Revealing the distributional effects of current and future flood risk under climate change in Austria

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Introduction

Introduction: Motivation

- Climate impacts have adverse consequences on macro-economy (e.g. Bosello et al., 2012; Cortés Arbués et al., 2024) but also within-country inequality (e.g. Bachner et al., 2023; Paglialunga et al., 2022)
- Increasing population at risk of poverty in developed countries (e.g. EU: Campagnolo et al., 2024)
- Uneven distribution of flood risk: Relative to the available financial means, expected flood damage is larger for low-income households than for high-income groups (Osberghaus, 2021)
- Inequalities in disaster recovery is determined by pre-existing disparities - e.g. Hurricane Katrina (Masozera et al., 2007, Finch et al., 2010)

➔ **From economic perspective crucial to know distributional effects, as it allows for targeted and eventually efficient adaptation**

Introduction: Contribution

- Often within-country effects are poorly understood
  → we disaggregate overall “welfare effects”

- Climate impact studies often only go until 2050 (using process-based modelling approaches such as bottom-up top-down combinations)
  → we go until 2080

- Question of how to finance reconstruction (who pays for it) is often only addressed implicitly
  → we offer a systematic and clear comparison for **three stylized schemes**

Introduction: Research question

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Who bears the costs of current and future flood risk…

…and what are the consequences of a re-distribution via different financing schemes for reconstruction?

Today

How is flood risk spread across the Austrian population (regions, income groups) already **today**?

Future

What are the macro effects of **additional future** flood risk under different financing schemes?

What are the distributional effects of expected **additional future** flood risk under different financing schemes?

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Method and data

Method: Computable General Equilibrium model

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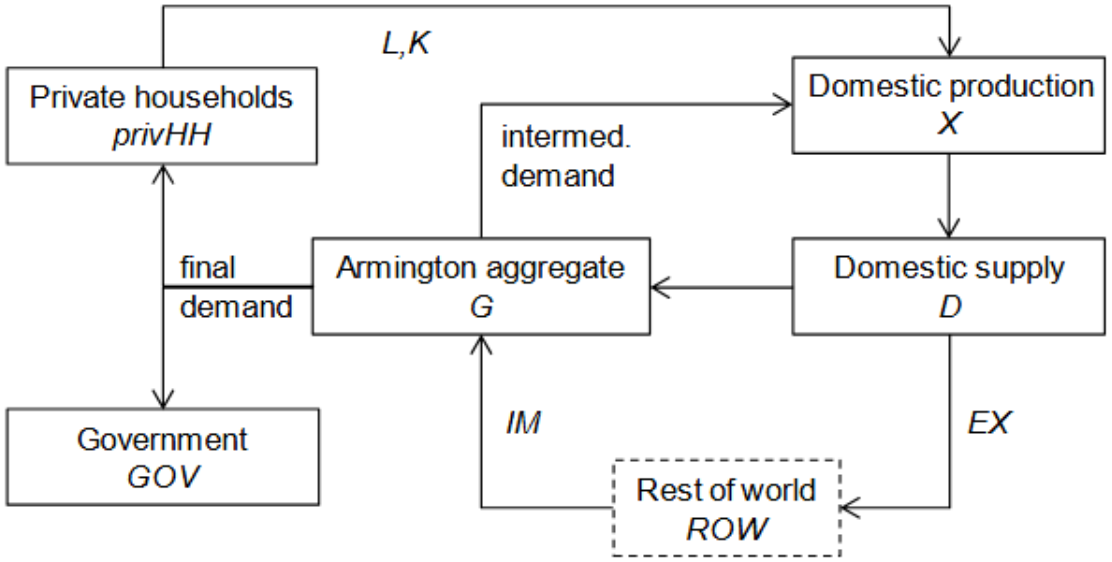
WEGDYN-AT model (Bachner, 2024)

- Calibrated to 2014
- Multi-sector (81 sectors)
- Multiple households (12 private, 1 public)
  - Private: 4 income quartiles x 3 regions of residence
- Small open economy (Armington)
- Recursive dynamic until 2080, solving in annual time steps
  - Endogenous capital accumulation subject to fixed savings rate
  - Calibrated to “Shared Socio-Economic Pathways” (SSPs)



