# Environment and the economy: Feedbacks in a country-level IAM

**Johannes Emmerling, CMCC**

**Malmsten Workshop, Gothenburg**
*21 January 2026*

cmcc
Centro Euro-Mediterraneo
sui Cambiamenti Climatici

RFF CMCC European Institute on Economics and the Environment

# Introduction / Outline

- Economic evaluation of climate change → Importance of welfare functions, heterogeneity of countries, impact specifications, and climate action → thoughts on *some* aspects

1. Natural Capital and Valuation
2. The role of the Oceans
3. The Social Cost of Carbon including non-market benefits and the role of endogenous adaptation
4. The SCC and interactions with global and national climate policies
5. What damage functions to use?

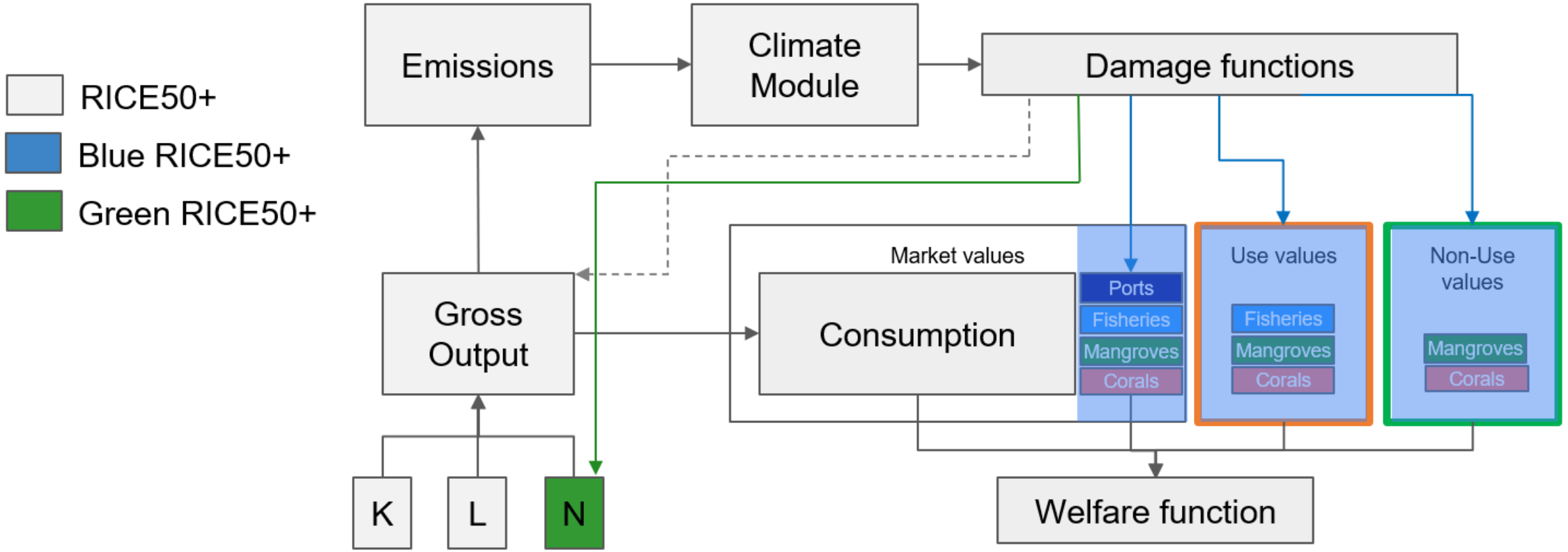
# Related literature

- Recent cost-benefit analyses (e.g., Barrage and Nordhaus, 2024, PNAS)
- Taking into account non-market values, dual discounting and relative prices, limited substitutability (Drupp et al., 2024, Science)
- Integration of nature / Ecosystems in economic models (Johnson et al., 2025, ARRE)
- Integration adaptation and extremes in CBA (Traeger (2025, WP)
- Welfare functions when aggregating over time and space, revisited; the role of transfers (Lang 2025 WP; Bauer et al., 2020, Nature)
- Large uncertainty, recent meta-studies on damage functions (Howard and Sterner, 2017, 2025, ERE)

# The RICE50+ model

- RICE50+: A Cost-Benefit IAM at the (almost) country level

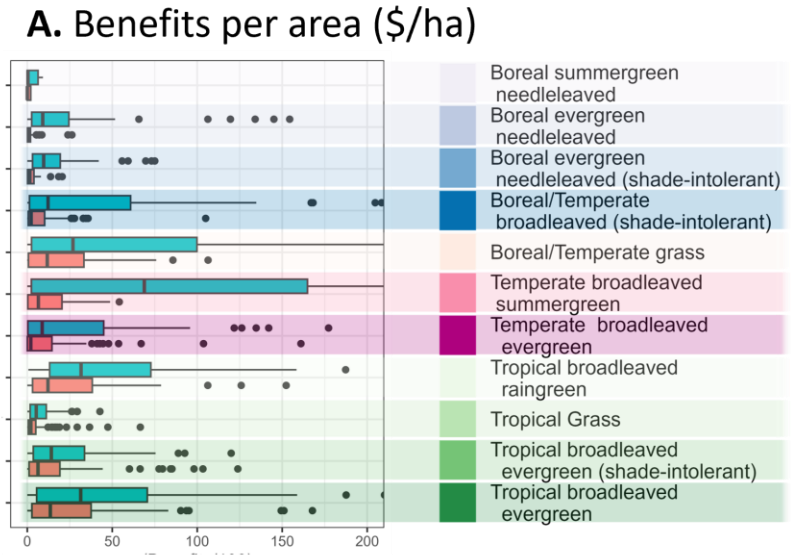
https://github.com/witch-team/RICE50xmodel *(OPEN SOURCE!)*

