



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

Equity in international climate policy scenarios with IAMs

PRISMA Summer School on Impacts and Equity
Utrecht, The Netherlands, July 10, 2025

Nico Bauer, et al.
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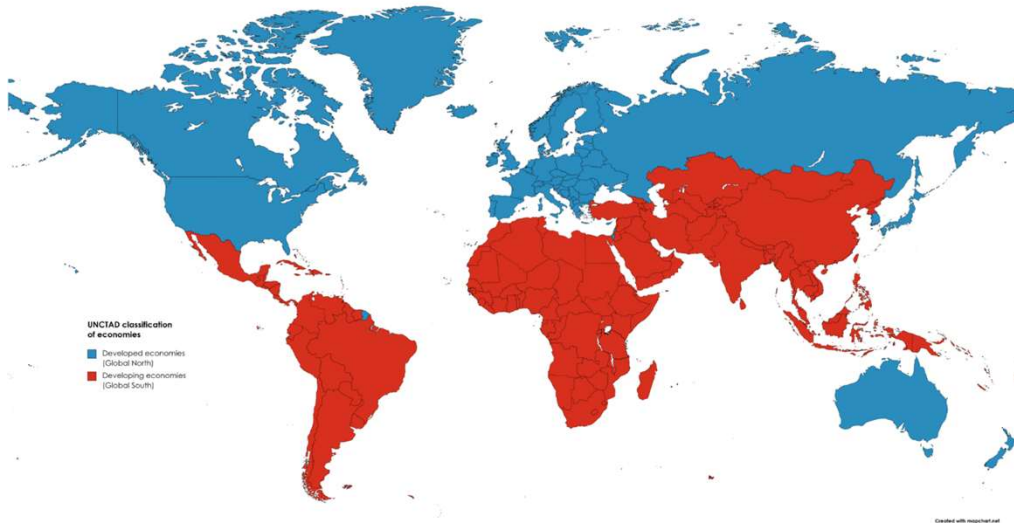


Content

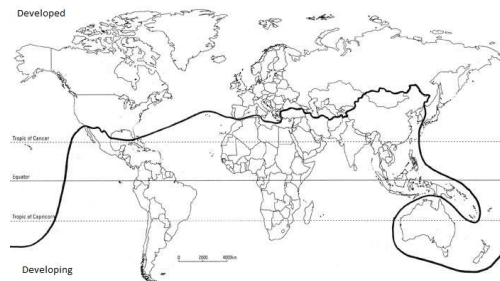
- Introduction
- Equity in the international climate policy context (UNFCCC, Paris Agreement)
- Fairness in mitigation scenarios – sharing the cake
 - Uniform carbon pricing
 - Differentiated carbon pricing
 - Mixed solutions: the sweet spot
- Fairness in integrated scenarios – baking the cake
 - Avoided climate damages and the willingness to pay
 - The Social Cost of Carbon, the Carbon Price and Transfers

What is the Global North and South?

UNCTAD

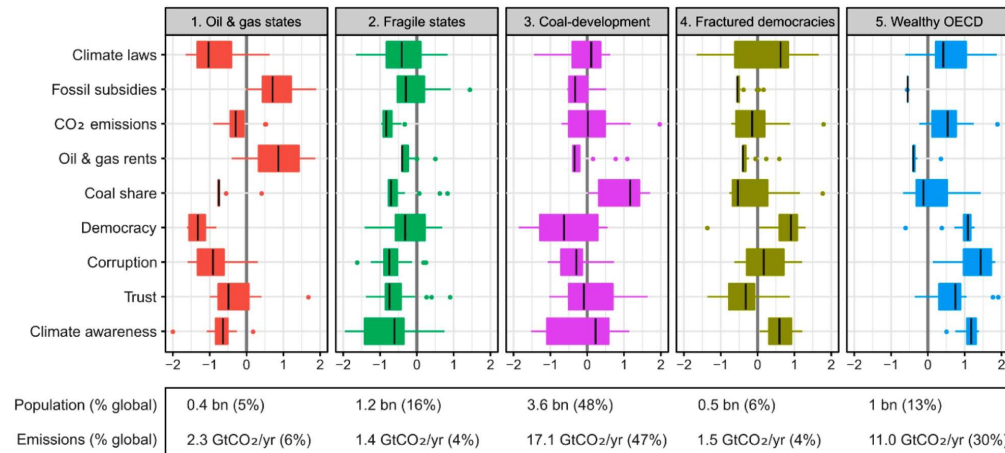
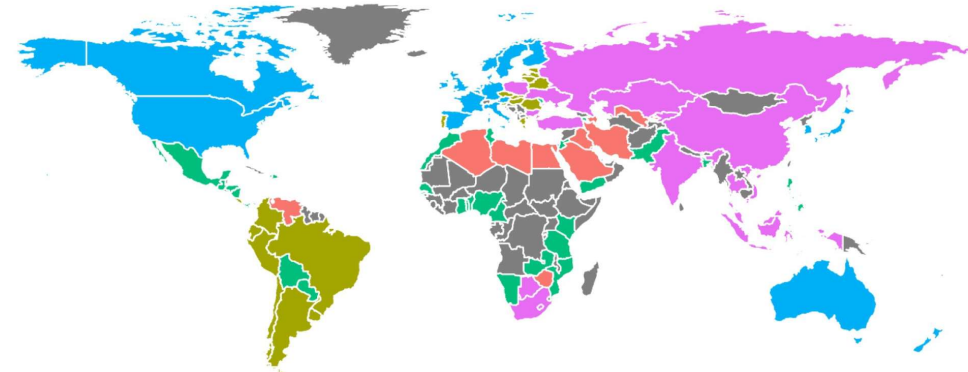


The Brandt line of 1980



Minx and Lamb (2020)

<https://doi.org/10.1016/j.erss.2020.101429>



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Projections of Economic Development – The SSPs

Between country inequality

Within country inequality

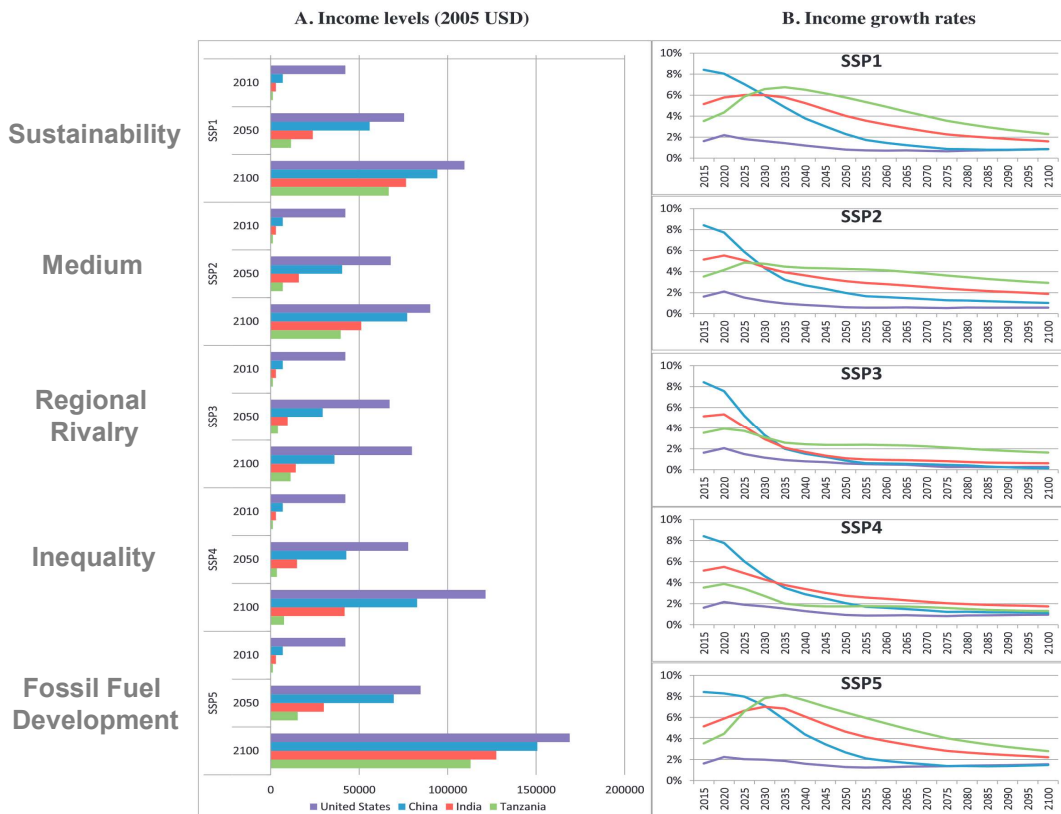


Fig. 4. Income levels and growth rates in selected countries across the five SSPs.

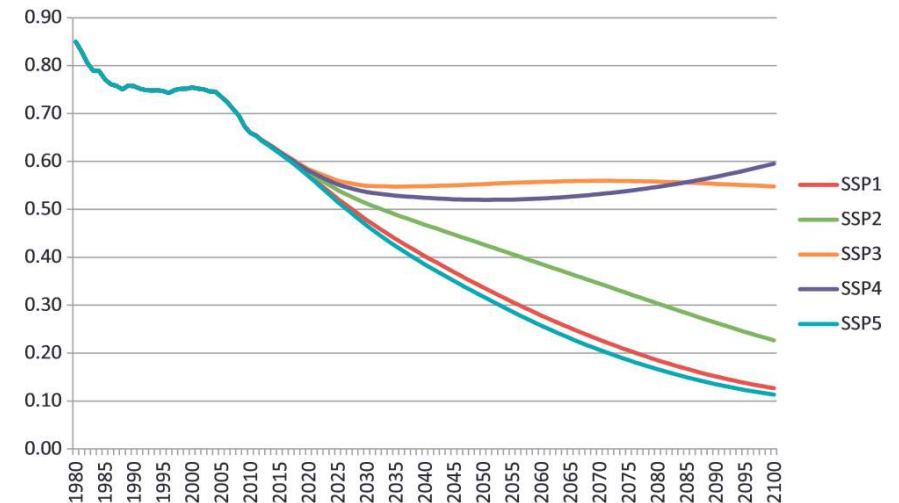
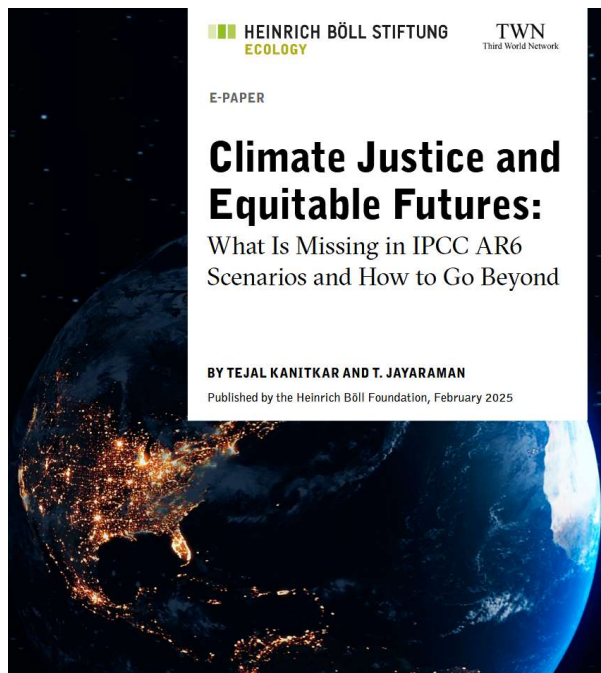


Fig. 8. Historical trends and projections for the between-country Gini coefficient.

Introduction: Do IPCC and IAMs ignore equity?

Currently, the scenarios of AR6 severely lack equity in distributing the mitigation burden; are premised on curtailing growth in the developing world, perpetuating gross energy inequalities; permit the continued disproportionate and unfair appropriation of even the remaining carbon budget by developed countries; and lead to the exacerbation of food insecurity and an increase in the numbers of those at risk of hunger (Kanitkar et al., 2024; Jaiswal et al., 2024).

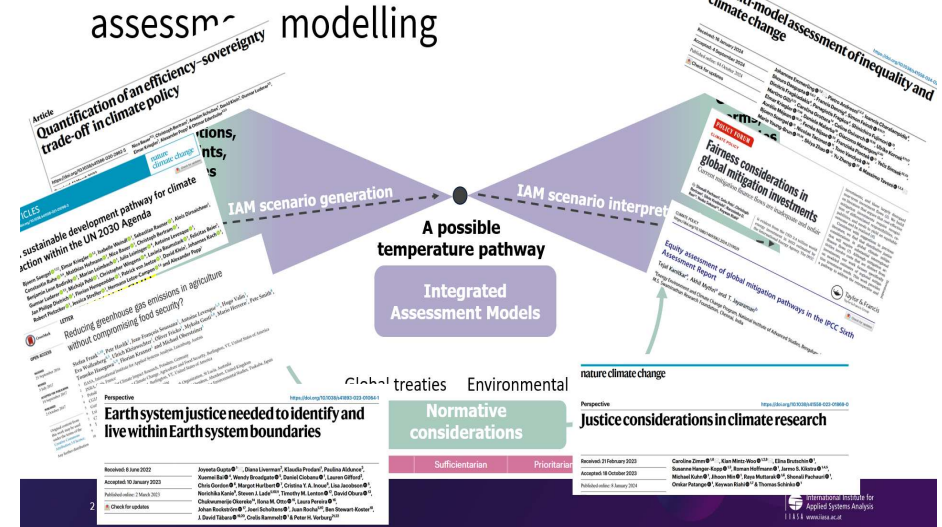


<https://www.boell.de/de/2025/02/06/climate-justice-and-equitable-futures>

Box SPM.1 | Assessment of Modelled Global Emission Scenarios

A wide range of modelled global emission pathways and scenarios from the literature is assessed in this report, including pathways and scenarios with and without mitigation.⁴⁴ Emissions pathways and scenarios project the evolution of GHG emissions based on a set of internally consistent assumptions about future socio-economic conditions and related mitigation measures.⁴⁵ These are quantitative projections and are neither predictions nor forecasts. Around half of all modelled global emission scenarios assume cost-effective approaches that rely on least-cost emission abatement options globally. The other half look at existing policies and regionally and sectorally differentiated actions. Most do not make explicit assumptions about global equity, environmental justice or intra-regional income distribution. Global emission pathways, including those based on cost-effective approaches, contain regionally differentiated assumptions and outcomes, and have to be assessed with the careful recognition of these assumptions. This assessment focuses on their global characteristics. The majority of the assessed

Normative considerations in integrated assessment modelling



Courtesy Setu Pelz (IIASA)

UNFCCC considers interregional equity and intraregional poverty eradication

UN Framework Convention on Climate Change 1992

Article 2

OBJECTIVE

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Article 3

PRINCIPLES

In their actions to achieve the objective of the Convention and to implement its provisions, the Parties shall be guided, inter alia, by the following:

1. The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.

Commitments

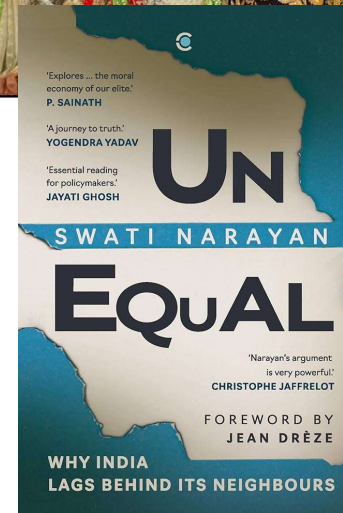
7. The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.



