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Climate change impacts and market driven
adaptation:
The costs of inaction including market rigidities

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EUROPEAN COMMISSION
European Research Area



GLOBAL-IQ final Conference
Brussels, 17th June 2014

Outline

- Objectives
- The model
- Climate change impact assessment
 - The impacts
 - Effects on world and regional GDP
 - Impact decomposition
- Limiting market adaptation
- Reduced form damage functions

Objectives

Climate change as a global challenge → what is its economic relevance?

Investigation tool: recursive-dynamic CGE model → allows for endogenous price formation and market autonomous response to economic shocks

Impacts are assessed in three RCP's (2.6, 6.0, and 8.5) as reference cases to extract then reduced form climate change damage functions

Moreover, firstly “full market-driven adaptation” is assumed, then limits or frictions in market adjustments is introduced.

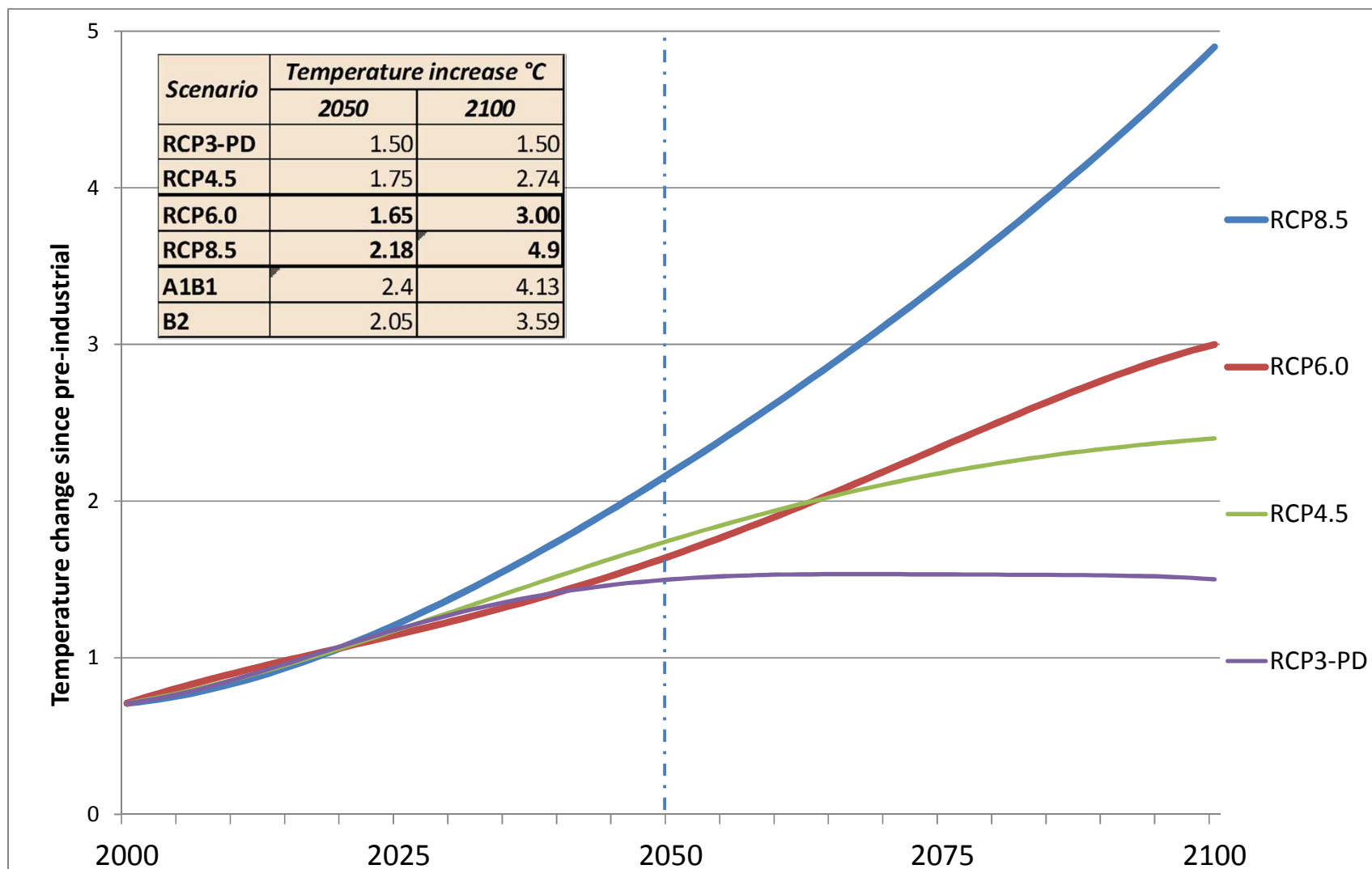
The model: ICES

Recursive dynamic computable general equilibrium (CGE) model

Multi-country, multi-sector model. Endogenous prices allocate resources → track feedback between “markets” and the macro economic context triggered by initial impacts

- Based on the GTAP 8 database (Narayanan et al. 2012)
- Simulation period: 2007-2050 in one-year time steps
- Multi-country (25 countries/regions)
- Multi-sector model with international trade (19 sectors)
- CO₂ emissions from fossil fuel combustion
- Renewable energy production (solar, wind, hydro)

Temperature increases in different RCPs



Sources: IIASA GGI Scenario database (Version 2.0.1)
Rogelj et al. (2012)



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Climate change impacts assessed and modelling strategy



