

THE COST OF CLIMATE CHANGE MITIGATION : UNCERTAINTIES AND METRICS MATTER

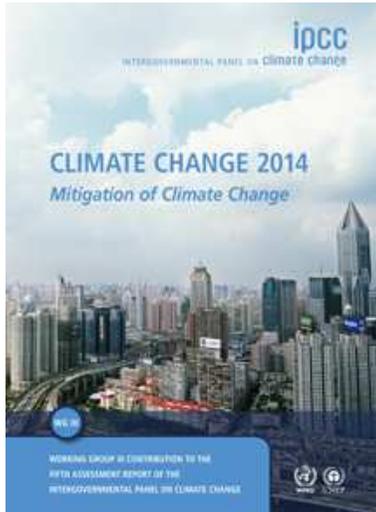
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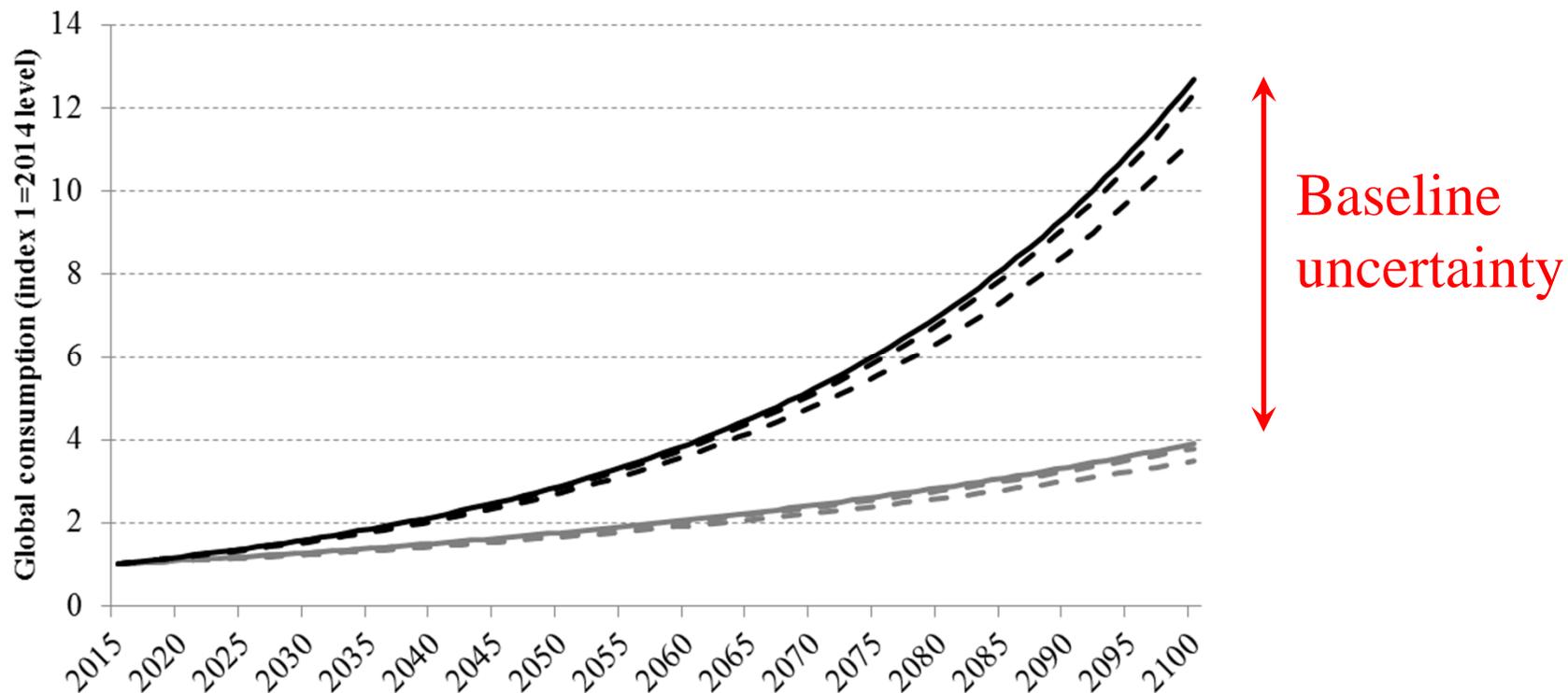
EEA-ESEM Congress, 25 August 2014, Toulouse

