Climate change mitigation costs:
a tale of uncertainties, metrics and misleading baselines

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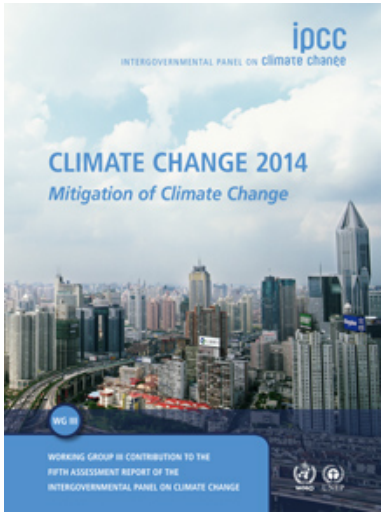
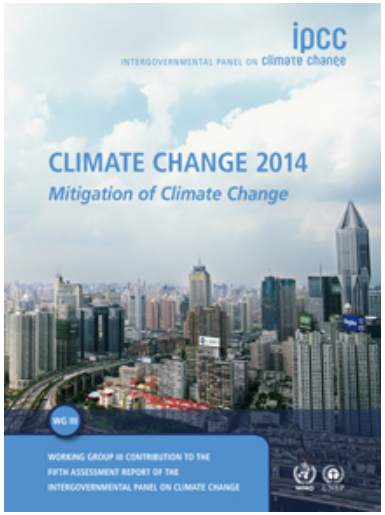


IPCC (2014) WGIII Summary for Policy Makers

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

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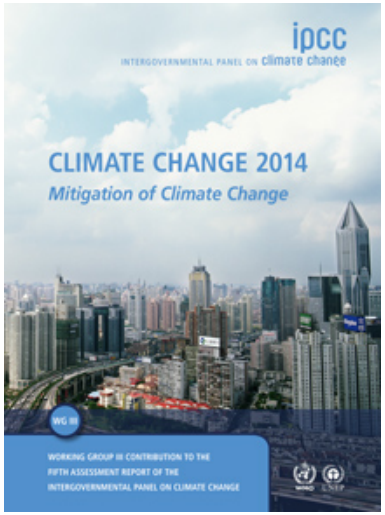

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The Economist

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
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- 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

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  - Analyze the influence of the different drivers on mitigation costs with statistical tools