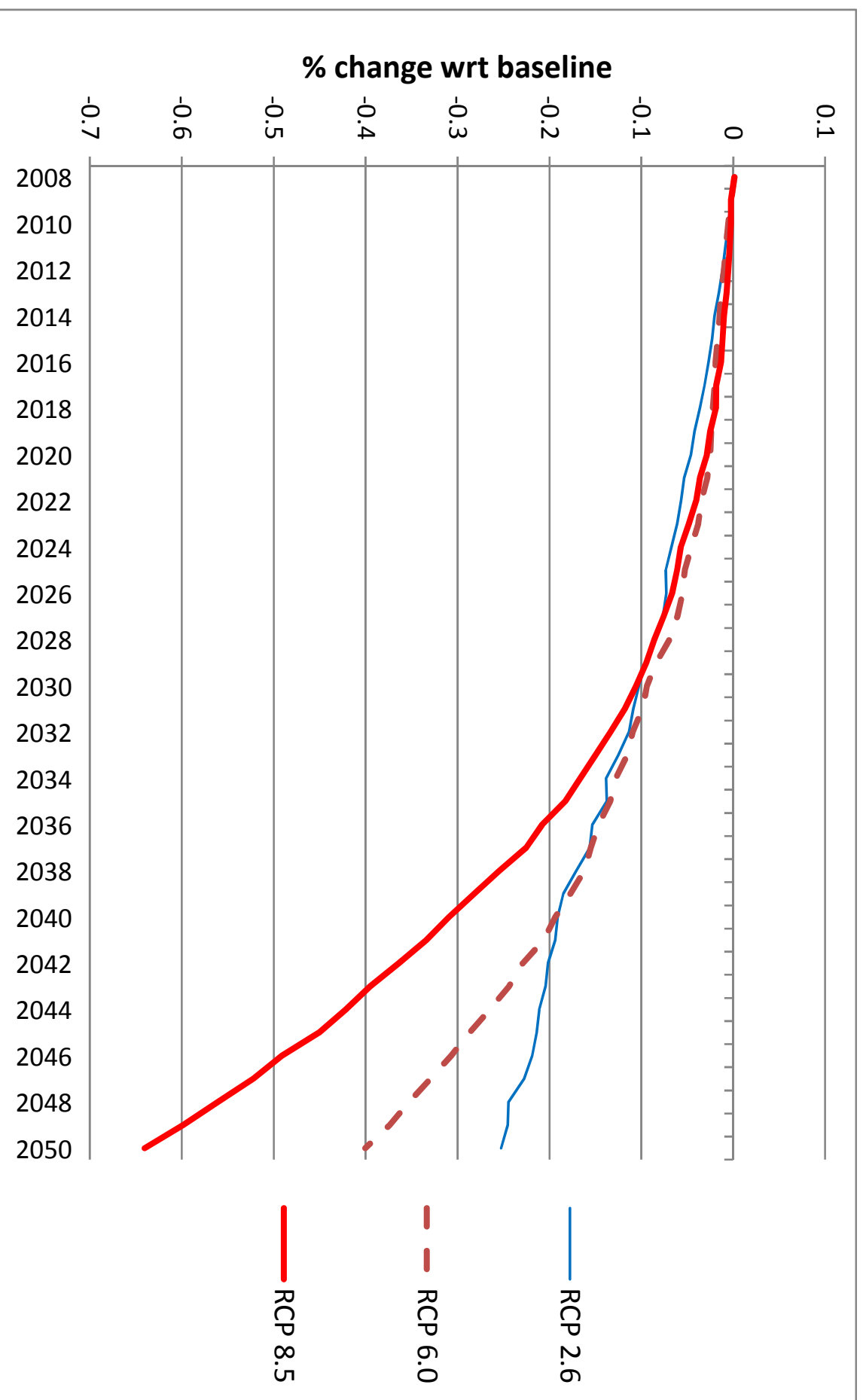
Climate change impacts: Sources

| CC Impacts | Sources | Available Scenarios |
|----------------|---|------------------------|
| Agriculture | PIK - LPJmL ISIP-MIP runs | RCPs 2.6, 6.0, and 8.5 |
| Health | ToI (2002) | Reduced form |
| Sea level Rise | Diva model - Vafeidis et. al (2008) CLIMATECOST project | A1B |
| Tourism | Hamburg Tourism Model - Bigano et. al (2007) CLIMATECOST project | A1, B2 |
| Energy demand | POLES model - Criqui (2001), Criqui et. al (2009) CLIMATECOST project | A1B |
| Forestry | PIK - LPJmL Bondeau et. al (2007), Tiejten et al (2009) CLIMATECOT project | A1B |
| Fisheries | Cheung et. al (2010) SESAME project | A1B |
| Ecosystem | Warren et al (2006) | Reduced form |

