Global Trade Analysis Project

Climate change impacts in an economic model

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ISI-MIP cross sectoral workshop on “Economic costs of climate change impacts: 1.5ºC—Necessary but too expensive?”
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Methodology

- **Relatively standard multi-sector, multi-region global recursive dynamic CGE model**
  - Nested CES production structure—3 archetypes (crops, livestock, other)
  - Vintage capital (substitution and mobility effects)
  - CDE utility function
  - Armington trade
  - Savings driven investment
  - Exogenous labor growth
  - Sector specific productivity (labor-augmenting)
  - Land productivity, AEEI, trade and transport margins improvement
  - Kyoto gases + climate module
- **Damages are sector specific and differentiated by ‘channel’**

Damages by source

sea	Sea level rise
agr	Agricultural productivity
wat	Water availability
onj	On the job productivity
hhe	Human health
tou	Tourism
end	Energy demand

Damages by channel

mp	Multi-factor productivity (TFP)
lp	Labor productivity (or stock)
kp	Capital productivity (or stock)
tp	Land productivity (or stock)
hc	Household consumption of energy
incab	International income transfers

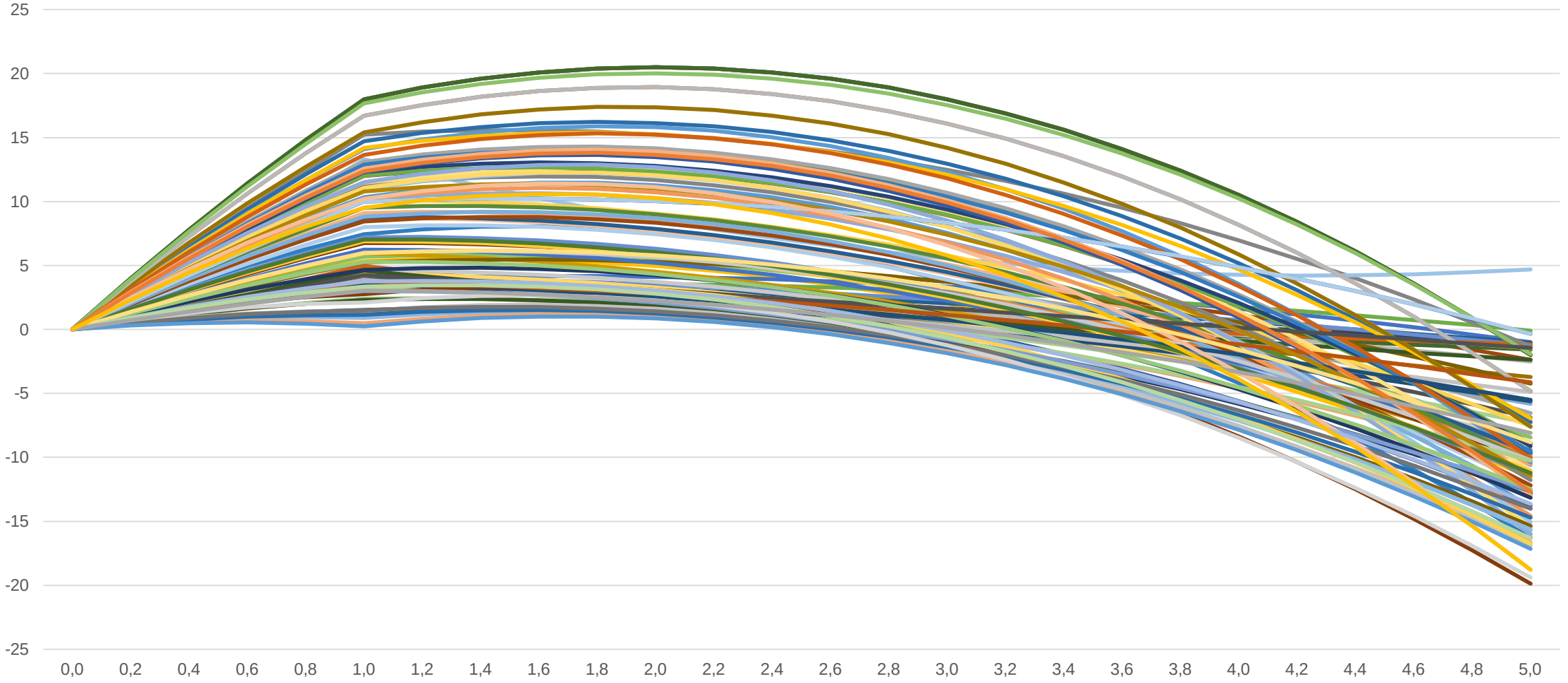
Agricultural damage (crops)