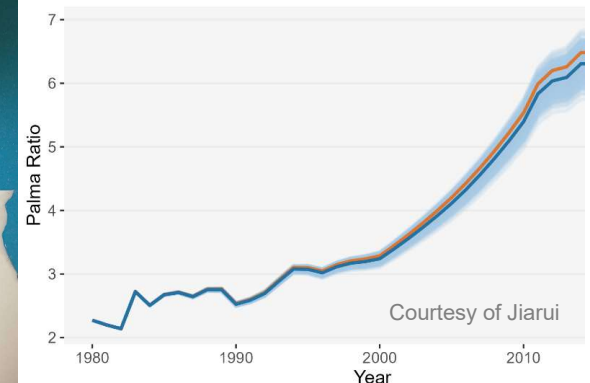
Anant Ambani-Radhika Merchant's \$600 million wedding to Princess Diana's \$163 million nuptials: The top six most expensive weddings in history

The Ambanis have raised the bar when it comes to wedding extravagance. With a price tag exceeding US\$600 million, Anant and Radhika's wedding has undoubtedly secured a place in the record books as one of the most expensive weddings ever held.

Written by **EE Lifestyle**
November 14, 2024 00:07 IST



Impact of anthropogenic climate warming on India Palma Ratio (1980 - 2019)



Nico Bauer, PRISMA Summer School
Utrecht, July 10, 2025

Modeling methods are frequently discussed

"IAMs could, in principle, support the evaluation of climate policies from the perspective of outcome fairness, to our knowledge [none] of them has been satisfactorily employed in this way. One of the possible obstacles to doing so lies in the mechanics of these models."

➔ Harsh critique, strong statement

"What limits the current generation of IAMs most severely in that regard is their focus on maximizing the sum of regional utilities."

➔ This statement is wrong; testimony of lack of expertise backed up by little knowledge of the relevant literature

Zebrowski, et al. (2022)

Global Cap-and-Trade System

Uniform carbon-pricing

Equity considerations are at the core of IAM analysis of climate policies

Environ Model Assess (2010) 11:155–173
DOI 10.1007/s10666-009-9204-8

Mitigation Costs in a Globalized World: Climate Policy Analysis with REMIND-R

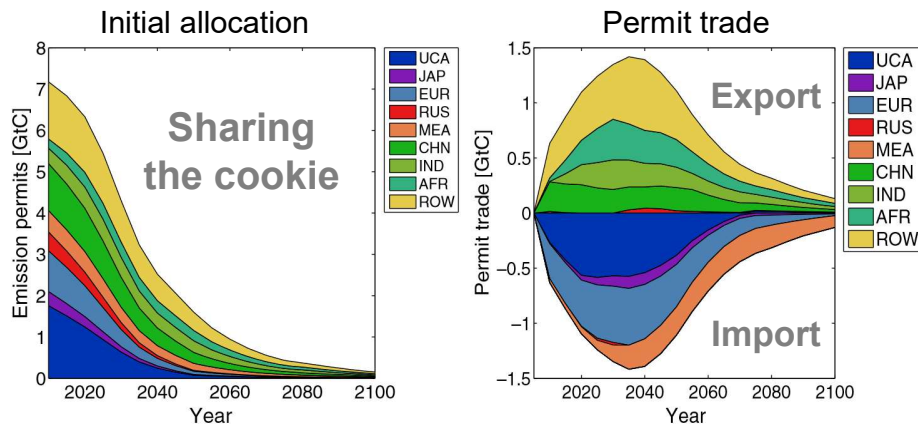
Marian Leimbach · Nico Bauer · Lavinia Baumstark ·
Ottmar Edenhofer

- Initial emission permit allocation is exogenous
- Market allocation is the efficient solution given permits are tradeable
→ global cap-and-trade system

Efficient solution

- **Permit price is uniform** across all regions
- Permit price independent from initial allocation
- Actual emissions independent from initial allocation
- Initial permit allocation is a purely distributional problem (Coase theorem)
- Distribution does not affect efficient solution ...
... but permit trade implies huge implicit transfers
- This is based on the “**Second Welfare Theorem**”
- **Uniform carbon tax** eliminates permit trade; transfers are extra policy

Contraction and Convergence Allocation



The value of the cake depends on technologies

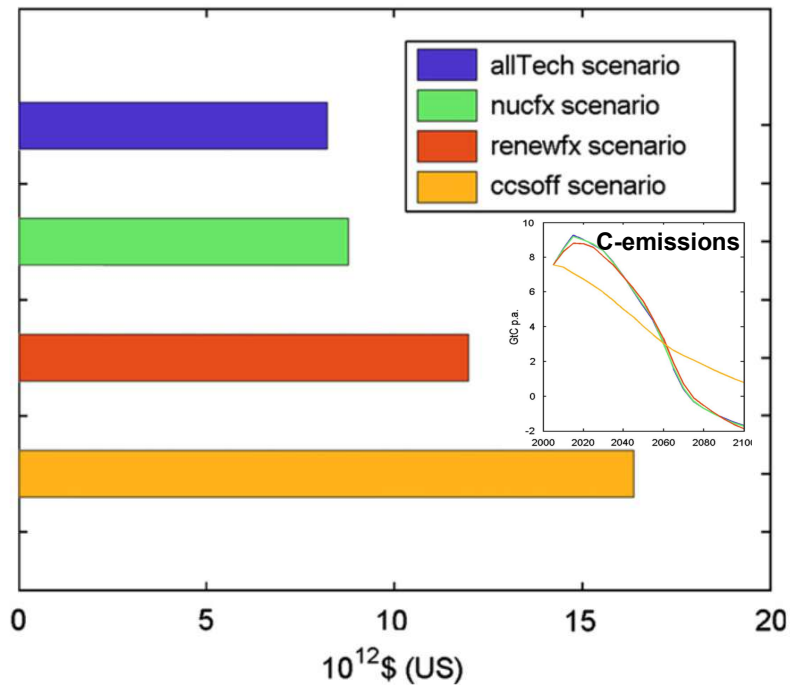


Fig. 8. Global discounted value of permits in 10¹²\$ (US).

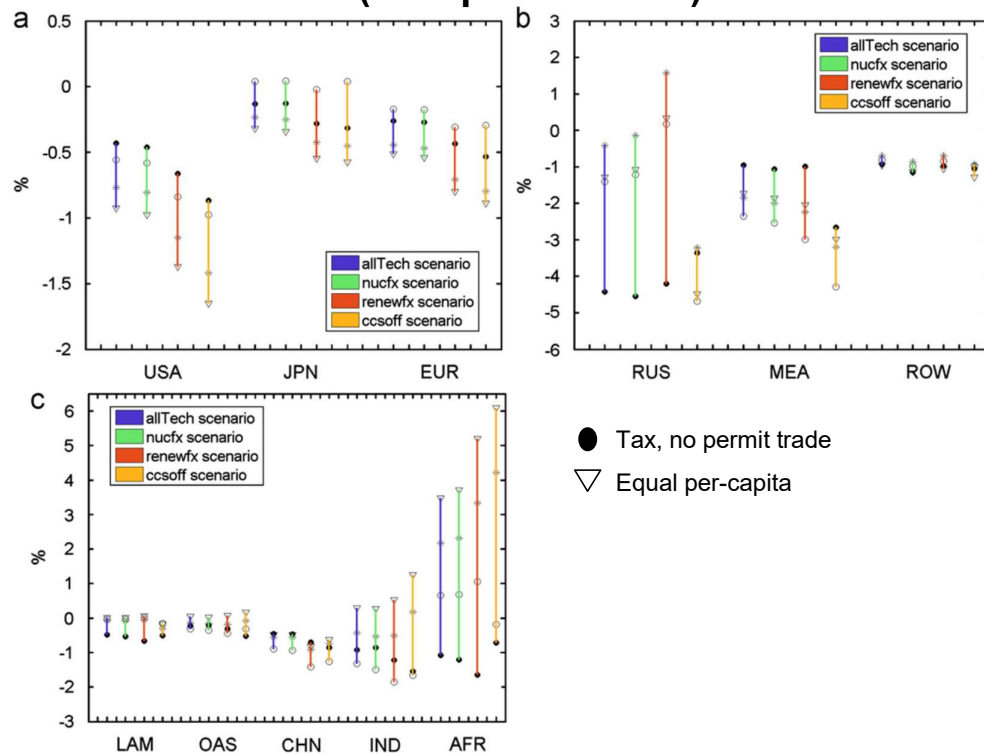
Lüken et al. (2011) 10.1016/j.enpol.2011.07.002

- C-budget value = C price * C-budget
→ Small value cake easier to negotiate
- Technology policies reduce the distributional conflict
- Innovation lowers carbon prices
→ value of the cake declines



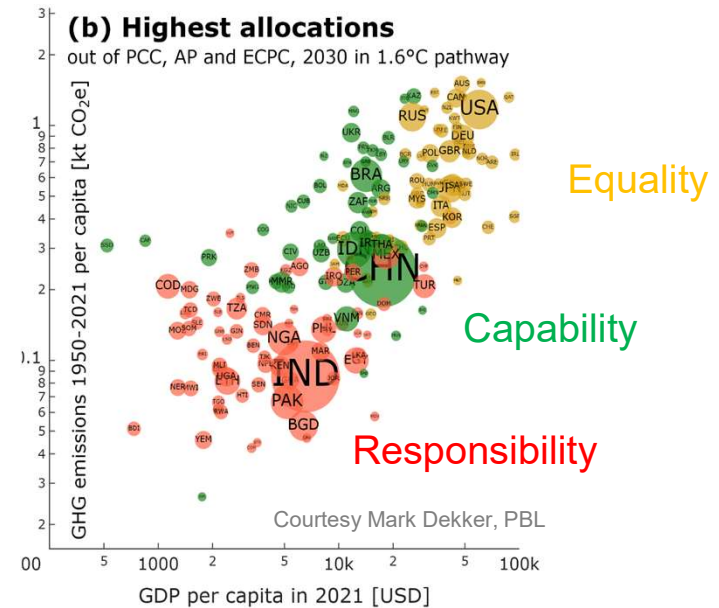
Political economy and permit allocation

Change of total consumption (incl. permit trade)



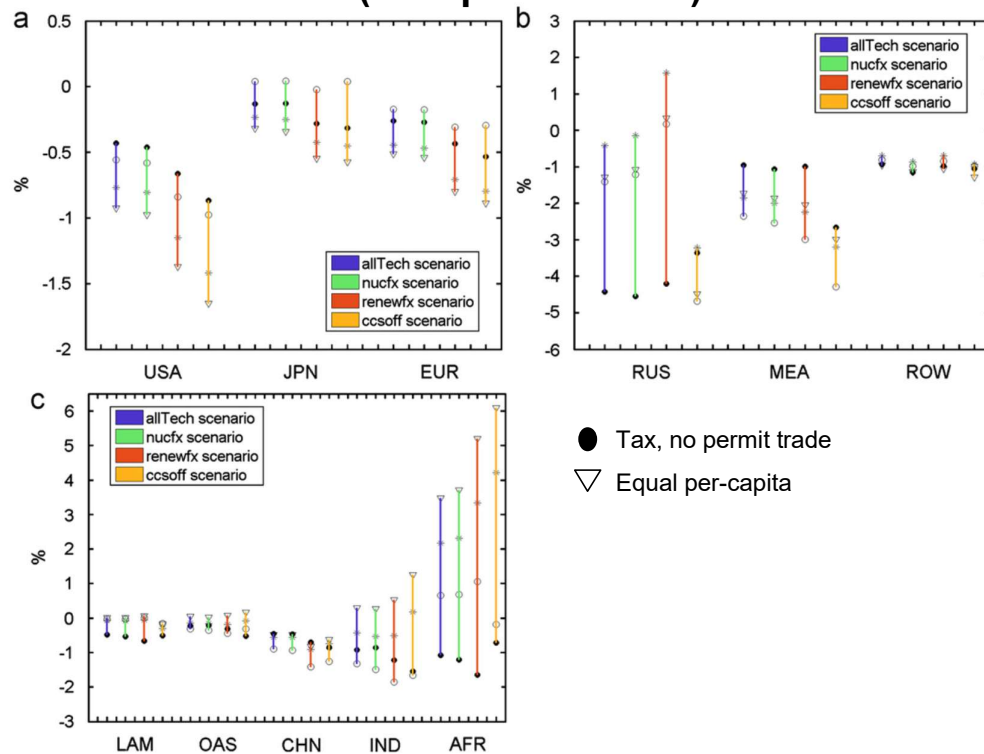
Lüken et al. (2011) 10.1016/j.enpol.2011.07.002
See also Leimbach et al. (2020) 10.1007/s10584-019-02469-8

- Cake sharing implies zero-sum game
- Regions prefer different allocation schemes
→ No consensus, no agreement



Political economy, technology and permit allocation

Change of total consumption (incl. permit trade)

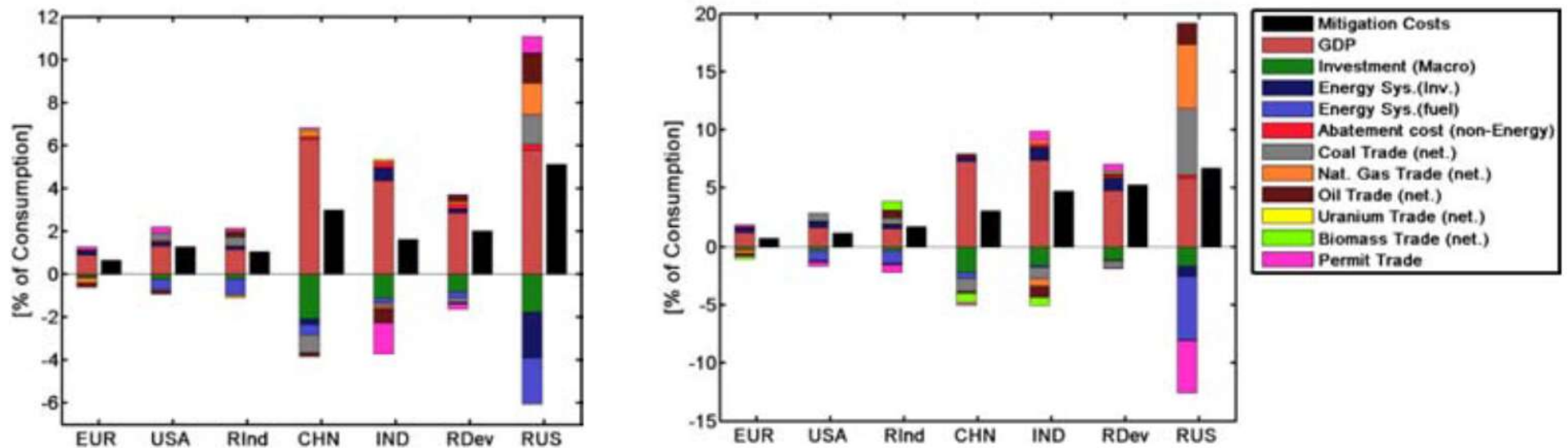


Lüken et al. (2011) 10.1016/j.enpol.2011.07.002
See also Leimbach et al. (2020) 10.1007/s10584-019-02469-8

- Cake sharing implies zero-sum game
- Regions prefer different allocation schemes
→ No consensus, no agreement
- Huge transfers are implied
→ For USA, JPN, EUR transfers exceed mitigation costs
→ questions (fiscal) sovereignty
- For potential permit importers technology development is attractive
→ reduced domestic mitigation costs
→ devaluation of permits lowers import value

What is driving the mitigation costs?

