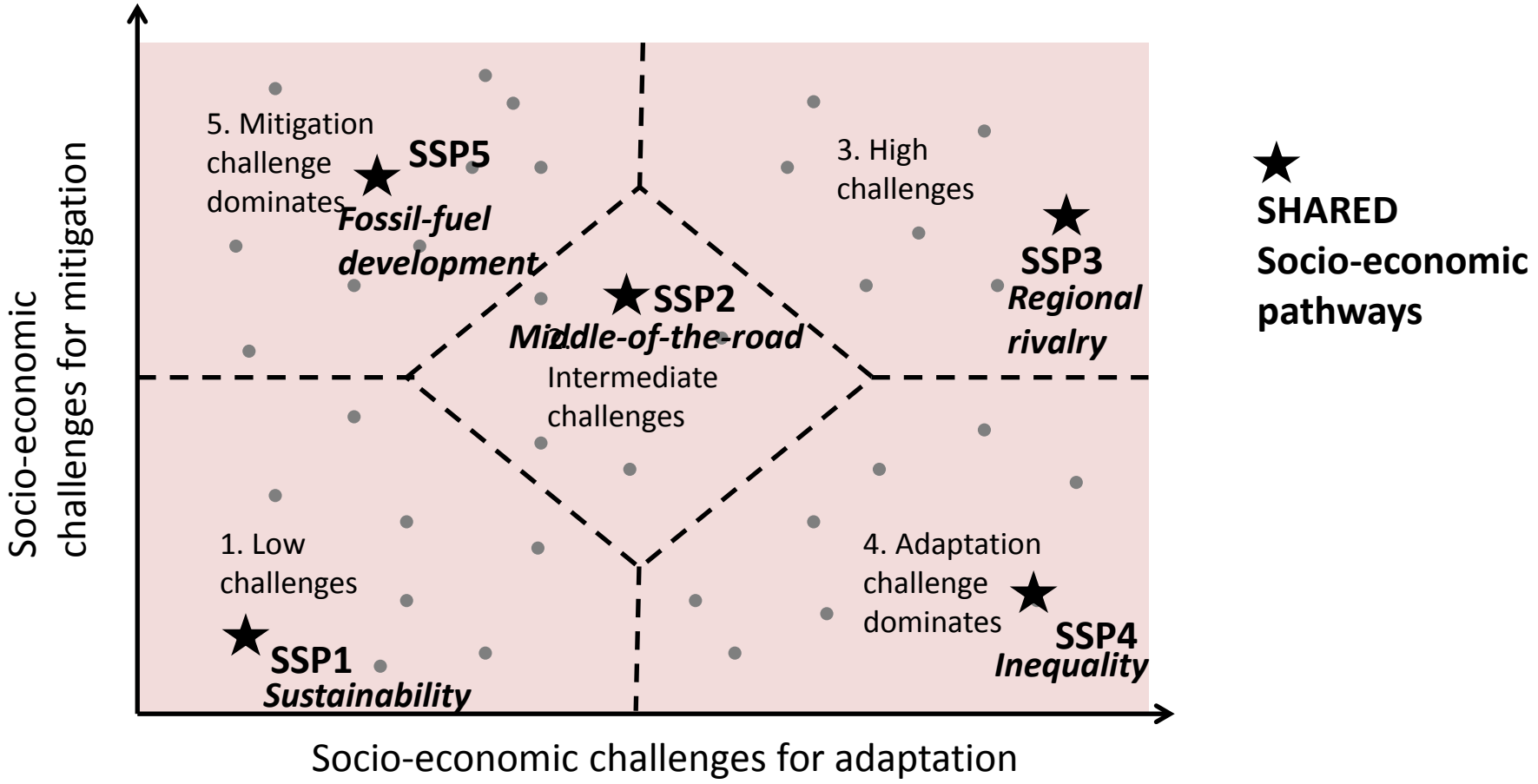
Motivation



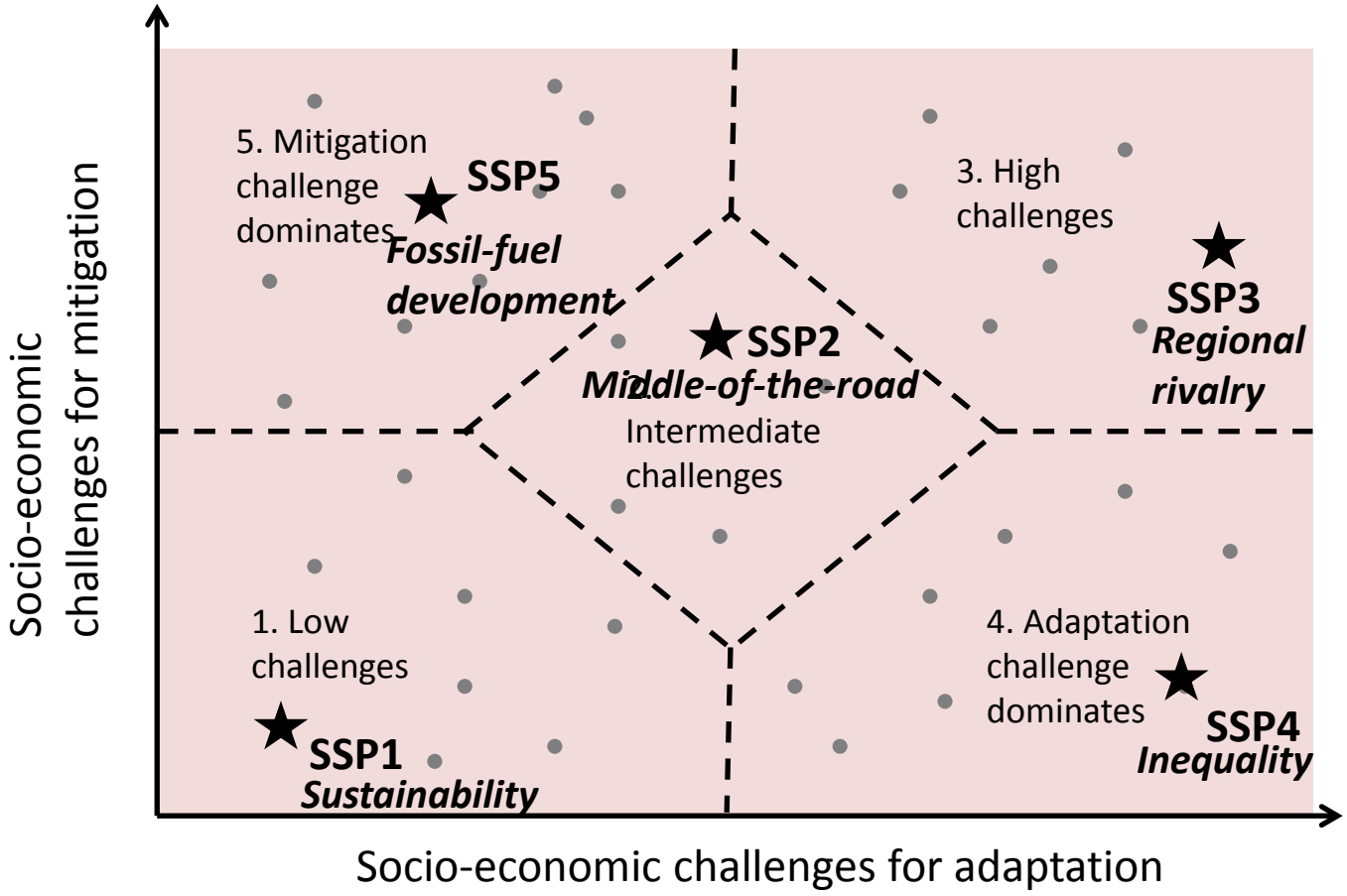
Socio-economic Pathways

→ Located in the space according to their « **outcomes** », or results

Motivation


Socio-economic challenges for mitigation
5. Mitigation challenge dominates
SSP5
Fossil-fuel development
3. High challenges
SSP3
Regional rivalry
SSP2
Middle-of-the-road
Intermediate challenges
1. Low challenges
SSP1
Sustainability
4. Adaptation challenge dominates
SSP4
Inequality
Socio-economic challenges for adaptation
SHARED Socio-economic pathways