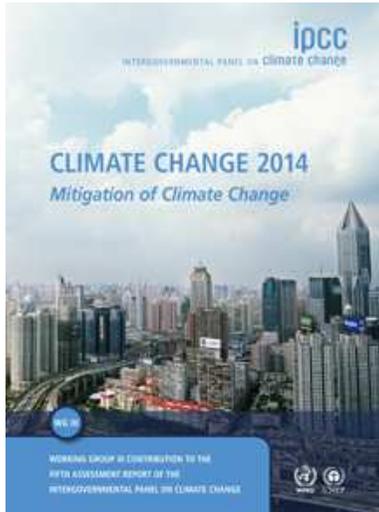




IPCC (2014) WGIII Summary for Policy Makers

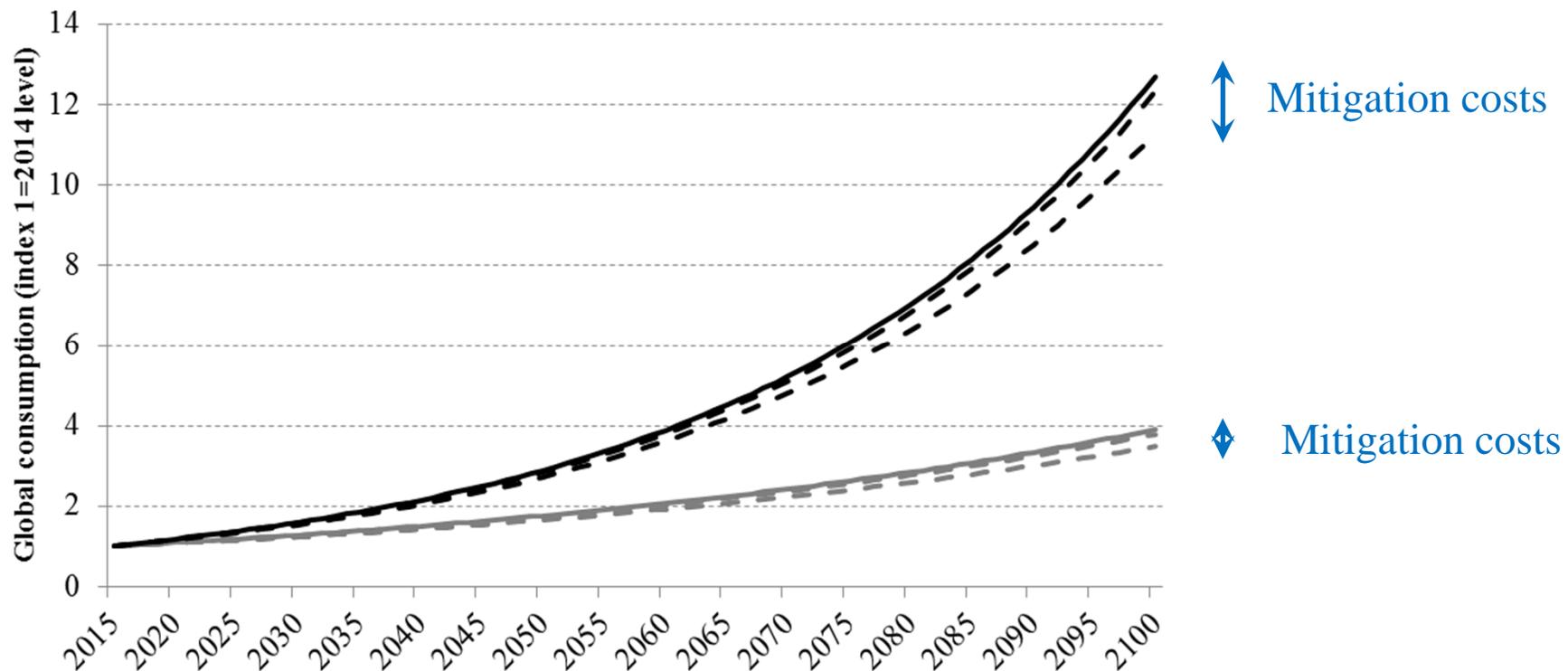
mitigation scenarios (450ppm CO₂eq in 2100) entail **losses in global consumption** [...] of 1% to 4% in 2030, 2% to 6% in 2050, and 3% to 11% in 2100 **relative to consumption in baseline scenarios** that grows anywhere from 300% to more than 900% over the century. These numbers correspond to an **annualized reduction of consumption growth** by 0.04 to 0.14 (median: 0.06) percentage points over the century **relative to annualized consumption growth in the baseline** that is between 1.6% and 3% per year.

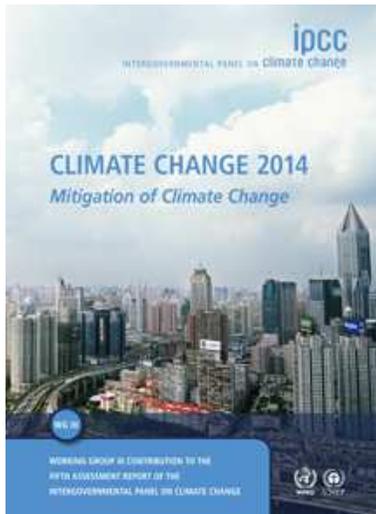




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The New York Times

The Opinion Pages | OP-ED COLUMNIST

Salvation Gets Cheap

APRIL 17, 2014



Paul Krugman

The point, instead, is that drastic cuts in greenhouse gas emissions are now within fairly easy reach.

So is the climate threat solved? Well, it should be. The science is solid; the technology is there; the economics look far more favorable than anyone expected.

The Economist

Global warming

Another week, another report

[...]the panel says, the world could keep carbon concentrations to the requisite level by actions that would reduce annual economic growth by a mere 0.06 percentage points in 2100.

These numbers look preposterous. Germany and Spain have gone further than most in using public subsidies to boost the share of renewable energy (though to nothing like 80%) and their bills have been enormous: 0.6% of GDP a year in Germany and 0.8% in Spain.

What is the cost of climate mitigation?

- How to measure « the cost »?
 - GDP or consumption losses against a baseline
 - Carbon price
 - Welfare (equivalent variation)
- Uncertainties on
 - technologies,
 - consumption behaviors,
 - future economic growth,
 - population,
 - fossil fuels resources,
 - etc
- These uncertainties add to the ones surrounding physical systems and future impacts of climate change.