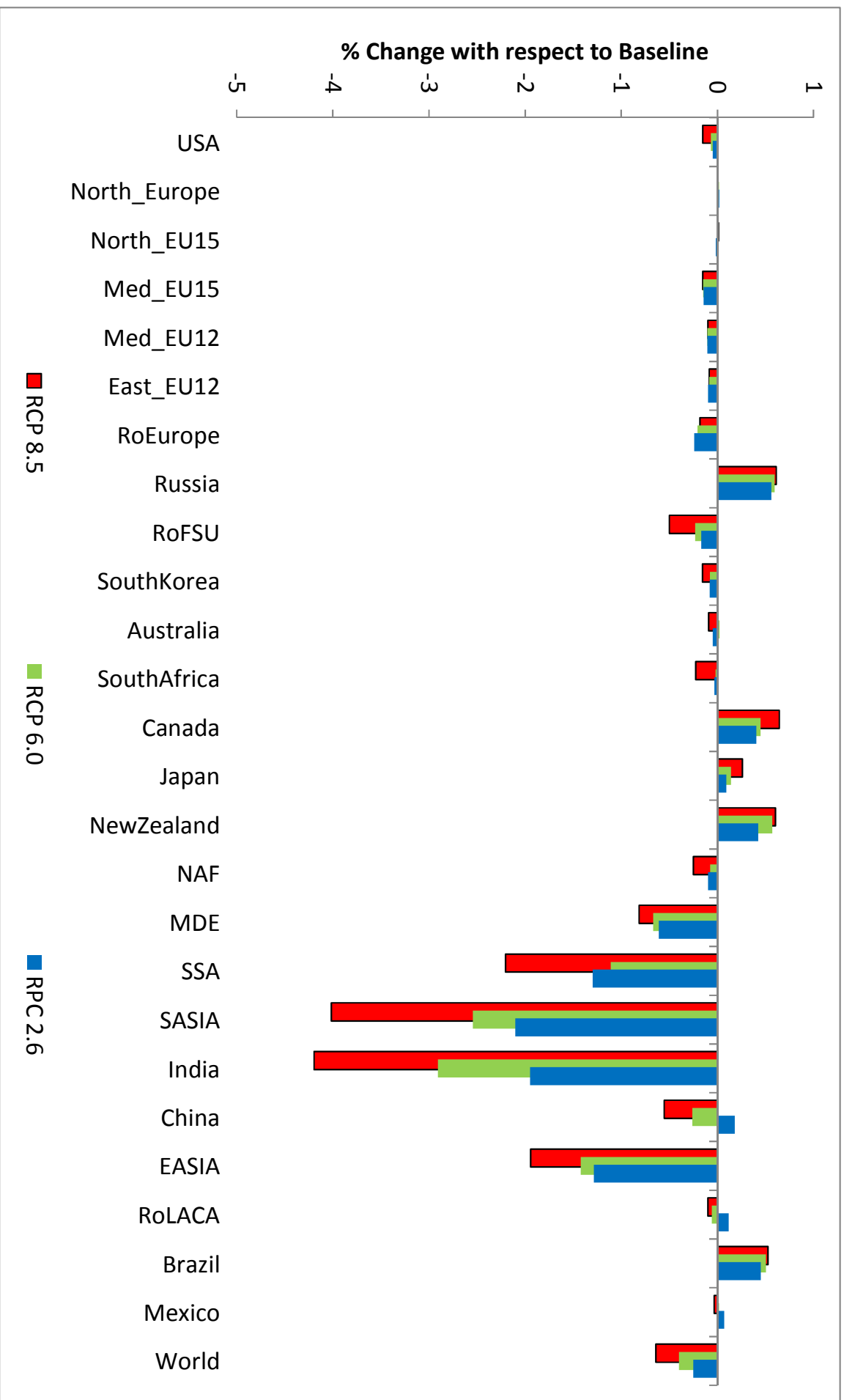
Summary of scenarios

- Economic reference: SSP2
- Full Adaptation
 - Climate change impact assessment
 - Climate change impacts (8)
 - RCPs: 2.6, 6.0 and 8.5
 - Impacts on world and regional GDP
 - Reduced-form damage functions
- Limited Adaptation

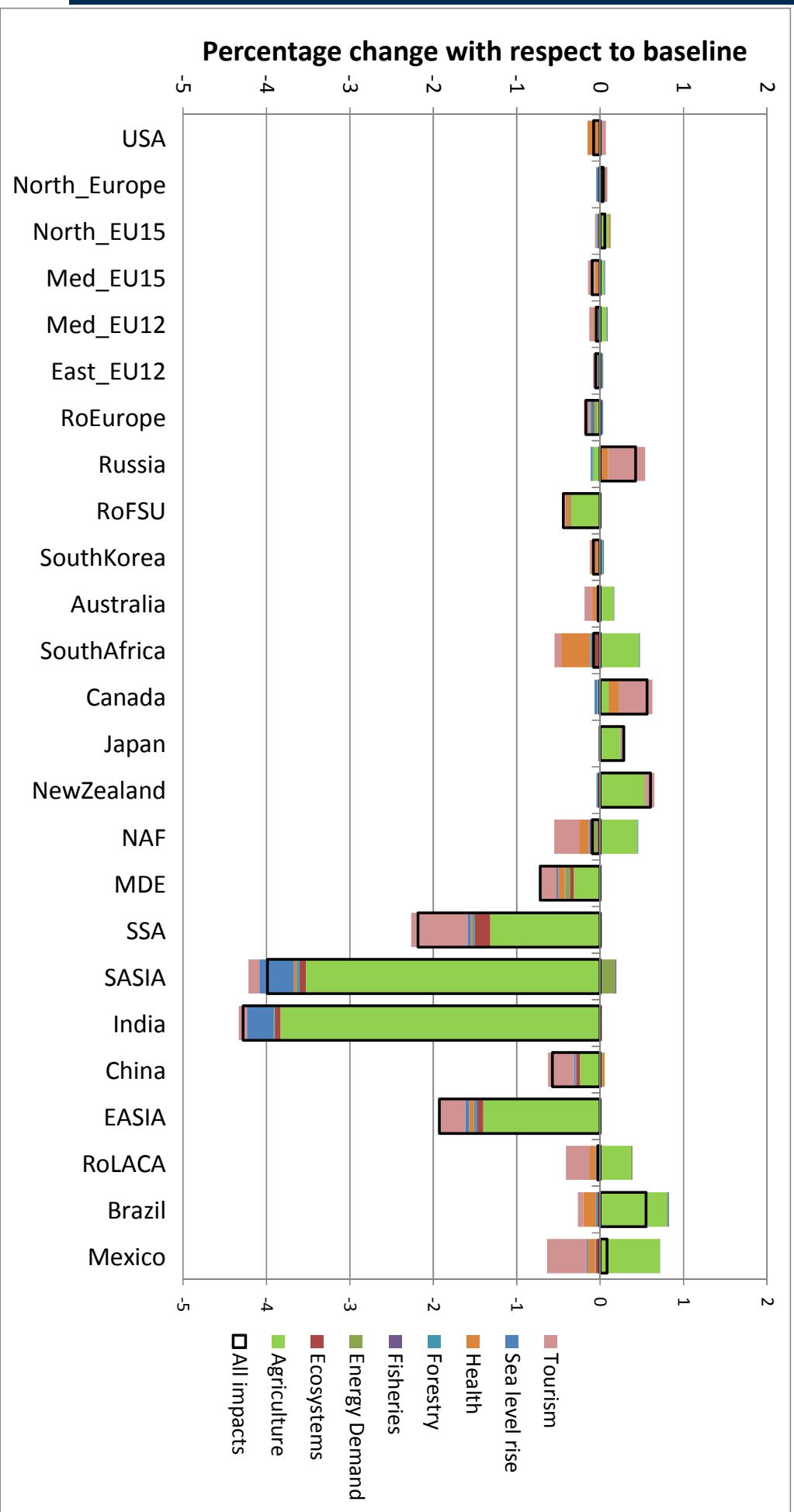
Climate Change Impact on Gross World Product