Imaclim-R model

- The Imaclim-R model (Waisman et al., 2012)
  - 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;
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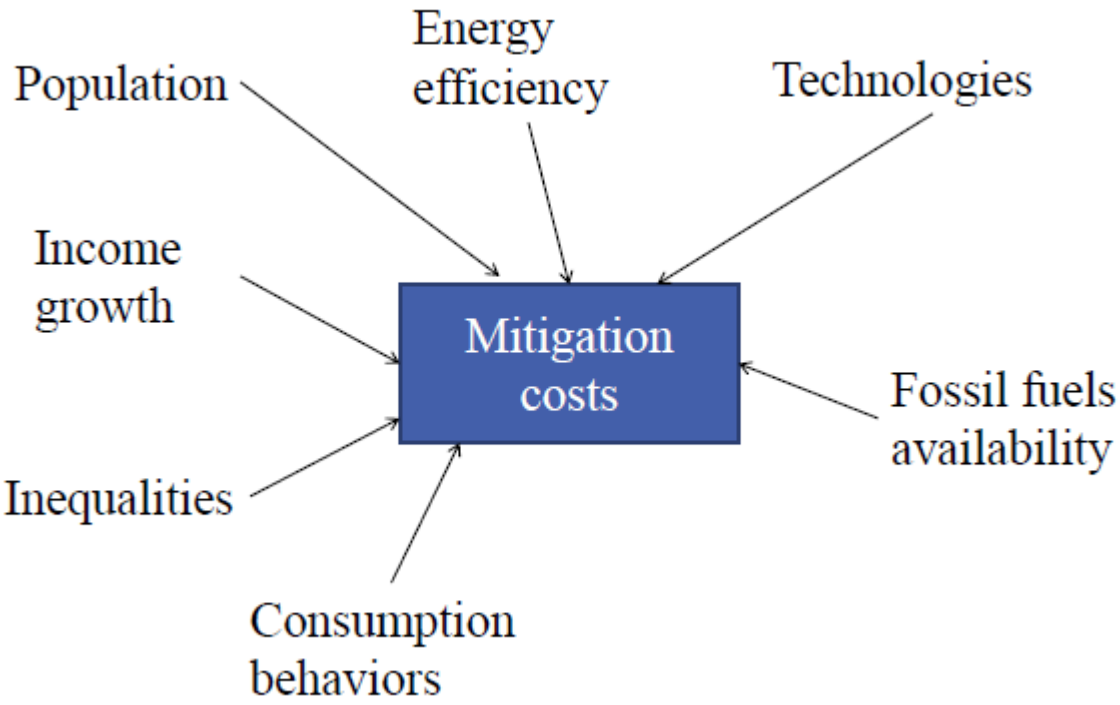
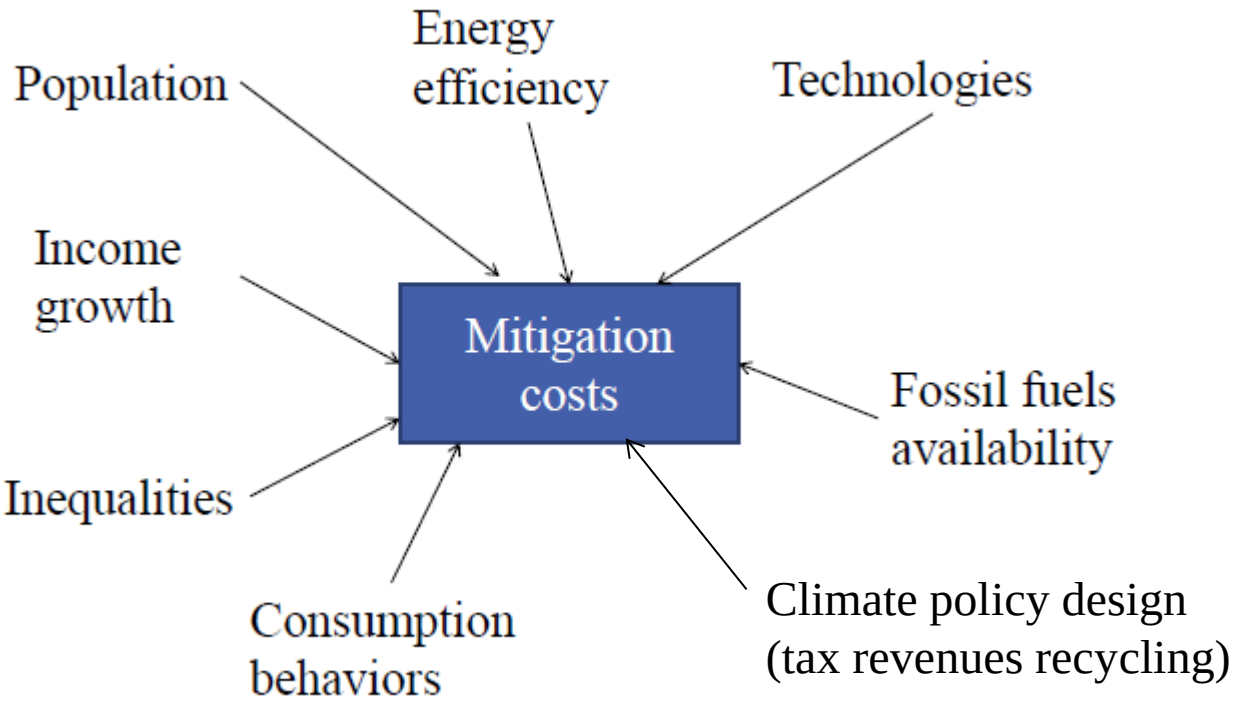
  - assumes **exogenous**:
    - Demography and labour productivity growth
    - Maximum potential of technologies (renewable, nuclear, CCS, EV...)
    - Learning rate decreasing the cost of technologies
    - Fossil fuel reserves
    - Parameters of the functions representing energy-efficiency in end-uses
    - Parameters of the functions representing behaviors and life-styles (motorization rate, residential space, evolutions in consumption preferences...)