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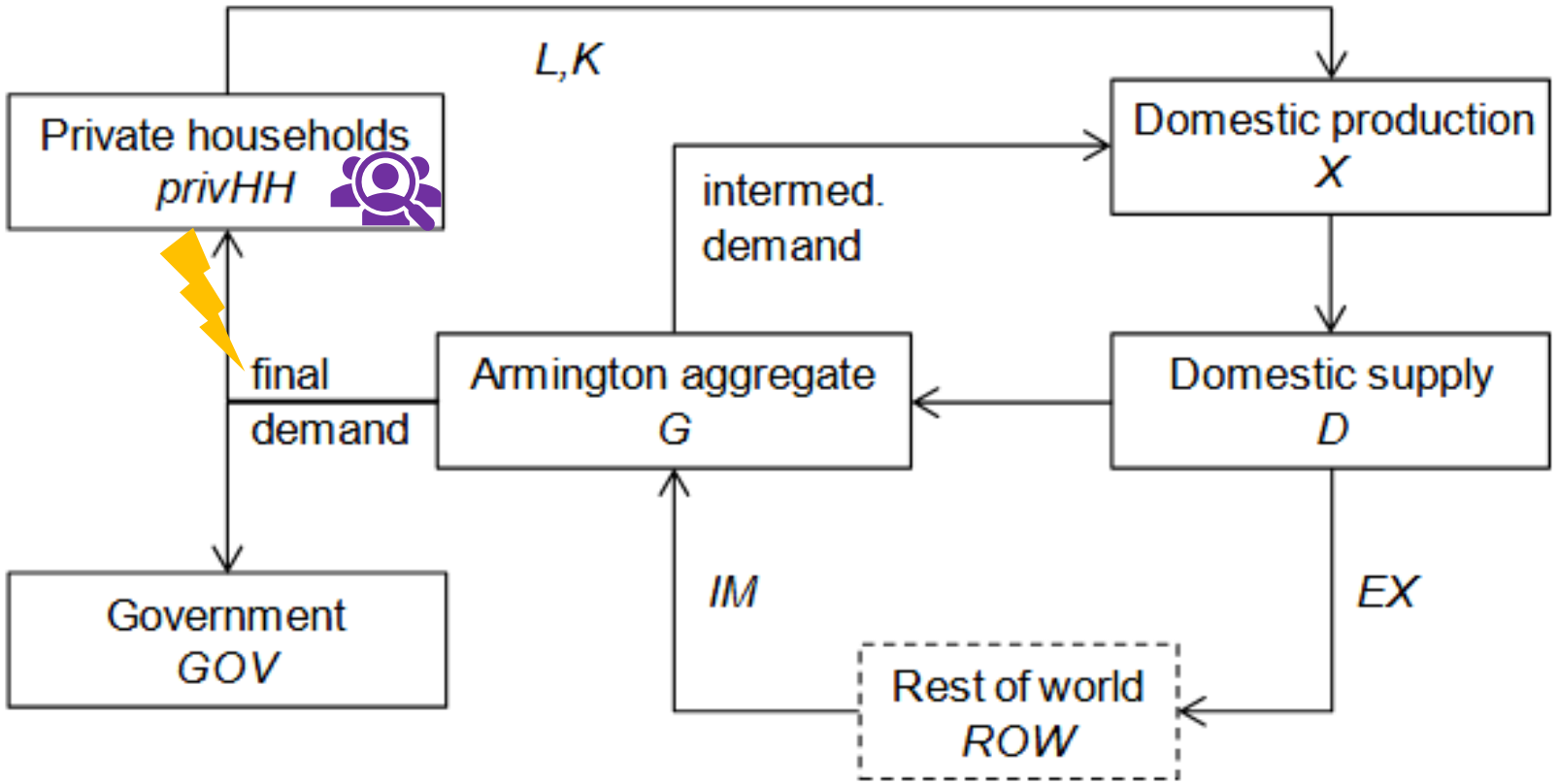
Method: implementation of flood risk



Further disaggregation:

- 3 regions
- 4 income quartiles
- **Flood exposed/ not flood exposed**

→ 24 household types

Shocking baseline equilibrium:

- Damages to residential building stock and respective income
- Increased demand for Buildings sector

Method: implementation of flood risk

Flood risk = expected annual damage
(coming from GLOFRIS model; details on next slides)

How to interpret damages to the residential building stock from a long-term macro view?