- Key source: Easterling, W.E. et al., (2007), "Food, fibre and forest products. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate", in: Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 273-313.
- Specification

$$\Delta DAM_{r,agr,t} = \alpha_r \min(1, T_t - T_0) + \beta_r \left(T_t - T_0\right) + + \gamma_r \left(T_t - T_0\right)^2$$

Agricultural productivity and temperature

percent change relative to baseline



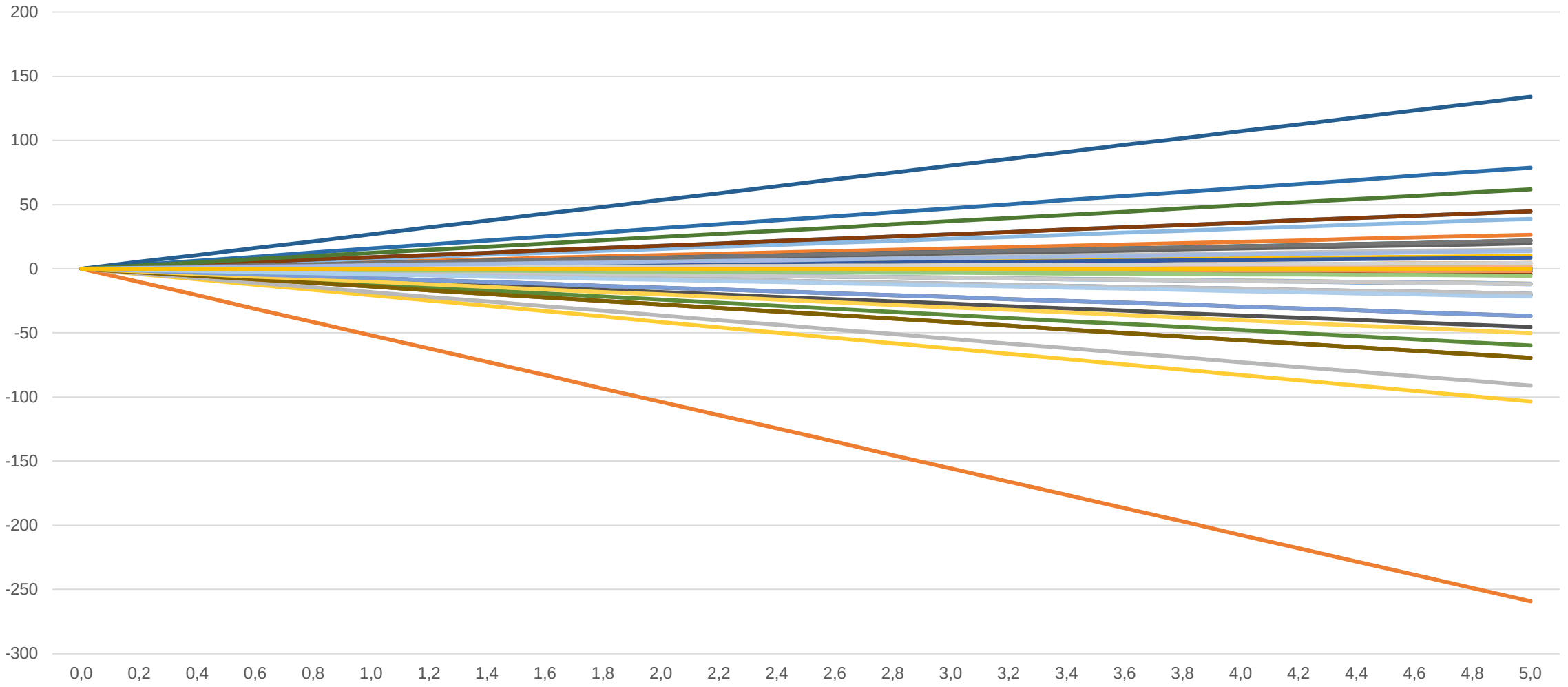
Water stress

- **Key sources: Strzepek K. and Boehlert B. (2009), Competition for Water for the Food System, Mimeo.**
- **Specification**