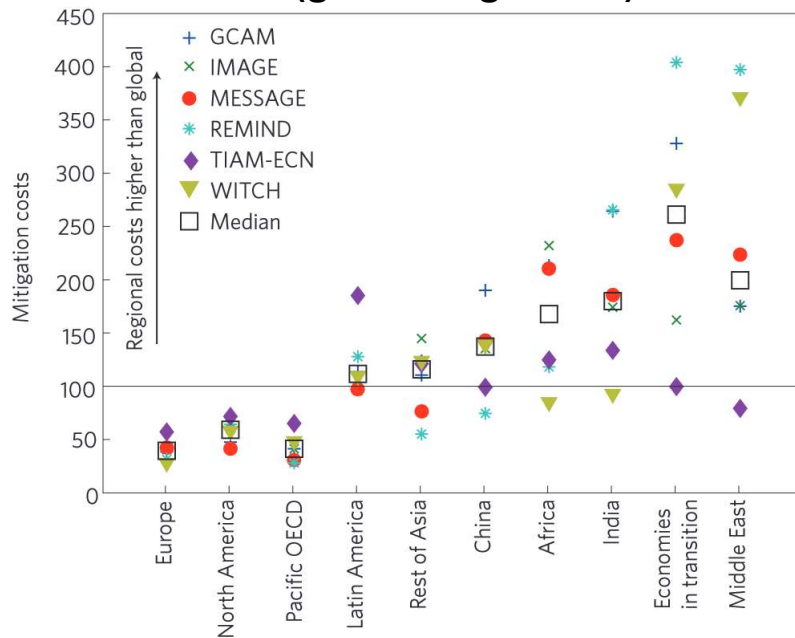
Decomposing the consumption losses of each region



Aboumahboub et al. (2014)
<http://www.worldscientific.com/doi/abs/10.1142/S2010007814400028>

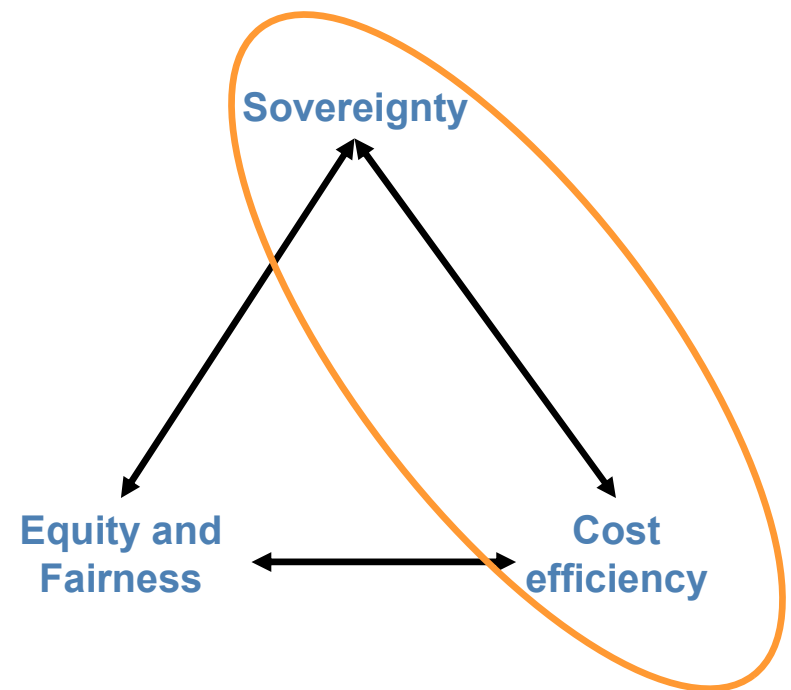
Mitigation costs and transfers – Are the differences ideosyncratic

**Regional mitigation costs
(global avg. = 100)**



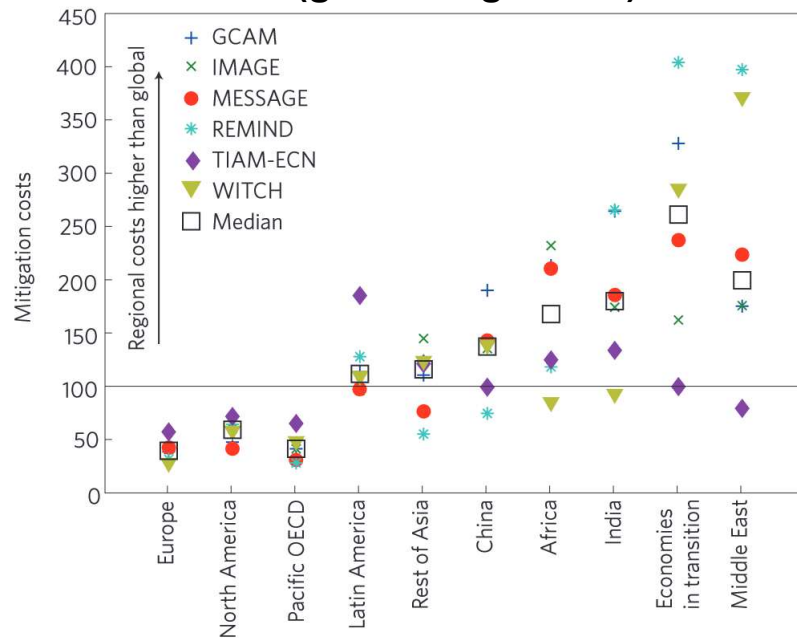
Tavoni et al. 2015, <http://www.nature.com/articles/nclimate2475>

Cap-and-trade + No transfer = unfair burden sharing



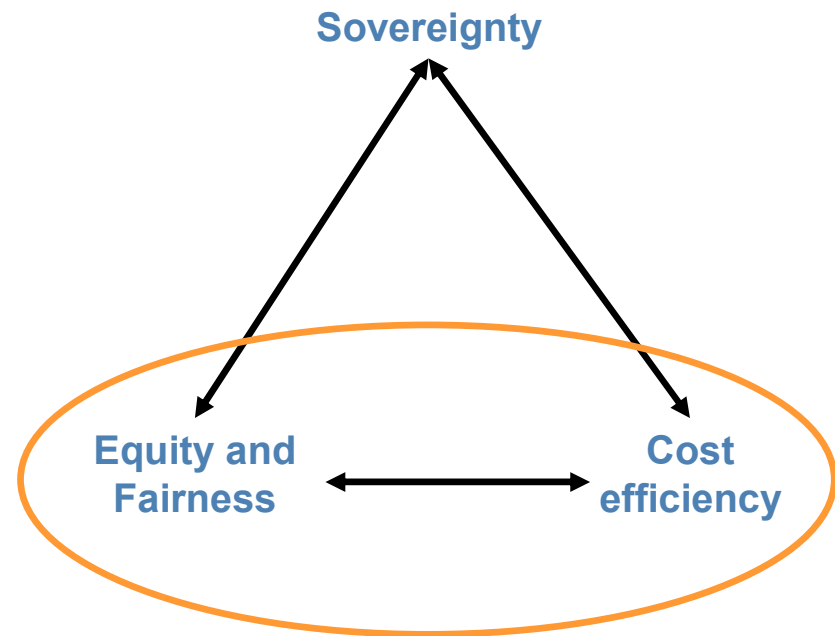
Mitigation costs and transfers – Are the differences ideosyncratic

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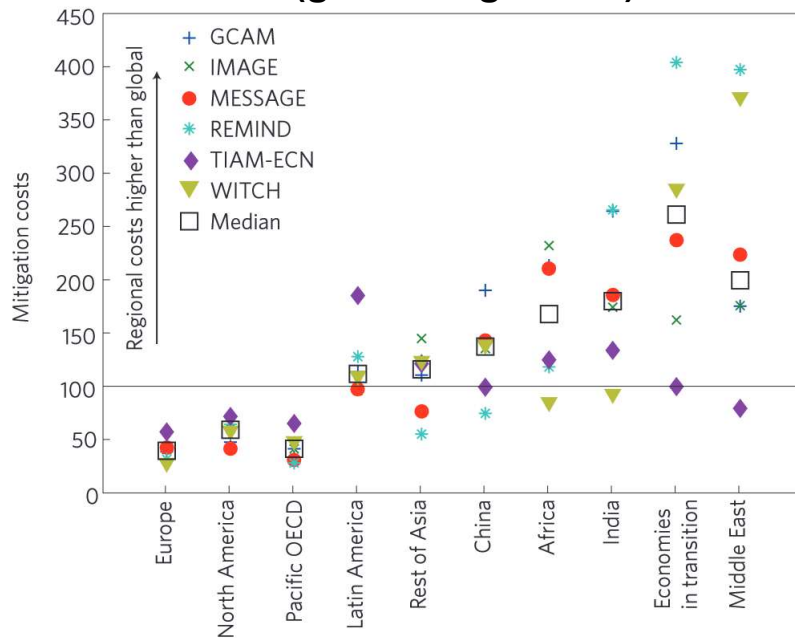
Tavoni et al. 2015, <http://www.nature.com/articles/nclimate2475>

Cap-and-trade + fair burden sharing = transfers needed

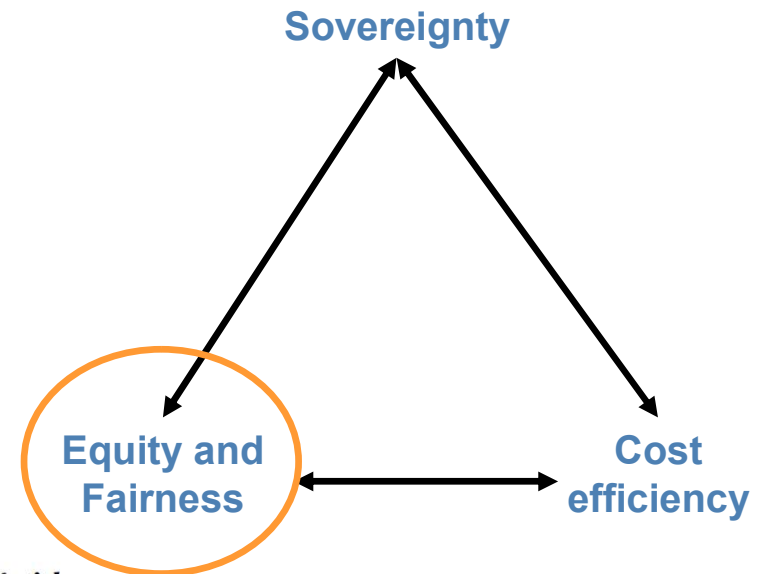


Mitigation costs before transfers – is the regional bias ideosyncratic

**Regional mitigation costs
(global avg. = 100)**



Tavoni et al. 2015, <http://www.nature.com/articles/nclimate2475>



Article

Quantification of an efficiency–sovereignty trade-off in climate policy

<https://doi.org/10.1038/s41586-020-2982-5>

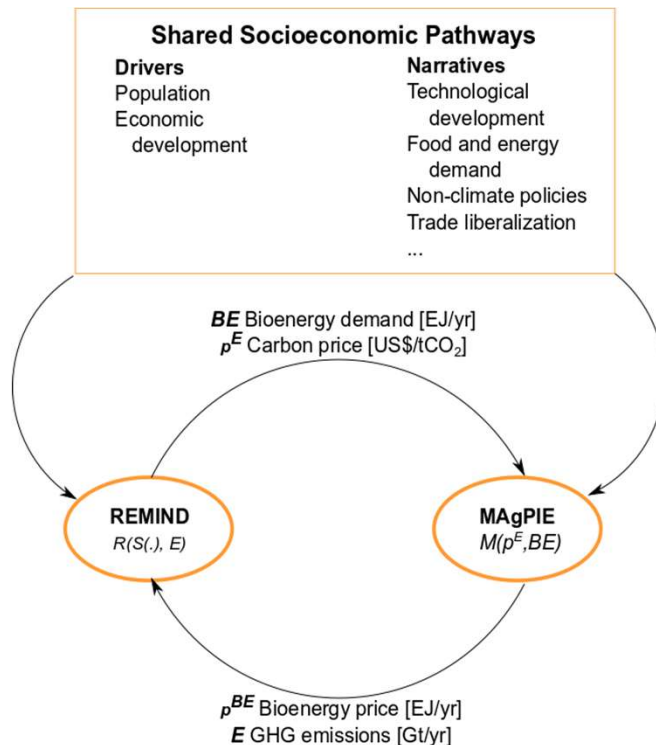
Received: 13 March 2020

Nico Bauer^{1,2}, Christoph Bertram¹, Anselm Schultes¹, David Klein¹, Gunnar Luderer^{1,2}, Elmar Kriegler¹, Alexander Popp¹ & Ottmar Edenhofer^{1,2,3}

Nico Bauer, PRISMA Summer School
Utrecht, July 10, 2025

**From here on we leave the save waters
of uniform carbon pricing**

Methodology – REMIND-MAgPIE model



Energy-economy and land-use model

12 regions up-until 2100

Trade in goods, energy and food

All GHGs from all sources

SSP2 drivers applied

2020 fixed to NDC policies

Carbon tax starts 2025 growing at 5%/yr, flattens post-2050

Total budget 2016-2100 is 1300GtCO₂

Effort indicator: equal relative income loss

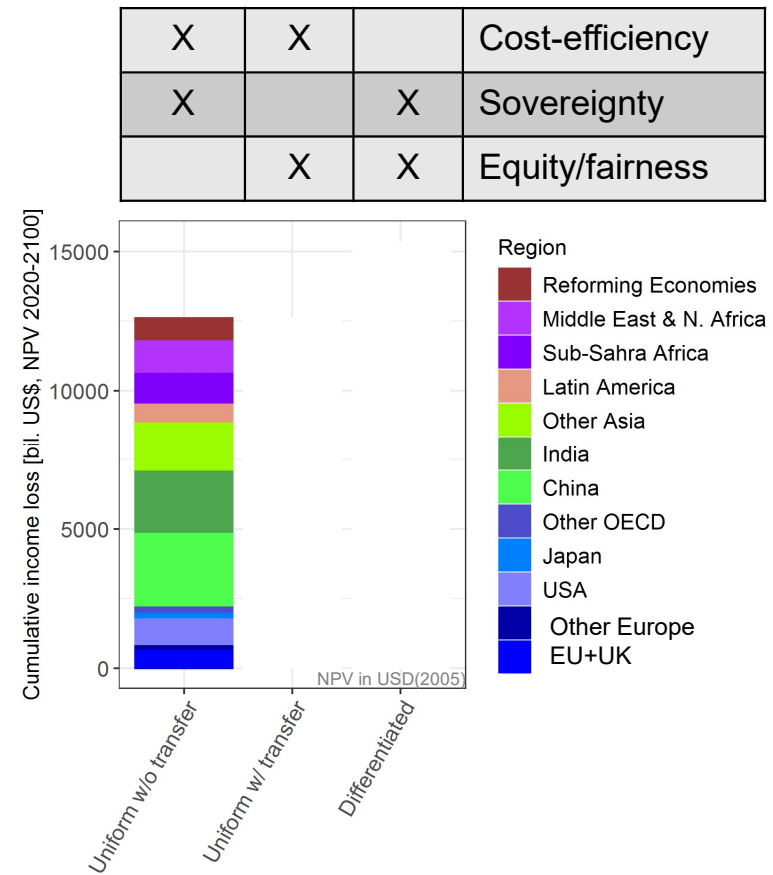
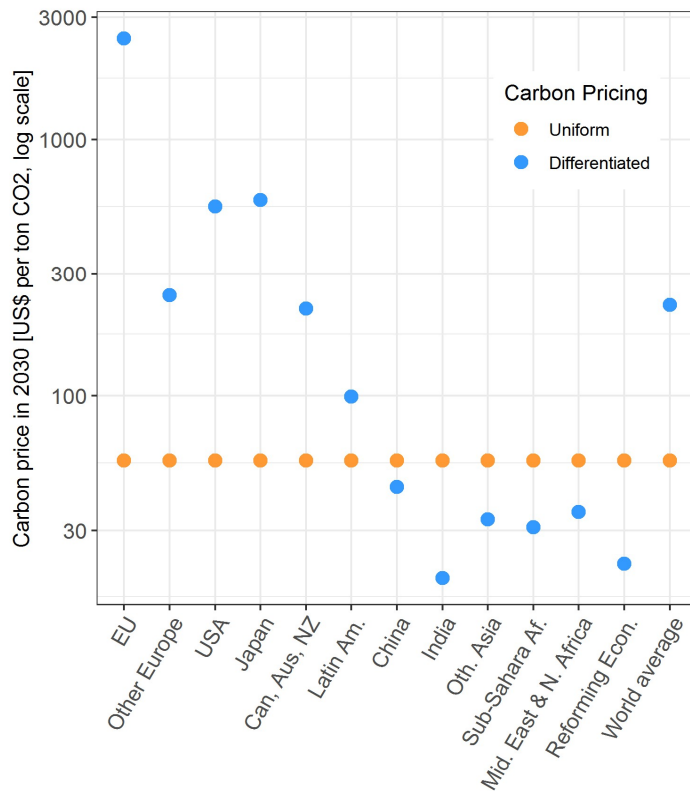
2021-2100 discounted at 5% p.a.