- Macroeconomic costs due to floods in the long term
  - private building stock as a form of productive stock (providing the “service” of housing in IO logic)

  → damages to building stock are treated as a reduction of productive means (and income) of households (similarly to established method for modelling damages to capital stocks)

  → GDP effect is **not** a neutral shift within consumption vector
- At the same time, consumption structure is changing towards more demand for building sector (and respective intermediate demand, labour etc.)
  - but crowding out other consumption/investment

Method: CGE model closures

Government closure:

- Fixed tax rates and flexible government income
- Transfers to households scale with tax income
  → Poorer households, who rely more on transfers, suffer more from reduced tax income

Savings-Investment:

- Fixed savings rate (share of income) that determines investment
  - Different for different households (income and savings rate are positively correlated)

Trade:

- Fixed trade balance that grows with GDP

Method: householf-specific flood recovery costs

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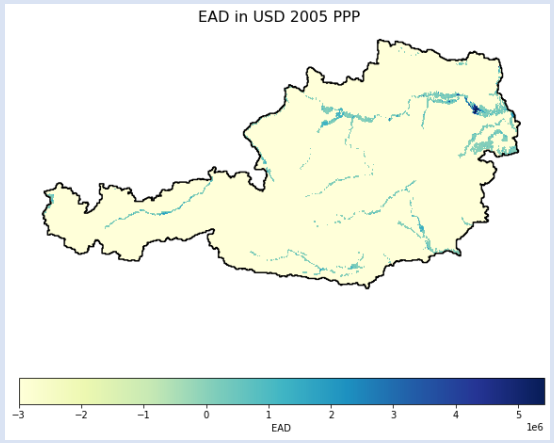
GLObal Flood RISk Model - GLOFRIS
(Winsemius et al., 2016)

- Expected annual recovery cost
- 1 km resolution
- Base period, 2030, 2050, 2080
- 3 socioeconomic scenarios
- 2 climate scenarios



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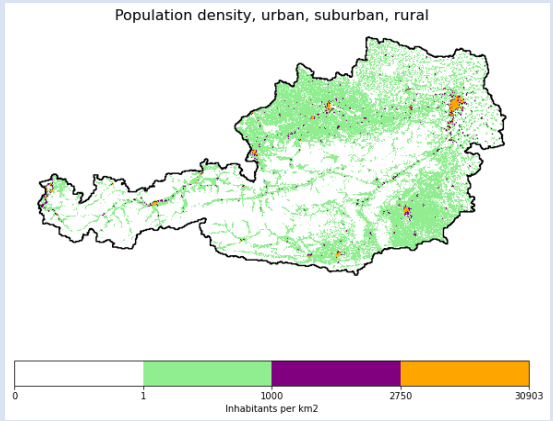
Socioeconomic data

- Labour & income tax statistics for 2019 (Statistik Austria): microdata for 6.7 mio people
- 1 km resolution
- Socioeconomic scenarios for GDP, income and urbanization trends until 2080