Potential drivers of climate mitigation costs



⟶ 216 baselines

Potential drivers of climate mitigation costs



⟶ 432 mitigation scenarios (+216 baselines)

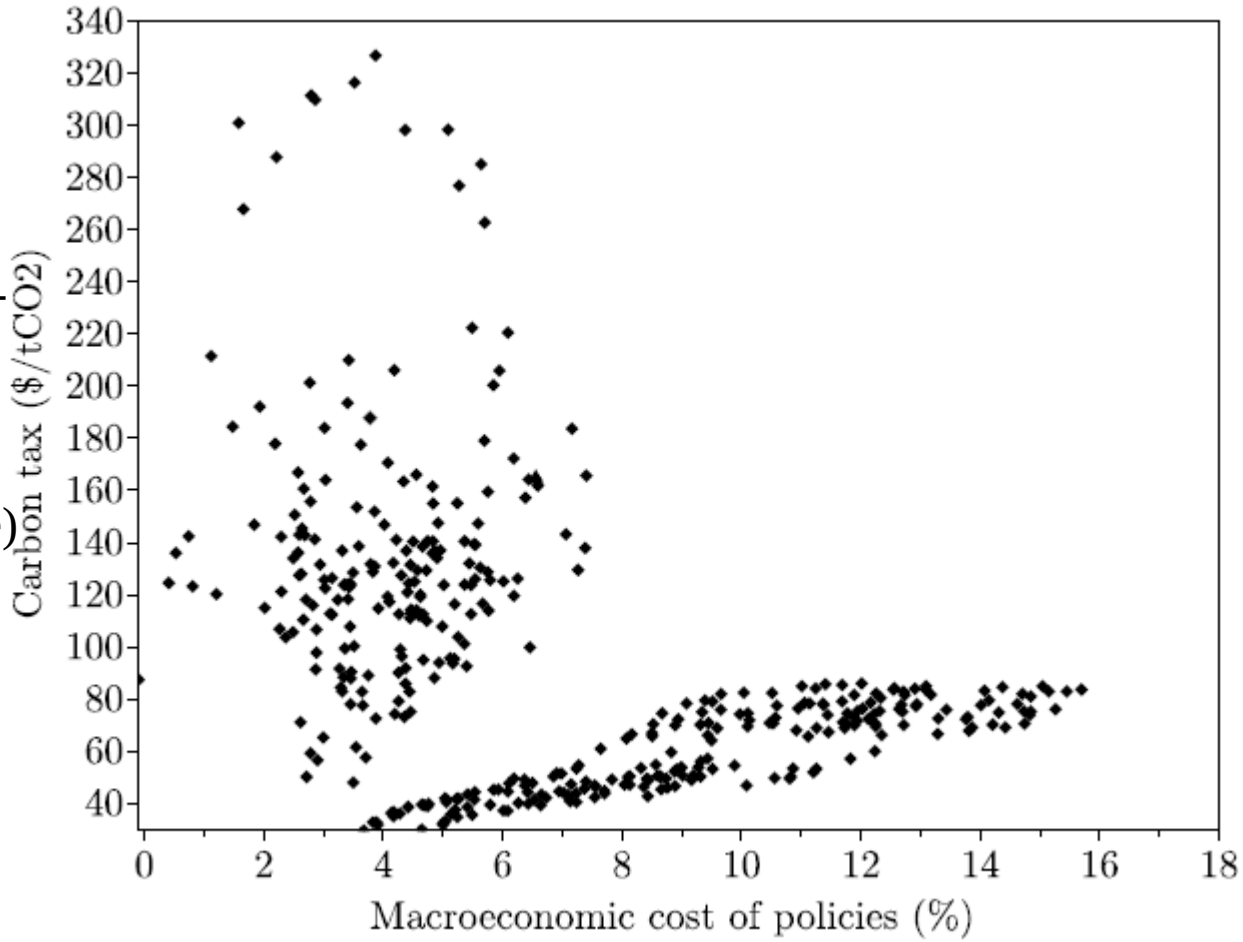
Two common metrics

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

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

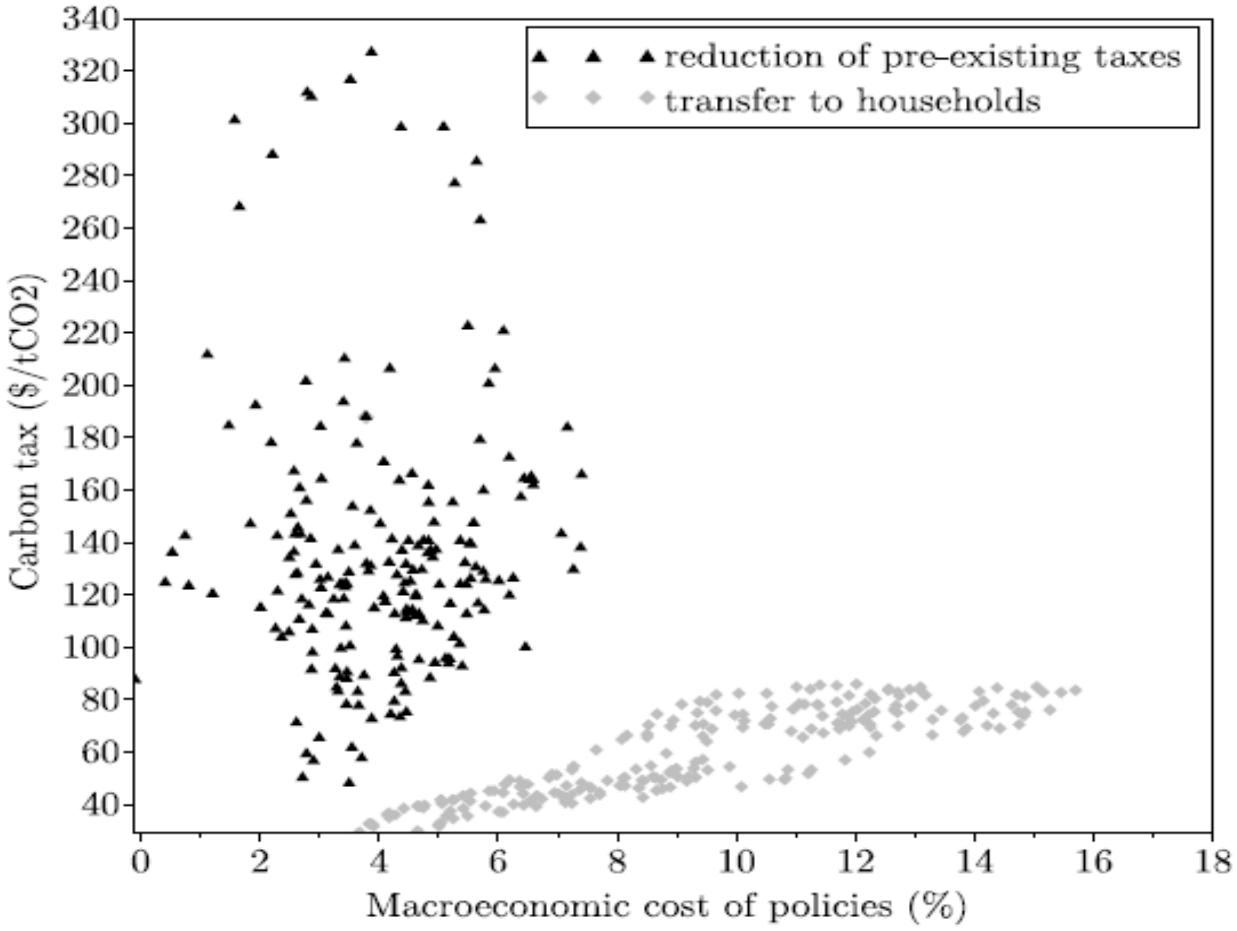
The possible range of costs is large and the two metrics are not good proxy for one another