➔ Avoid regressive income effects

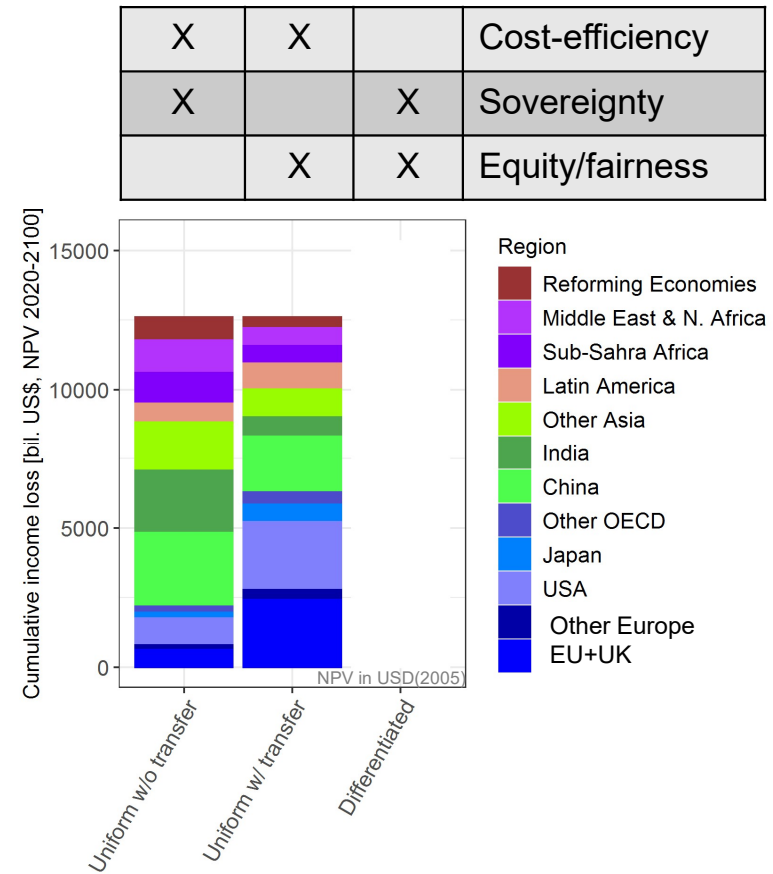
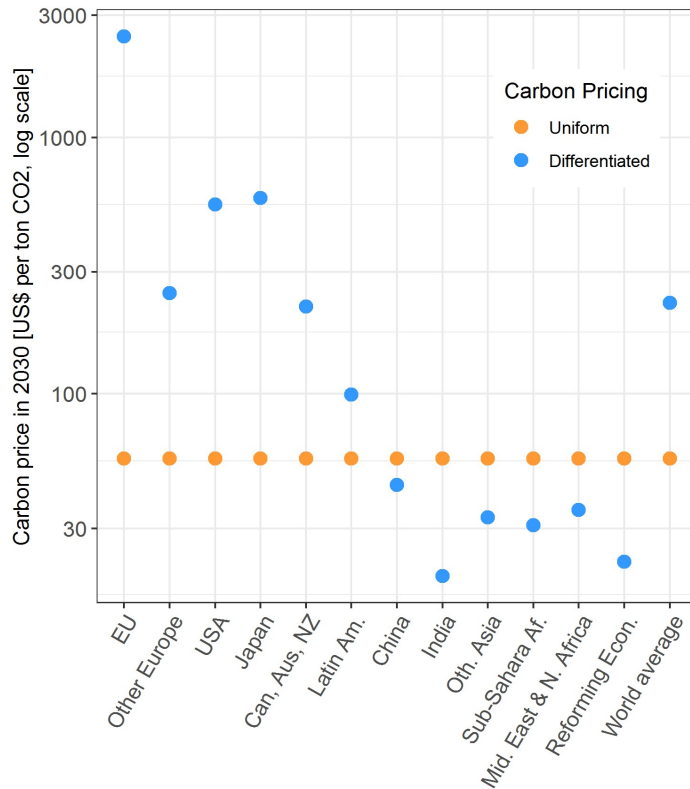
Important notion

- From here onwards: no cap-and-trade any more
- Now: Emissions taxes with
 - domestic revenue recycling and
 - International transfers
- Emissions taxes can vary across regions

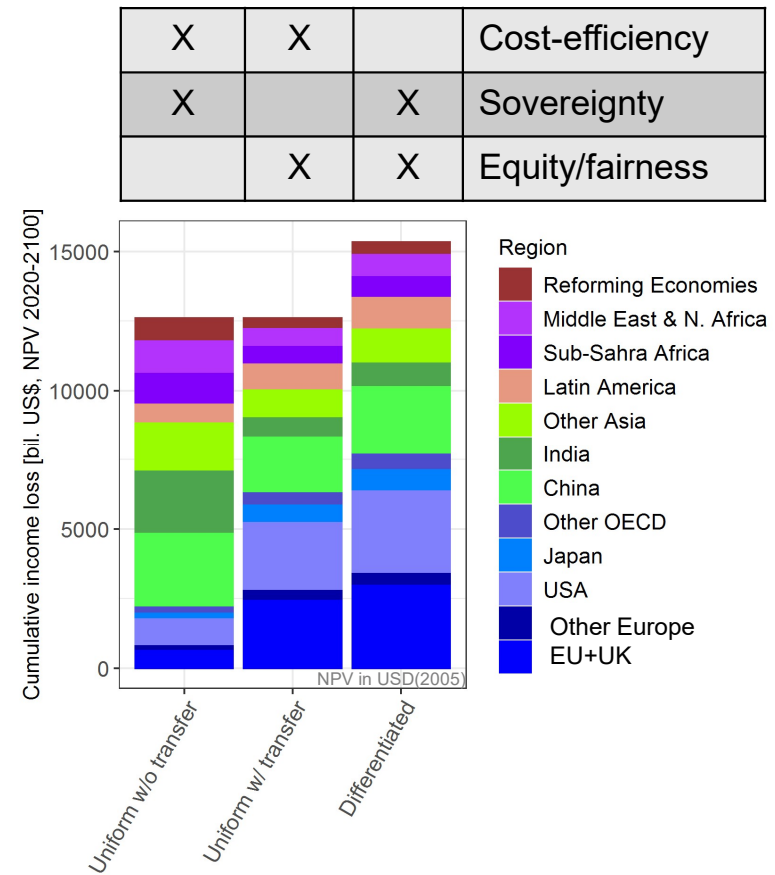
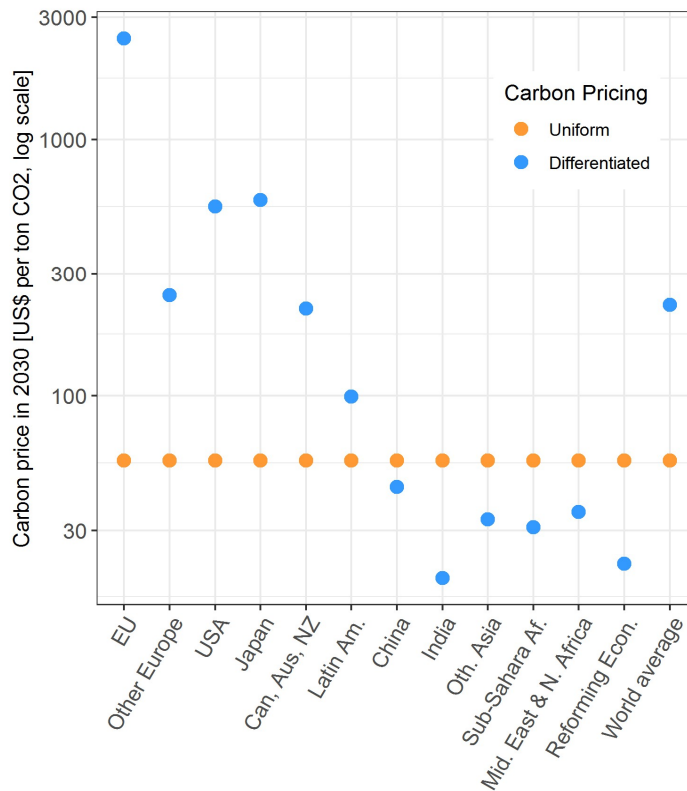
Trilemma: Cost-efficiency, sovereignty and equity



Trilemma: Cost-efficiency, sovereignty and equity



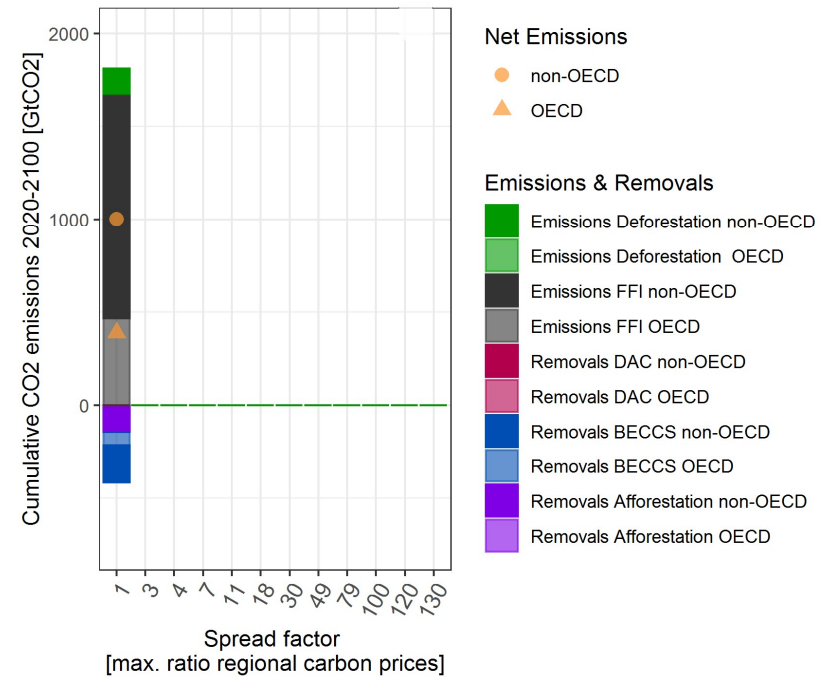
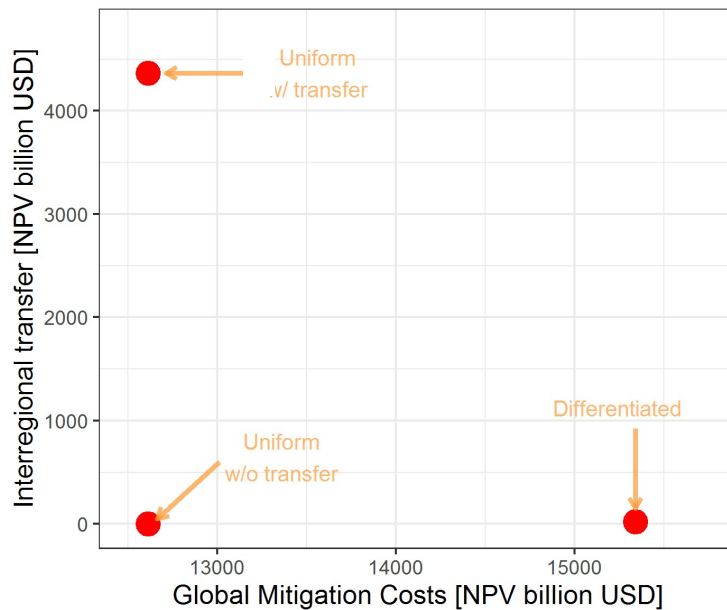
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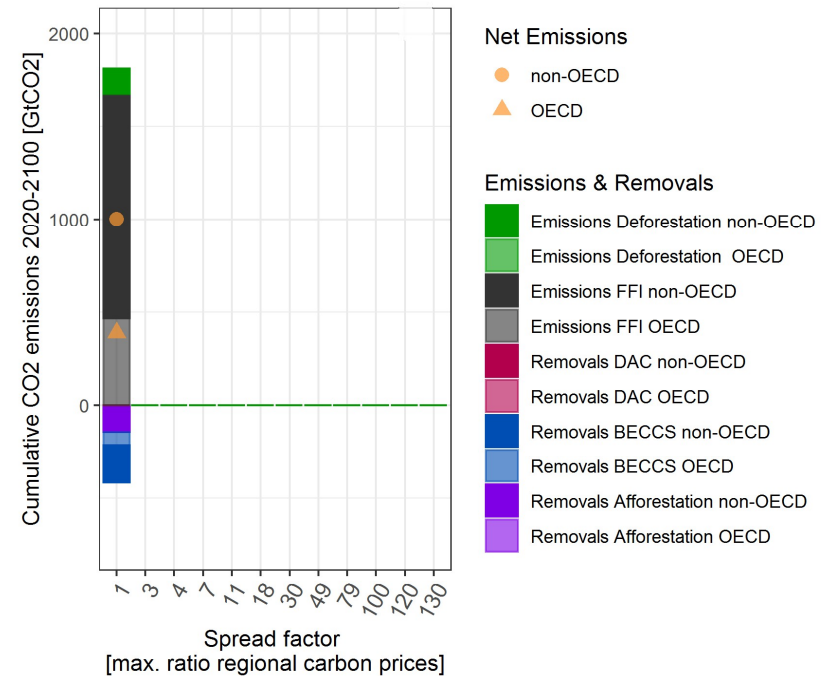
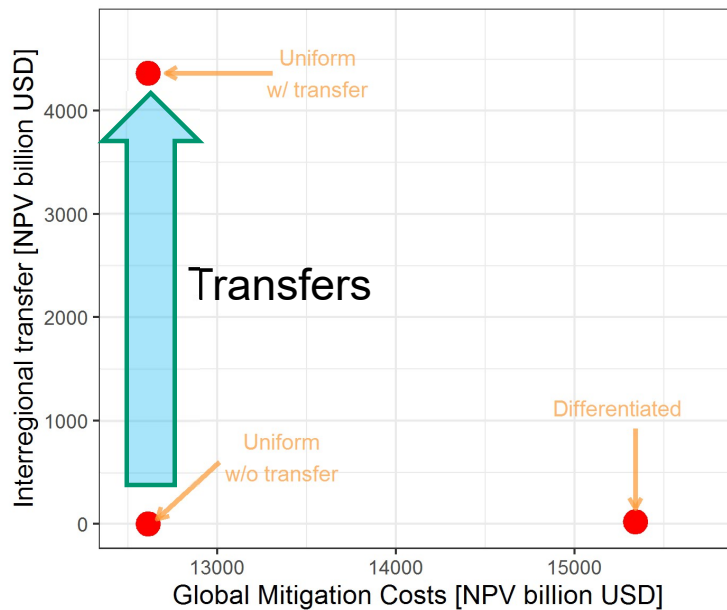
Results