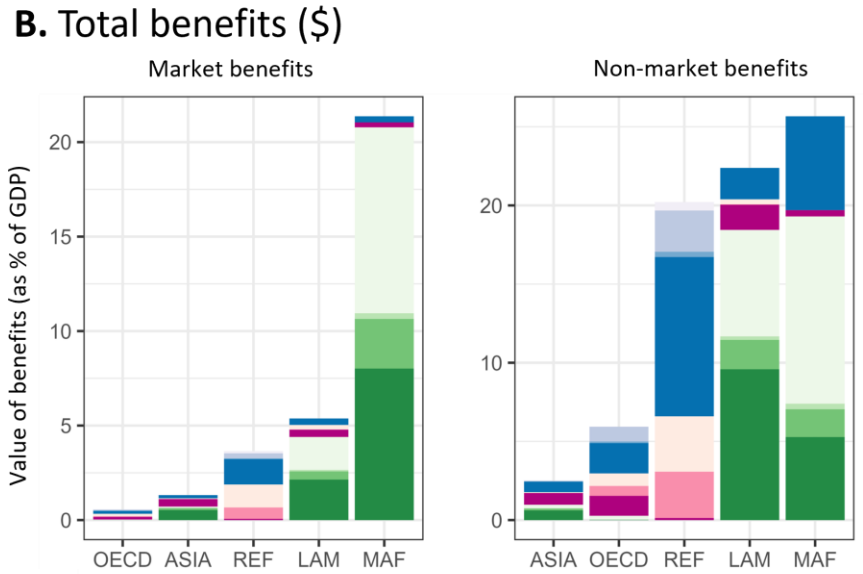


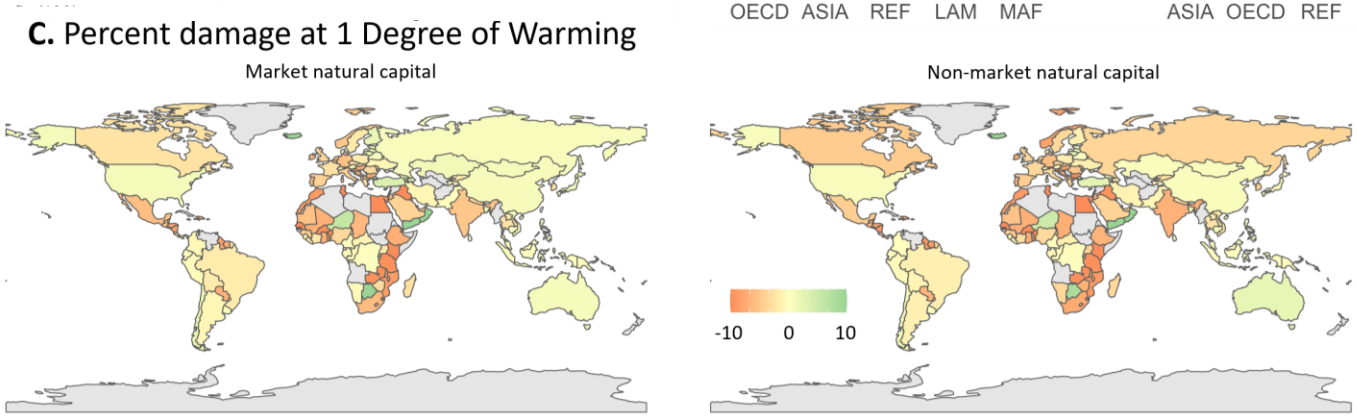
# A model of biome shifts and attached Ecosystem Services

$$Y = AS^{\beta}K^{a}H^{b}R^{(1-a-b)}$$

As in the Dasgupta Review
- Global environmental good S
- Regional natural capital R
- (a,b) estimated per-country



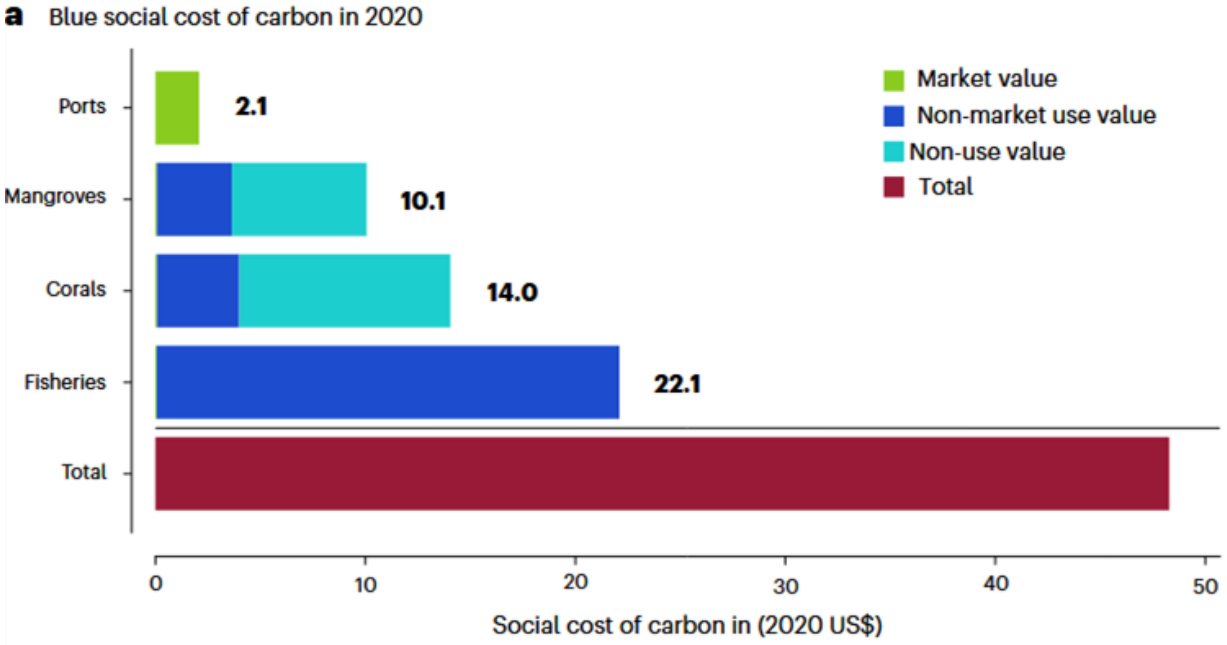

Source: Bastien-Olvera et al. (2024, Nature)