Discounted time-averaged carbon price, over 2011-2050 (3% discount rate)



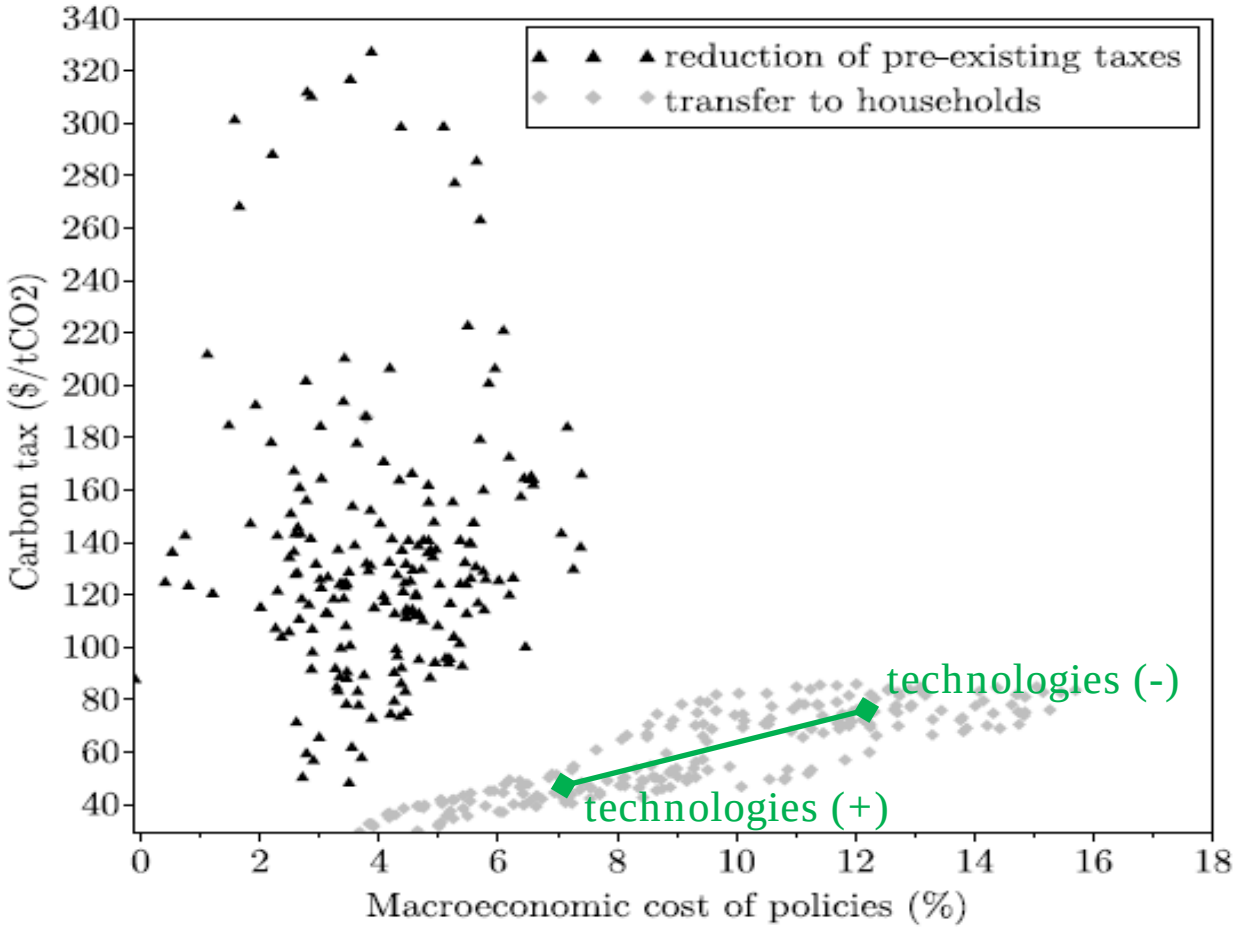
Discounted GDP losses wrt baseline, over 2011-2050 (3% discount rate)