$$\Delta DAM_{r,mp,t} = \beta_r \left(T_t - T_0 \right)$$

Water stress and agricultural productivity

percent change relative to baseline



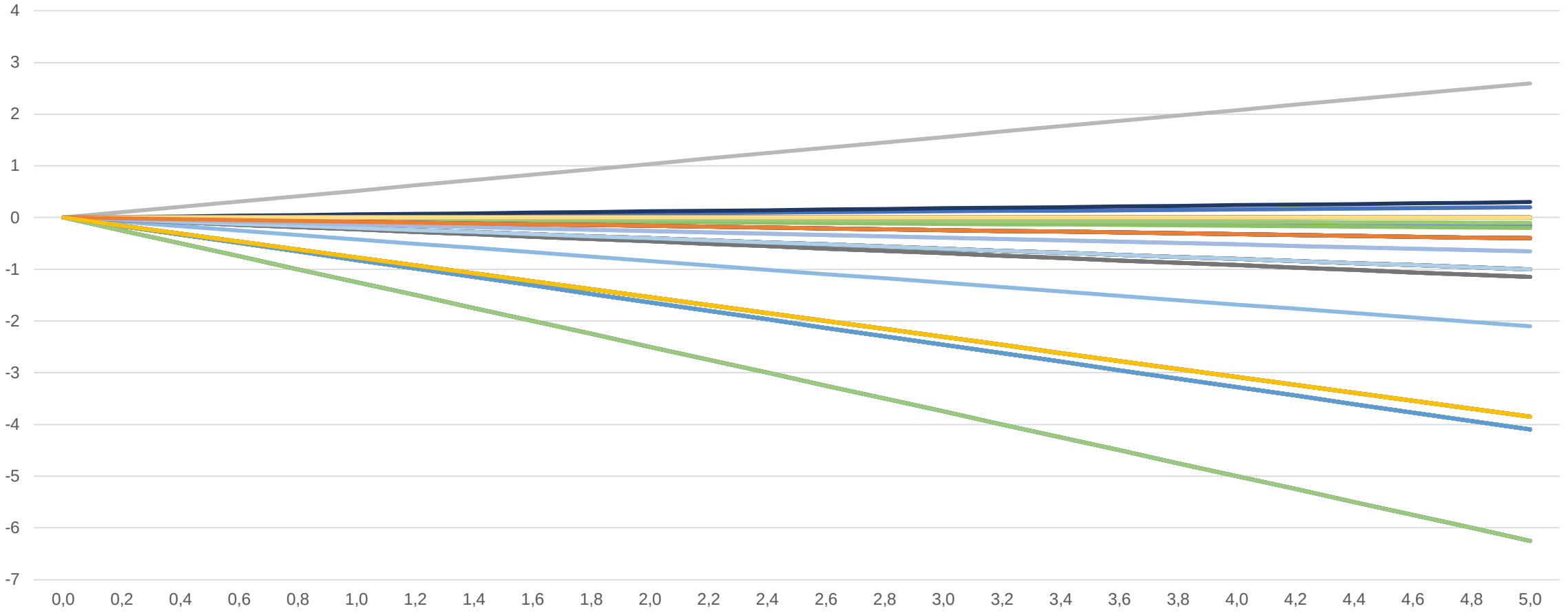
Heat related labor productivity

- **Key sources: Kiellstrom T., R.S. Kovats, S.J. Lloyd, T. Holt, R.S.J. Tol (2008), The direct impact of climate change on regional labour productivity, ENSEMBLES Deliverable D7.8, European Commission, VI Framework Programme. Bosello and Roson.**
- **Specification**