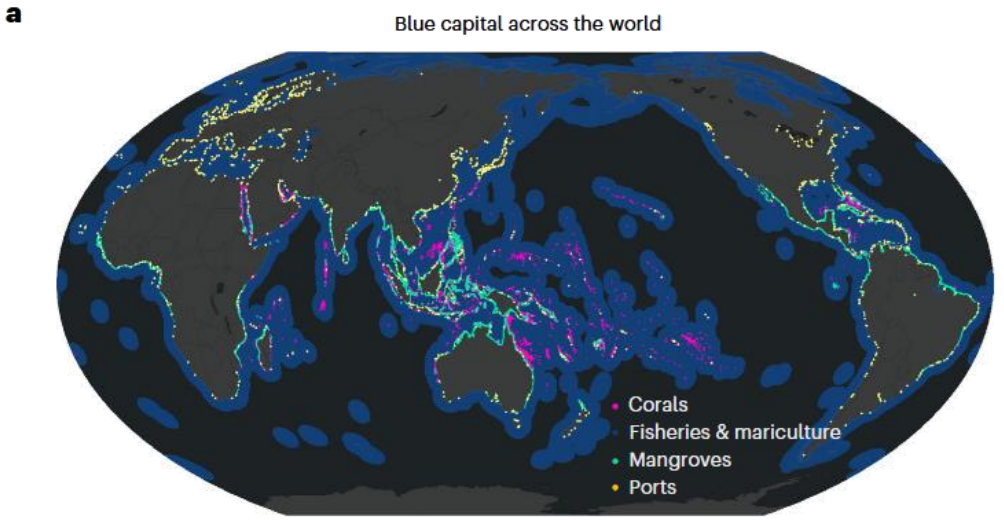
# The role of Oceans

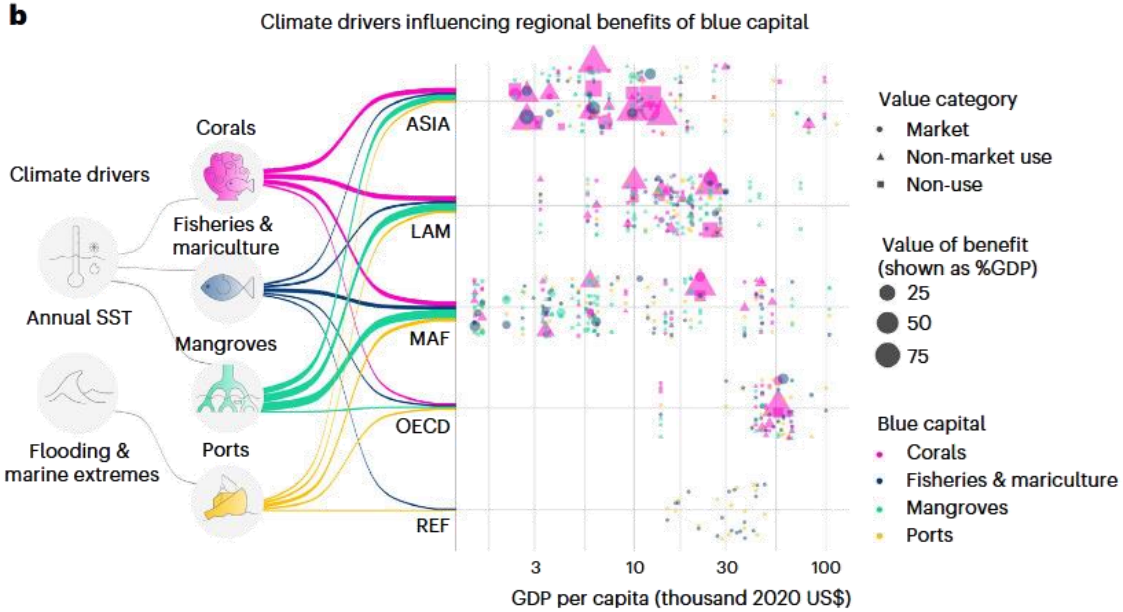
- 4 types of ECS
- In the Social Welfare Function

$$Utility_{c,t} = \frac{1}{1-\eta}\left[s_{1,1} \cdot Use_{c,t}^{\theta_2} + s_{1,2} \cdot Nonuse_{c,t}^{\theta_2}\right]^{\frac{1-\eta}{\theta_2}}$$

- Taking into account relative prices



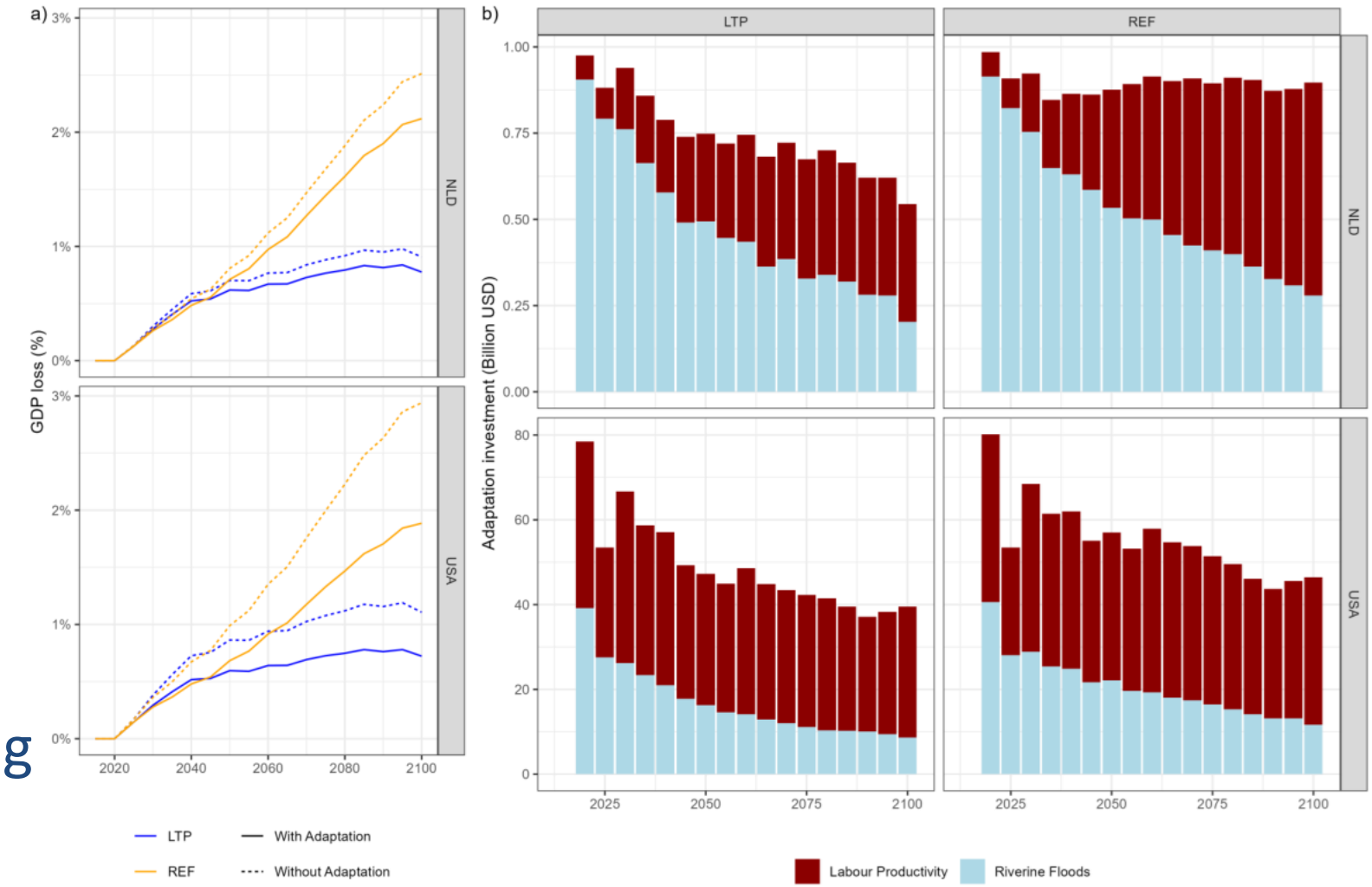




Source: Bastien-Olvera et al. (2026, NCC)