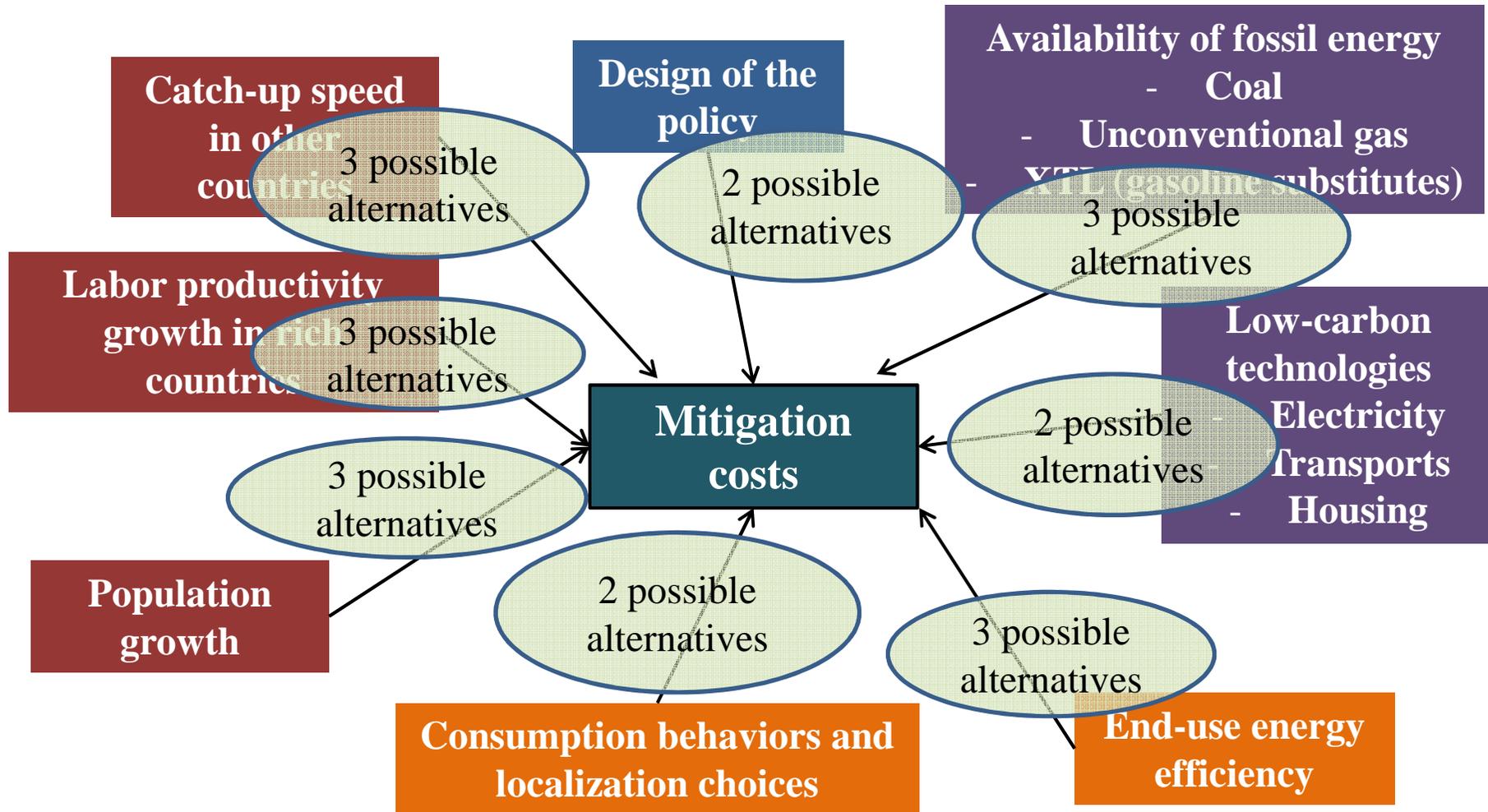
Methodology

- Objective: analyze mitigation costs across an ensemble of scenarios spanning socio-economic uncertainties.
 - Set an emission reduction objective (eg emissions trajectory leading to 50% reduction in 2050 wrt 2000)
 - Define ex-ante the important drivers of emissions and mitigation costs
 - Run hundreds of scenarios combining uncertainty on these drivers
 - Chose metrics for mitigation costs
 - Analyze the influence of the different drivers on mitigation costs with statistical tools