$$\Delta DAM_{r,lp,t} = \beta_r \left(T_t - T_0 \right)$$

Heat stress and labor productivity

percent change relative to baseline



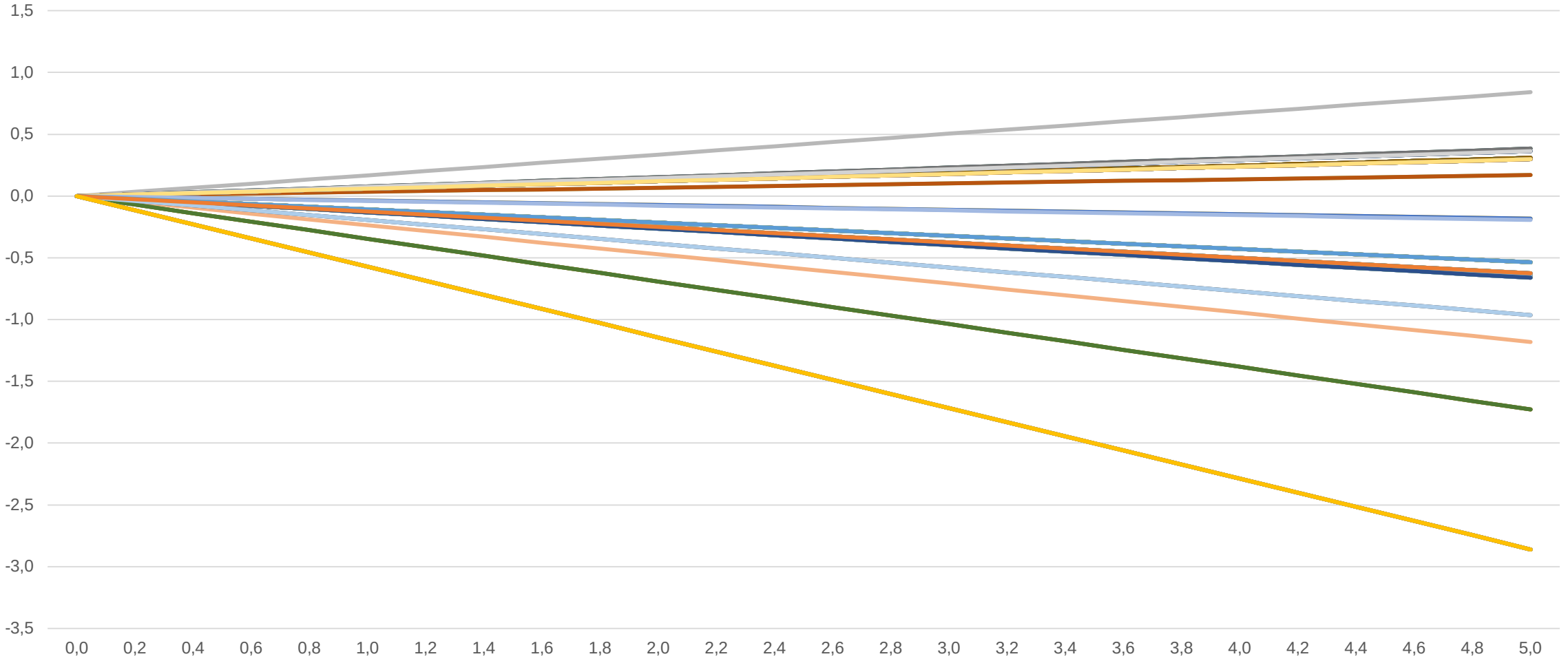
Health-related labor productivity

- **Key source: Bosello, F., Roson, R. and Tol, R.S.J. (2006), "Economy wide estimates of the implications of climate change: human health", Ecological Economics, 58, 579-591.**
- **Specification**