Motivation



★ **SHARED Socio-economic pathways**

Uncertainty in the scenario drivers leading to a specific outcome

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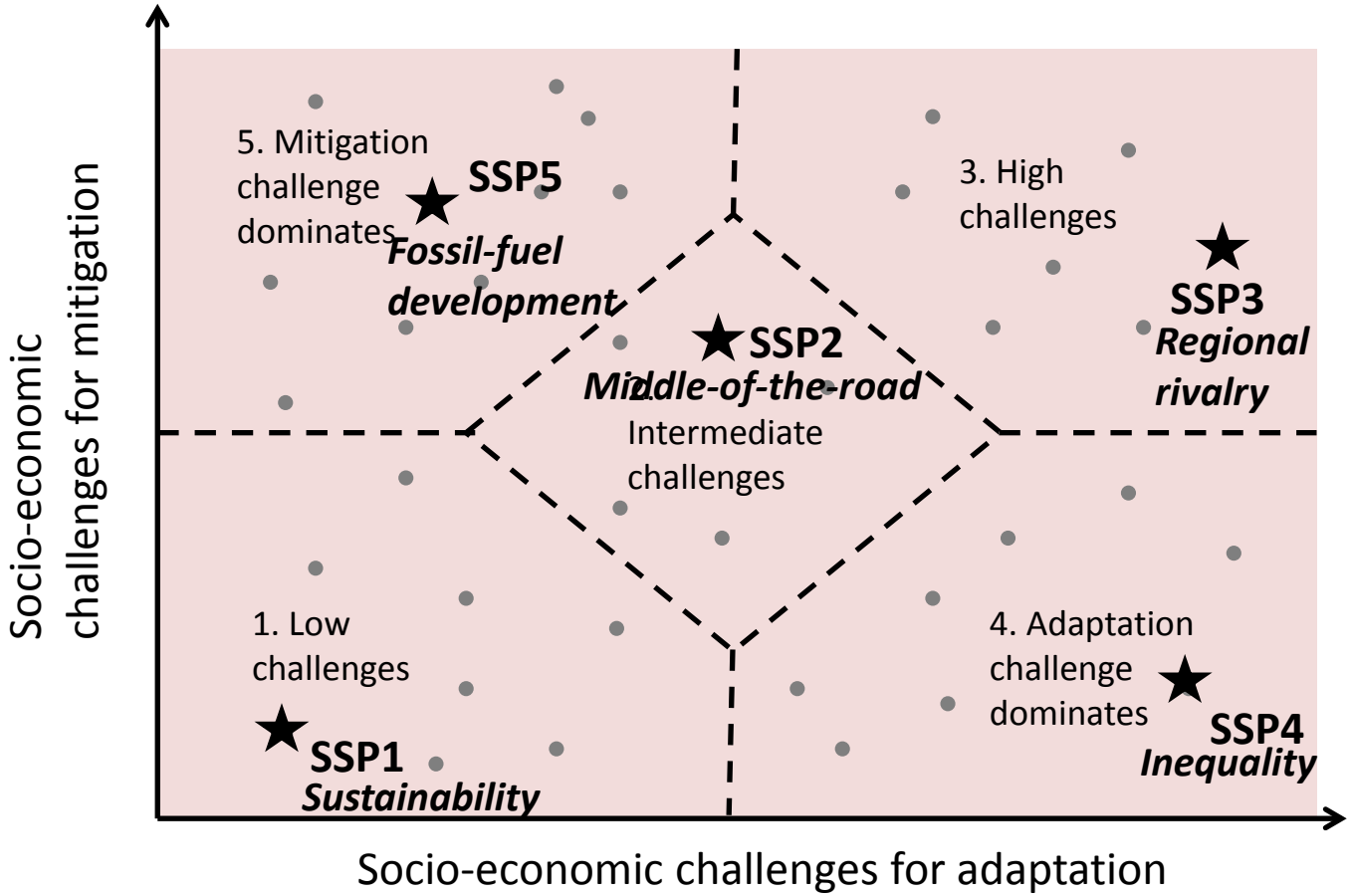


★ **SHARED Socio-economic pathways**

Uncertainty in the scenario drivers leading to a specific outcome

- Systematically **investigate the diversity of socio-economic pathways**
  - that can be located within a particular domain of the challenges space
  - (more broadly) with similar outcomes

Methods

3 steps:

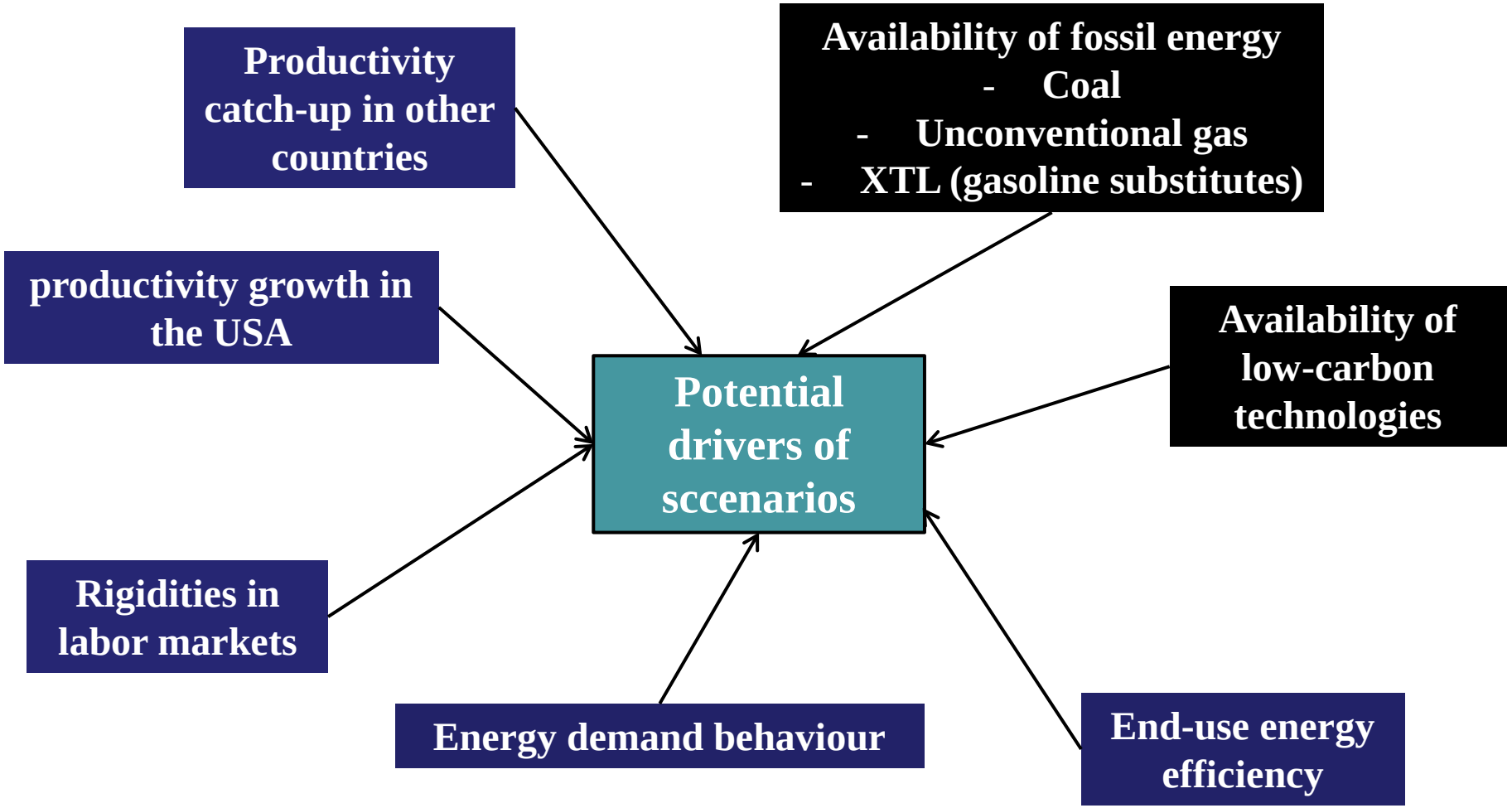
1. Identify *a priori* the **main driving forces** (or main uncertainties) affecting the system's future outcomes, e.g. population growth or fossil fuel reserves.