CC impacts on GDP in 2050 – regional breakdown



CC impacts on GDP in 2050 – decomposition RCP 8.5



Introducing limited adaptation

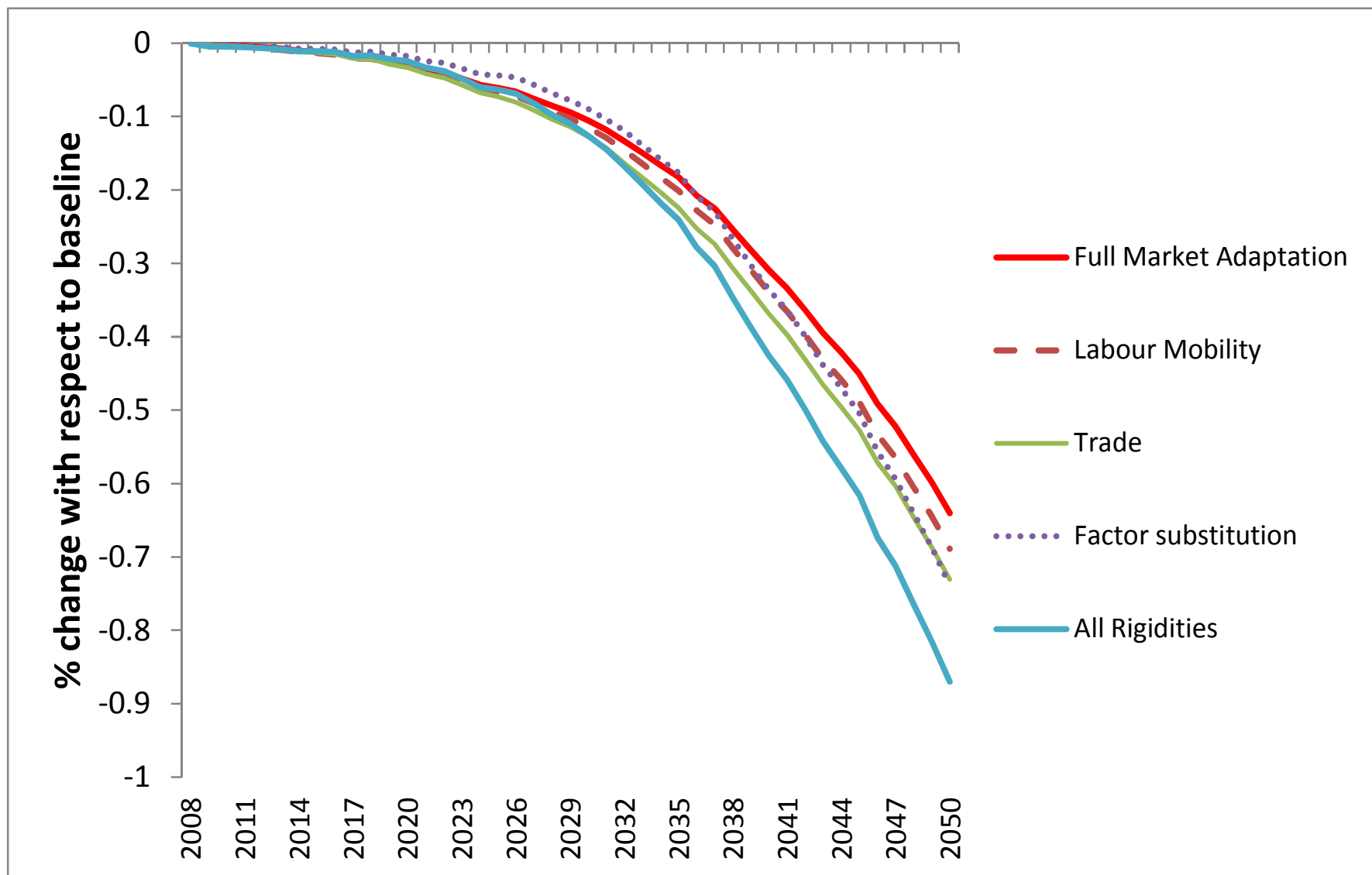
- Set of simulations considering limited market-driven adaptation in three specific features (parameters) of the model:
 - Trade (*LA-TR*): reducing the model's flexibility to accommodate international trade flows.
 - Labor mobility (*LA-LM*): limiting workers mobility within sectors in each region.
 - Primary factor substitution (*LA-PFS*): decreasing the flexibility to combine production factors (labor, natural resources, land and capital-energy).