# The Social Cost of Carbon and the role of adaptation

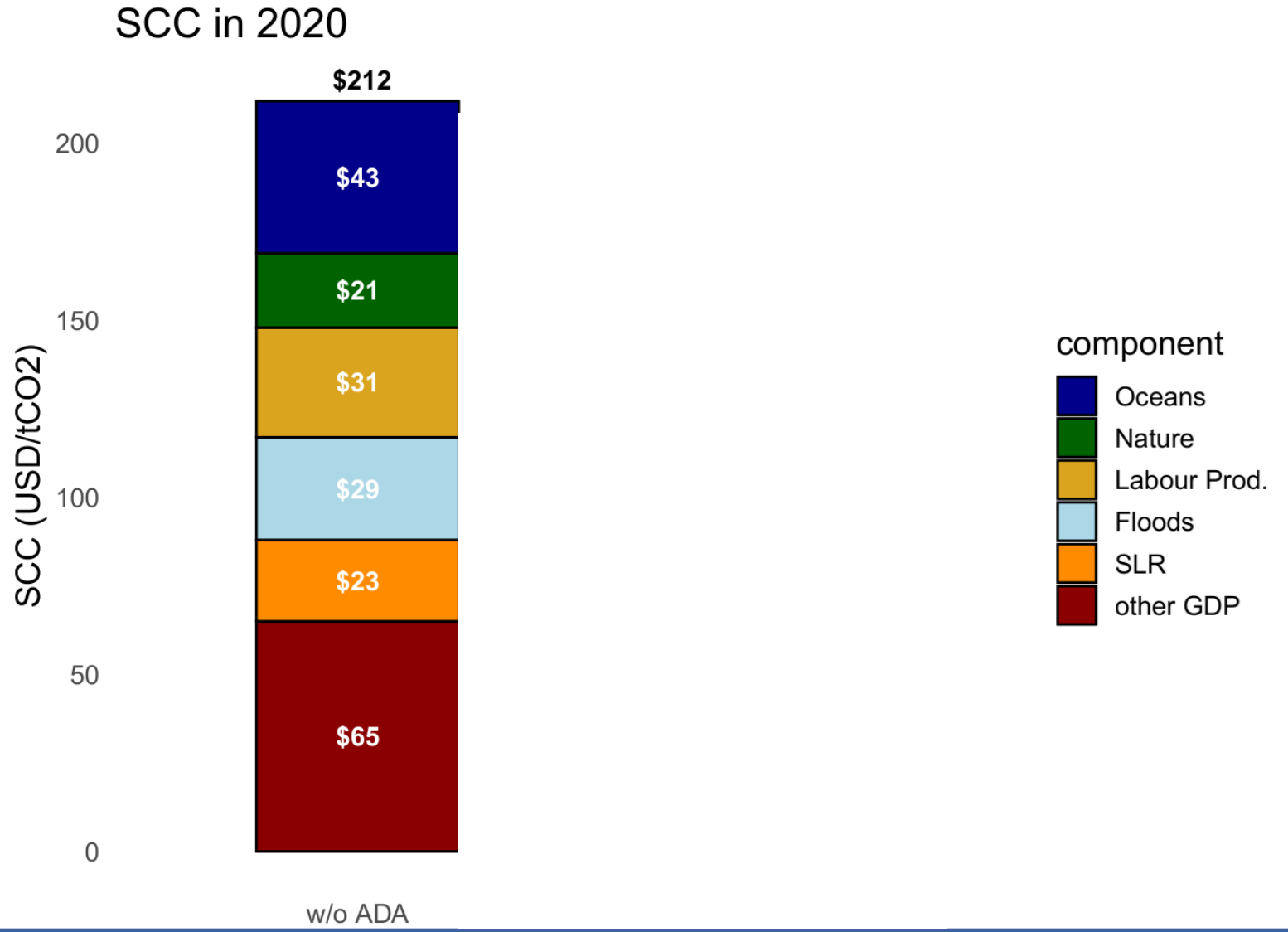
- Adaptation: micro-based, optimal vs. behavioral
- Coupling IAM with an agent based model of adaptation (CRAB) via emulator (Traeger, 2025)
- For now: flooding and labor productivity (3 technologies each)
- Private adoption (including bounded rationality, myopia)




Source: Taberna et al. (2025, *under review at JEEM*)

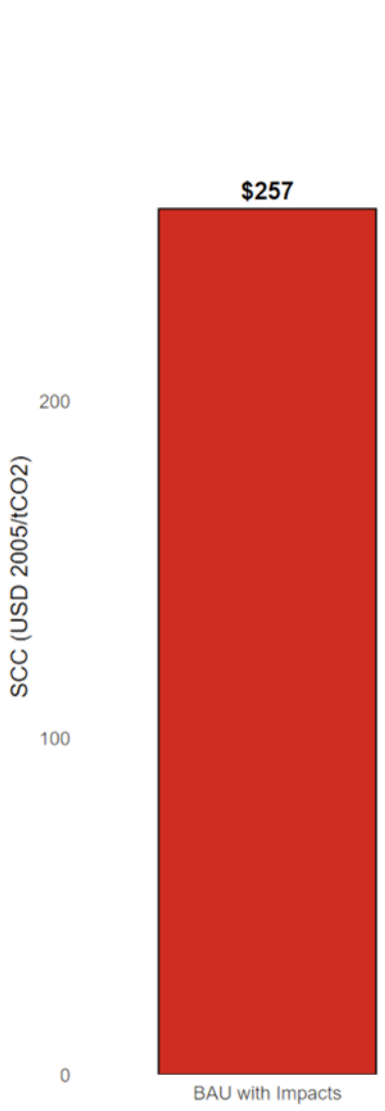
# The comprehensive Social Cost of Carbon