2. Translate these driving forces into parameters for a model of the system studied, and combine these parameters to build **a large number of model runs**.

   →systematically explore the implications of different combinations of drivers.

A large number of model runs to explore socio-economic uncertainties

Combining alternative assumptions on a large number of ***Imaclim-R*** parameters



A large number of model runs to explore socio-economic uncertainties

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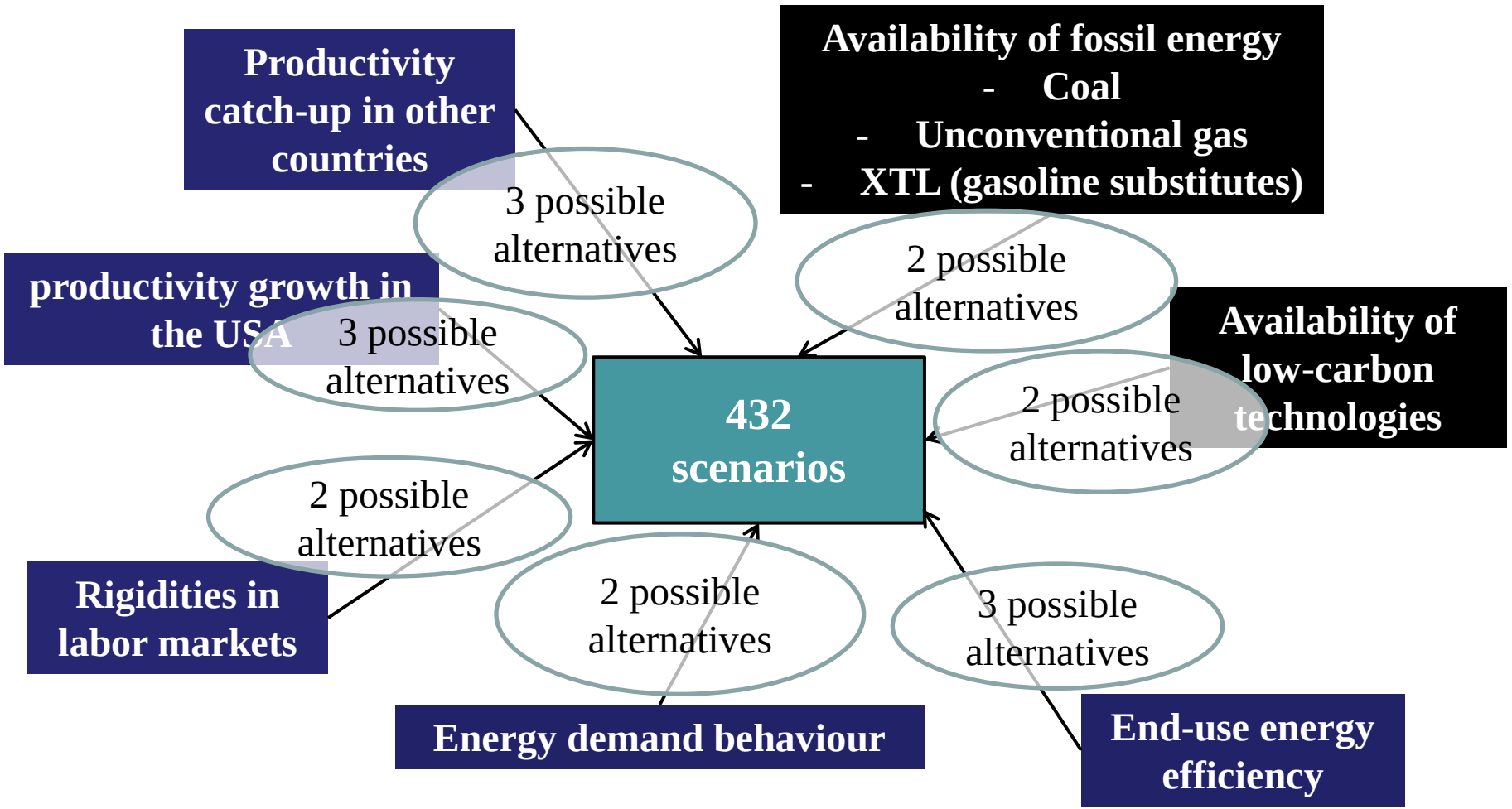

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   →systematically explore the implications of different combinations of drivers.

3. Select a subset of scenario **outcomes of interest**, and iterate a ***"scenario discovery" cluster analysis*** to identify the **diversity of combinations of drivers** that lead to the selected subset of scenario outcomes.

Scenario discovery cluster analysis

- Statistical algorithms applied to databases of simulation model results to **characterize the combinations of uncertain input parameter** values (or “drivers”) most predictive of specified classes of results (Lempert et al. 2003).
- **Iteration** to identify the **diversity** of combinations of drivers.

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- Demonstration with an application on scenarios with high cumulative CO_2 emissions
  - Damages for climate change impacts and capacities to adapt will (also) depend on future socio-economic worlds.
  - ➢ Explore what a high emissions/high temperature change world would look like in socio-economic terms.

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  - Damages for climate change impacts and capacities to adapt will (also) depend on future socio-economic worlds.
  - ➢ Explore what a high emissions/high temperature change world would look like in socio-economic terms.
  - A few archetypes of high emissions worlds in the literature, e.g. RCP 8.5 and SRES A2 and A1F, but there remains a relatively small number of such high emissions scenarios.
  - ➢ Systematically study the diversity of socio-economic conditions that could lead to high emissions.