Policy design matters



Policy design matters

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



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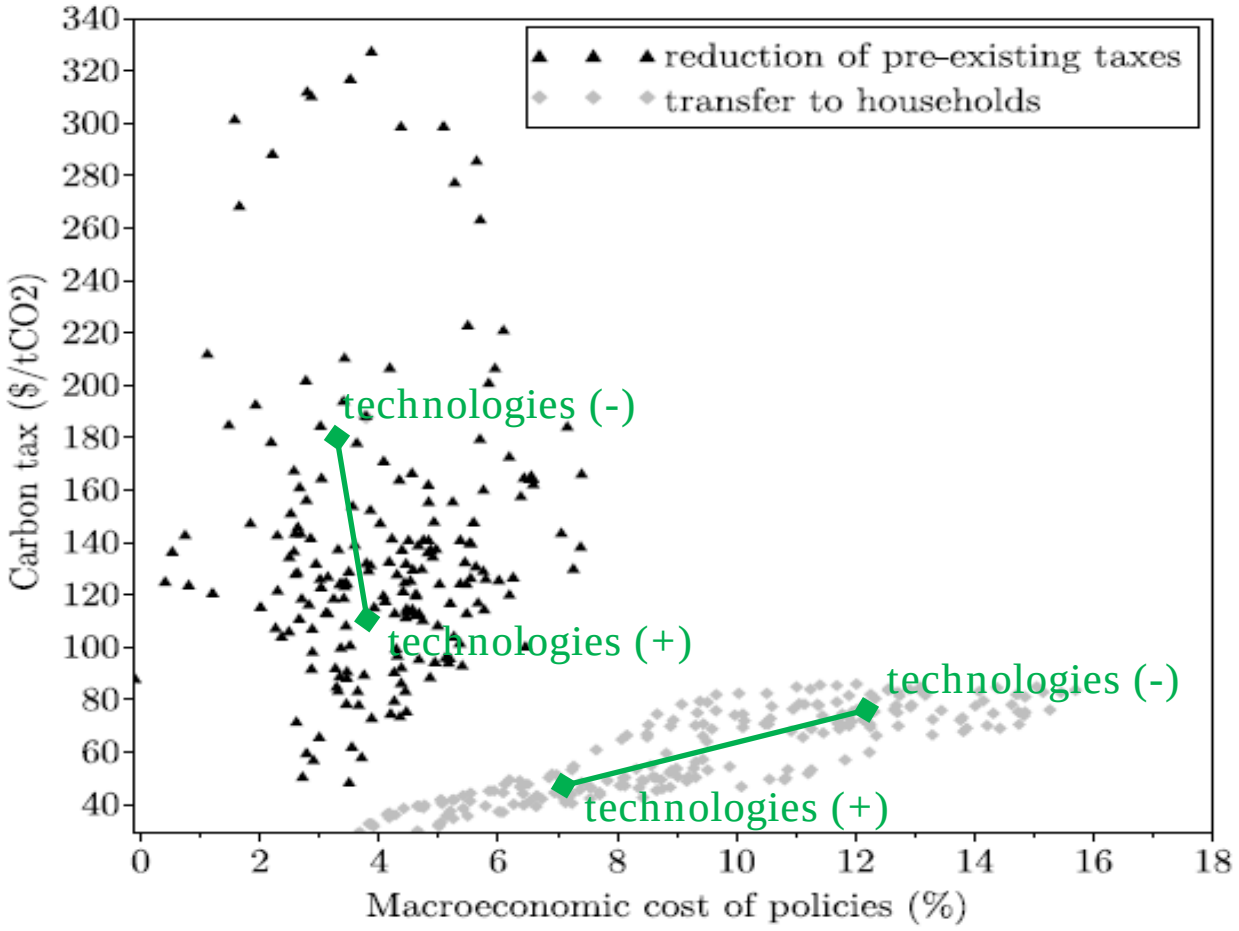