- Aggregating market, non-market impacts, with and without adaptation



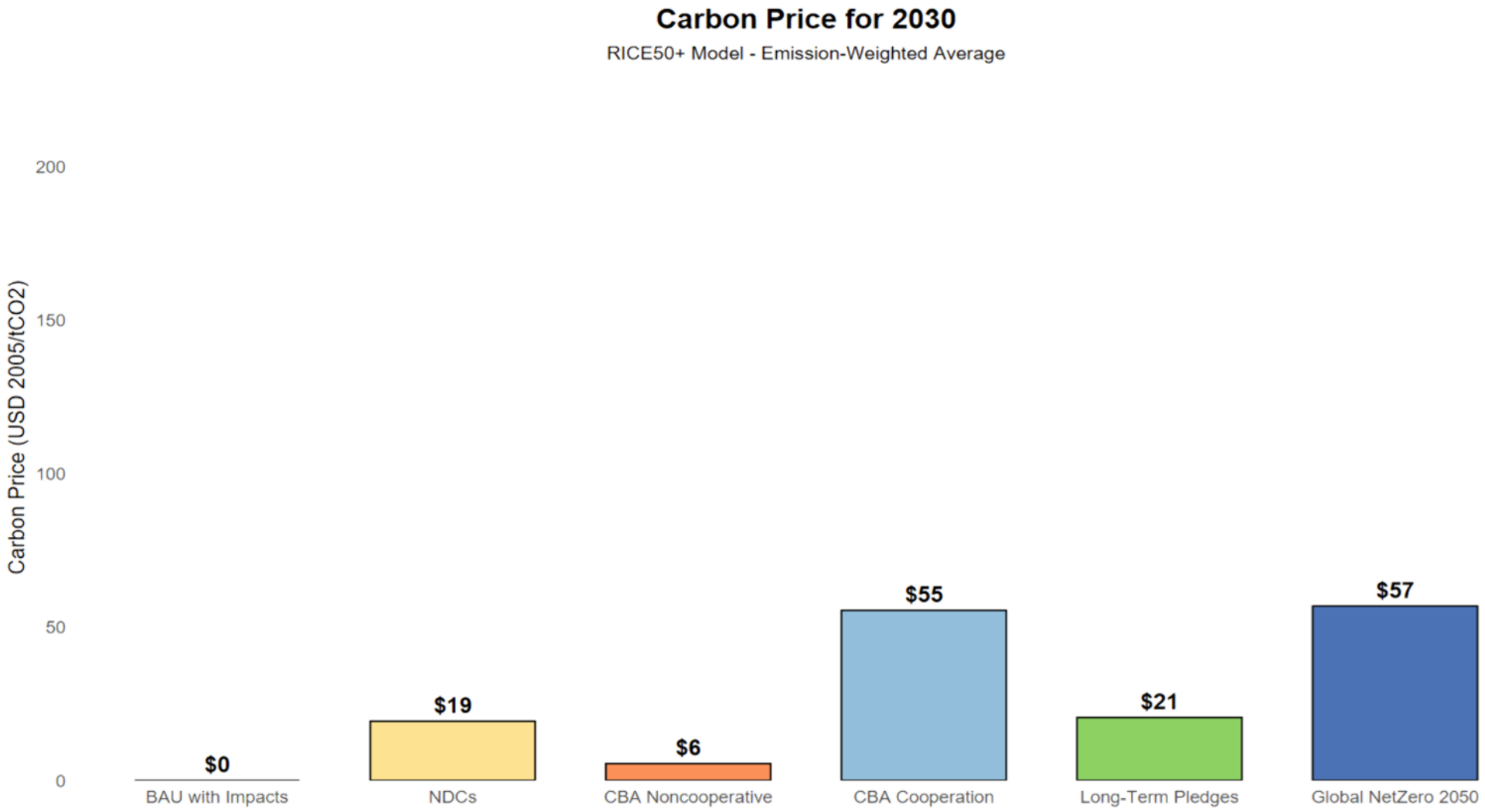
# The Social Cost of Carbon and Global Climate Policies

- Climate Policies increasingly affect “BAU” emissions ➔ SCC?



# The Social Cost of Carbon and Global Climate Policies

- … with an increasing ( and region-specific!) private carbon price



# Which damage function?

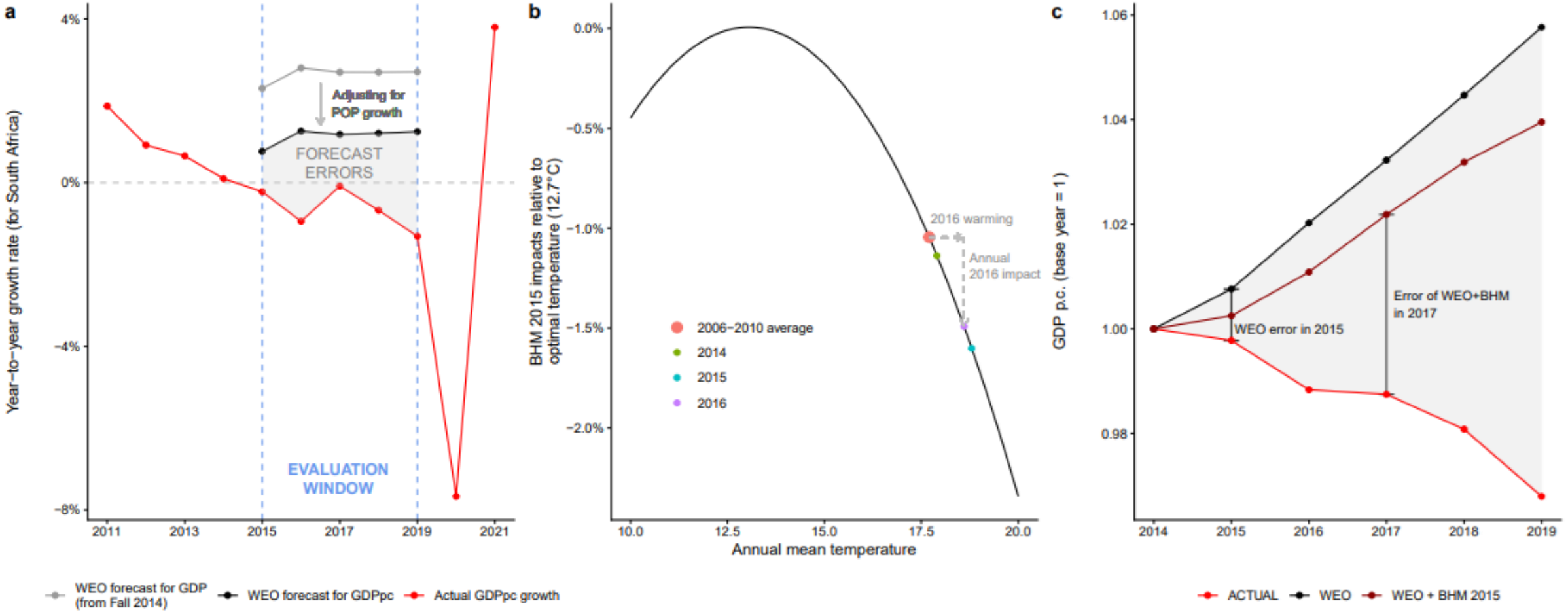
- Large uncertainty (IPCC AR6), some meta-studies available (Howard and Sterner, 2017, 2025) at least at the global level
- Also here, country-level heterogeneity is important, and large
- Is there a way to “validate” or compare the different econometric specs?
- No counterfactual of GDP without climate impacts available

*This paper:*

- Over the last decade, can climate change explain some of the observed GDP deviations from IMF-WEO forecasts?
- Quasi-counterfactual based on annual five-year GDP forecasts, for 200+ countries since 1990 (here focus on 2010-2019), i.e., approx. 2000 obs.