The trade-off curve

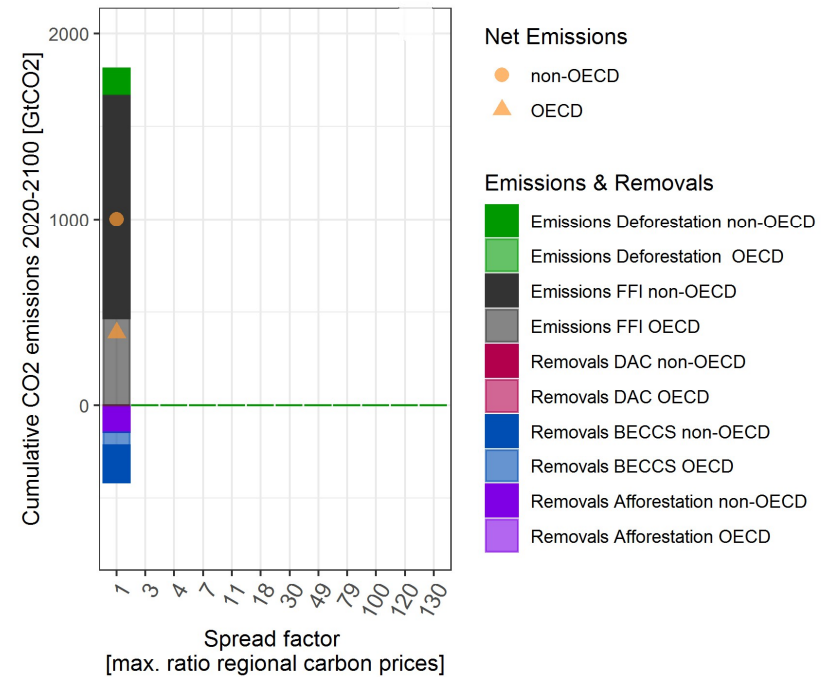
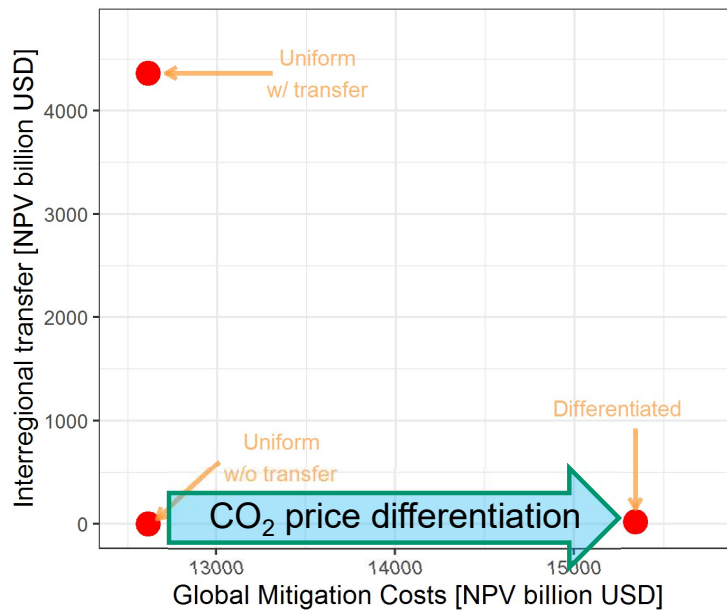
Efficiency-sovereignty trade-off and regional emissions