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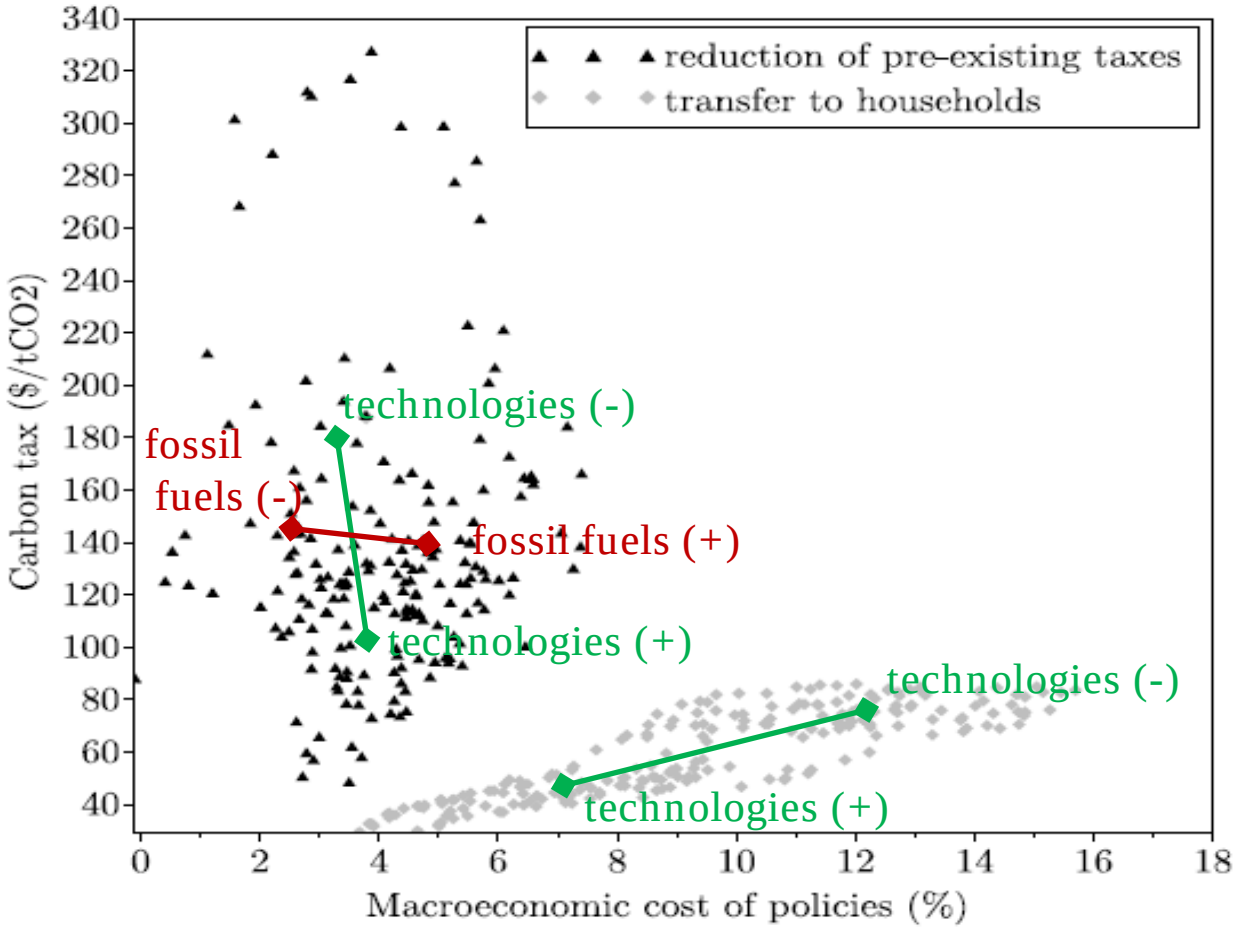
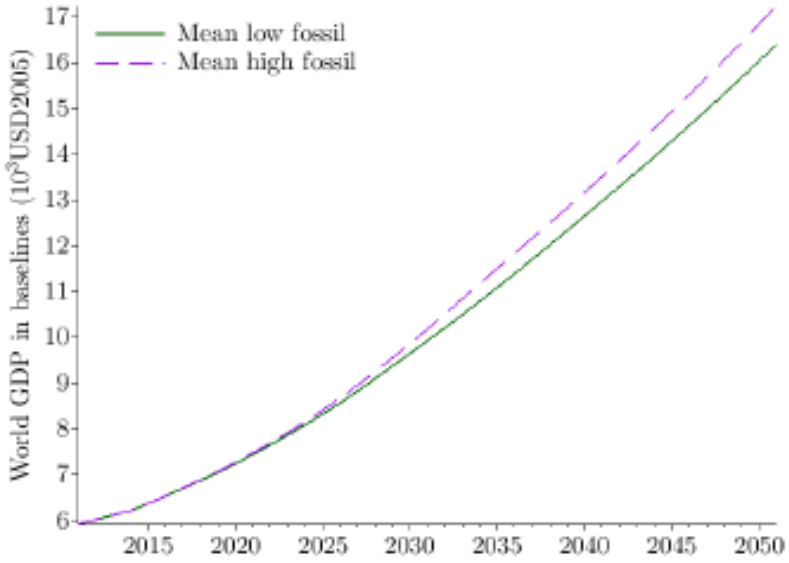
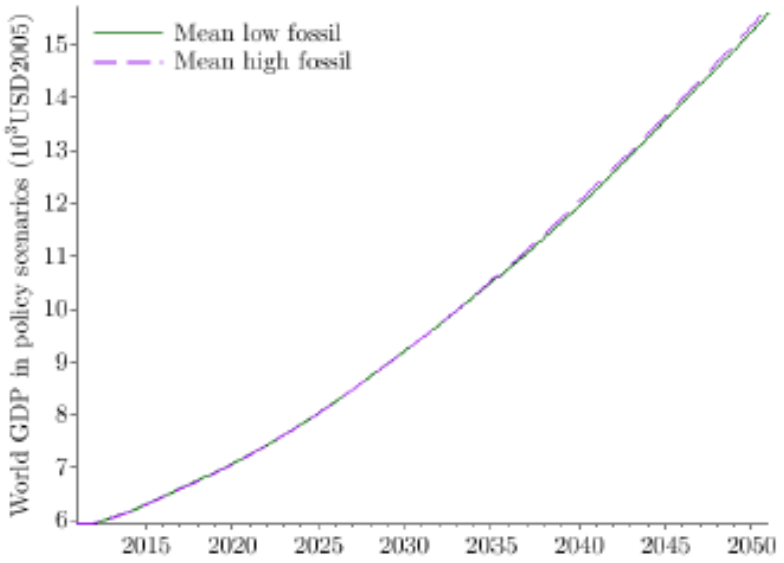