1. Define outcome of interest

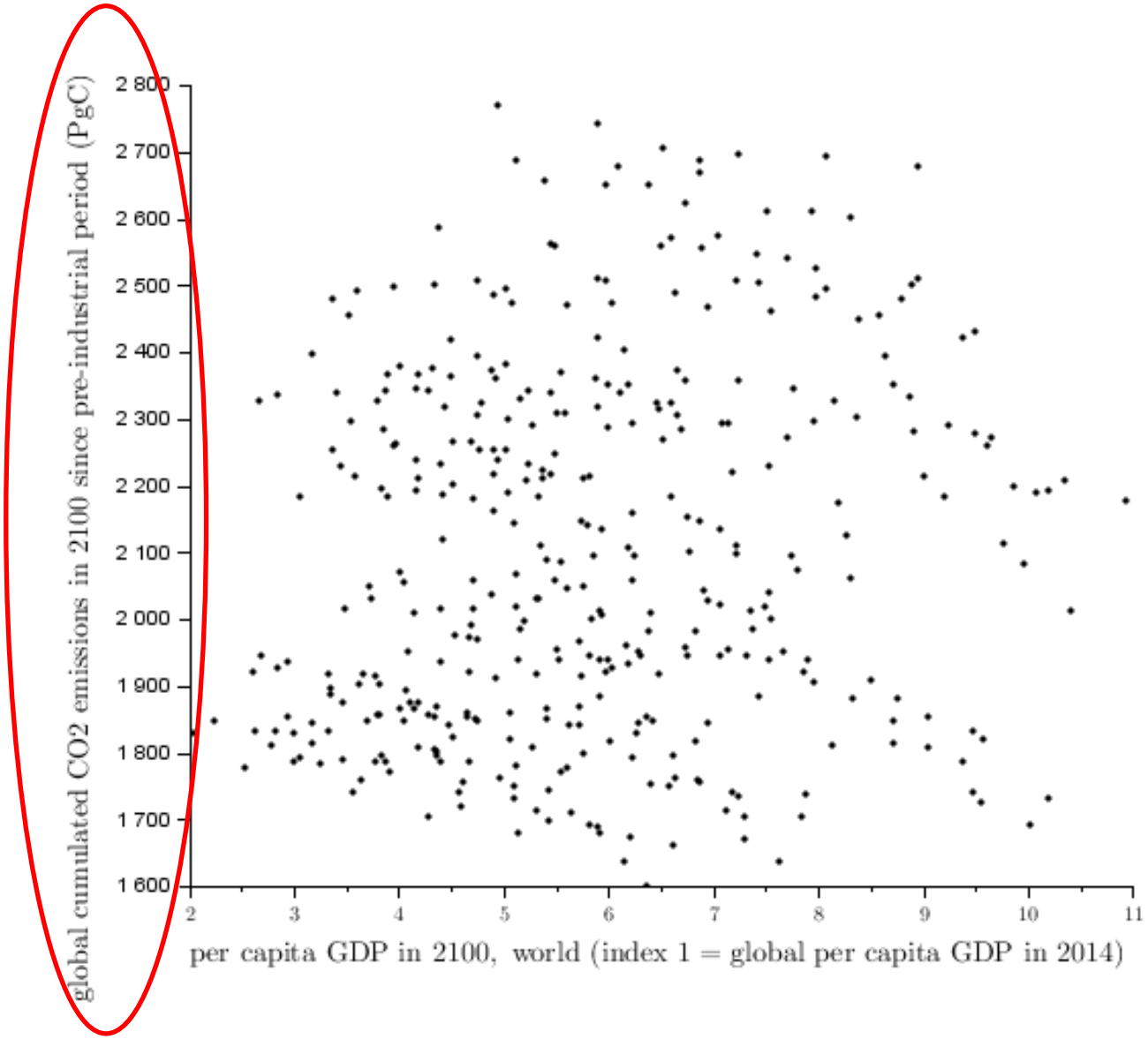
2. Define subset of scenarios of interest as the scenarios that lead to outcome of interest

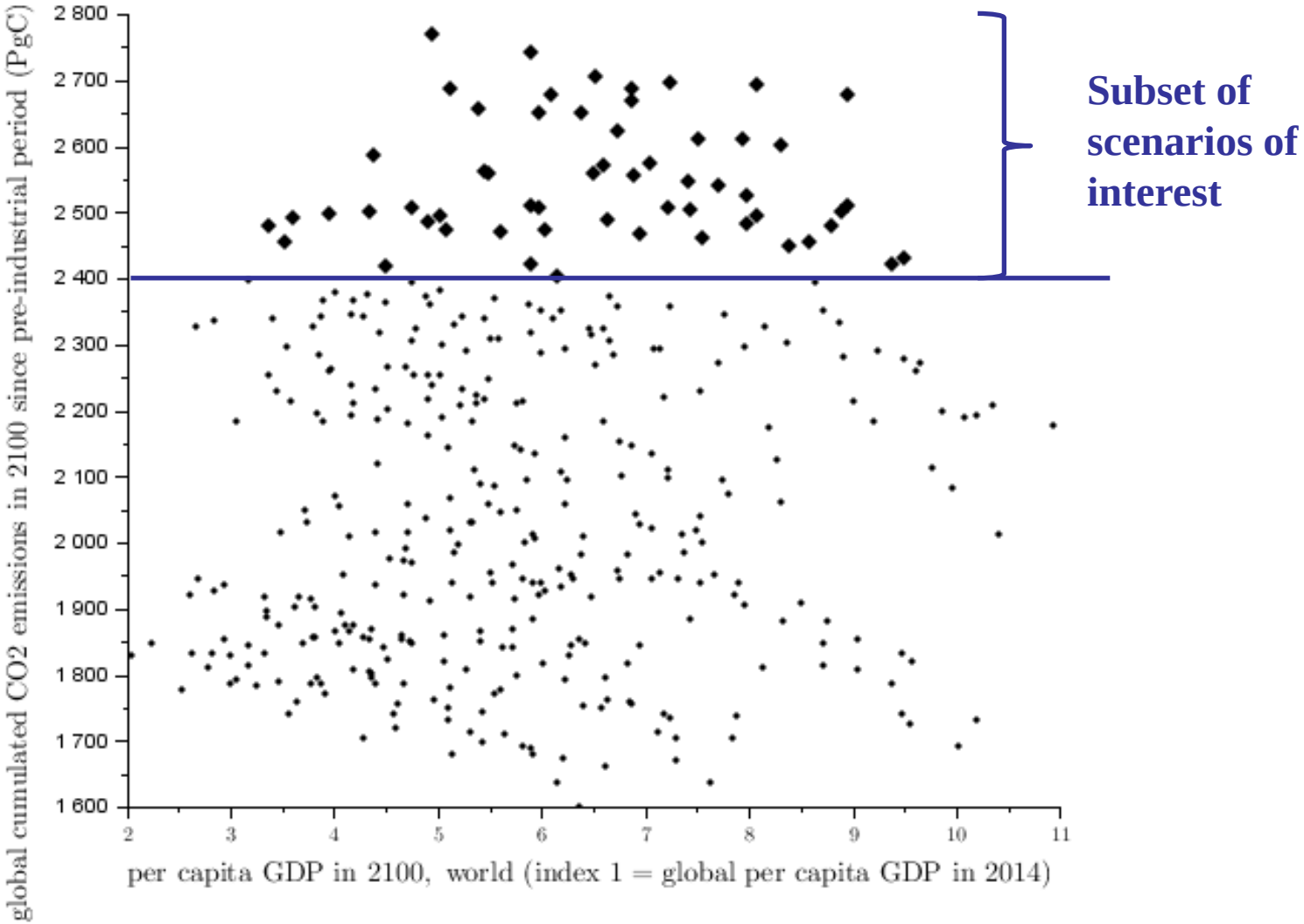
- Global cumulated CO_2 emissions in 2100 since pre-industrial period above a threshold