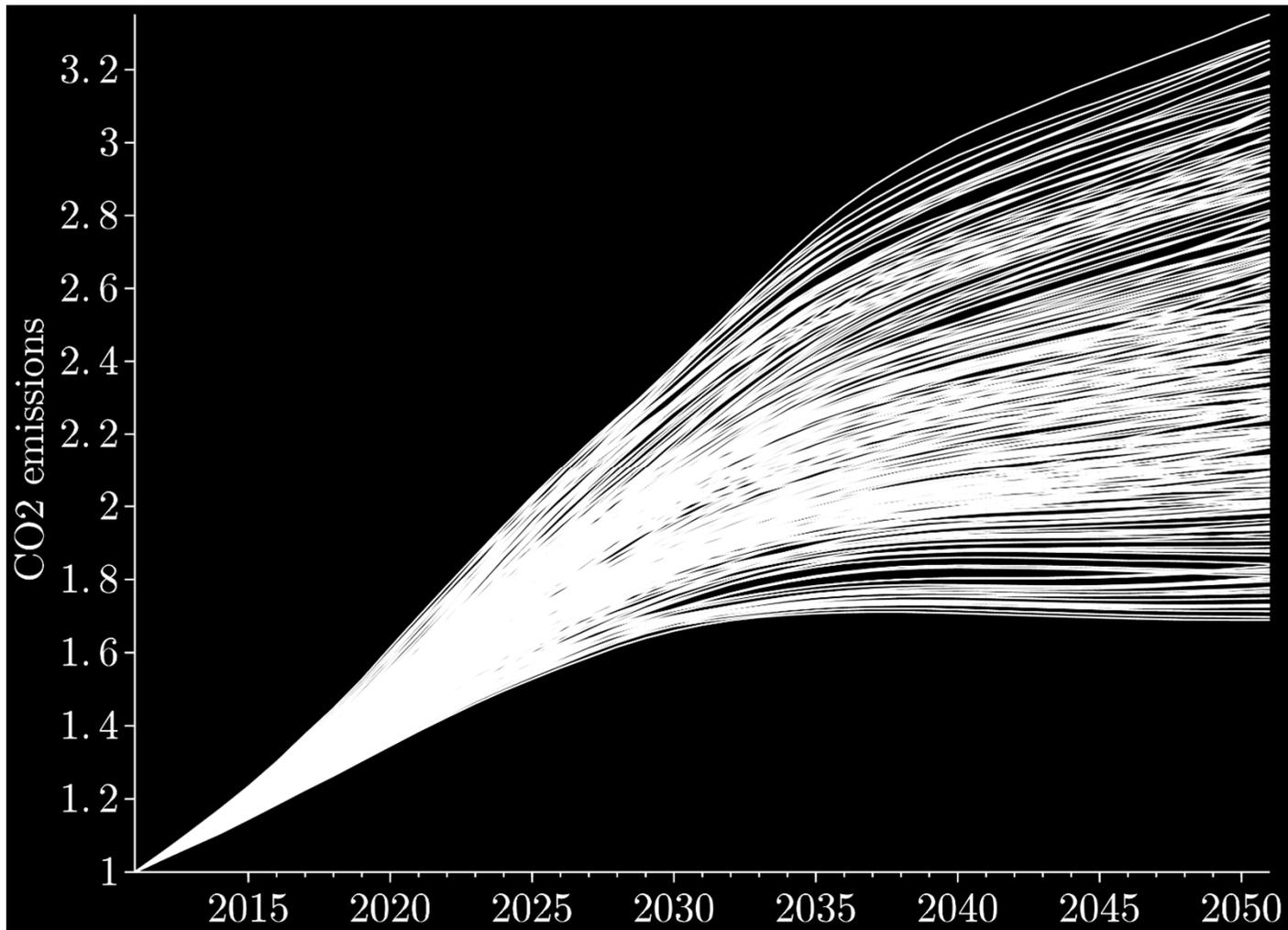
Imaclim-R model

- The Imaclim-R model (Waisman et al., 2012. *Clim. Change* 114(1))
 - is a **multi-region** and **multi-sector** model of the world economy (12 regions and 12 sectors);
 - combines a **Computable General Equilibrium** framework with **bottom-up sectoral modules** (explicit representation of energy technologies);
 - has a recursive dynamic architecture;
 - represents the intertwined evolutions of **technical systems, energy demand behaviors** and **economic growth**;
 - represents **endogenous**:
 - GDP and structural change
 - energy markets
 - induced technical change
 - assumes **exogenous**:
 - Demography and labour productivity growth
 - Maximum potential of technologies (renewable, nuclear, CCS, EV...)
 - Learning rates decreasing the cost of technologies
 - Fossil fuel reserves
 - Parameters of the functions representing energy-efficiency in end-uses
 - Parameters of the functions representing behaviors and life-styles (motorization rate, residential space, evolutions in consumption preferences...)

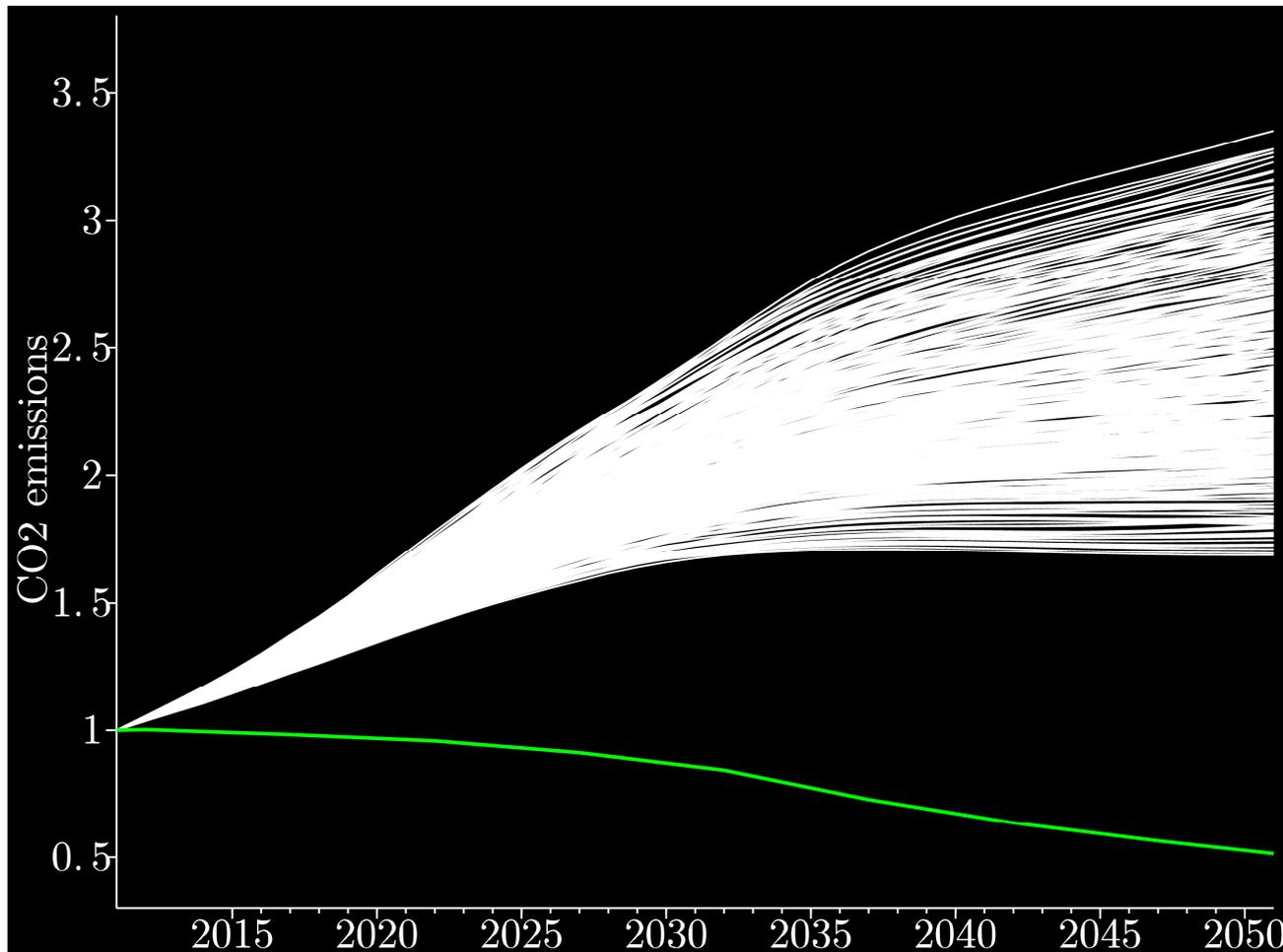
Potential drivers of climate mitigation costs