# Which damage function?

- Reconstructing Climate Impacts 2010-2019 (9 recent damage functions)




Source: Emmerling, Waidelich, Bellon, and Massetti (2026, under prep.)

# Which damage function?

- How much of the IMF's forecast errors can the different damages explain?

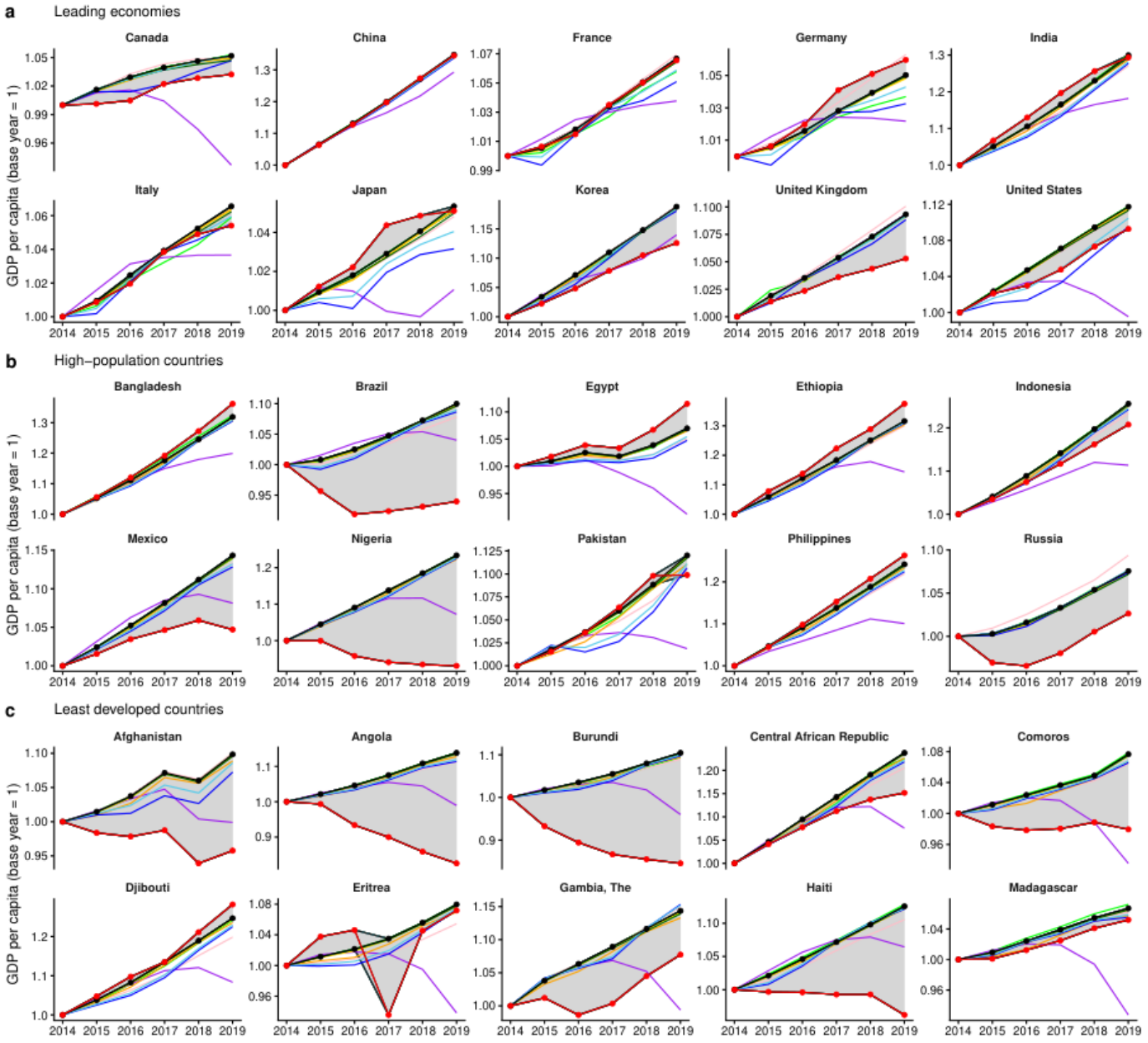
# Conclusion

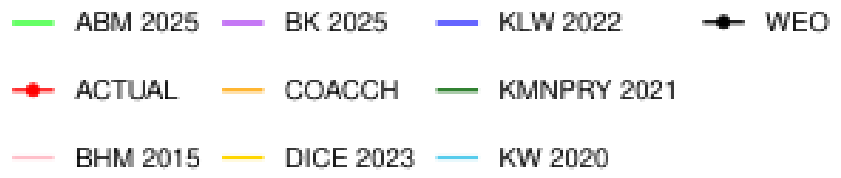
- The integration of in particular non-market benefits and ecosystem is increasingly becoming relevant and lot of improvement in the literature (Johnson et al., 2025)
- The cost of inaction becoming more relevant politically
- Interaction with climate policies, adaptation not trivial
- Discounting, inequity aversion continues to matter
- As does uncertainty about the damage function (IPCC AR7 hoping for less uncertainty there)
- Future work: integrating endogenous structural change (Comin et al., (2021 Ecta, 2025), Public sector and redistribution (Kornek et al., 2021), …

Thank you very much!