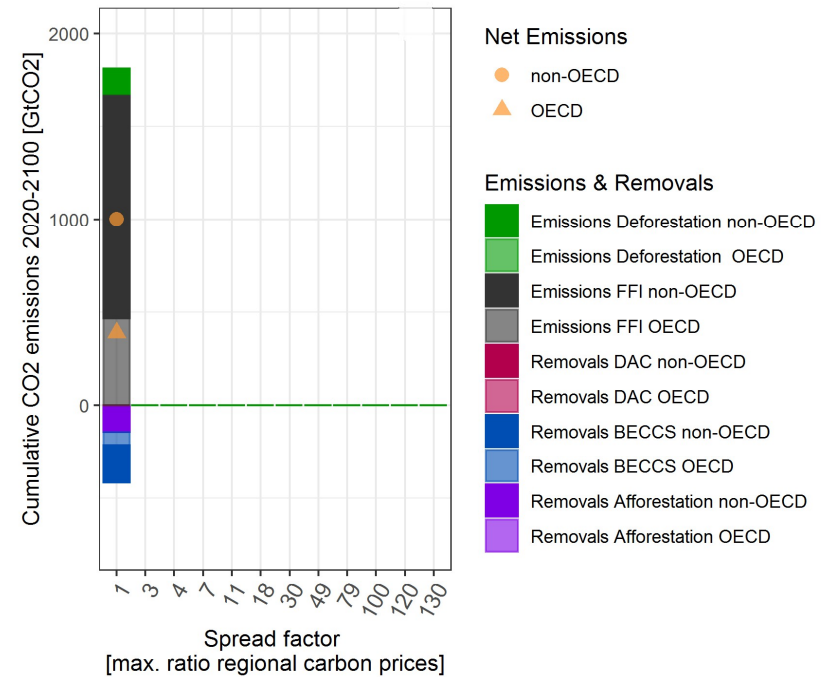
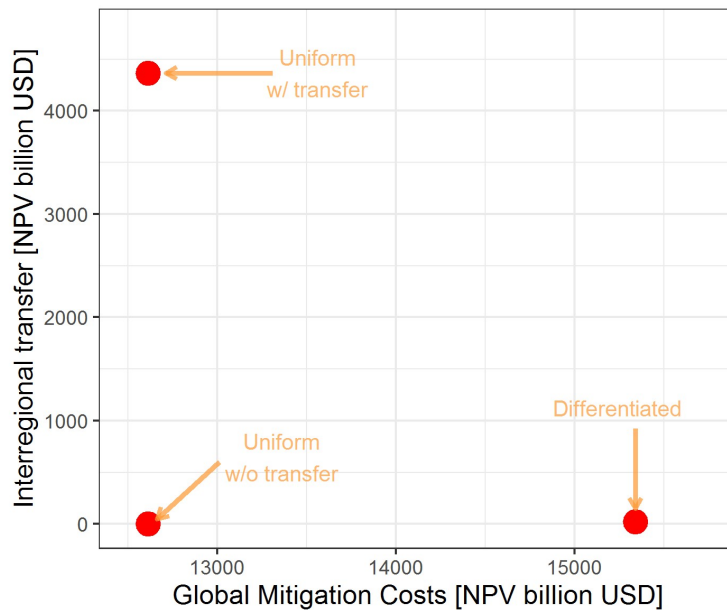
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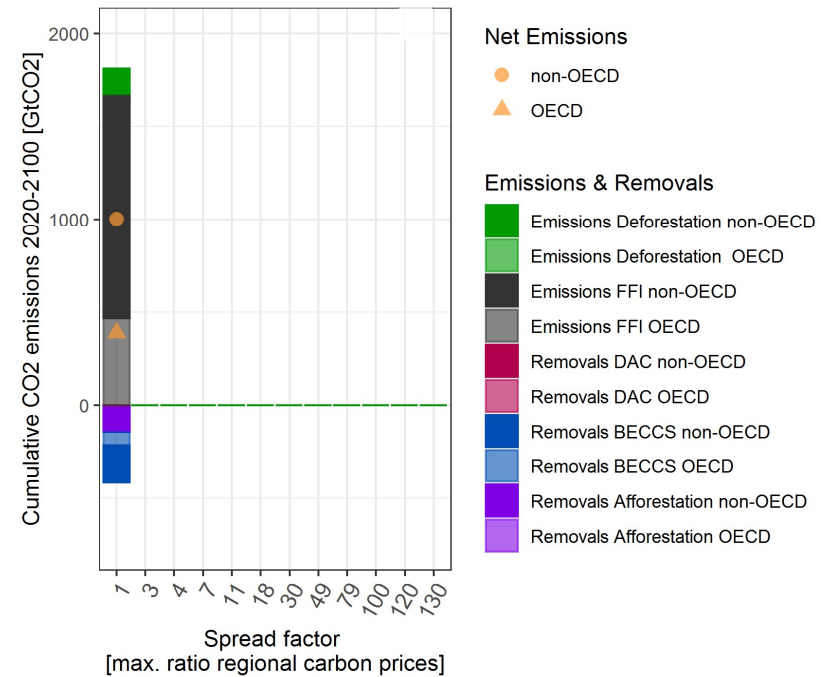
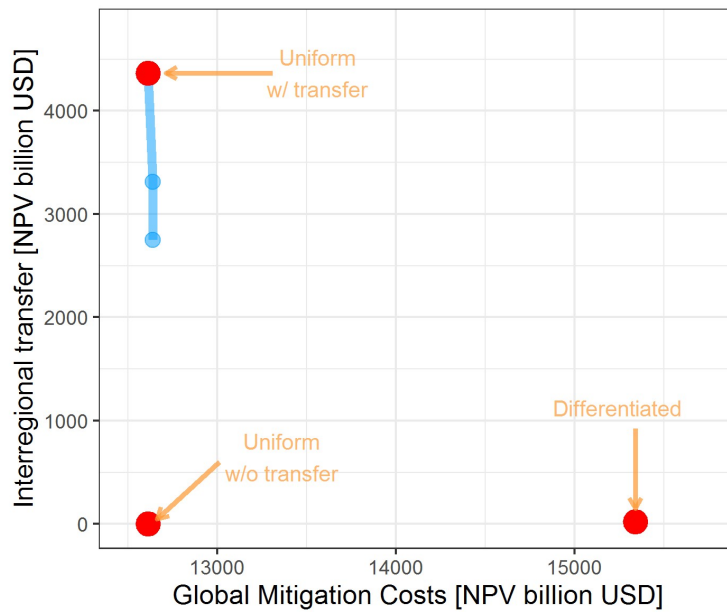
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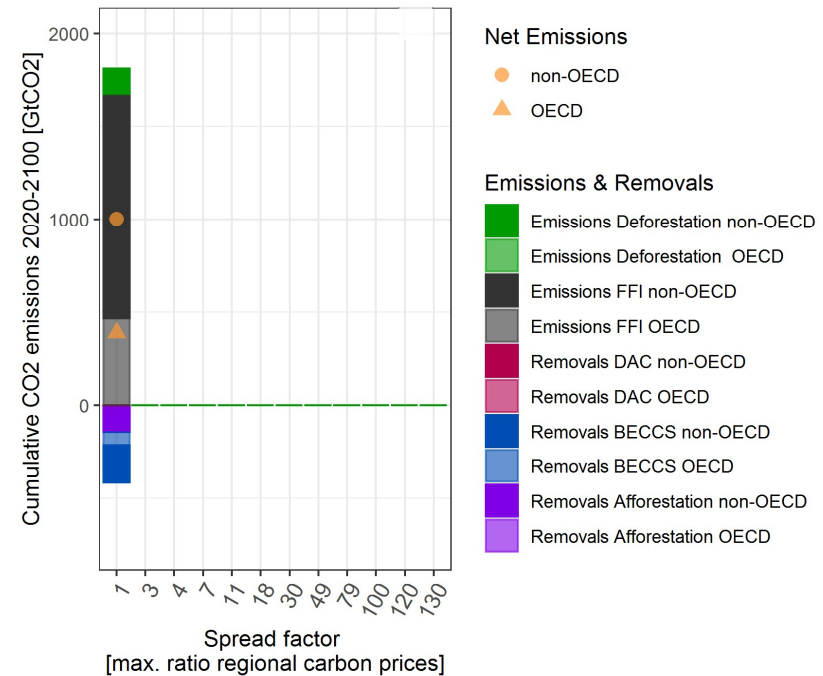
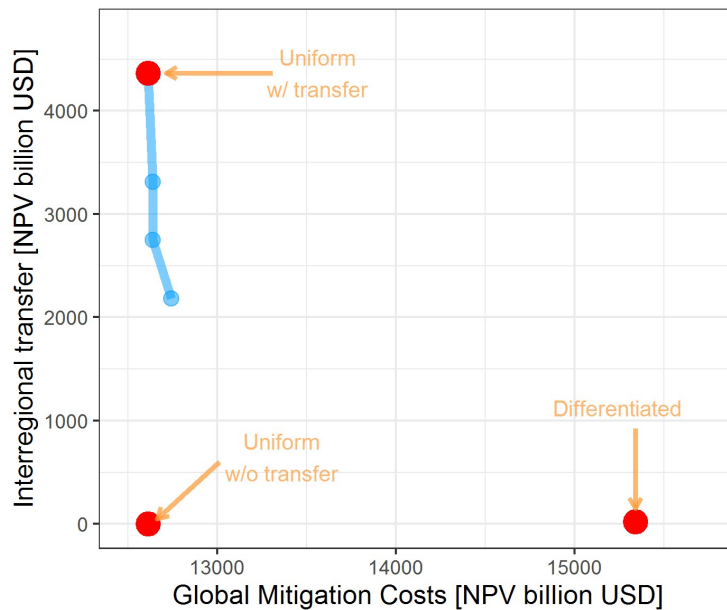
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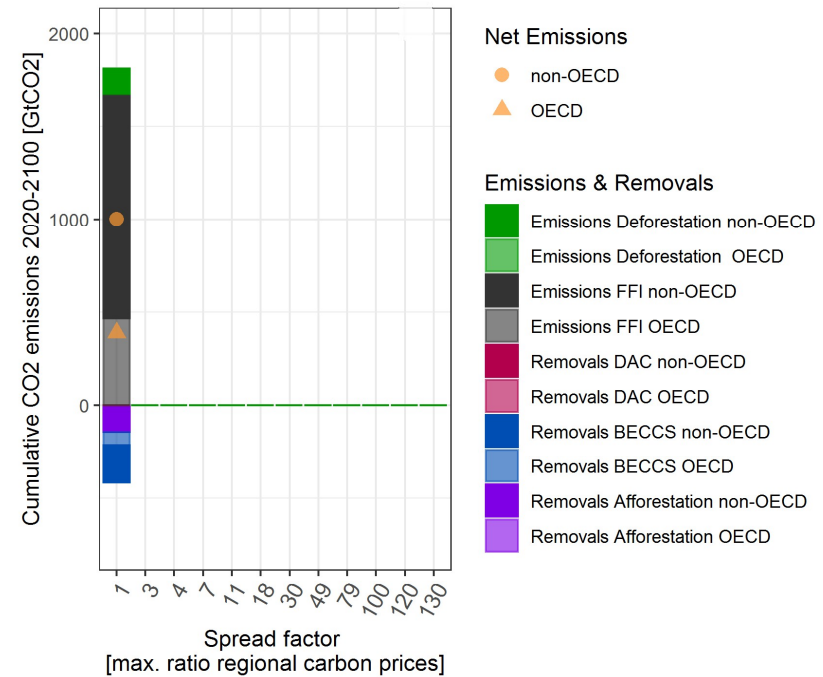
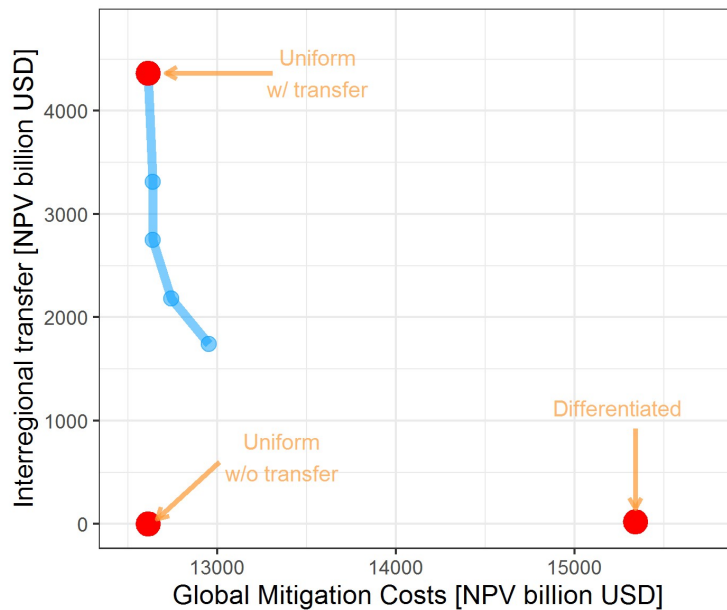
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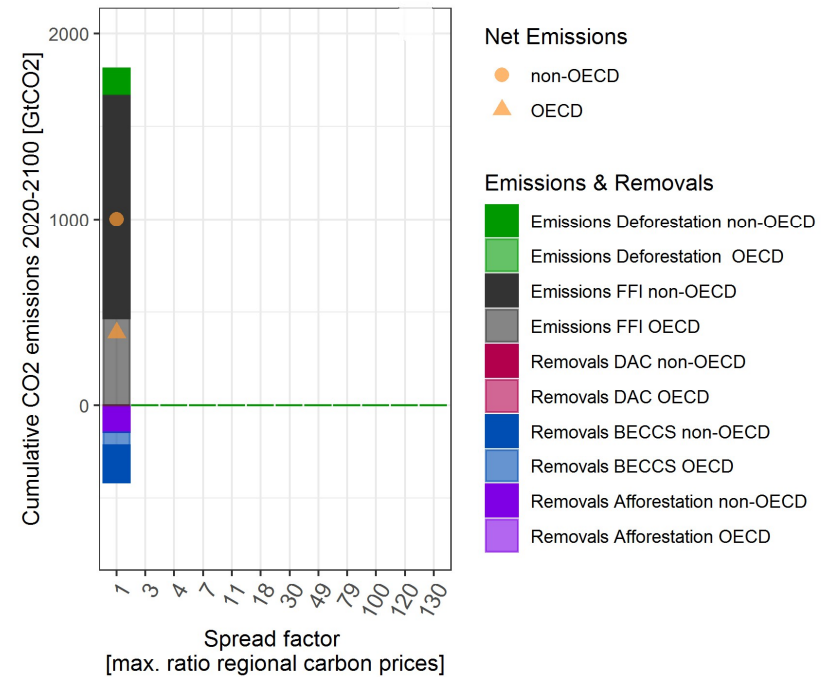
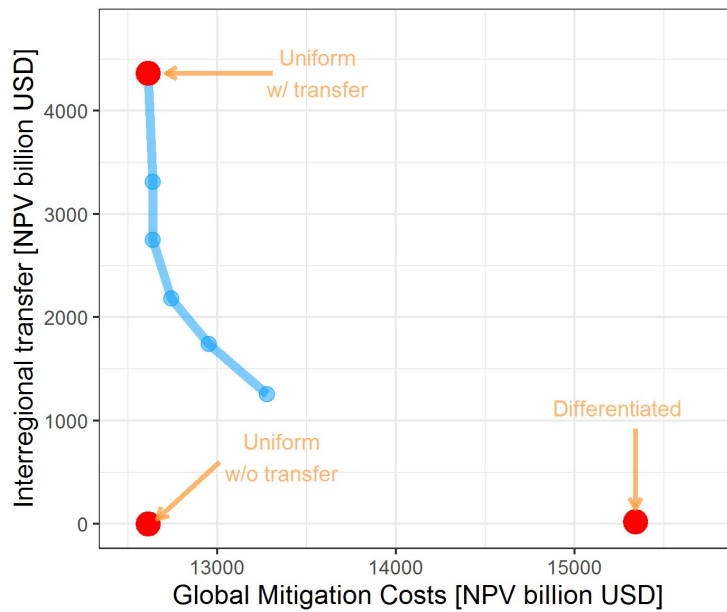
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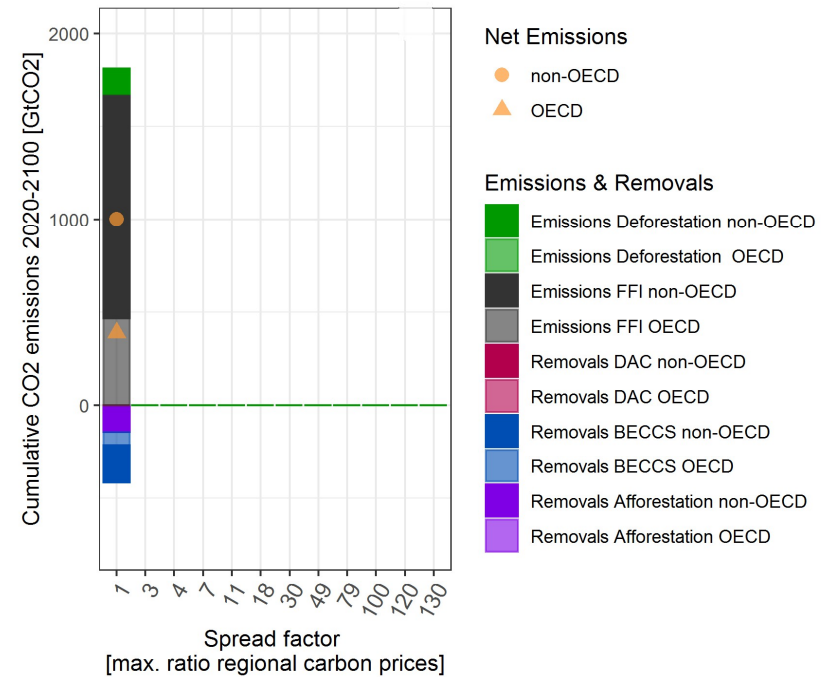
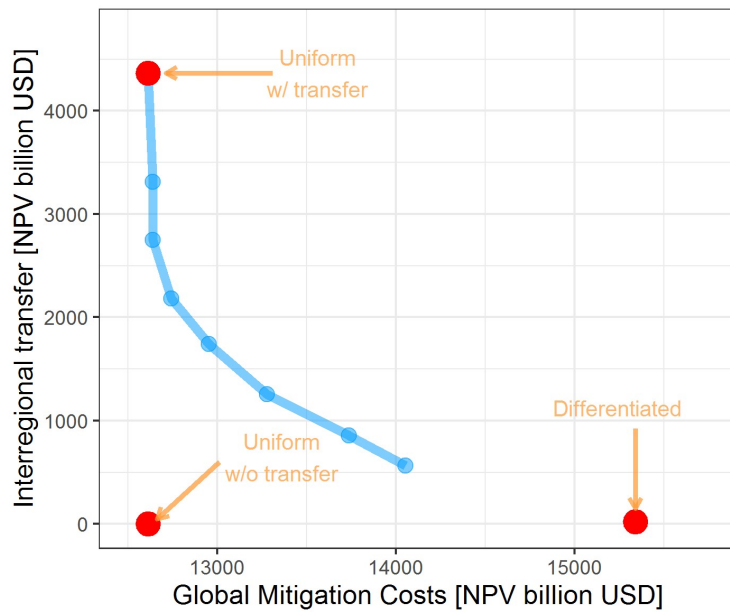
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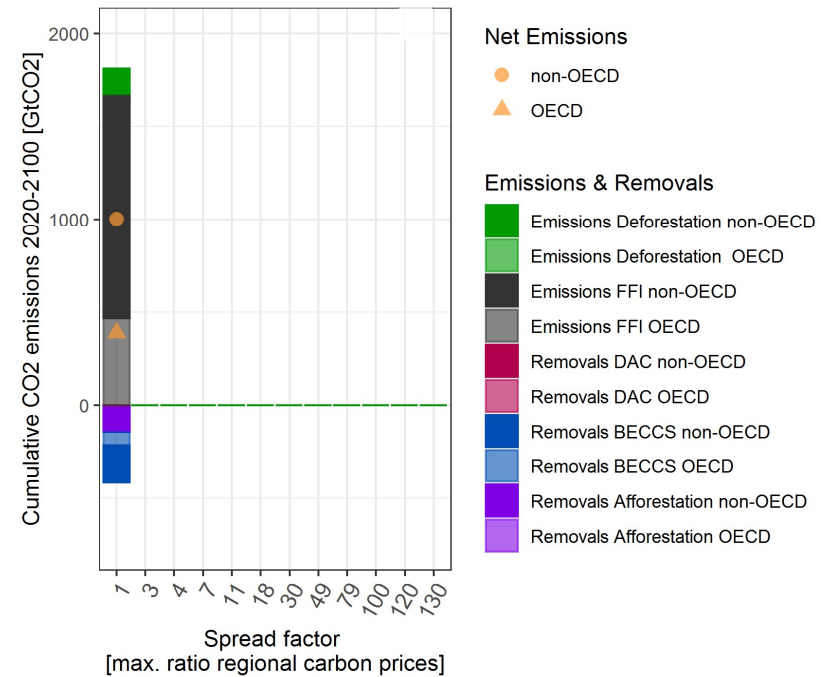
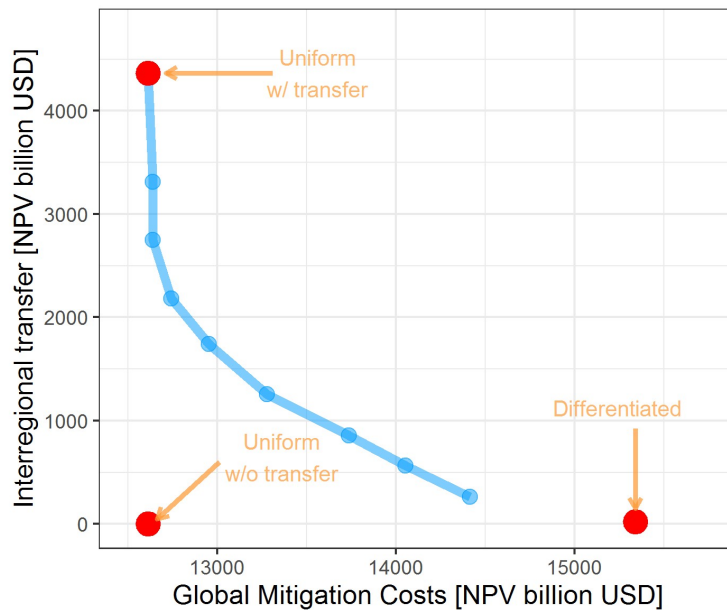
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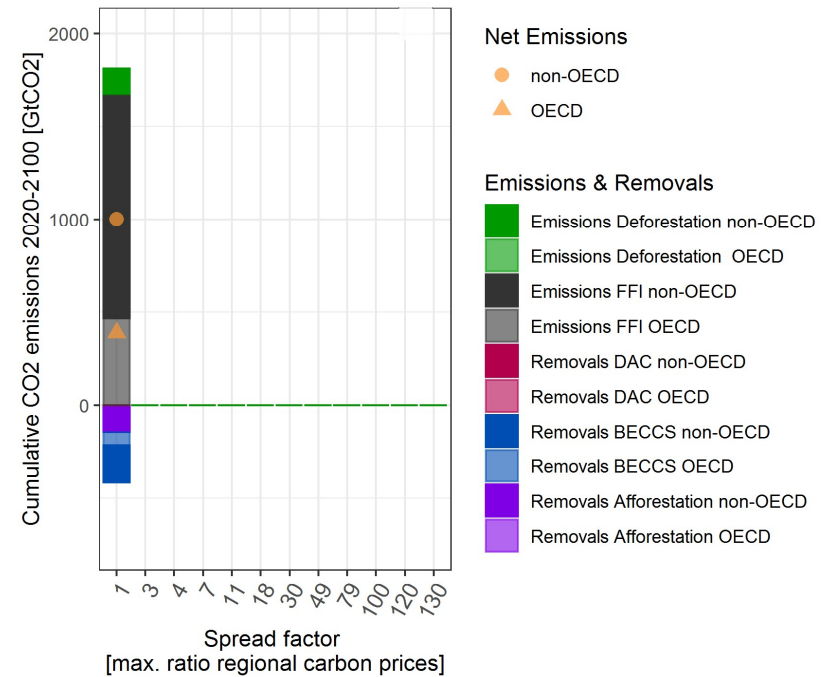
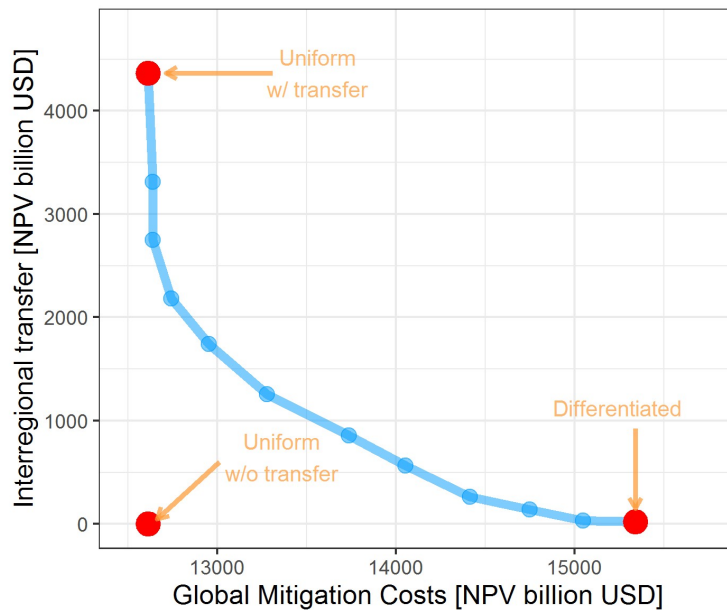
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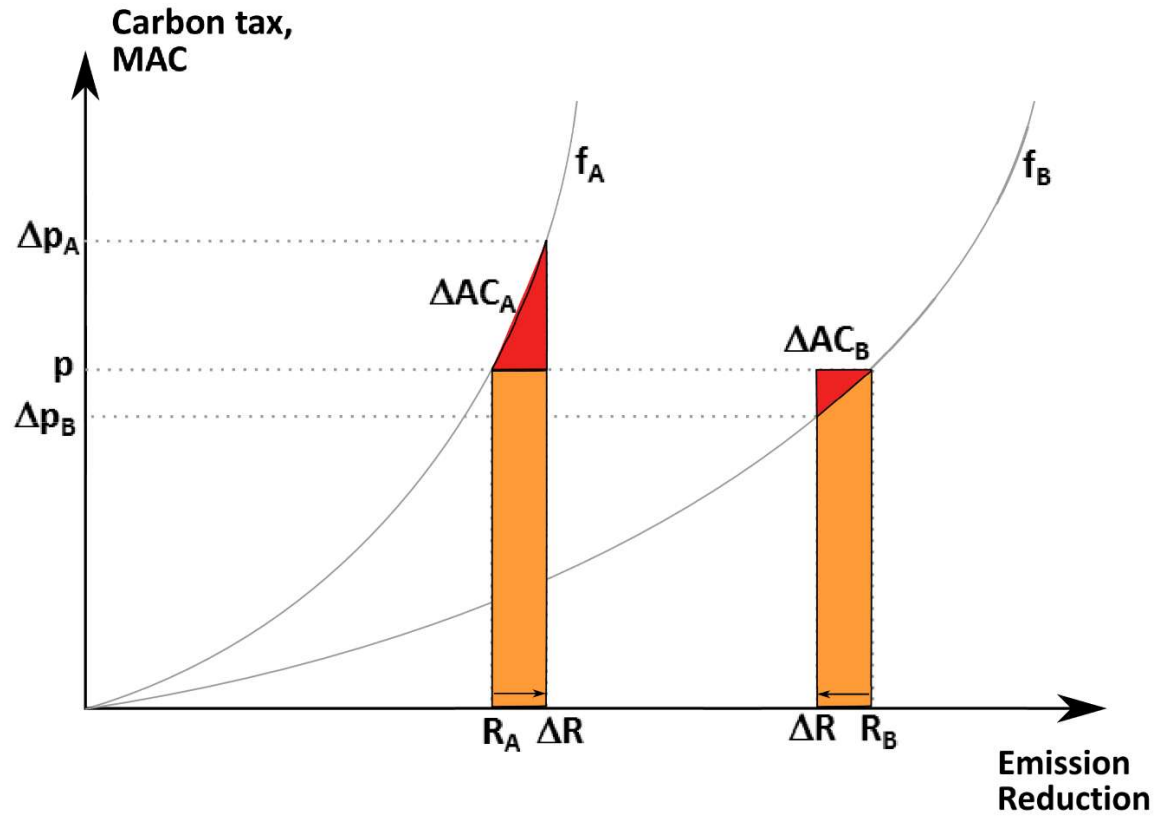
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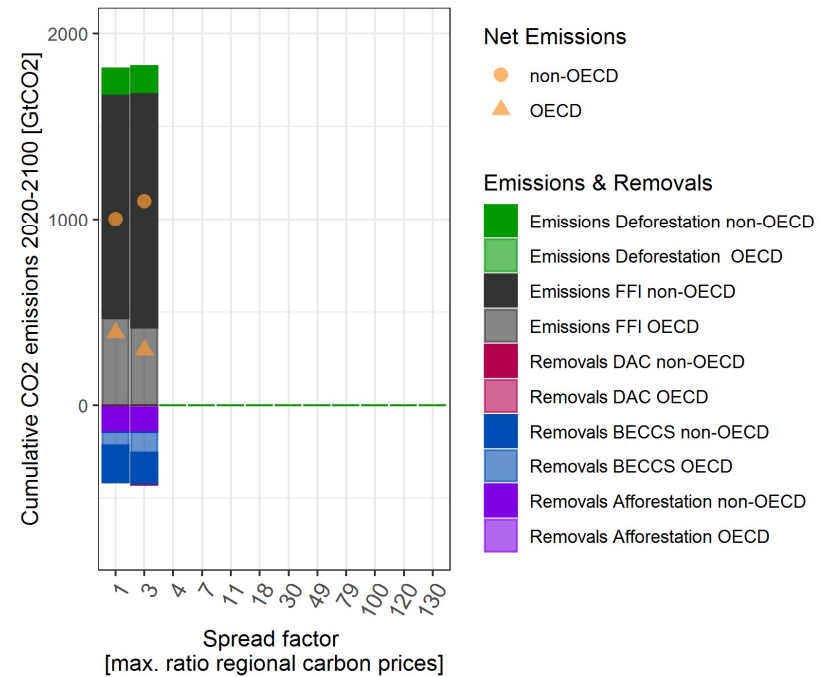
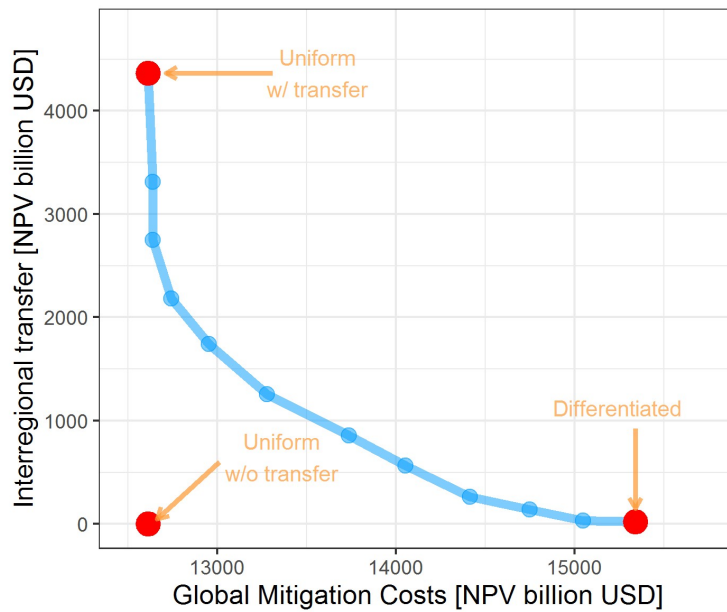
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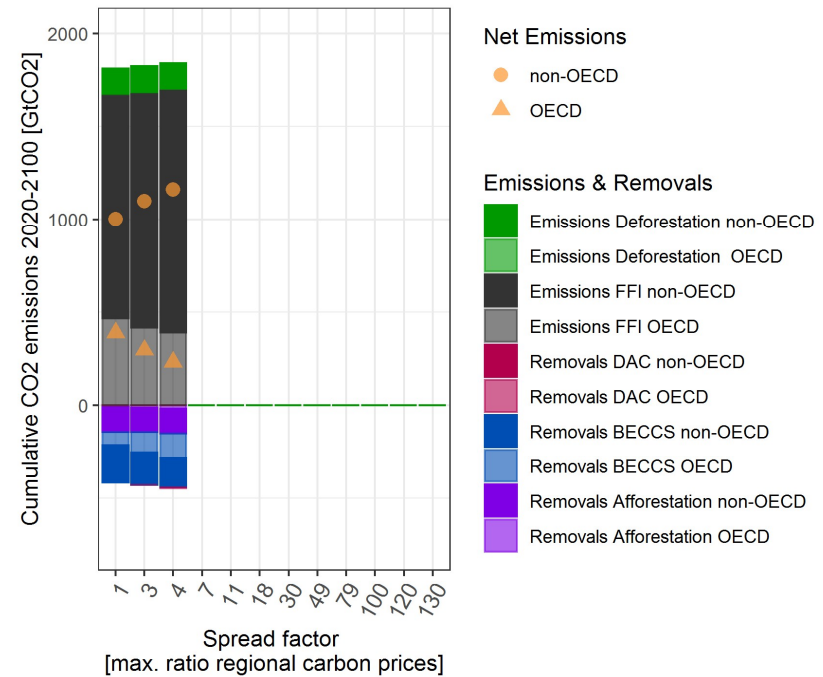
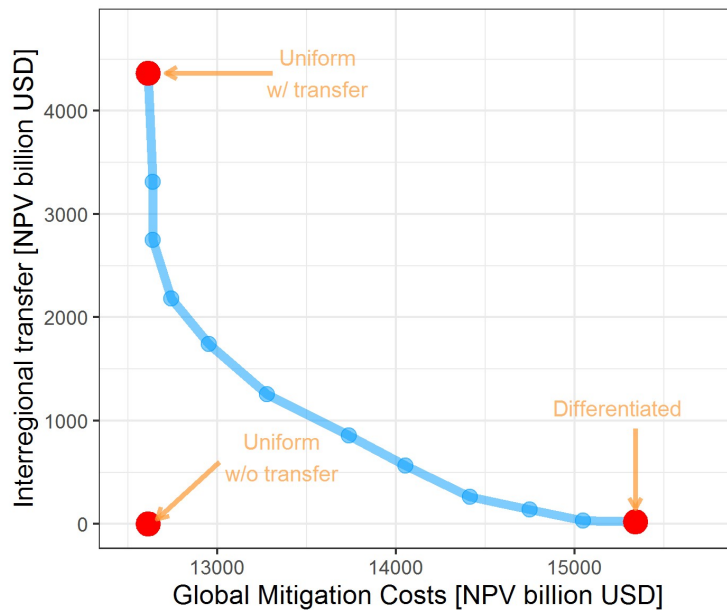
The nonlinearity results form economic market equilibrium