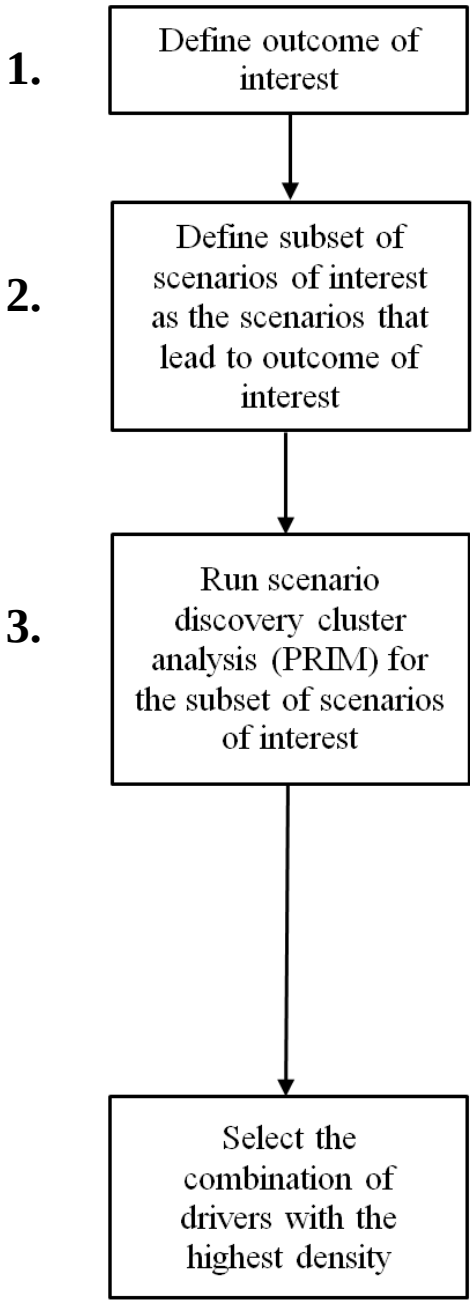
- The scenarios that lead to cumulative CO_2 emissions since the pre-industrial period above 2400 GtC.

→about as likely as not to exceed 4°C by 2100

Outcome of interest




global cumulated CO2 emissions in 2100 since pre-industrial period (PgC)
2 800
2 700
2 600
2 500
2 400
2 300
2 200
2 100
2 000
1 900
1 800
1 700
1 600
2
3
4
5
6
7
8
9
10
11
per capita GDP in 2100, world (index 1 = global per capita GDP in 2014)
Subset of scenarios of interest

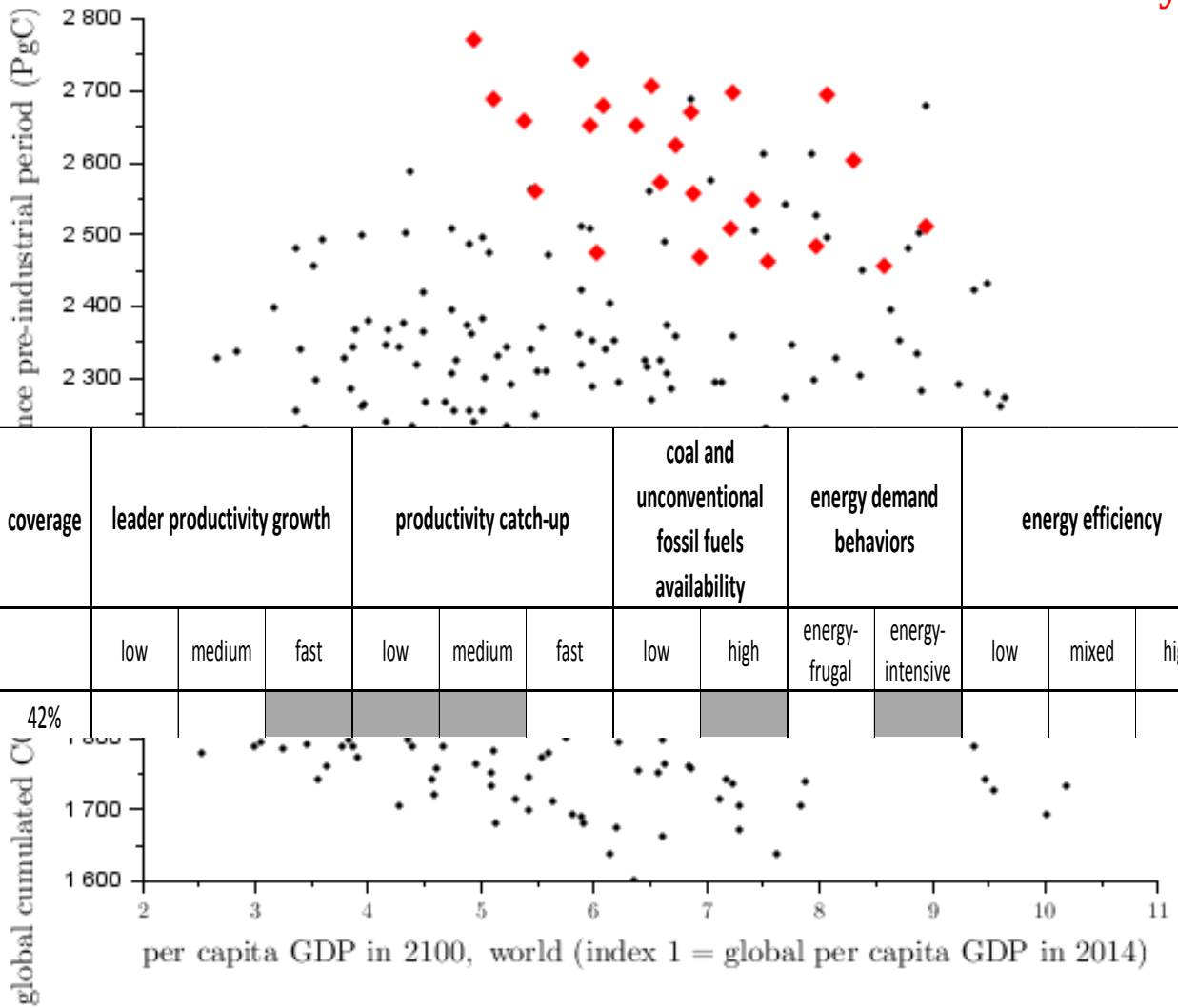


PRIM algorithm implementation:
sdtoolkit 2.3 with R 3.2.2

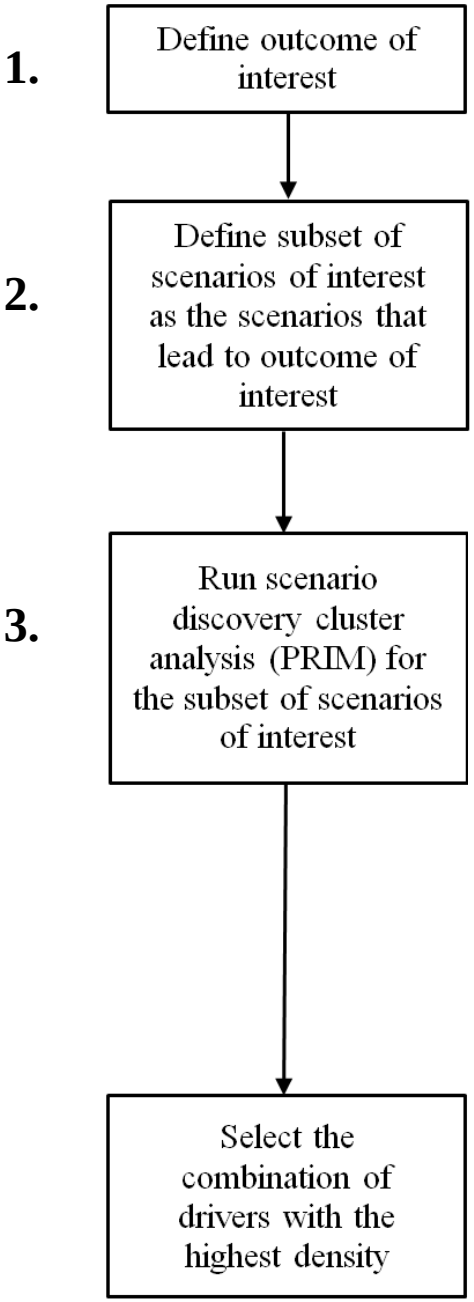
PRIM identifies several combinations of drivers and their:

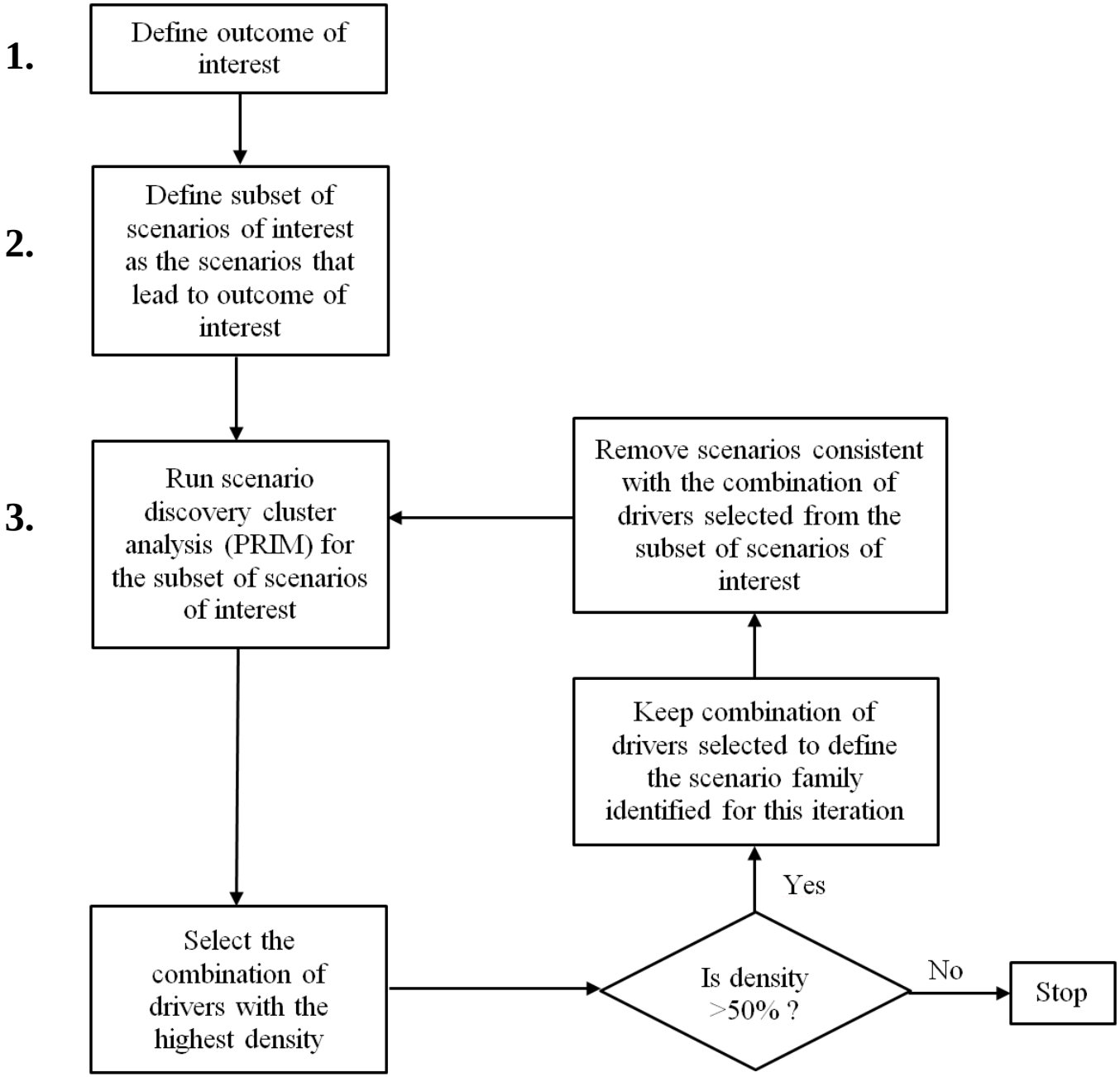
- **Density**: fraction of all scenarios characterized by the combination of drivers identified that are in the subset of scenarios of interest.
- **Coverage**: fraction of scenarios in the subset of scenarios of interest that are also characterized by the combination of drivers identified.