ICES: Limited Adaptation scenarios

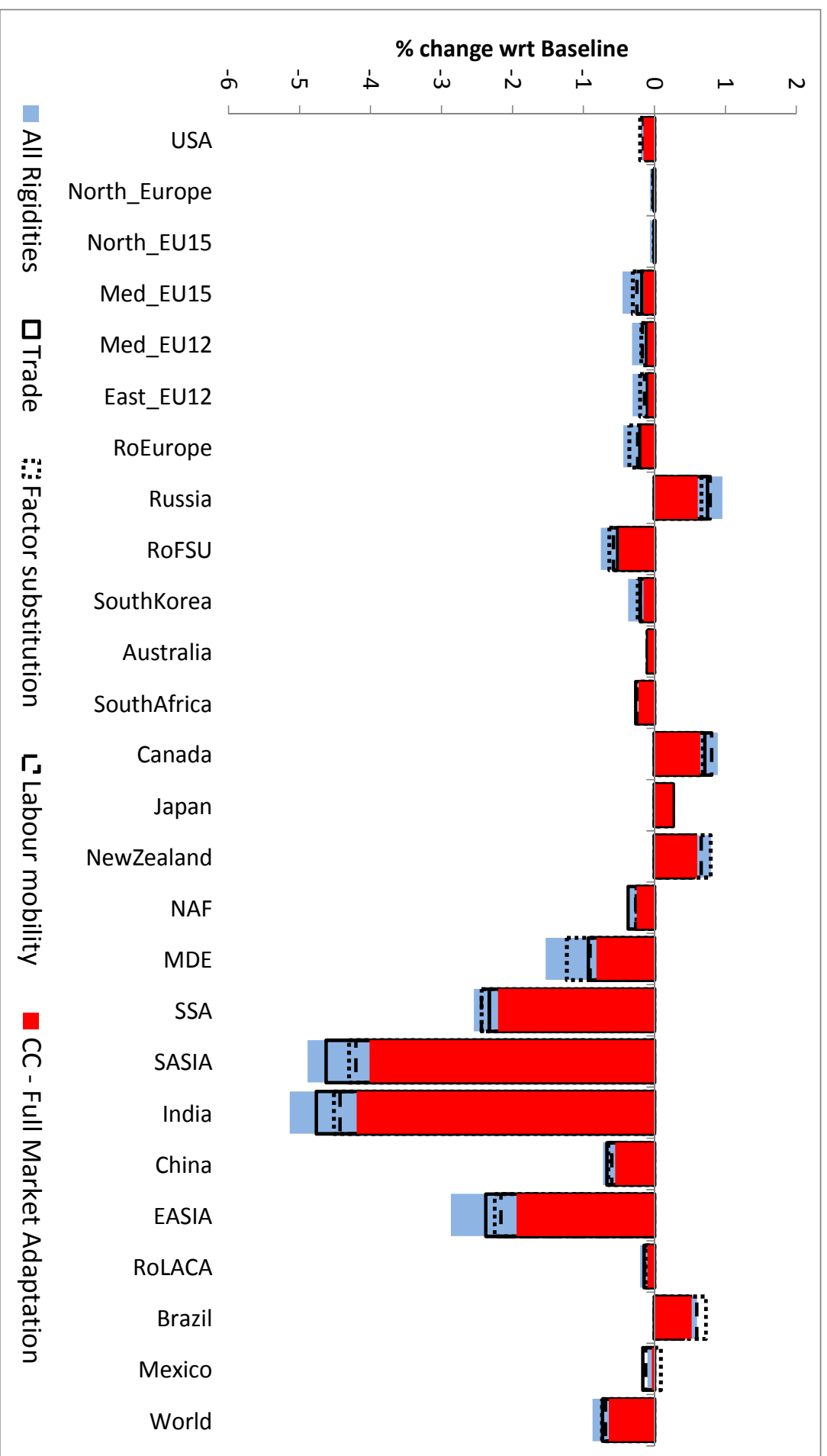
- Climate change impacts with RCP 2.6, 6.0 and 8.5
 - Trade (Armington elasticities reduced to 75%): *LA-TR*
 - Primary factor substitution (substitution elasticity reduced to 75%): *LA-PFS*
 - Limited labor mobility allowing for wage differences: *LA-LM*
 - All rigidities (TR, LM, PFS): *LA-AR*
 - Impacts on world and regional GDP

- We set the limited adaptation values for elasticities based on:
 - Armington elasticities: ratio of mean elasticity to the lower end of the 68% confidence interval: $\mu/(\mu - 1\sigma)$.
 - Factor substitution: ratio of short term to medium term elasticities.