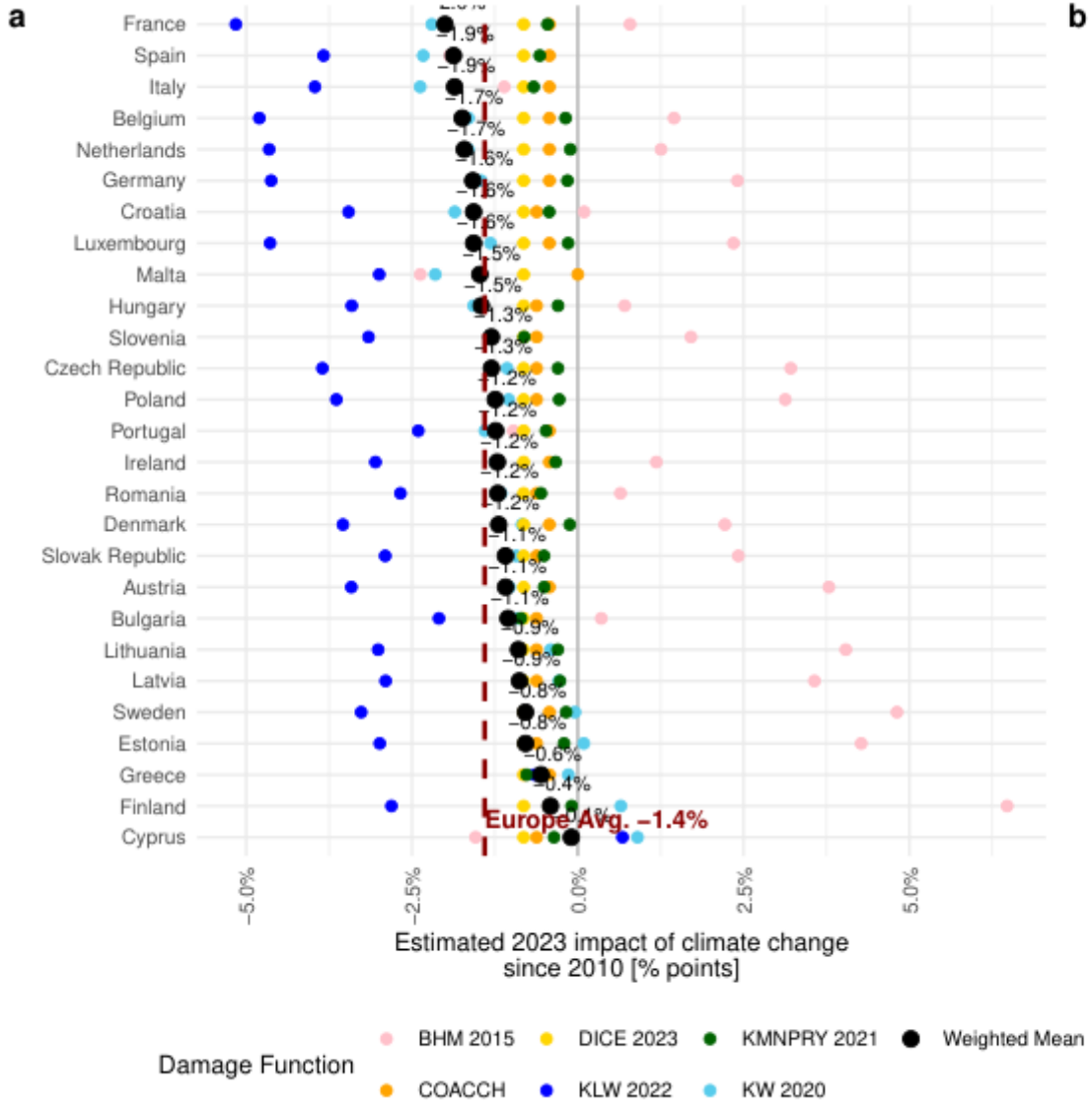
https://github.com/witch-team/RICE50xmodel