Annual recovery costs for 12 **exposed** household types (located in flood plain)

for 2015, 2030, 2050, 2080

→ Linear interpolation between time steps

CGE model input

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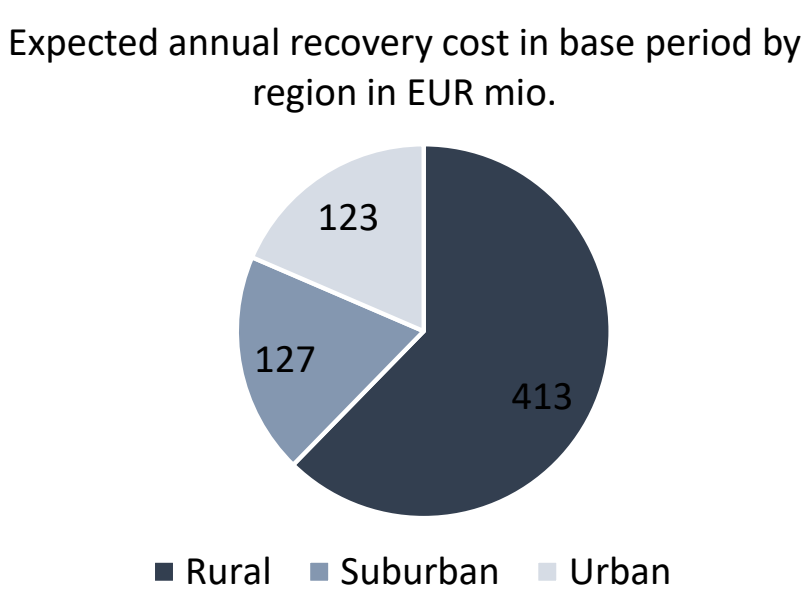
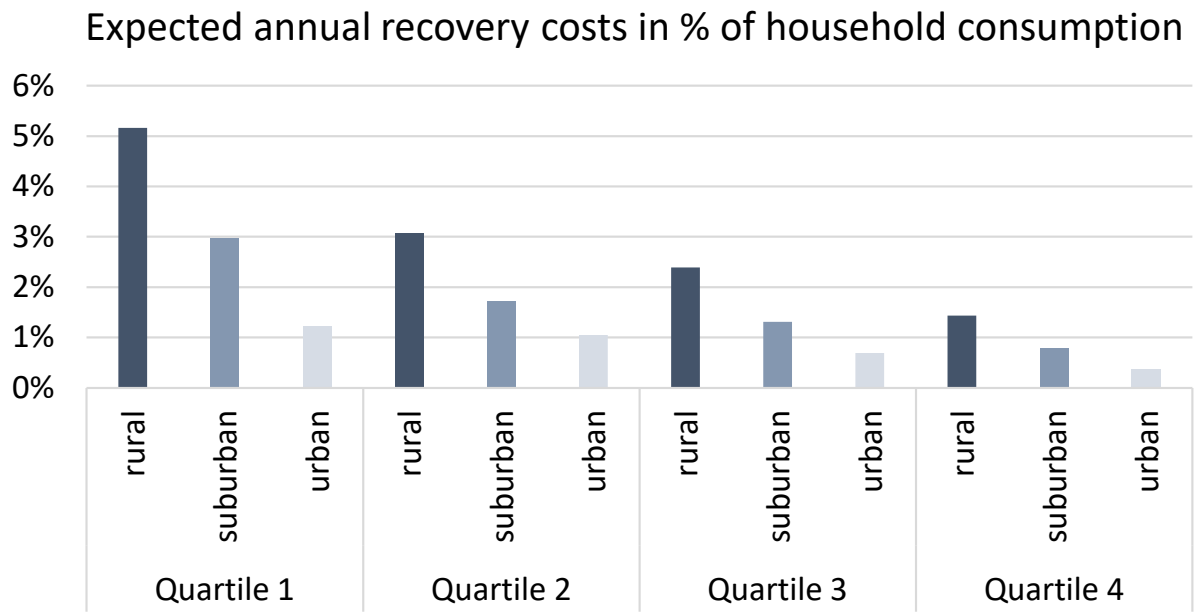
Method: Intermediate results

Current distribution of flood risk to residential buildings (base period 2015), source: GLOFRIS





→ How does it evolve into the future under climate and socio-economic change?