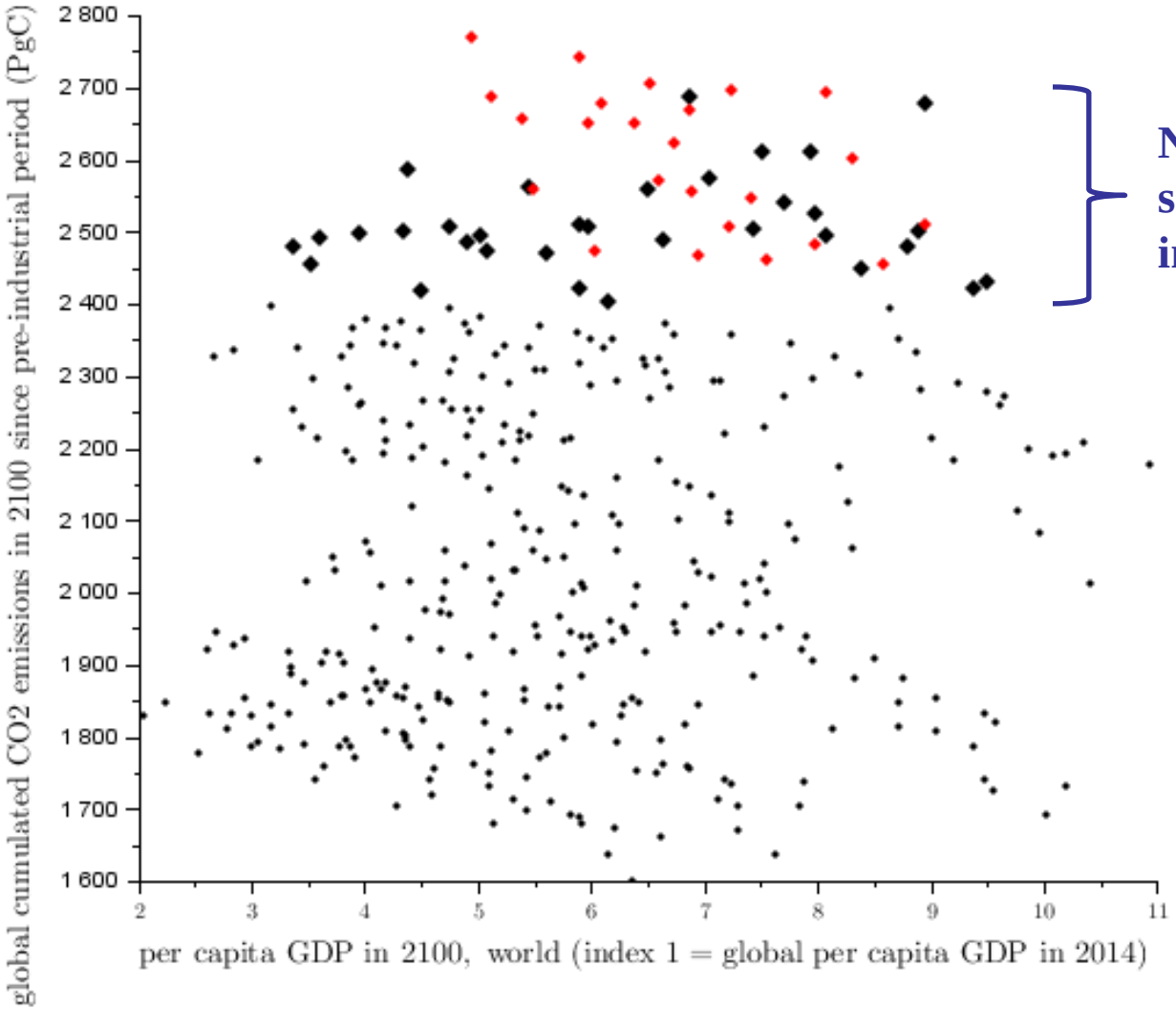
family 1



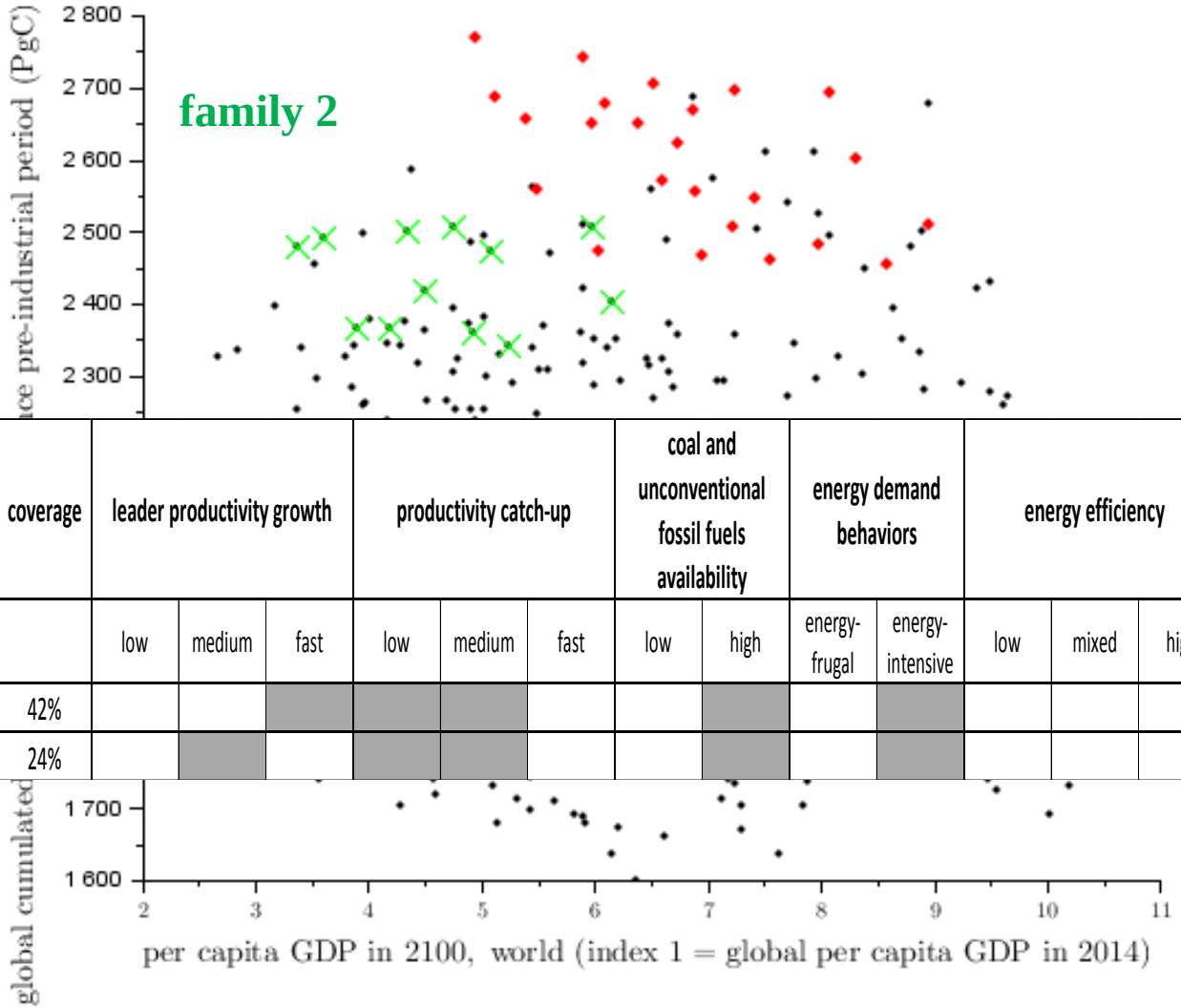
High cumulative emissions scenarios	density	coverage	leader productivity growth			productivity catch-up			coal and unconventional fossil fuels availability		energy demand behaviors		energy efficiency			availability of low-carbon technologies		rigidities in labor markets	
PRIM clusters			low	medium	fast	low	medium	fast	low	high	energy-frugal	energy-intensive	low	mixed	high	low	high	low	high
1	100%	42%																	


1.
Define outcome of interest
2.
Define subset of scenarios of interest as the scenarios that lead to outcome of interest
3.
Run scenario discovery cluster analysis (PRIM) for the subset of scenarios of interest
Select the combination of drivers with the highest density


1.
Define outcome of interest
2.
Define subset of scenarios of interest as the scenarios that lead to outcome of interest
3.
Run scenario discovery cluster analysis (PRIM) for the subset of scenarios of interest
Remove scenarios consistent with the combination of drivers selected from the subset of scenarios of interest
Keep combination of drivers selected to define the scenario family identified for this iteration
Yes
Select the combination of drivers with the highest density
Is density >50% ?
No
Stop