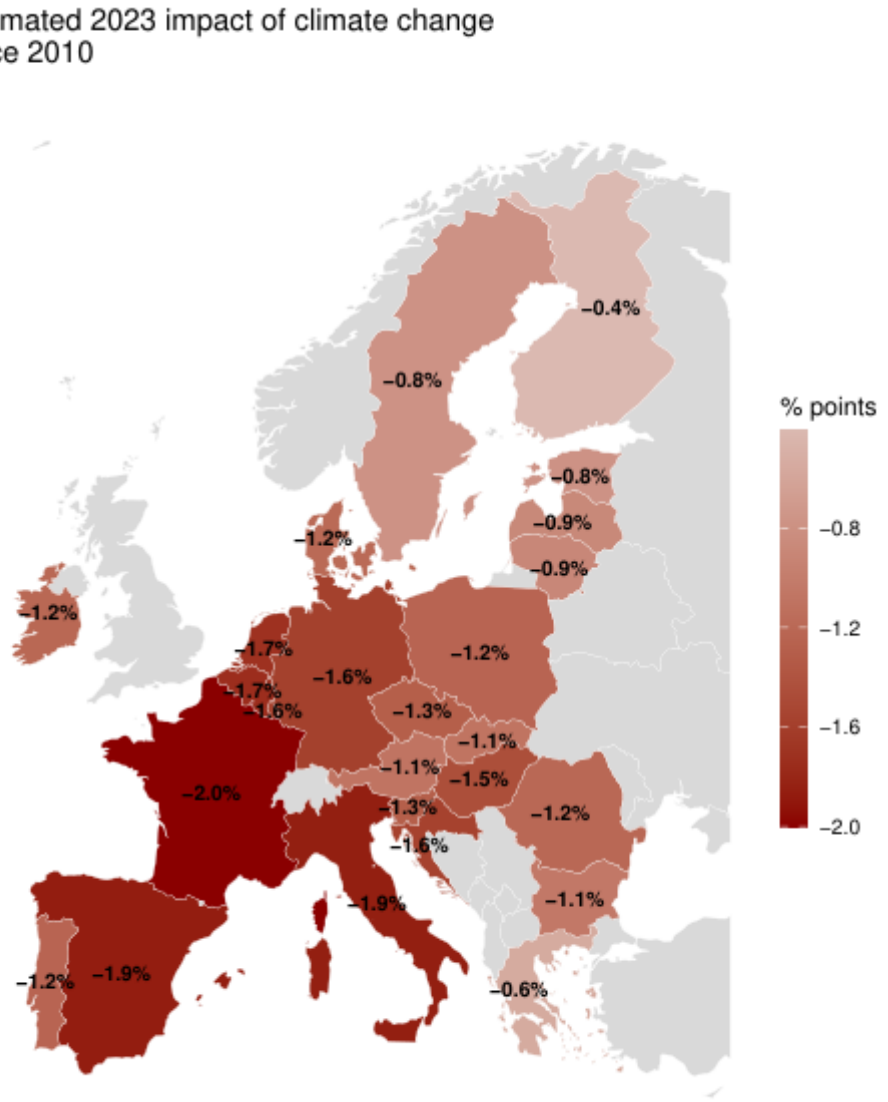

# Country level damage functions



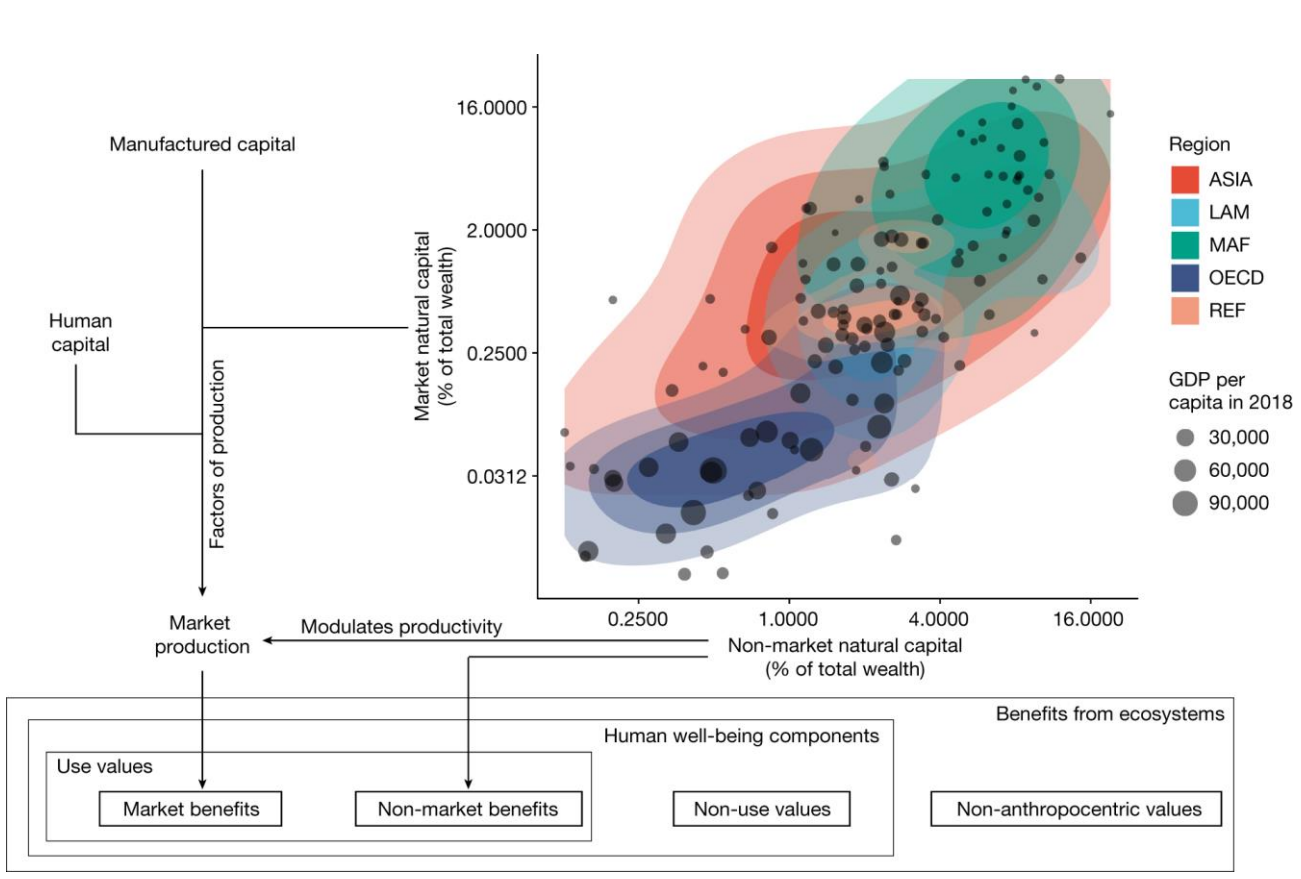
# Country level damage functions

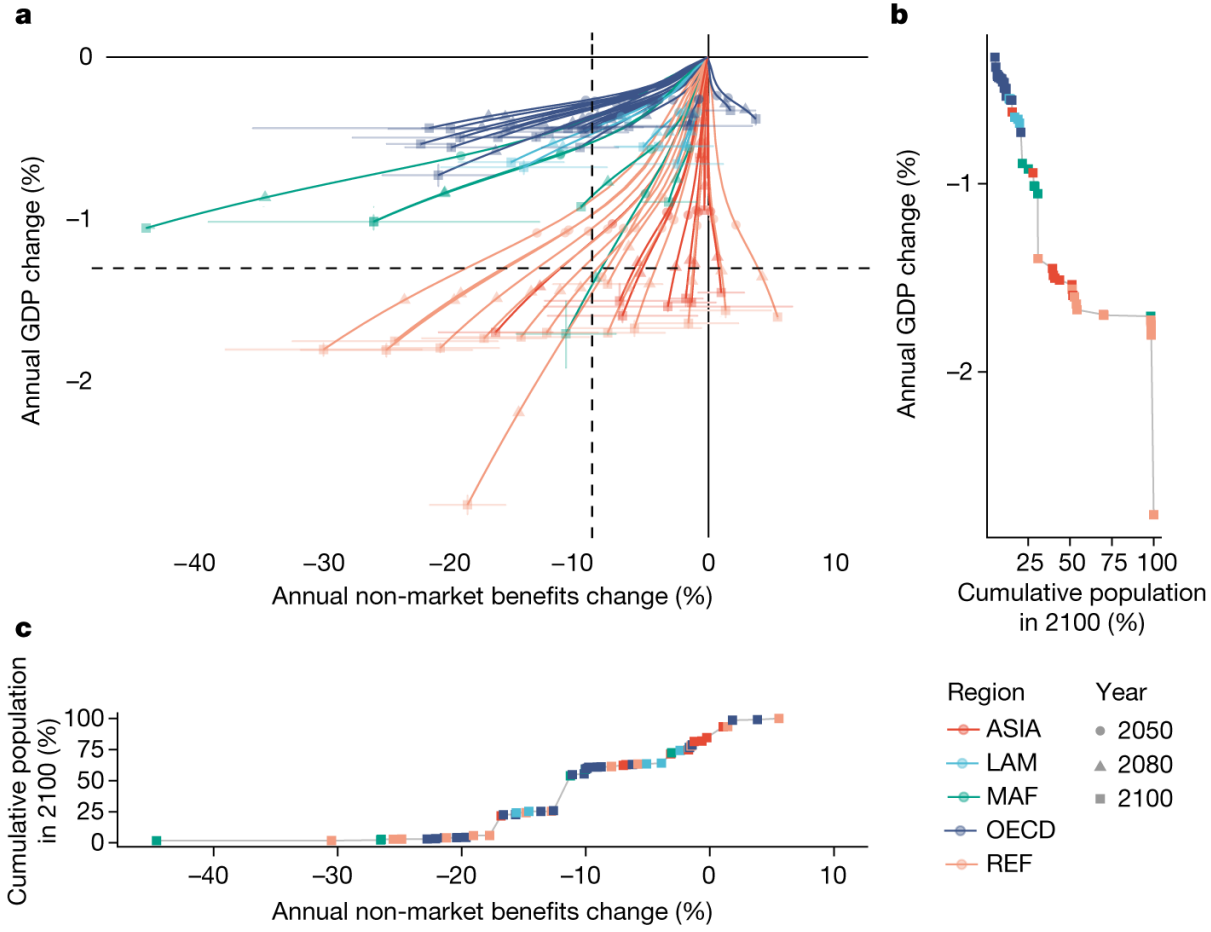


# Natural Capital

- Natural Capital and ECS




Source: Bastien-Olvera et al. (2024, Nature)