216 baseline scenarios



2 mitigation scenarios for each baseline



2 types of policies to reach ~500ppm CO₂-eq:

- **Carbon price revenues recycled to households**
- **Carbon price revenues recycled through a reduction of other taxes**



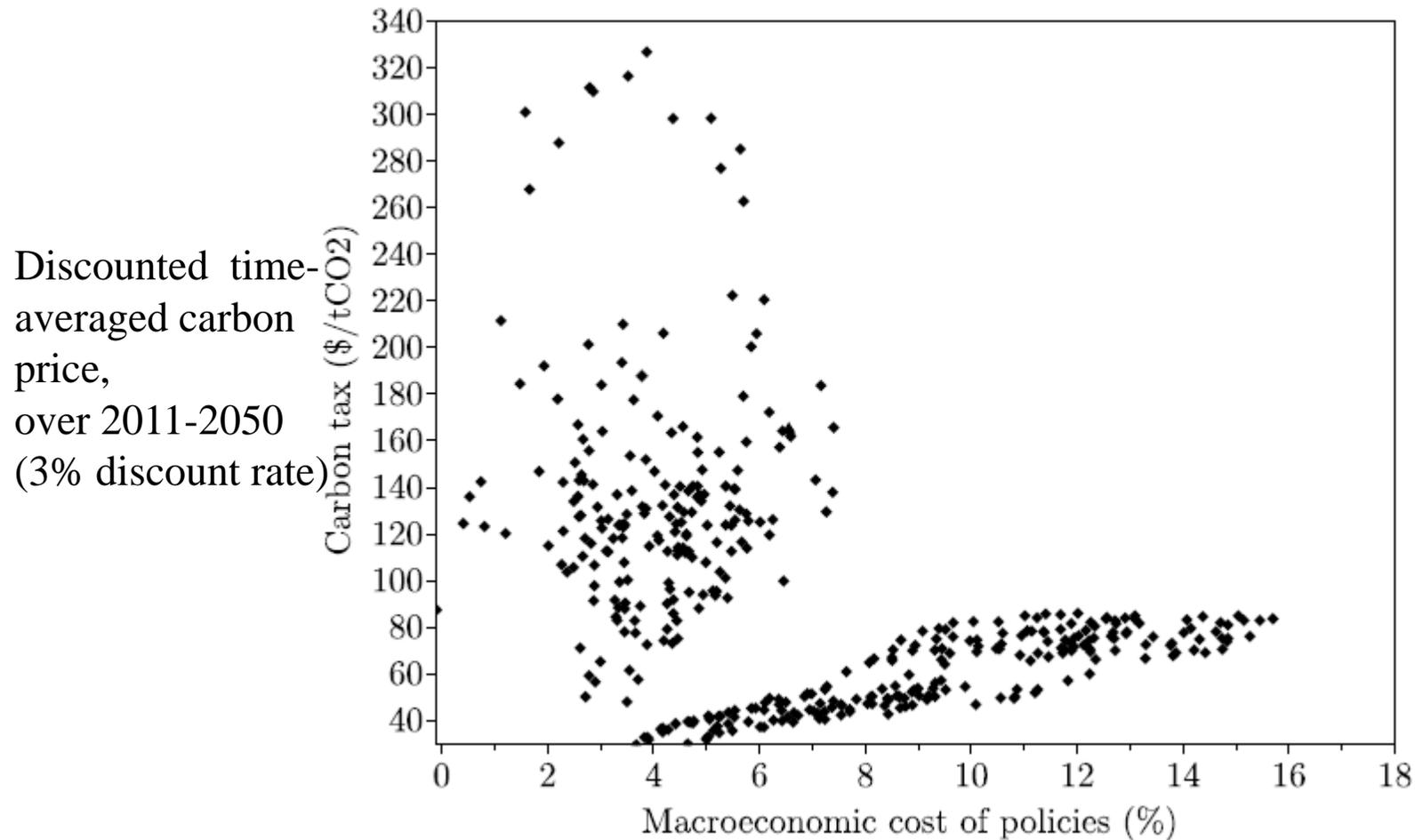
432 policy scenarios

Two common metrics

- Carbon price (marginal abatement cost)
- Macroeconomic cost:

$$\text{macro_cost} = - \left(\frac{GDP_{policy}}{GDP_{base}} - 1 \right)$$

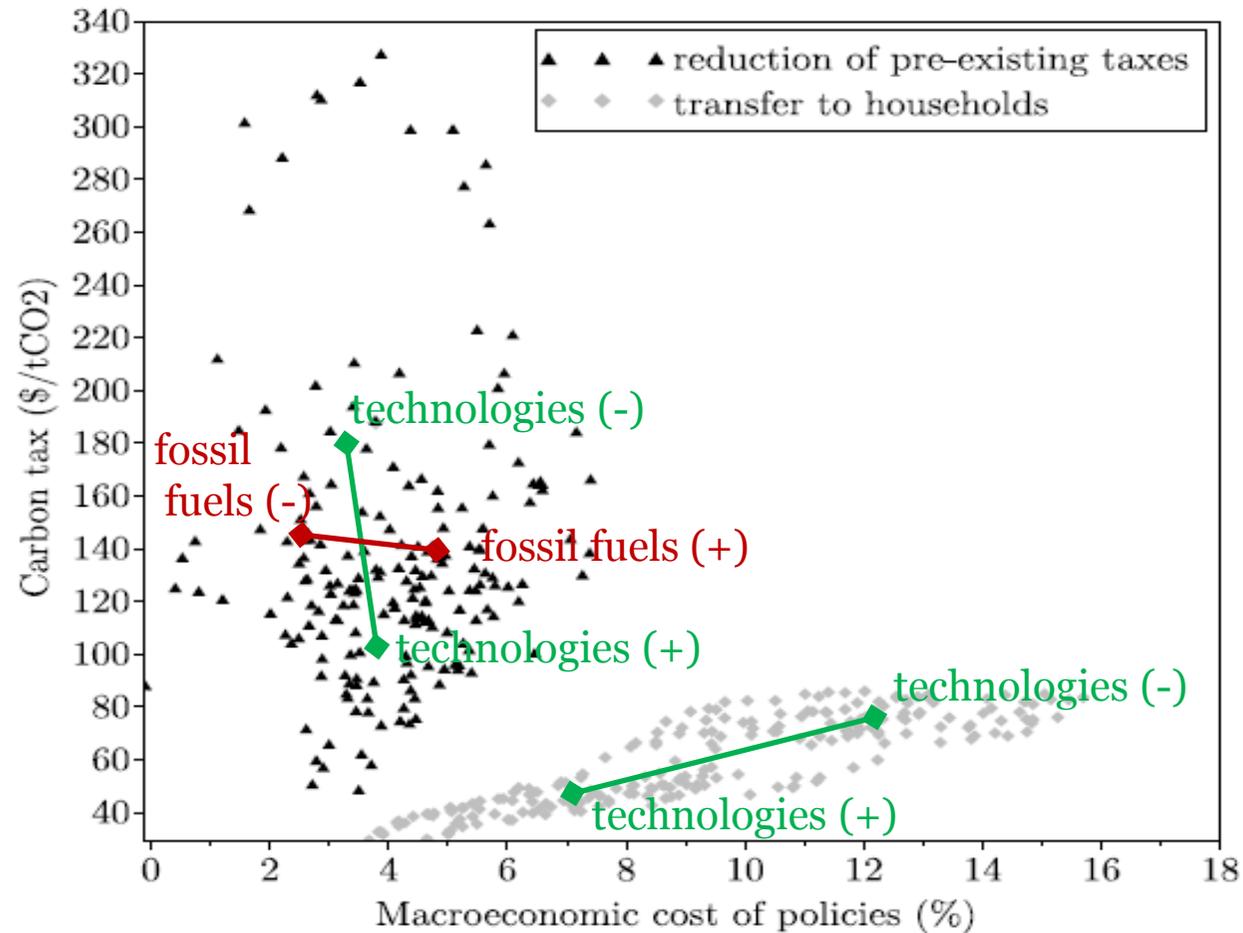
The possible range of costs is large
and the two metrics are not good proxy for one another



Discounted GDP losses wrt baseline, over 2011-2050 (3% discount rate)

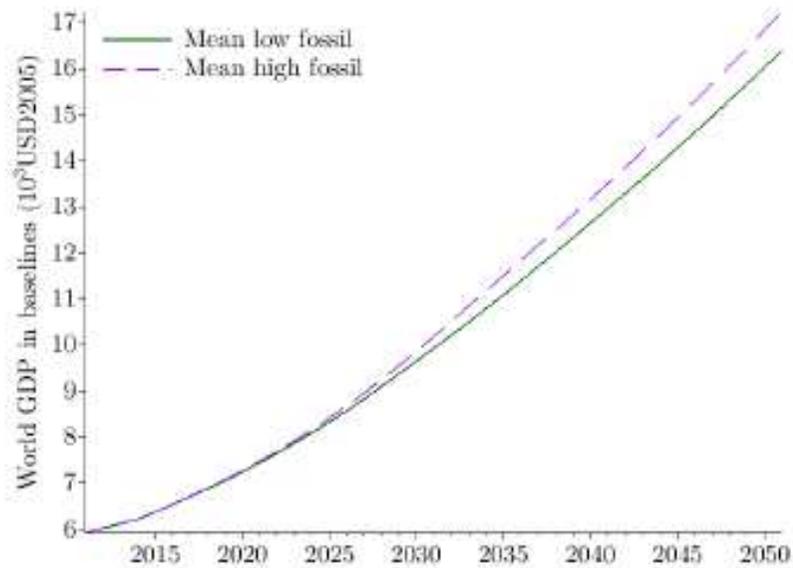
Policy design matters

Results from Classification and Regression Tree (CART, Breiman et al., 1983) algorithm