Fossil fuels uncertainty only impact baseline per-capita GDP

Baseline per-capita GDP



Policy per-capita GDP

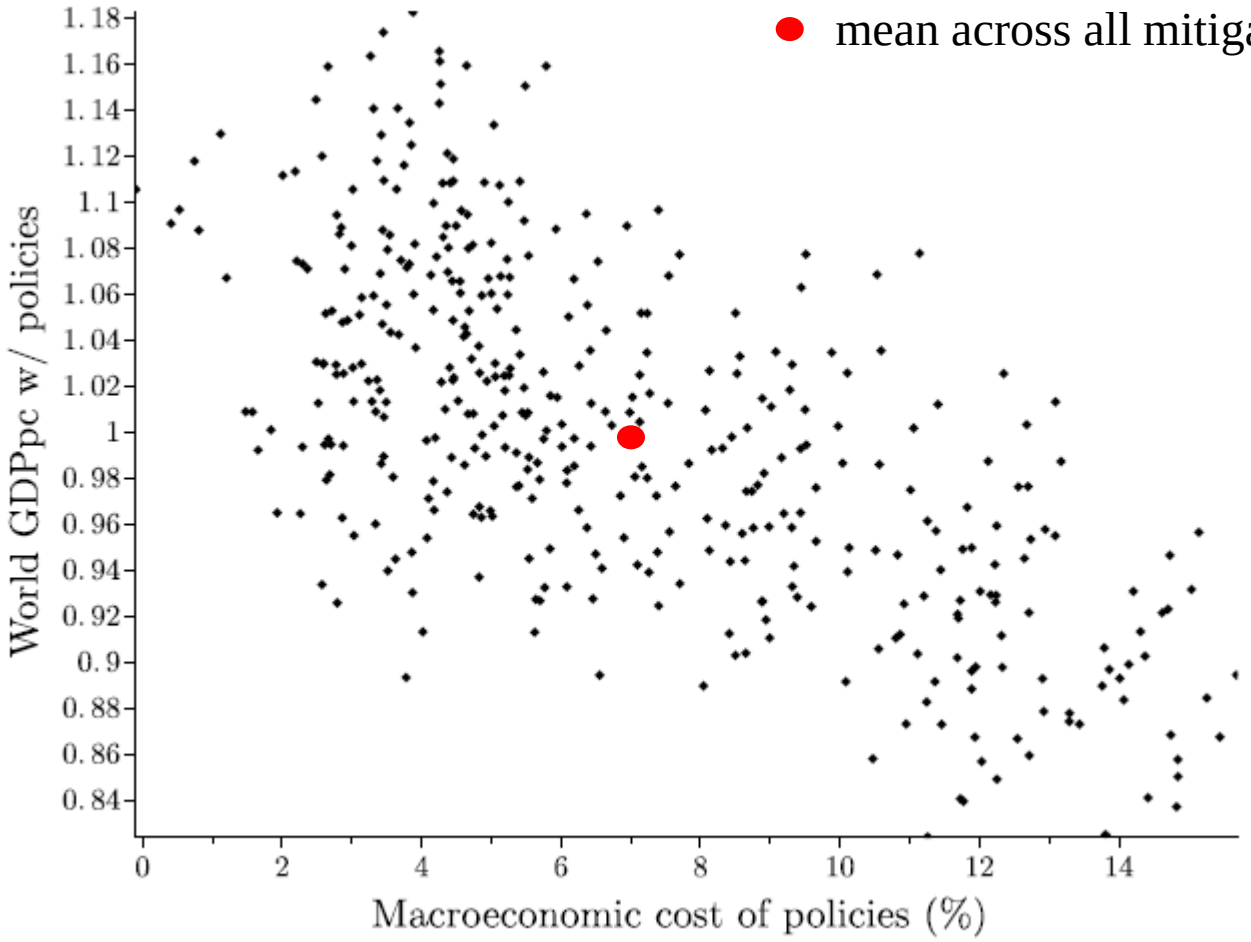


New metric: per-capita GDP in policy scenarios

- 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.
- Policies can be based on 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

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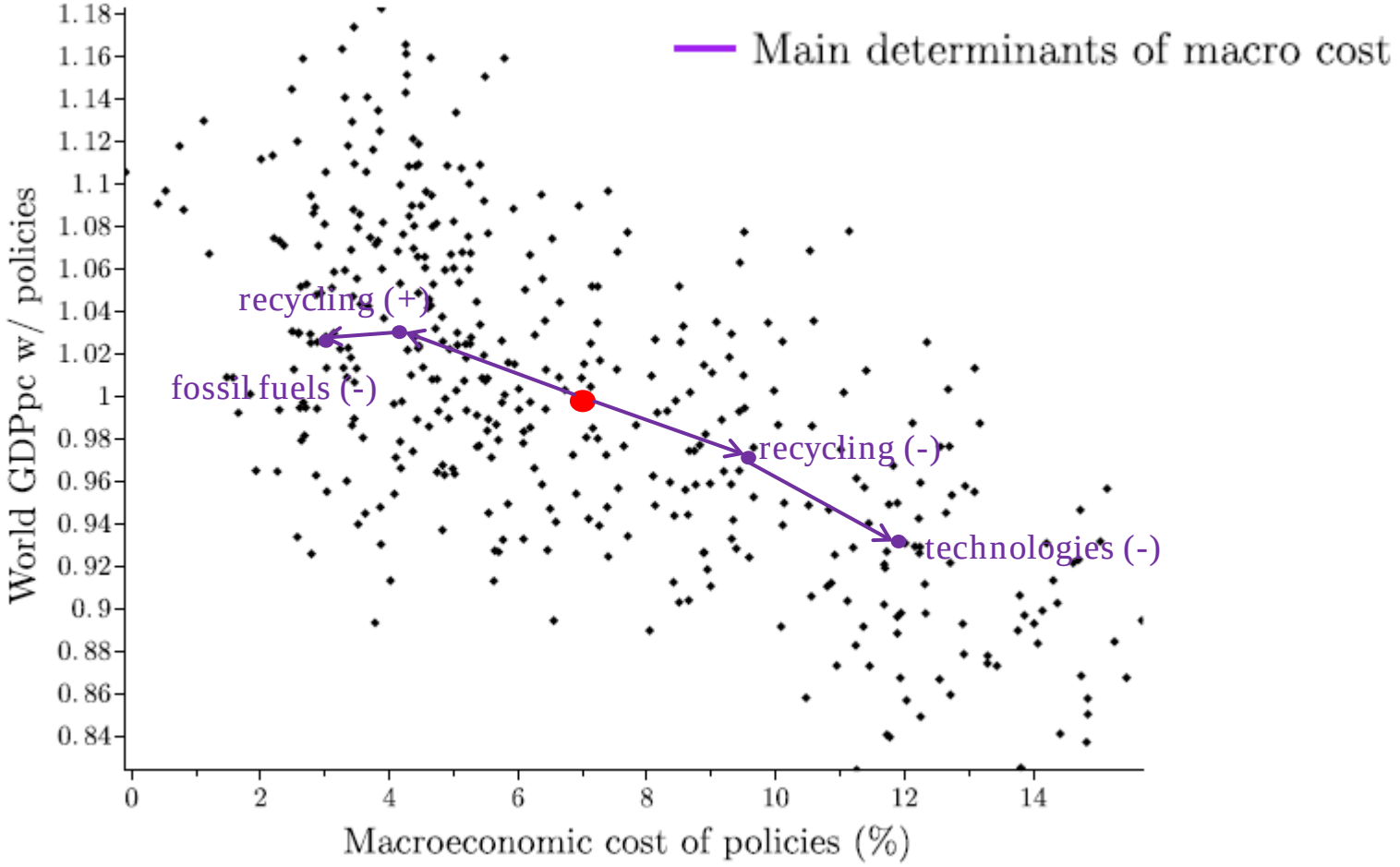