$$\Delta DAM_{r,lp,t} = \beta_r \left(T_t - T_0 \right)$$

Health-related labor productivity

percent change relative to baseline



Sea level rise

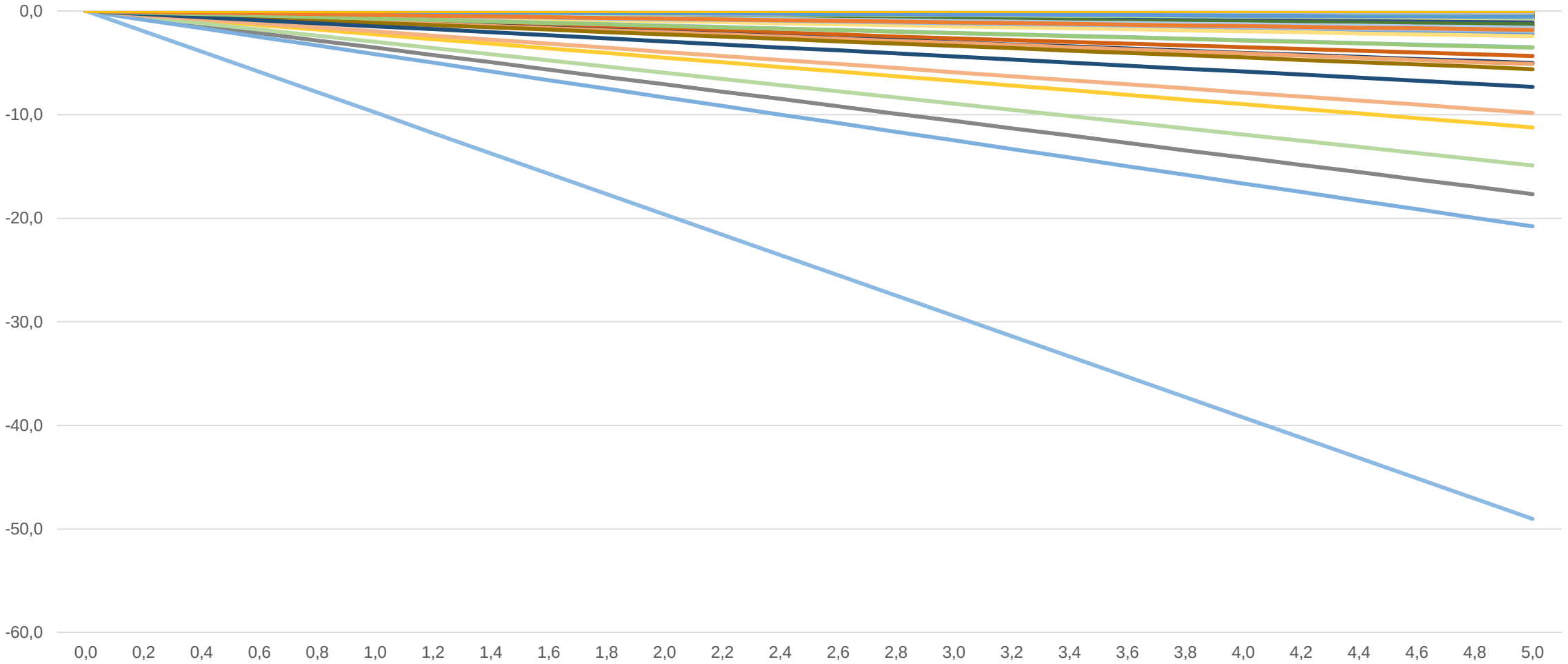
- Key sources: Bosello, F., Roson, R. and Tol, R.S.J. (2007), “Economy wide estimates of the implications of climate change: sea level rise”, Environmental and Resource Economics, 37, 549-571. Vafeidis A. T., R. J. Nicholls, L. McFadden, R. S. J. Tol, J. Hinkel, T. Spencer, P. S. Grashoff, G. Boot, R. J. T. Klein (2008), A New Global Coastal Database for Impact and Vulnerability Analysis to Sea-Level Rise, Journal of Coastal Research, 24(4), pp. 917-924.
- Specification