Climate change impacts on GWP for RCP 8.5



RCP 8.5 impacts on regional GDP with limited adaptation

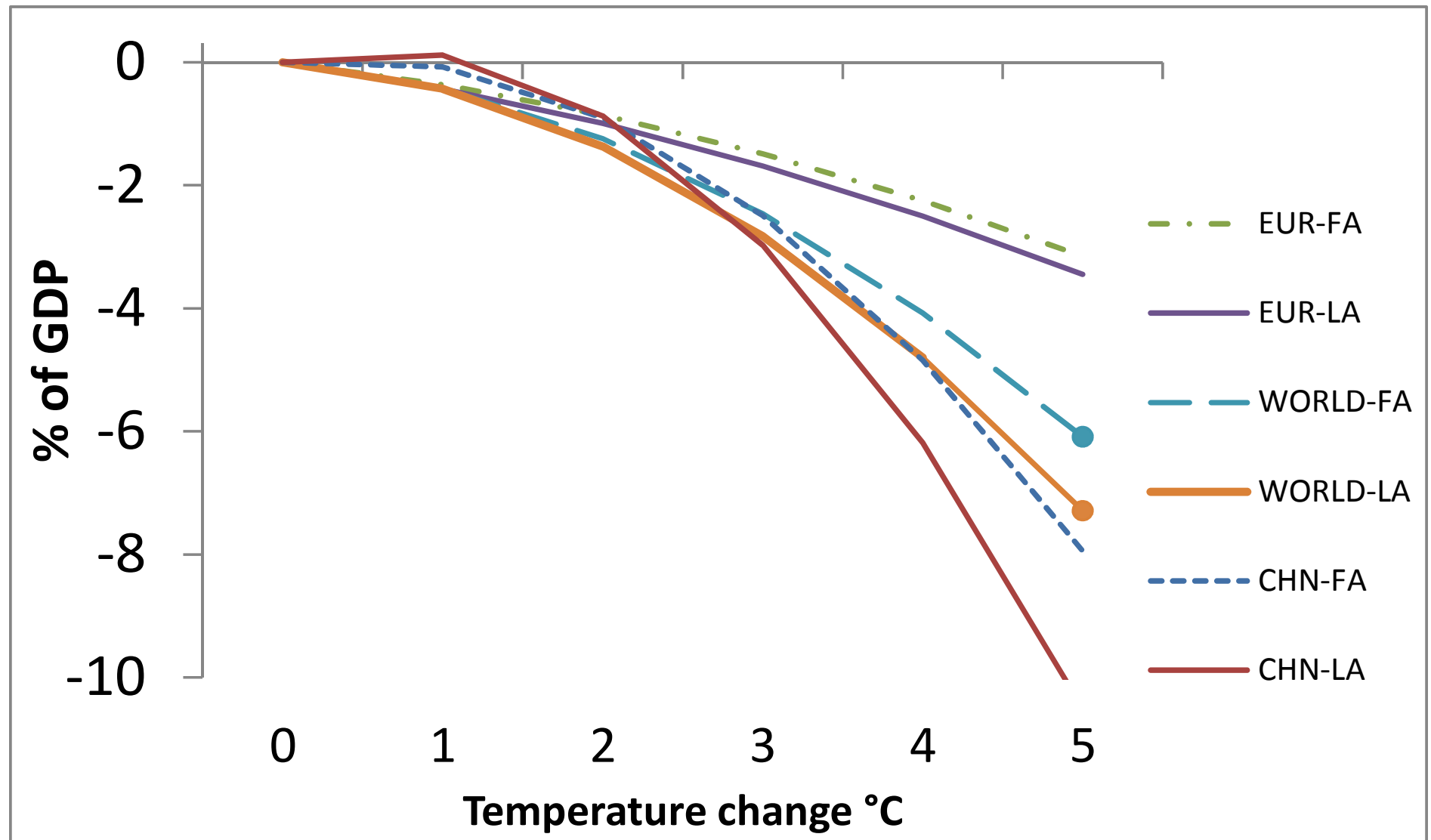


Reduced-form climate damage functions

- Using different RCPs to obtain also different (namely 3) temperature increases and therefore impacts and GDP effects in the same year.
- To “clean” or control for the social economic factors we selected as reference one single year (2050).
- Each pair (GDP cost, temperature increase) for each region account for **market impacts**.
- We include a **catastrophic damage** component following Nordhaus and Boyer (2000) and Nordhaus (2007).

- The **total damage** is the sum of **market** plus **catastrophic** damages which we finally use to extrapolate the reduced-form climate change damage function.

Reduced-forms with Full (FA) and Limited adaptation (LA)



Conclusions (1)

- In 2050 total costs roughly amount to 0.64% of GWP in RCP 8.5 (2.5C increase).
- Aggregate figures hide important regional asymmetries and a differentiation in regional exposure, sensitivity and adaptive capacity.
- Higher vulnerability of developing countries to climate change impacts. (South Asia and India lose more than 4% of their GDP, Eastern Asia and Sub Saharan Africa losing roughly 2% of their GDP in 2050 for RCP 8.5).
- Introducing rigidities in impact assessment reveals an increase of climate change costs. GWP losses rise roughly to 0.87%.
- A major driver of these peaking costs is the lower degree of substitution across primary factors, pushing alone losses to more than 0.73% of Global GDP in 2050.

Conclusions (2)

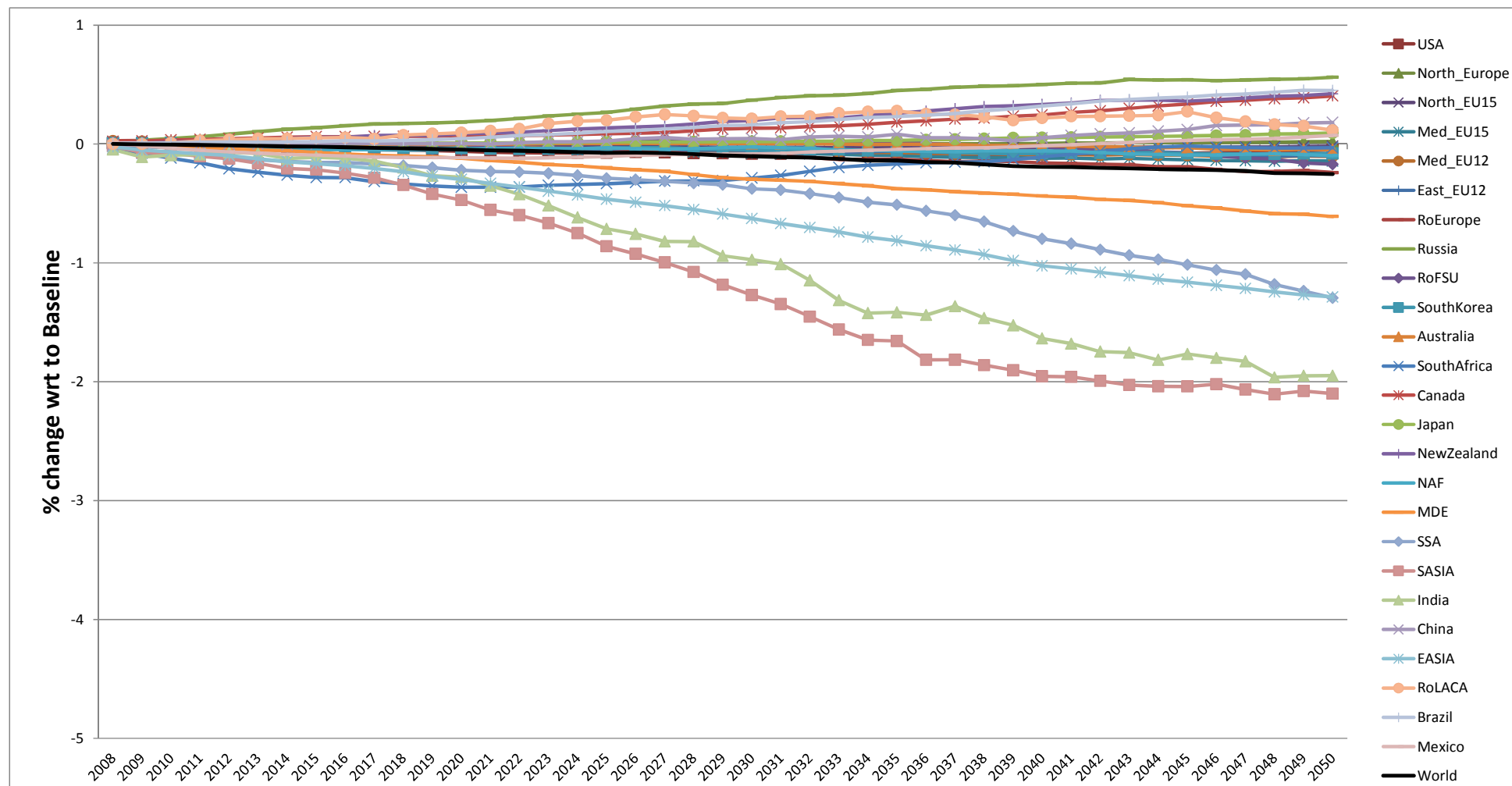
- Relatively minor deviations from the basic parameterization of the model are able to increase impacts by roughly 30% at the global level.
- Considering reduced-form damage functions, limited adaptation results in a higher damage for the world in particular for higher temperatures (20% higher than with full adaptation at a temperature of 5° C).