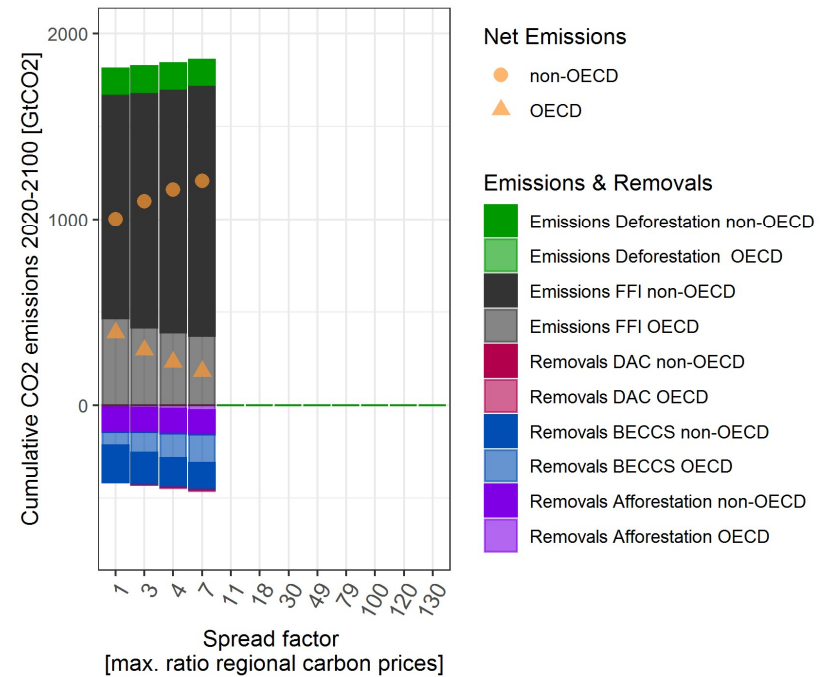
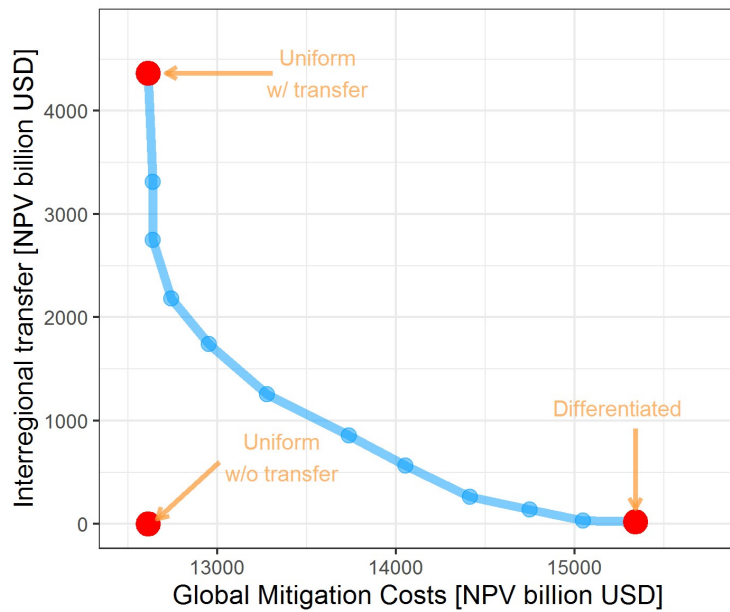
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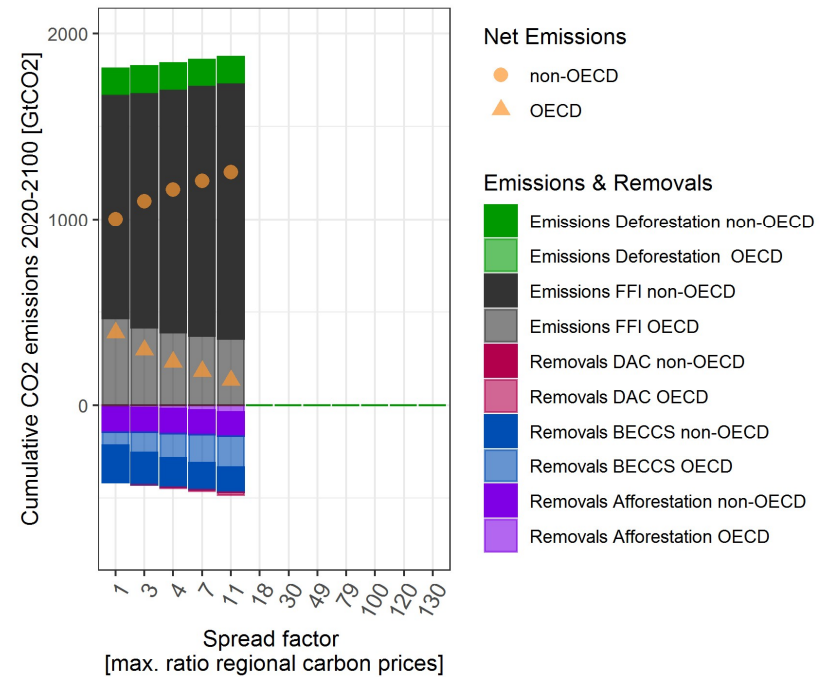
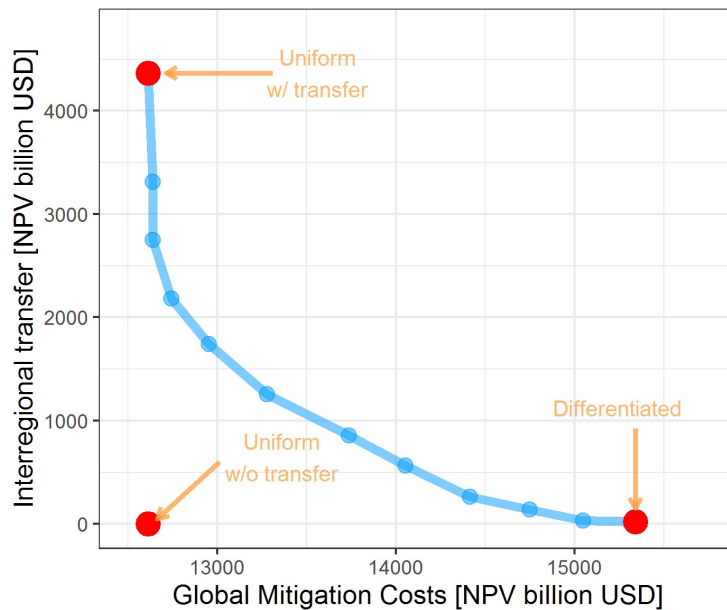
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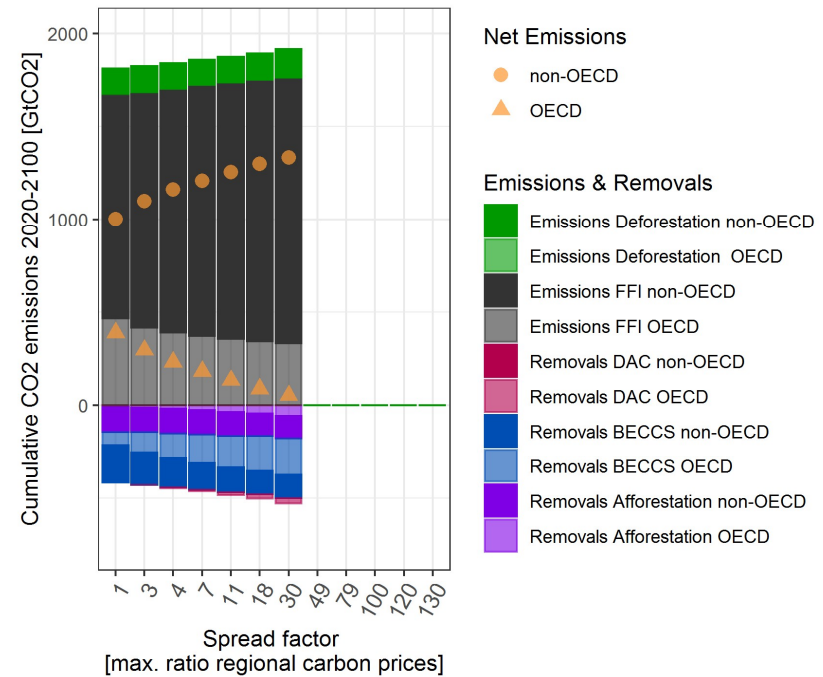
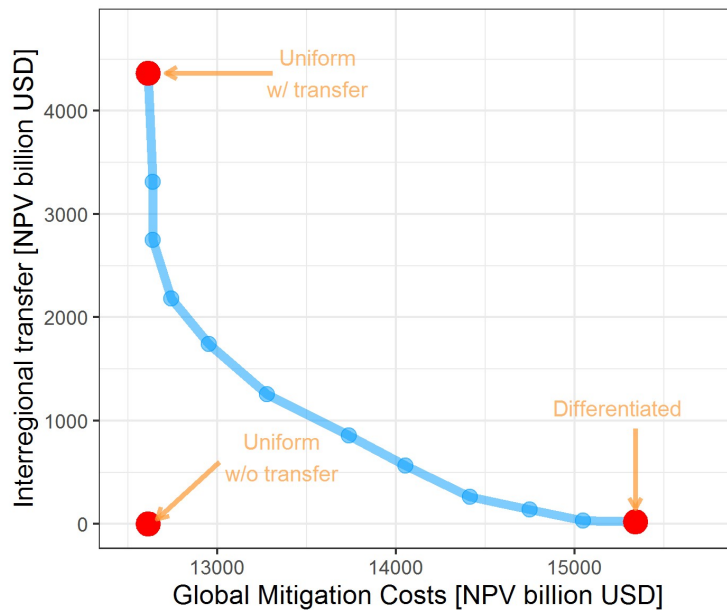
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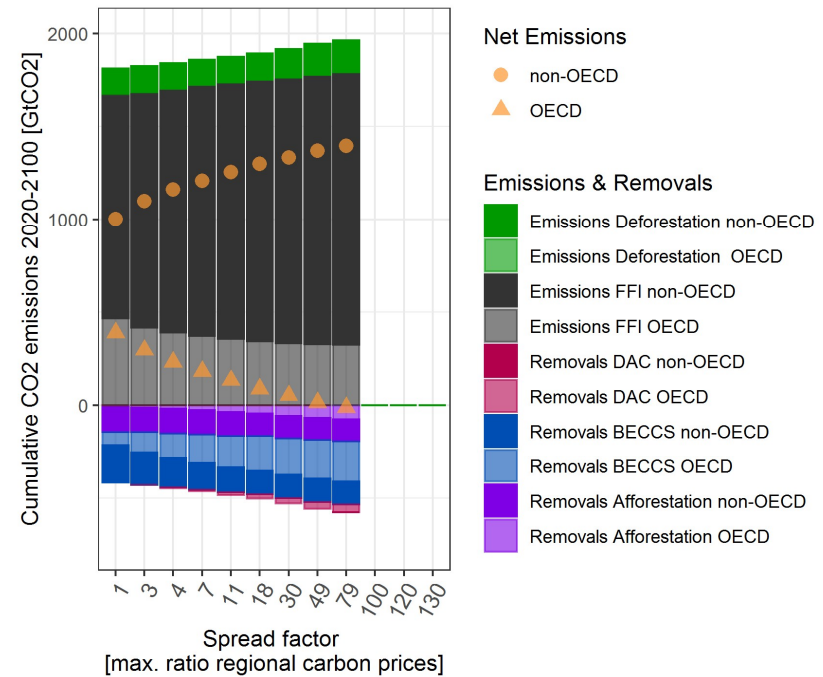
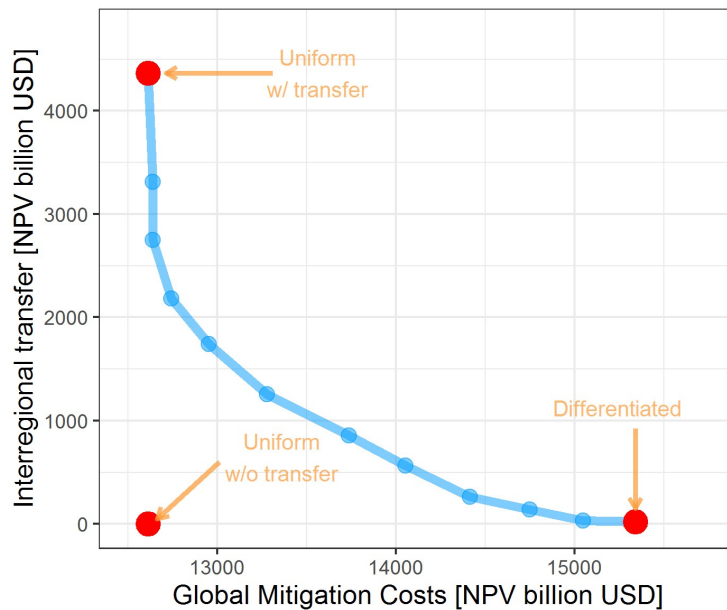
Efficiency-sovereignty trade-off and regional emissions