$$\Delta DAM_{r,kp,t} = \beta_r \left(T_t - T_0 \right)$$

$$\Delta DAM_{r,tp,t} = \beta_r \left(T_t - T_0 \right)$$

Sea level rise and capital and land productivity

percent change relative to baseline



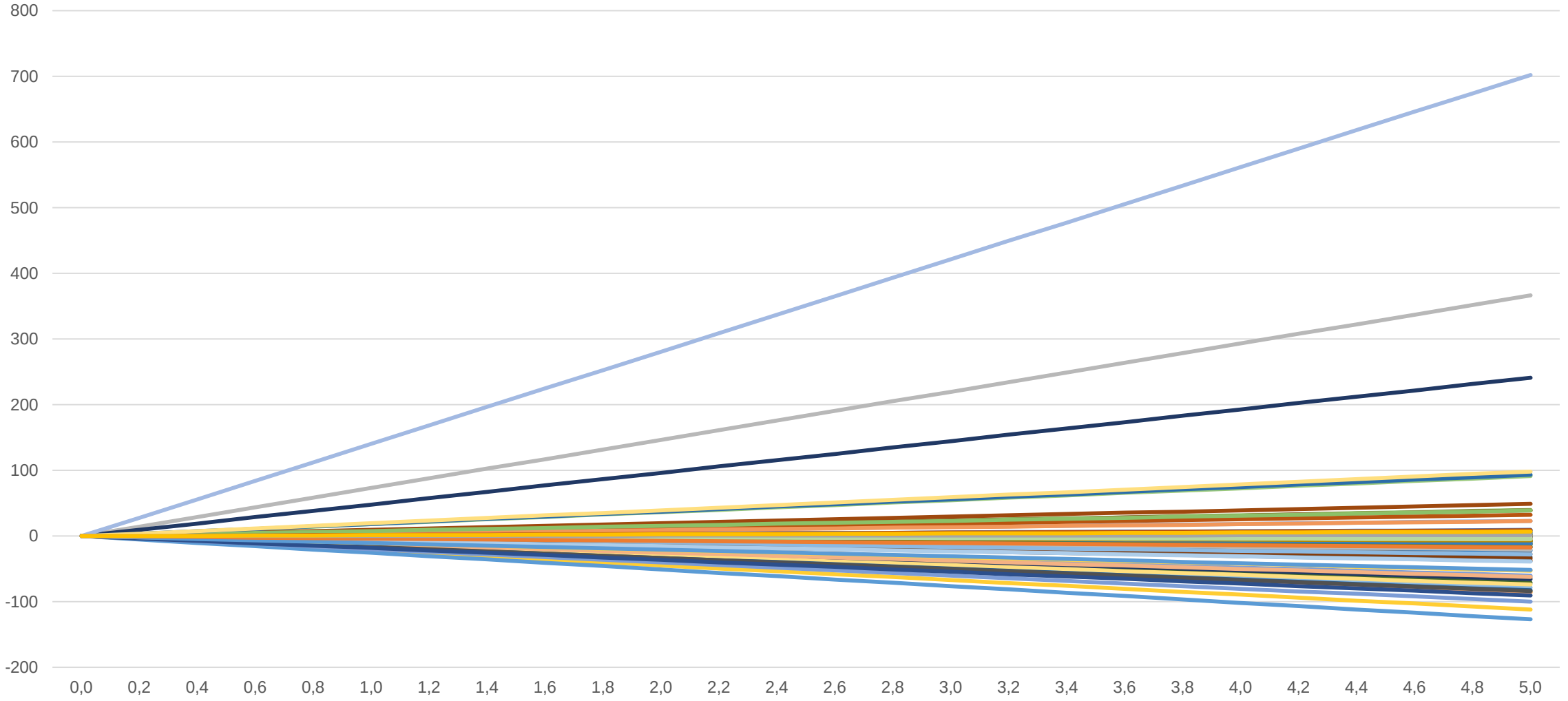
Tourism impacts

- **Key source: Hamilton J.M. , Maddison D.J. and Tol R.S.J. (2005), Effects of climate change on international tourism, Climate Research, 29, pp. 245–254.**
- **Specification**