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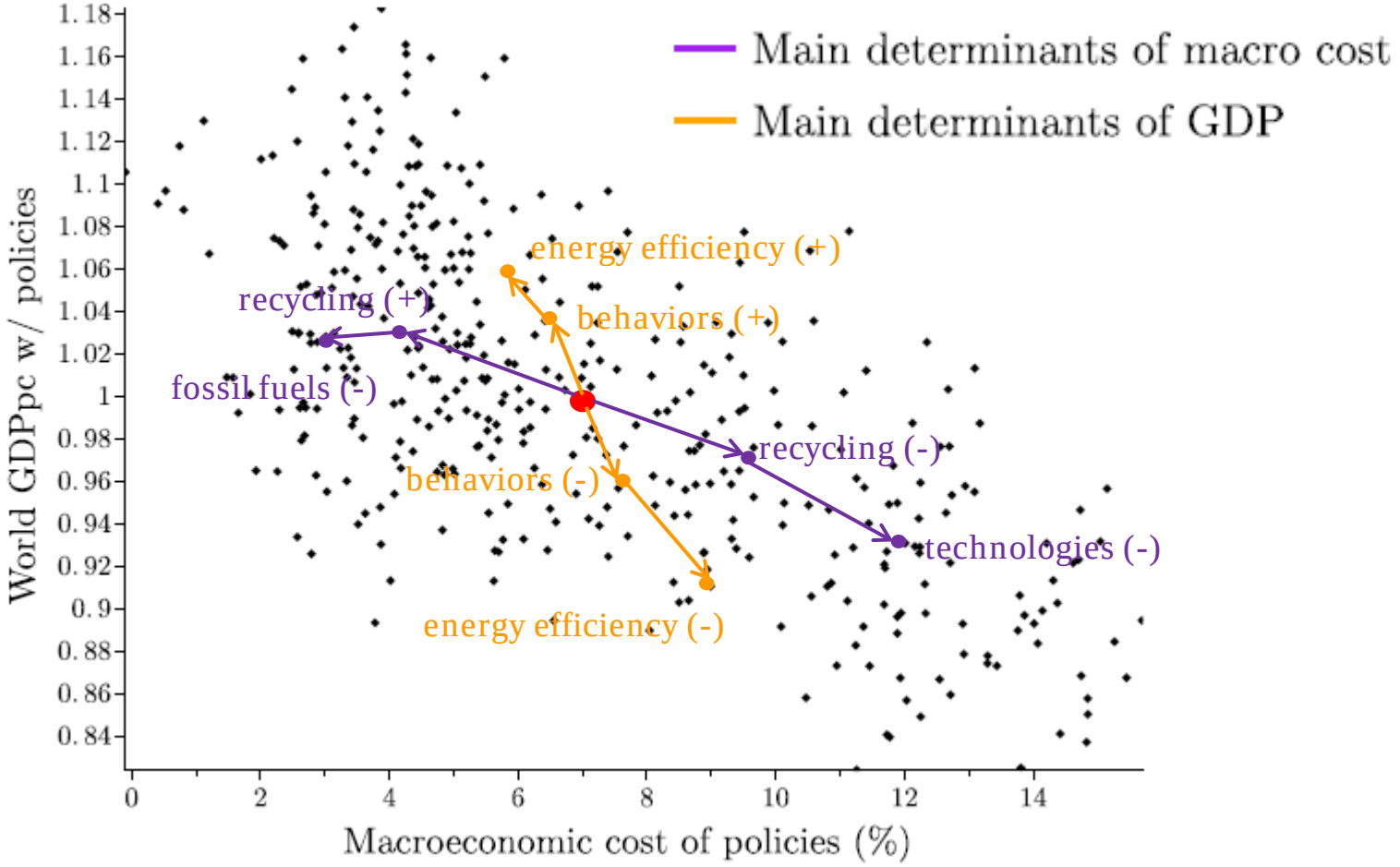

Conclusions

- Framing matters when answering “what is the cost of climate change mitigation?”
- Socio-economic uncertainties are important for the evaluation of mitigation costs
- 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

Thank you !

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