New subset of scenarios of interest



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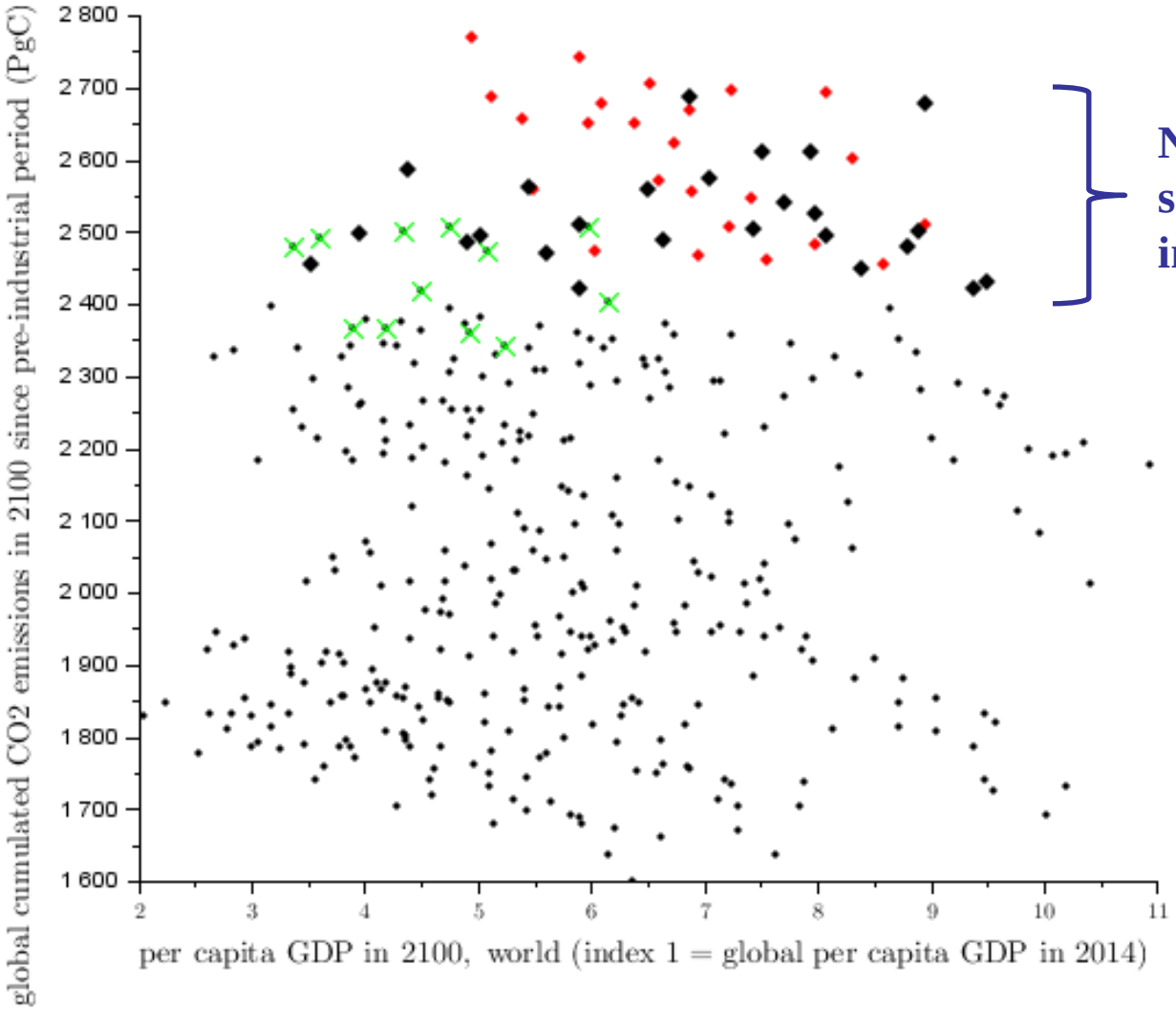

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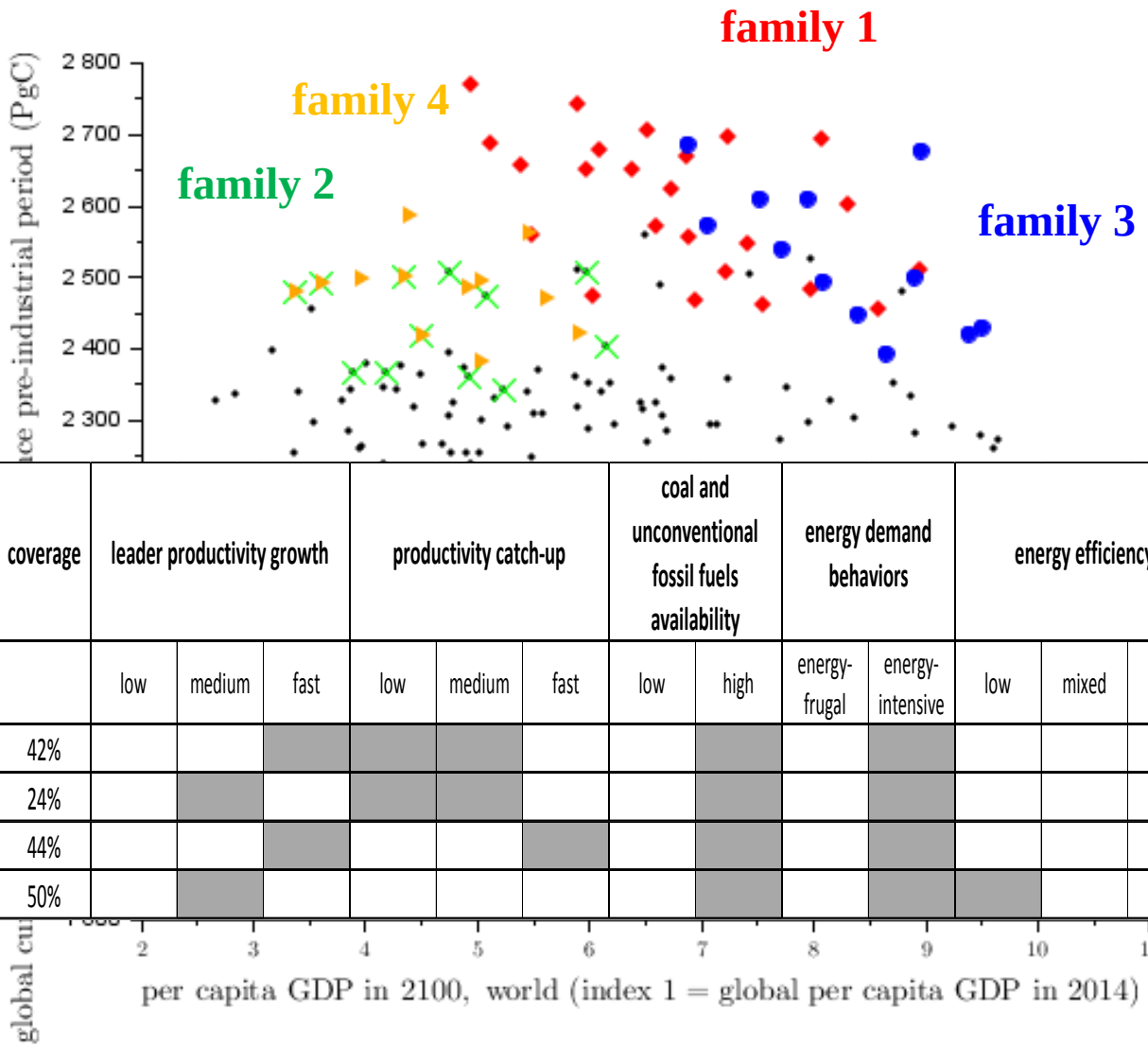

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1	100%	42%			■	■	■			■		■							
2	67%	24%		■		■	■			■		■				■			
3	92%	44%			■			■		■		■							
4	58%	50%		■						■		■	■						

Conclusions (1)

- **High emissions scenarios are not necessarily associated with high per capita GDP growth**,
- but can be associated with relatively low per capita GDP growth, if counterbalanced by high population growth and/or slow energy intensity improvement.
  - **Implications for financing capacities** for mitigation actions, and **for vulnerability**, impacts and adaptation.
  - A high emissions world without high per capita GDP poses larger challenges for financing capacities than a high emissions world associated with high per capita GDP.

Conclusions (2)

- Even though a large ensemble of scenarios is created through this approach, only a portion of the full uncertainty space is investigated, and results are conditional to the choices of sets of parameters to vary and of the alternative values tested.

- Further development of the methodology would include further explorations of the differences between the families of scenarios identified, in particular the exploration of their respective dynamic behaviour.

- This methodology may be useful when scenario diversity is a question worth exploring. It could be used to inform the development of alternative narratives and quantified scenarios that are located in specific domains of the “challenges space”.

Thank you for your attention!

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