$$\Delta BoP_{r,t} = BoP_{r,t0}\left(T_t - T_0\right)$$

Tourism receipts and temperature change

$billion



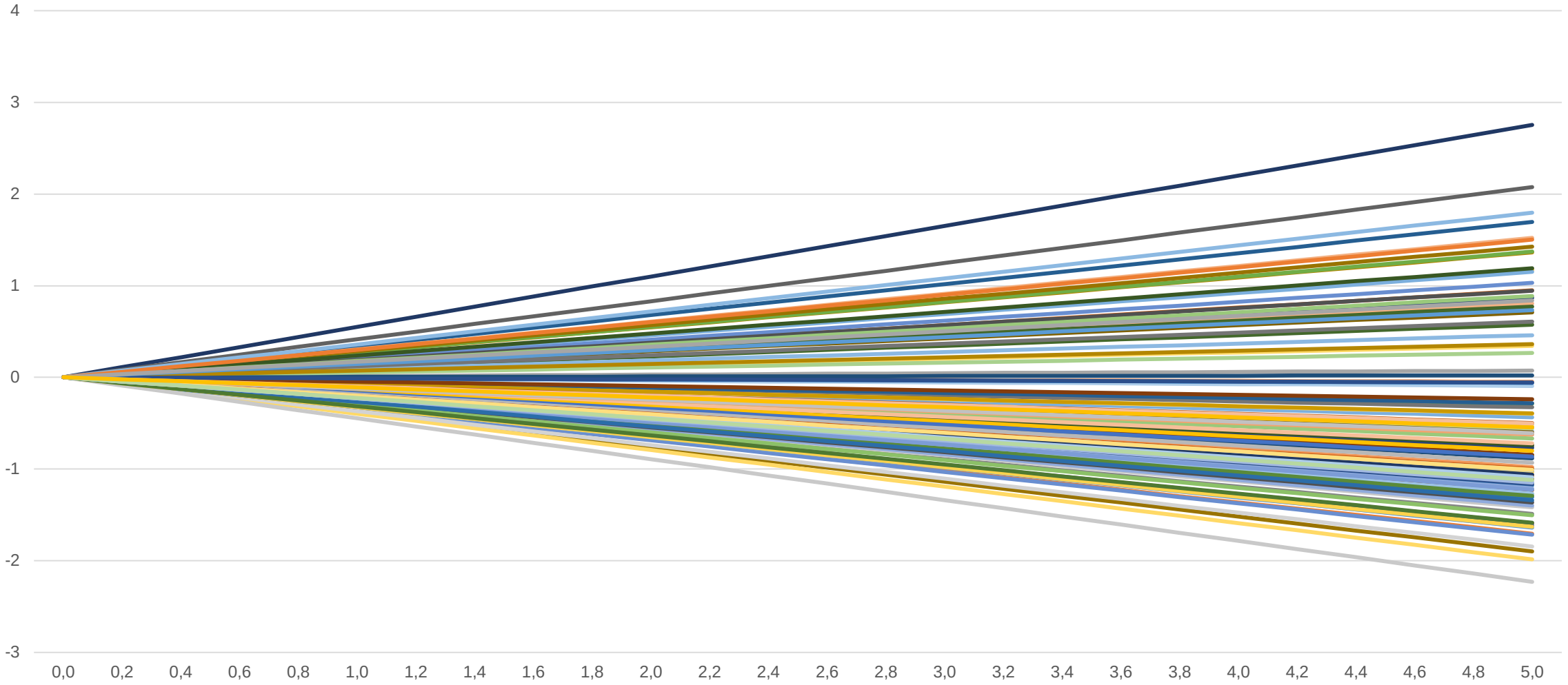
Impacts on energy demand

- **Key source: De Cian, E., Lanzi, E. and Roson, R., (2007), The Impact of Temperature Change on Energy Demand: A Dynamic Panel Analysis, FEEM Working Paper N.46.2007.**
- **Specification**

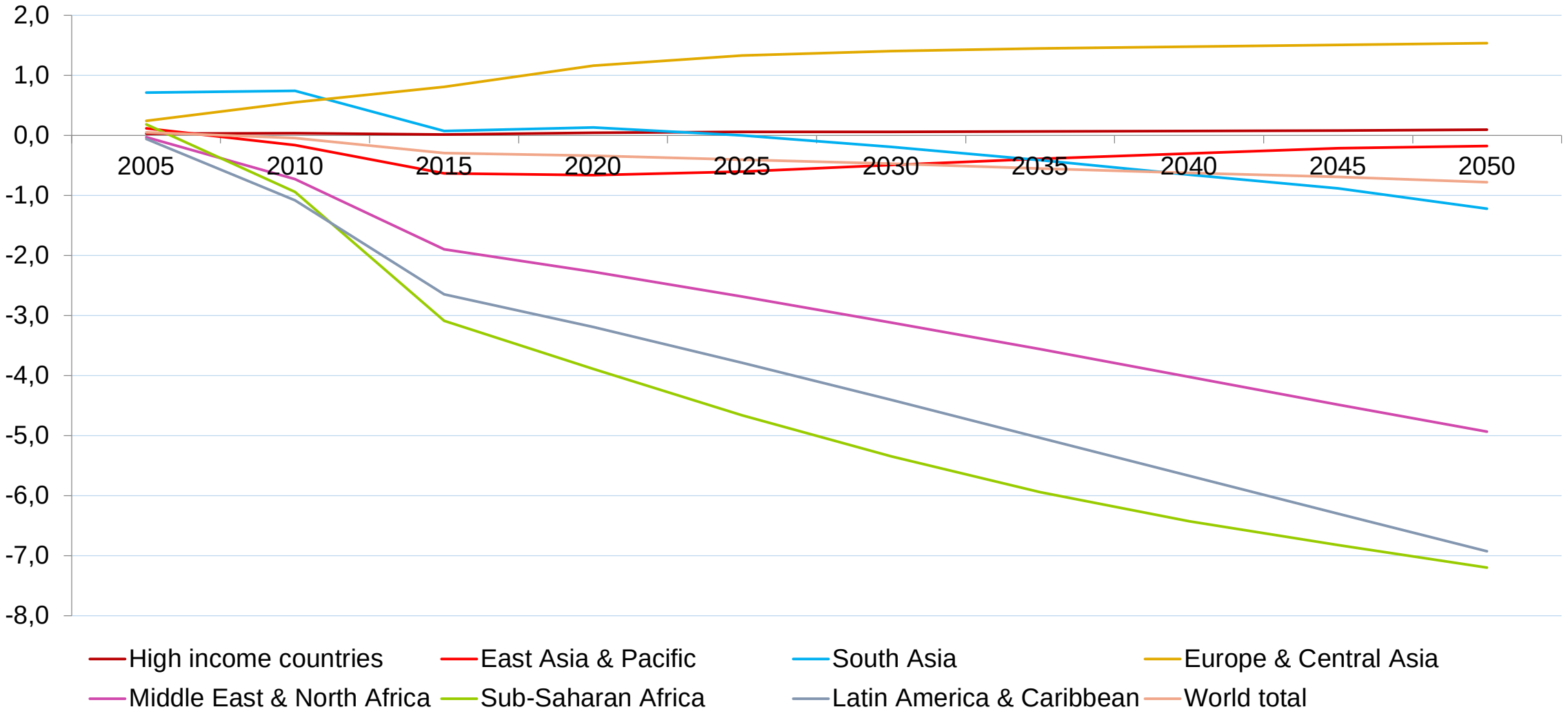
$$\Delta NRG_{r,h,t} = \beta_{r,t} \left(T_t - T_0 \right)$$