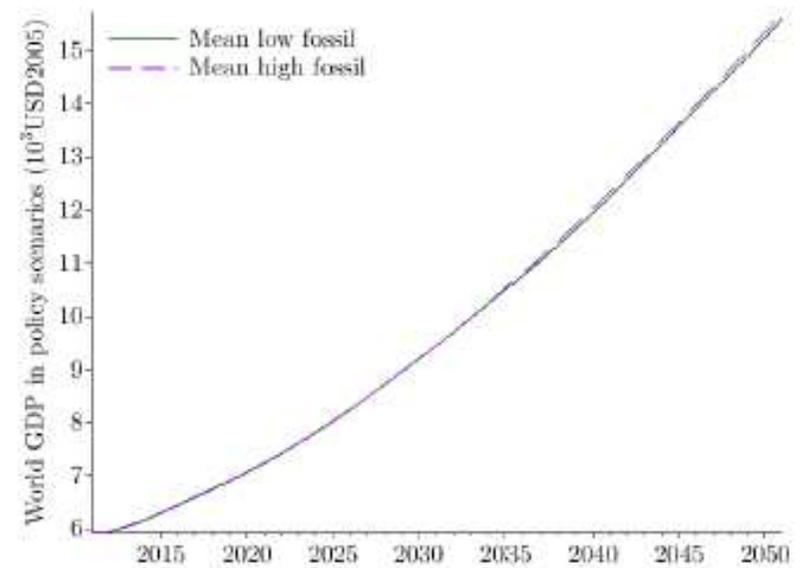


Fossil fuels uncertainty only impact baseline per-capita GDP

Baseline per-capita GDP



Policy per-capita GDP

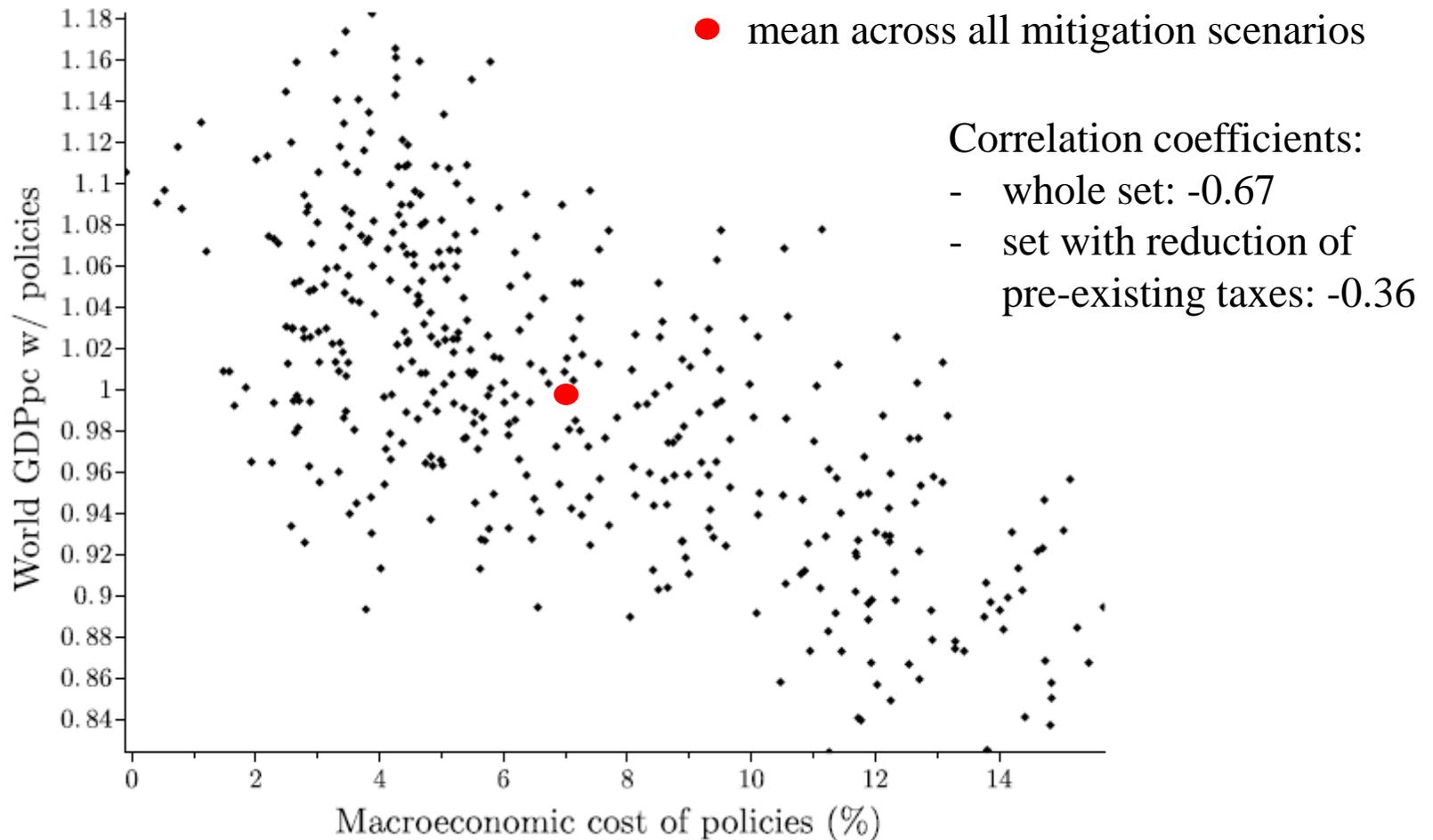


New metric: per-capita GDP in policy scenarios

- In a context of uncertainties, baselines differ in:
 - GDP
 - emissions
- Once a mitigation target has been chosen, assessing GDP or consumption losses compared to a counterfactual point of reference - the baseline without additional mitigation actions or impacts from climate change - becomes irrelevant.
- Evaluate instead performance measures - in terms of absolute GDP or consumption - for alternative pathways that meet this target.