Thanks!

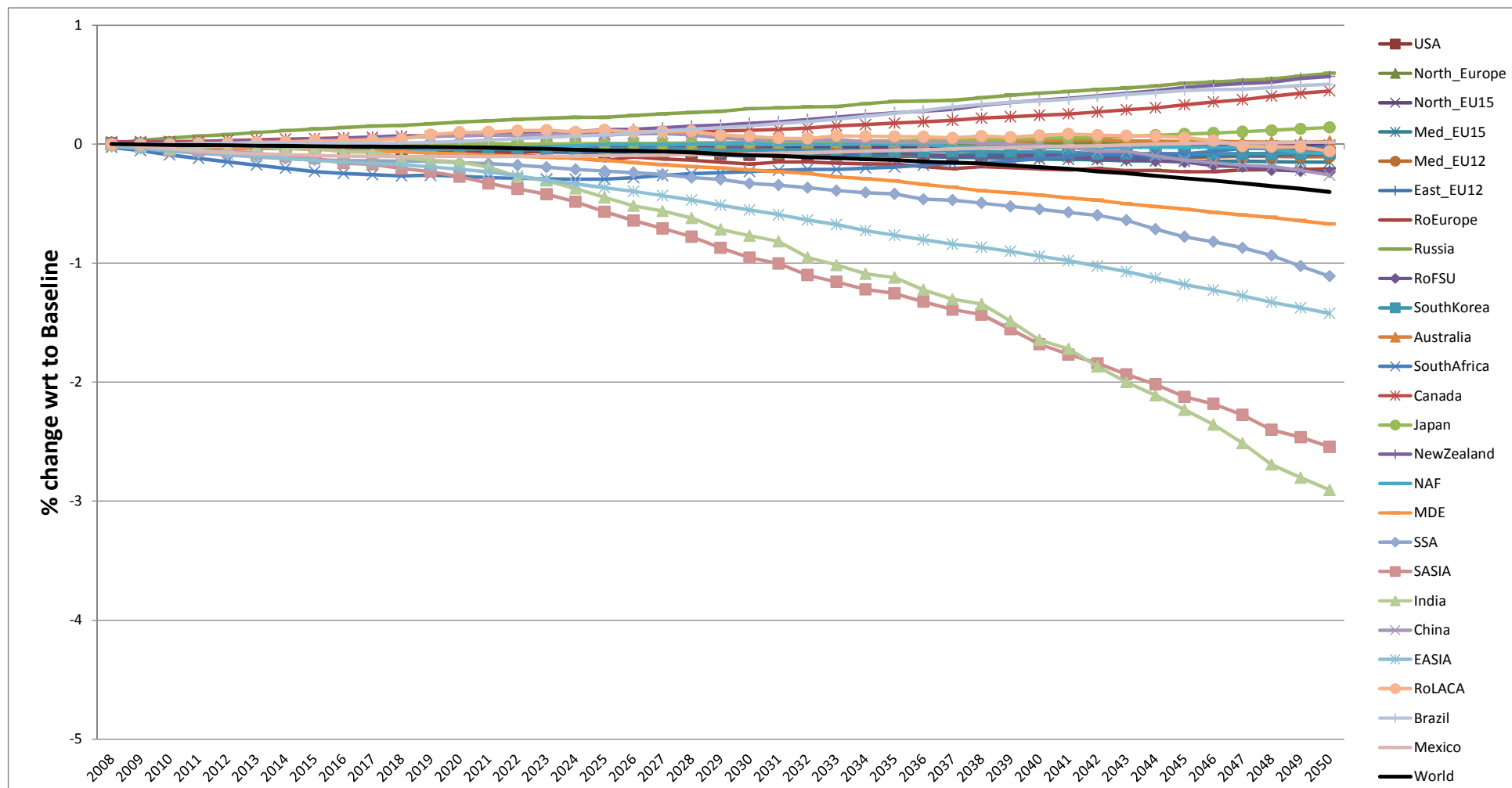
This research project has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under the grant agreement n° 266992 (Global IQ)