Household energy demand and temperature change

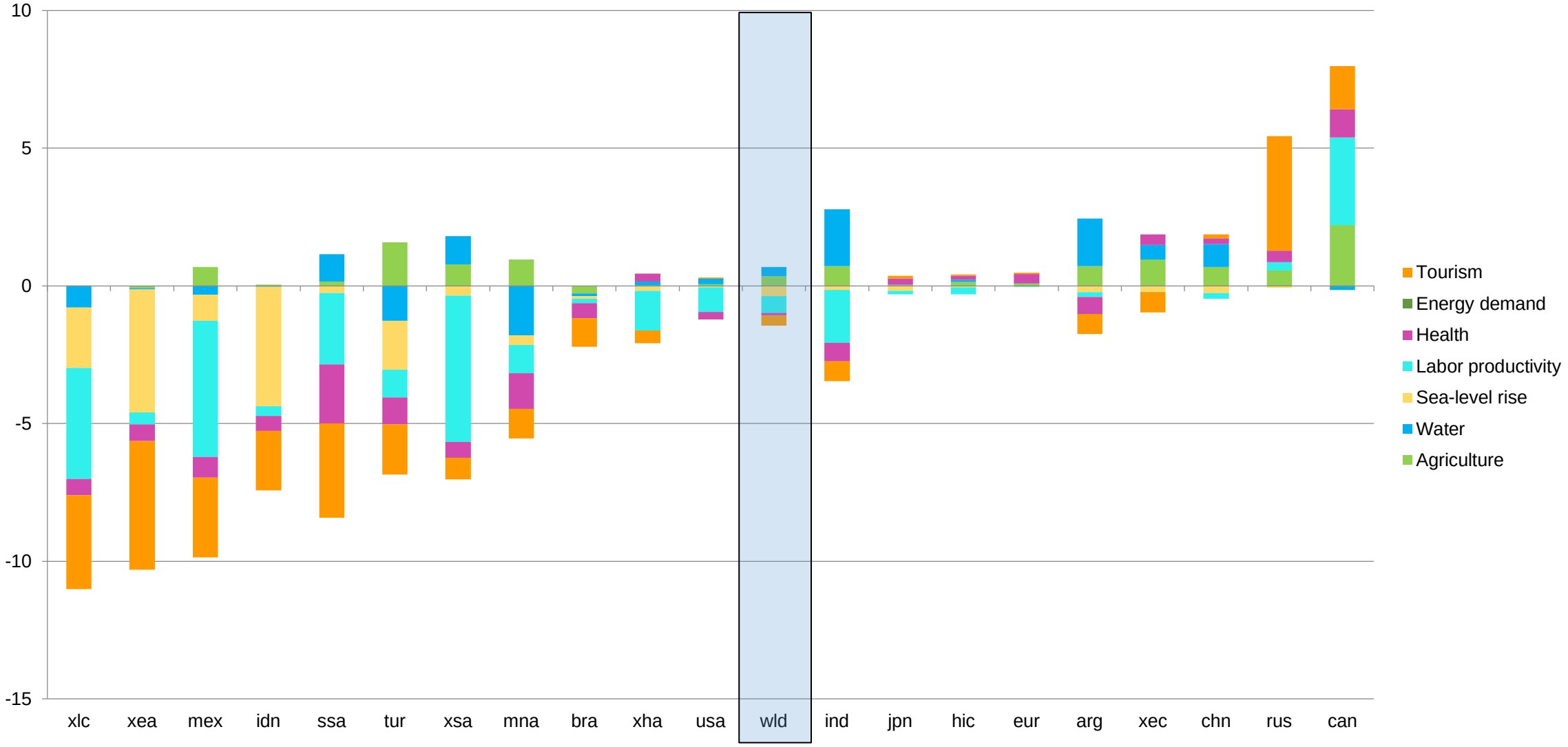
percent change relative to baseline



GDP deviations from baseline with climate impacts



Decomposition of climate impacts in 2050



Take away messages

- **Shows importance of regional and activity differentiation**
- **Need for much greater econometric estimation and validation**
  - Can we be confident of out-of-sample outcomes?
- **Potential gaps**
  - Adaptation
  - Household level impacts
  - Extreme events, threshold effects
  - Uncertainty