New metric: per-capita GDP in policy scenarios

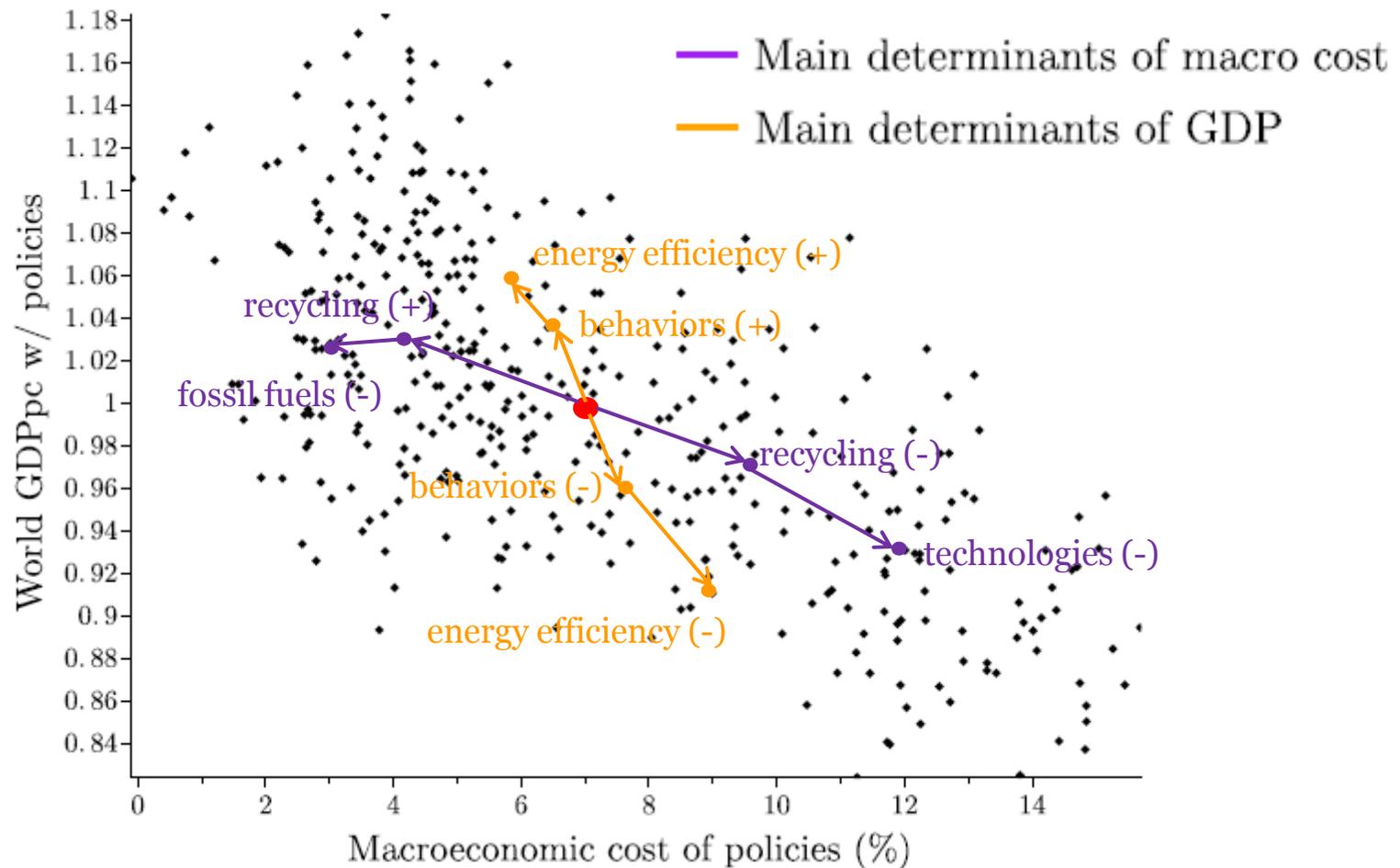
Discounted
per capita
GDP,
over 2011-
2050 (3%
discount rate)



Discounted GDP losses wrt baseline, over 2011-2050 (3% discount rate)

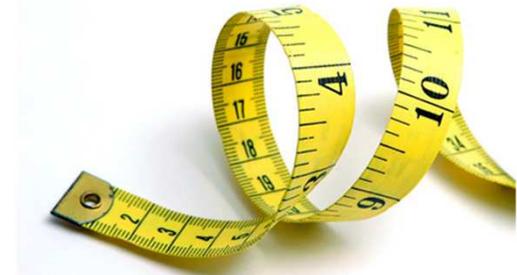
Per-capita GDP and macroeconomic cost are not good proxy for each other

Results from Classification and Regression Tree (CART, Breiman et al., 1983) algorithm



Conclusions

- Framing matters when answering “what is the cost of climate change mitigation?”
- Socio-economic uncertainties are important for the evaluation of mitigation costs
 - Using only one baseline for policy assessment is insufficient
- The three measures (carbon price, GDP losses and per capita GDP) are not well correlated and not determined by the same drivers.
- The choice of the measure therefore affects the main messages that emerge from the modelling results
 - If the mitigation target is fixed, measuring the cost of mitigation against a baseline becomes misleading for policy decisions



THANK YOU FOR YOUR ATTENTION!

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