RCP2.6: climate-change impact on macro-regional GDP



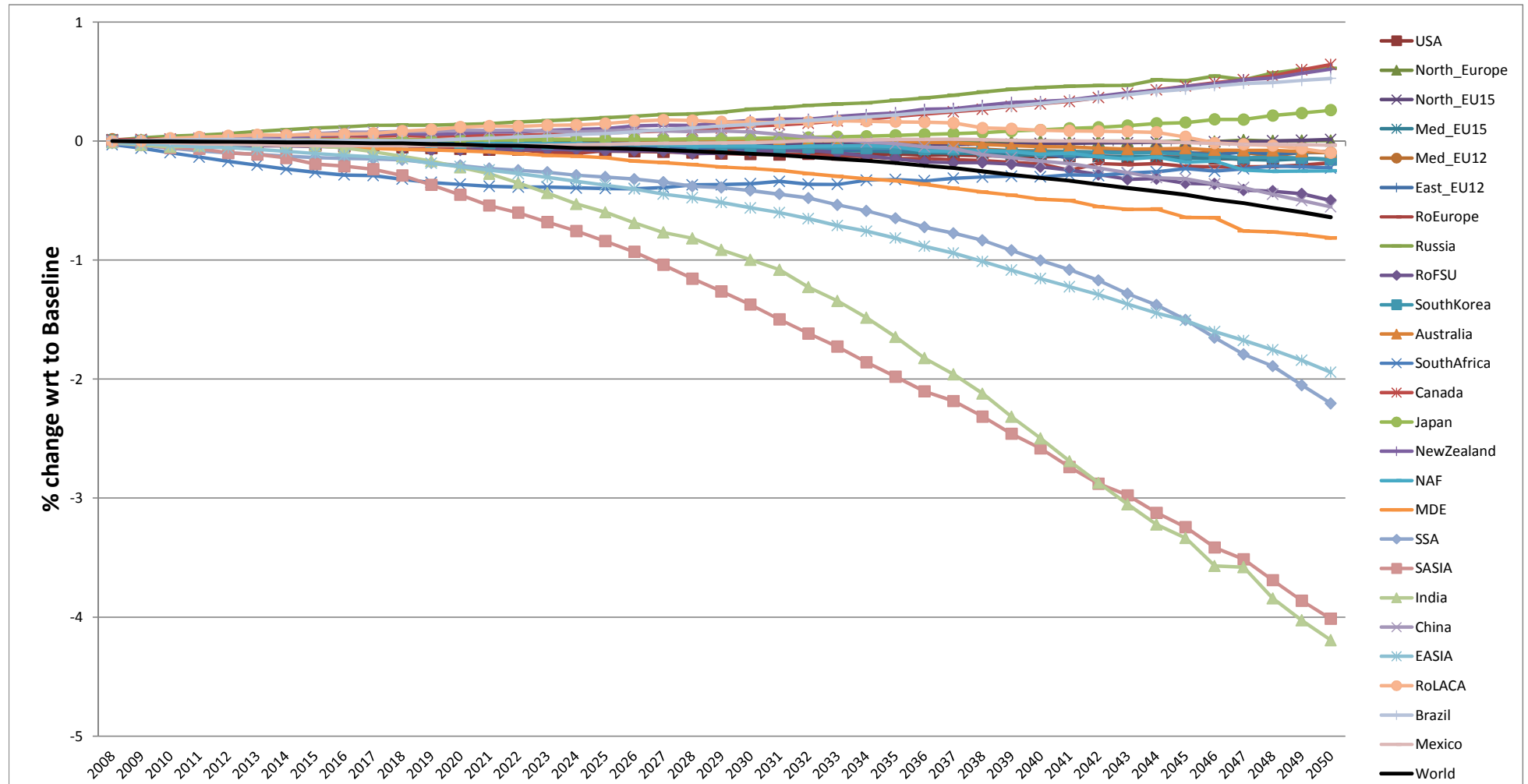
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RCP6.0: climate-change impact on macro-regional GDP



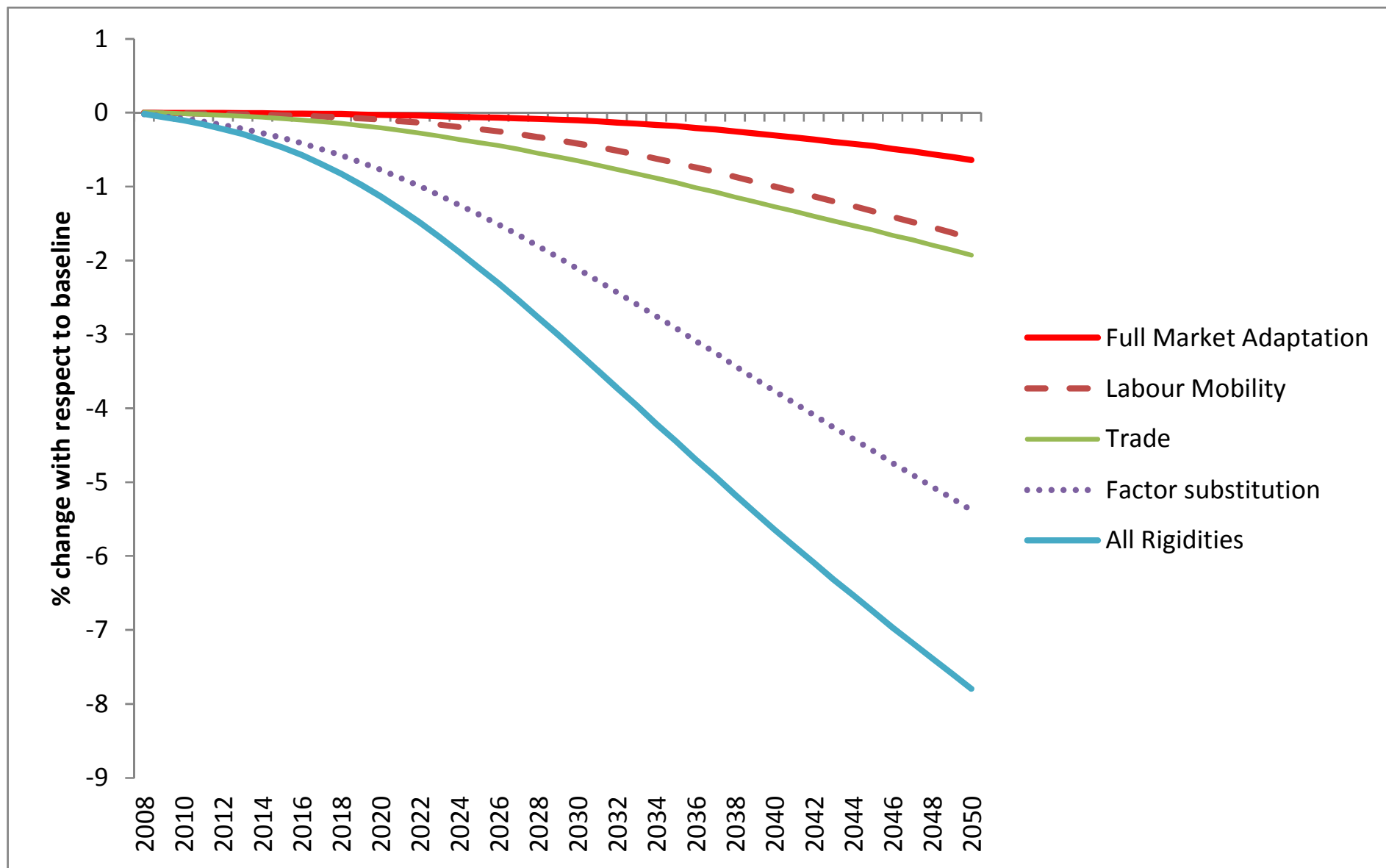
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RCP8.5: climate-change impact on macro-regional GDP



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Climate change impacts on GWP for RCP 8.5 vs a Full adaptation baseline



RCP 8.5 impacts on regional GDP with Limited adaptation vs a Full adaptation baseline