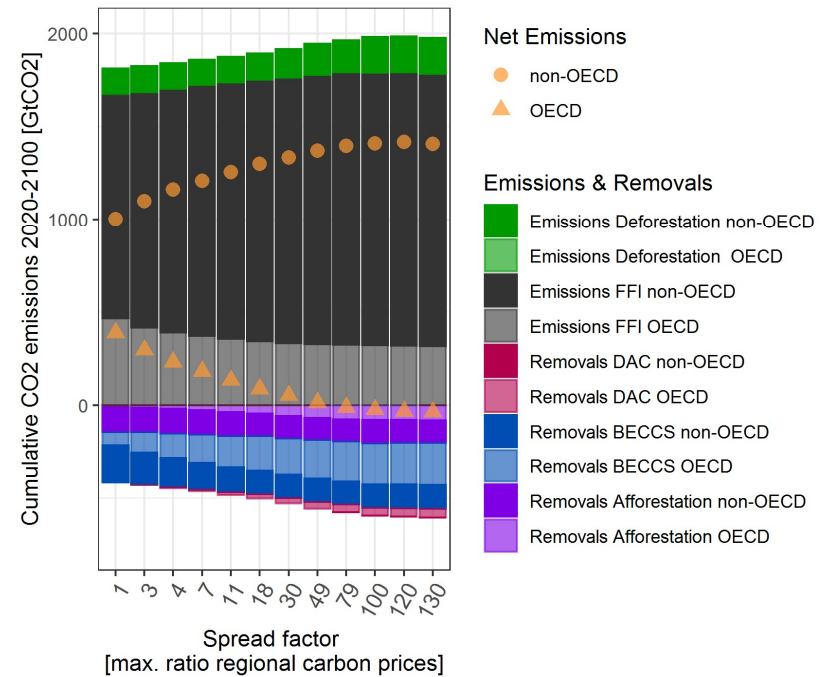
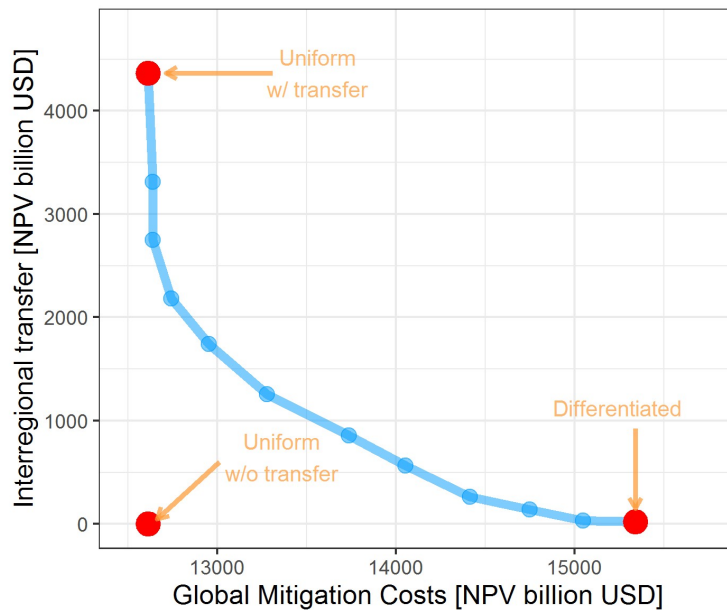
Efficiency-sovereignty trade-off and regional emissions



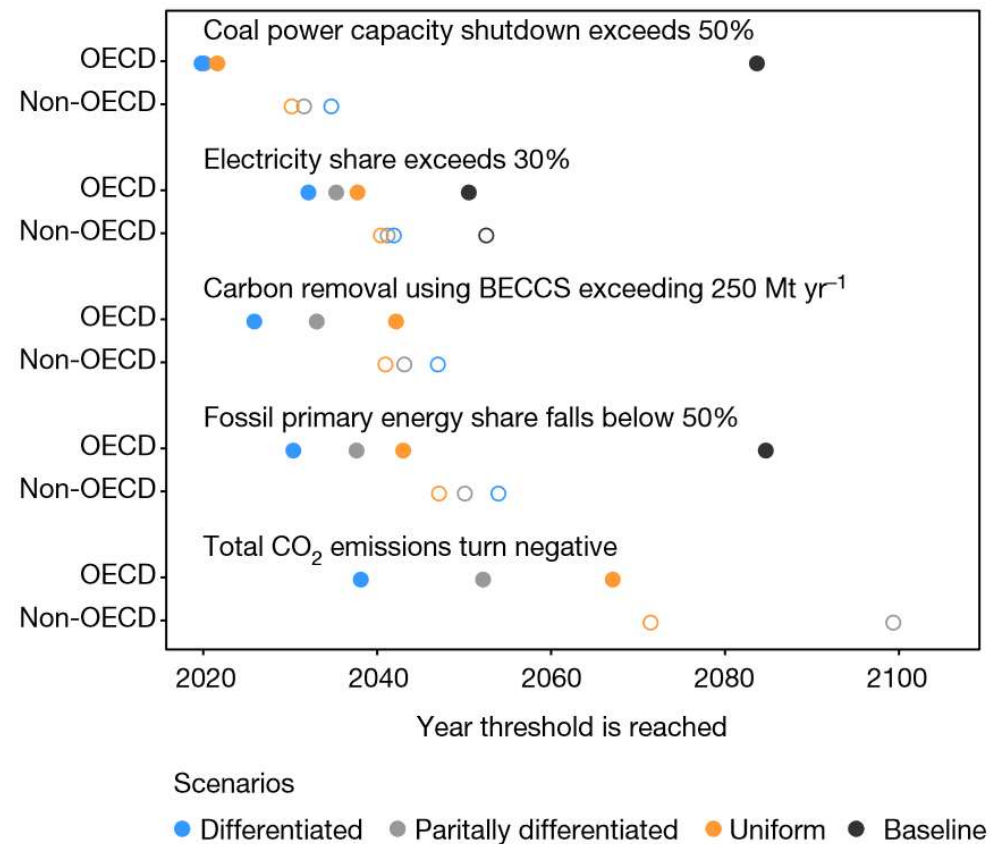
Efficiency-sovereignty trade-off and regional emissions



Efficiency-sovereignty trade-off and regional emissions

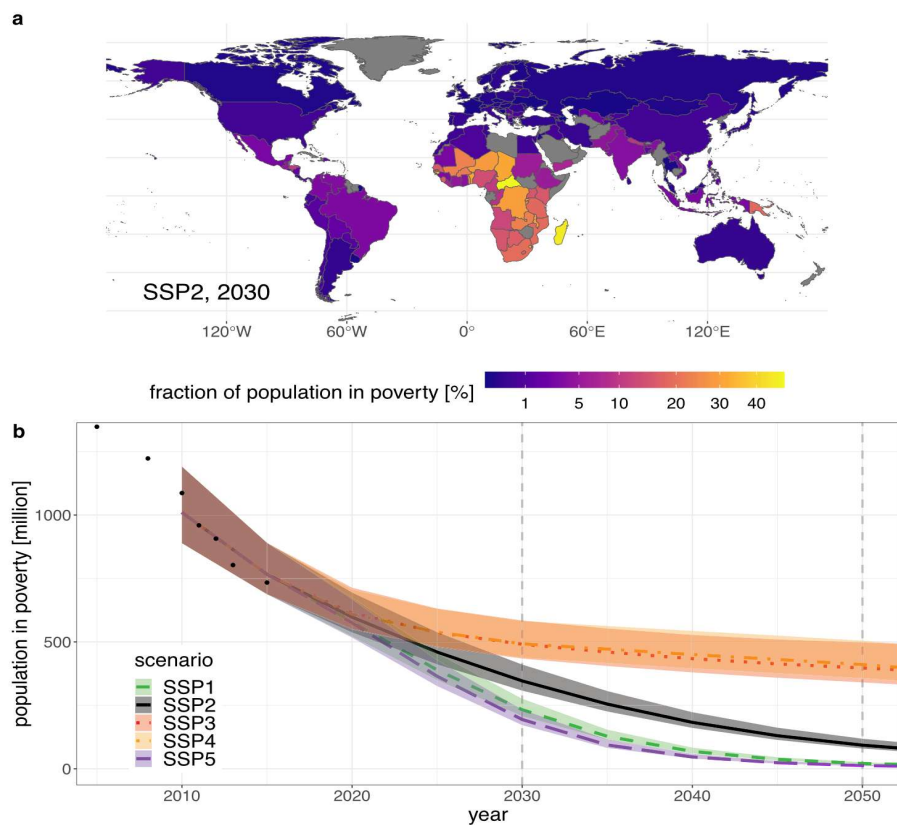


Differentiated carbon prices lead to different speeds of the transition

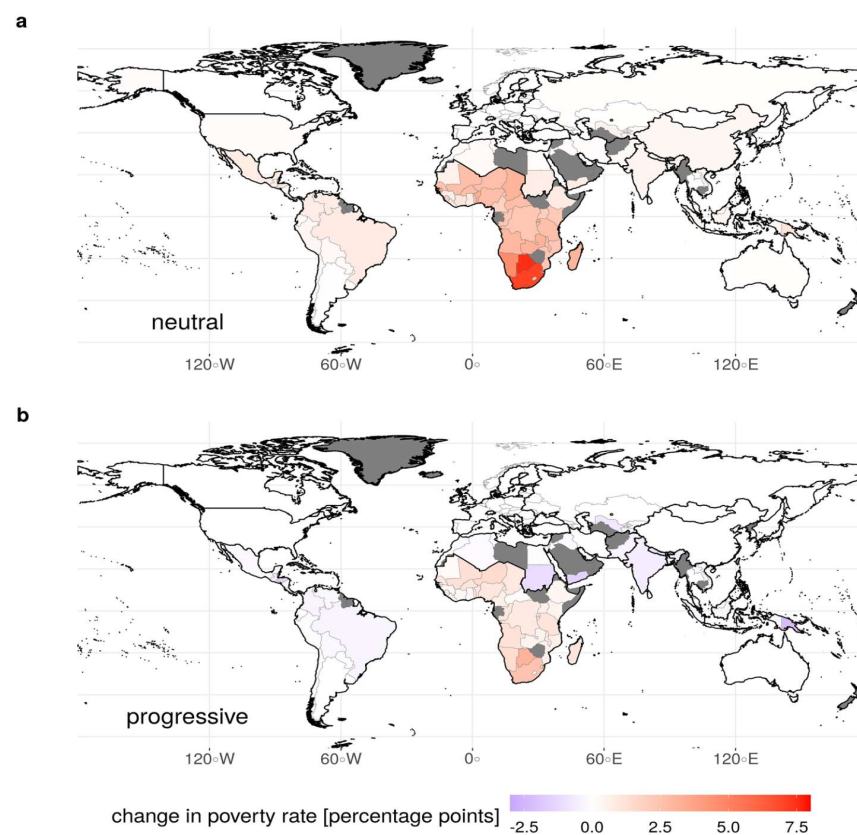


Intranational and International inequity and climate policy

Poverty eradication w/o climate policy



Poverty eradication with climate policy

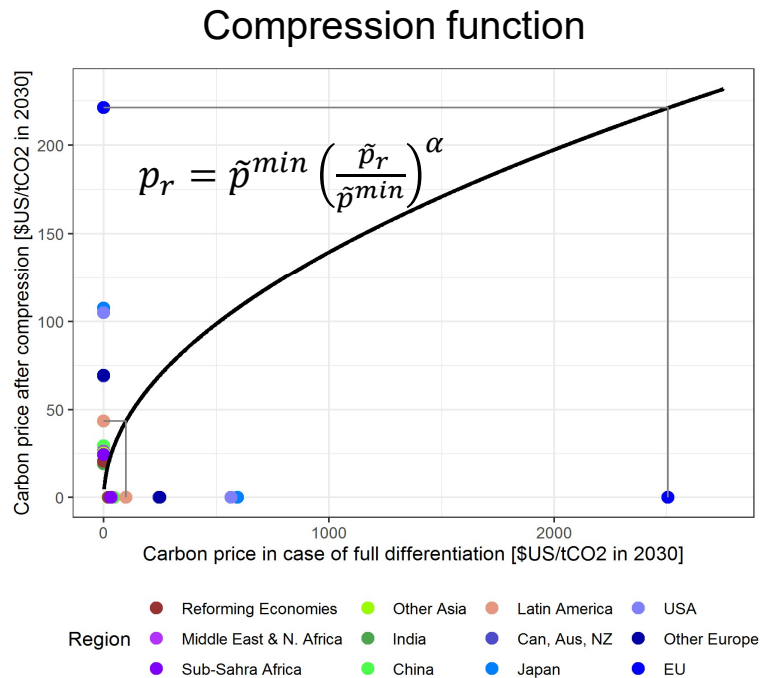


Fairness in integrated scenarios – from sharing to baking the cake

- Basically, the carbon budget logic defines a zero-sum game
- Analytically, very appealing to apply our methodological arsenal and write papers on fair distribution and equity
- Practically, zero-sum games are difficult to negotiate, because ...
- The carbon budget misses the motive that countries have to protect climate
➔ Approach here: Inclusion of willingness-to-pay to avoid climate warming
- Alternative approaches: issue linkage with SDGs, minimum safety and security standards, broader political arguments



Computing the trade-off curve



1. Compress set of regional carbon prices
2. Shift set of carbon prices to comply with global carbon price using REMIND-MAGPIE
→ mitigation costs
3. Compute transfers to fulfill equal effort criterion