Scenarios

Scenarios

- Emission scenarios:
  - RCP4.5 (~ 2.7°C)
  - RCP8.5 (~ 4.4°C)
    [Different climate models to test robustness]
- Socio-economic scenarios:
  - SSP2 „middle of the road“
  - SSP1 „sustainability“
  - SSP4 „inequality“
- Focus: SSP2-RCP4.5

  results are robust, but stronger in RCP8.5 and distributional effects more pronounced in SSP4

Scenario: financing schemes for reconstruction

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Financing scheme	Flood recovery	Who finances recovery?	Financing via reduction of…
Risk-based burden sharing	Increased building sector demand	Exposed households themselves	Private consumption and investment of flood exposed households
Government-supported burden sharing	Increased building sector demand	Exposed households and a fraction by government: 50% of costs for Q1 & Q2 25% of costs for Q3 & Q4	Public consumption and private consumption and investment of flood exposed households
Solidarity-based burden sharing	Increased building sector demand	All households proportionally to their market income	Private consumption and investment of all households

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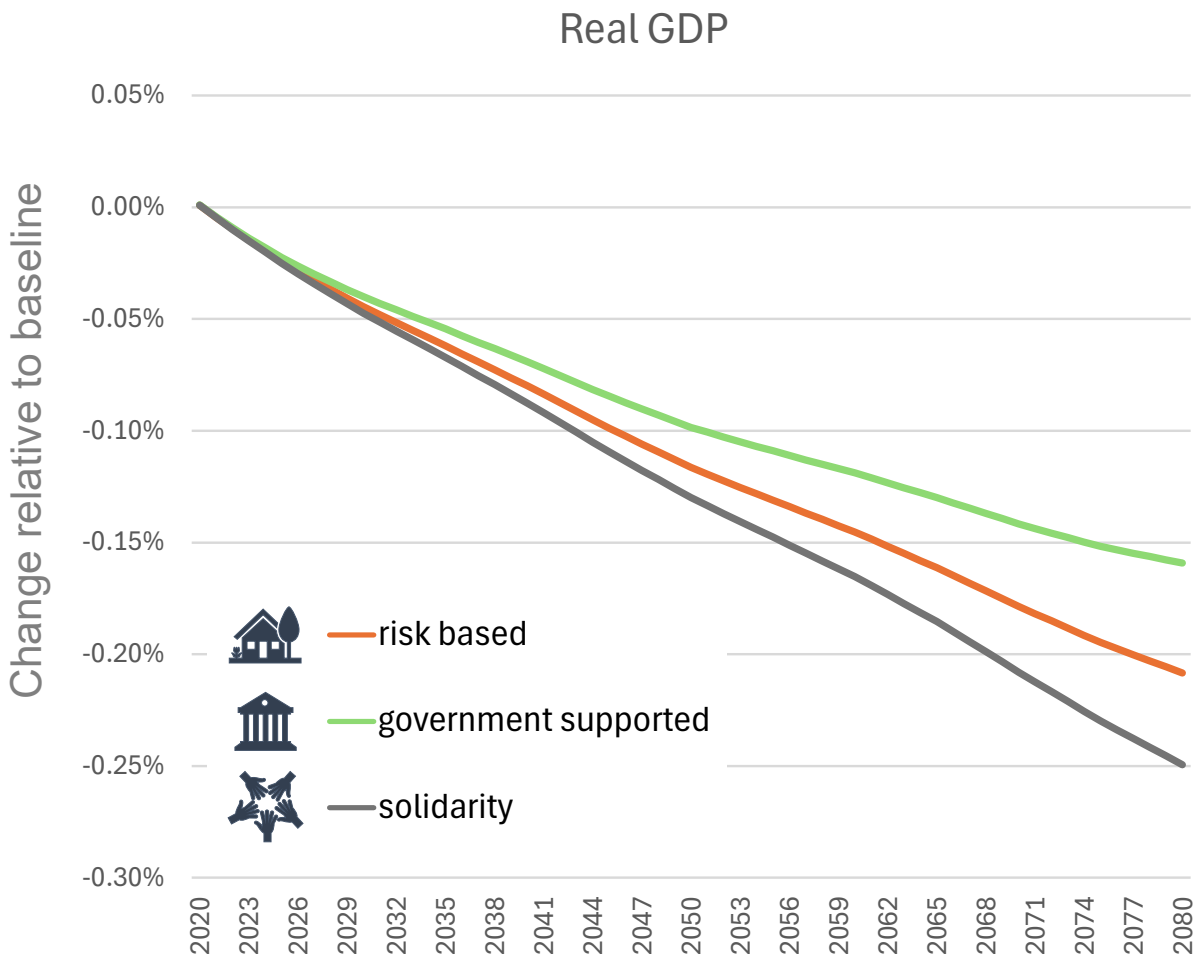
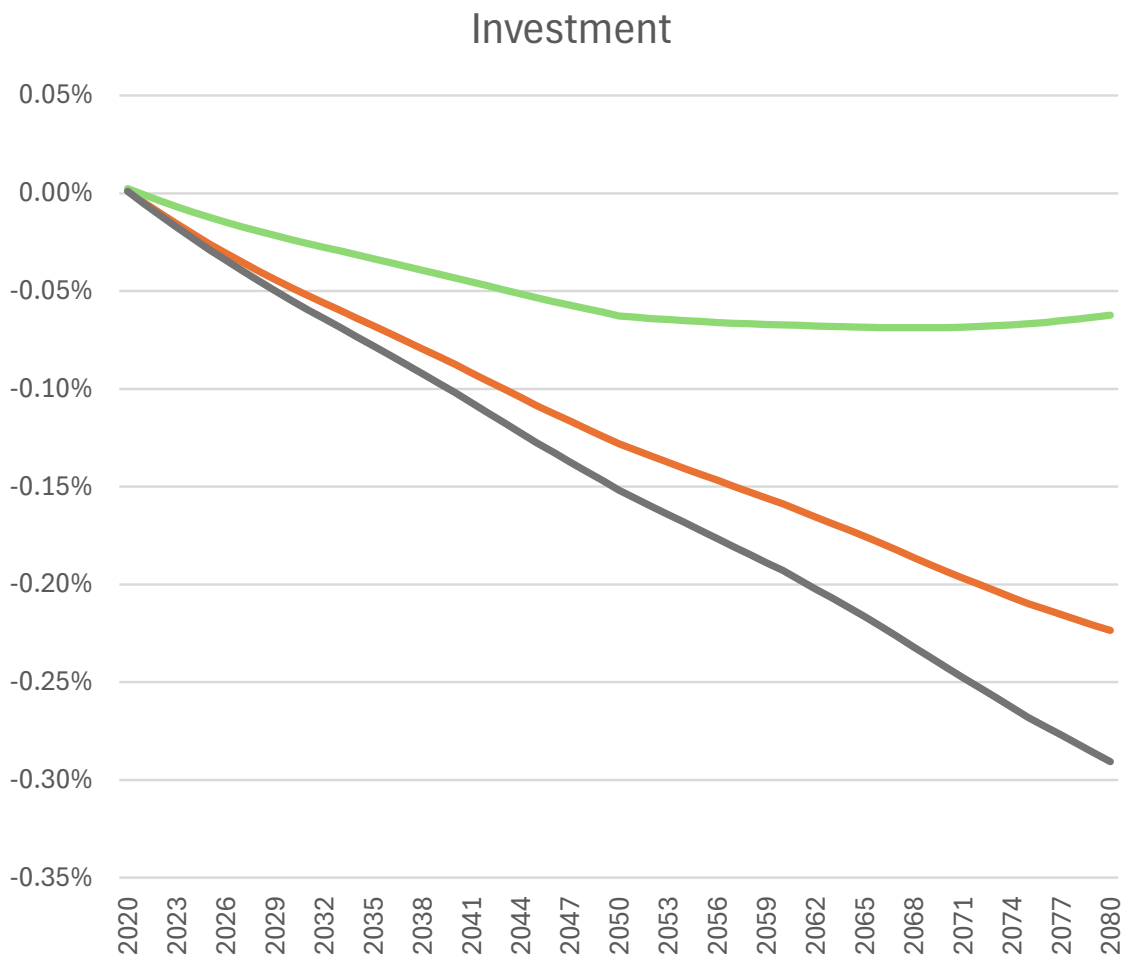
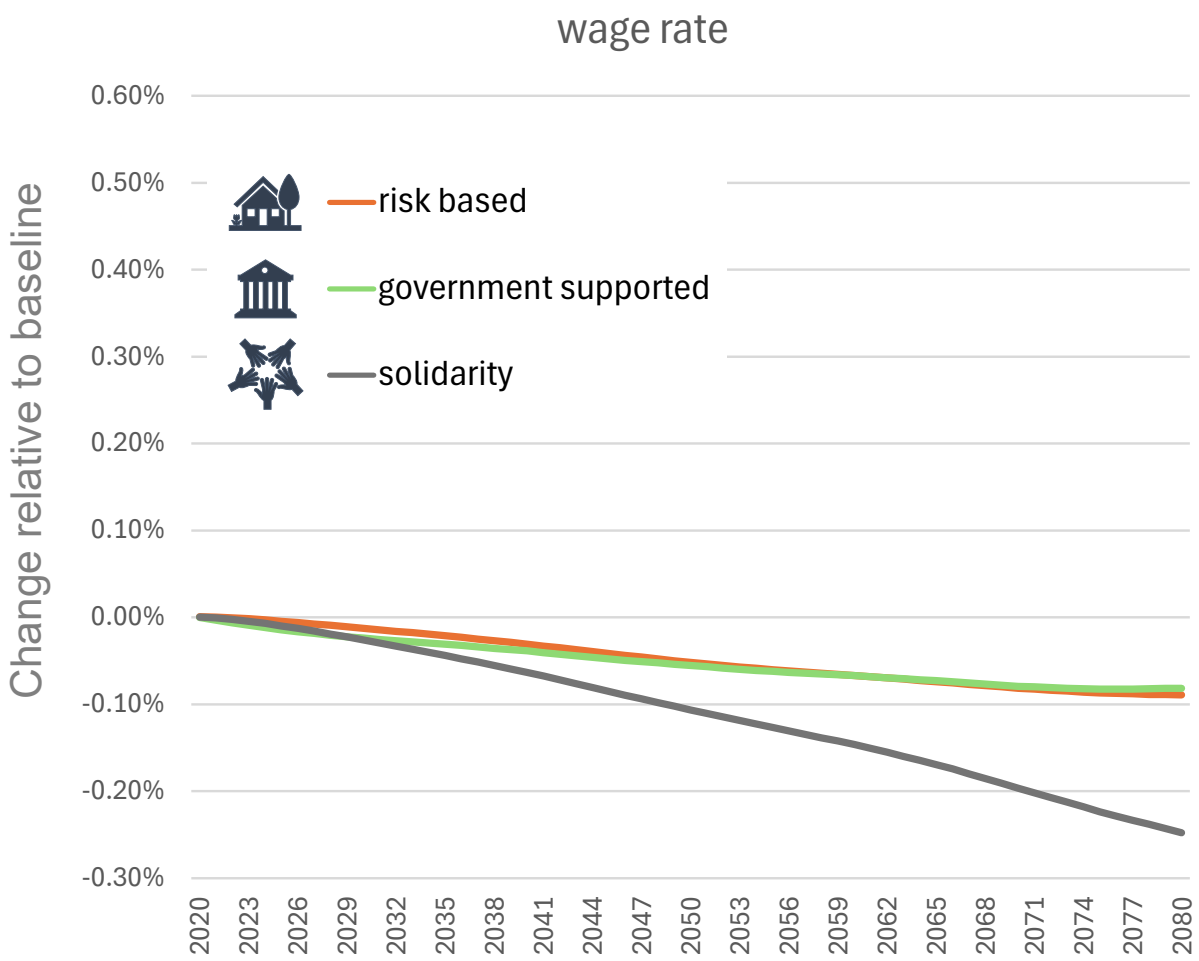
Results

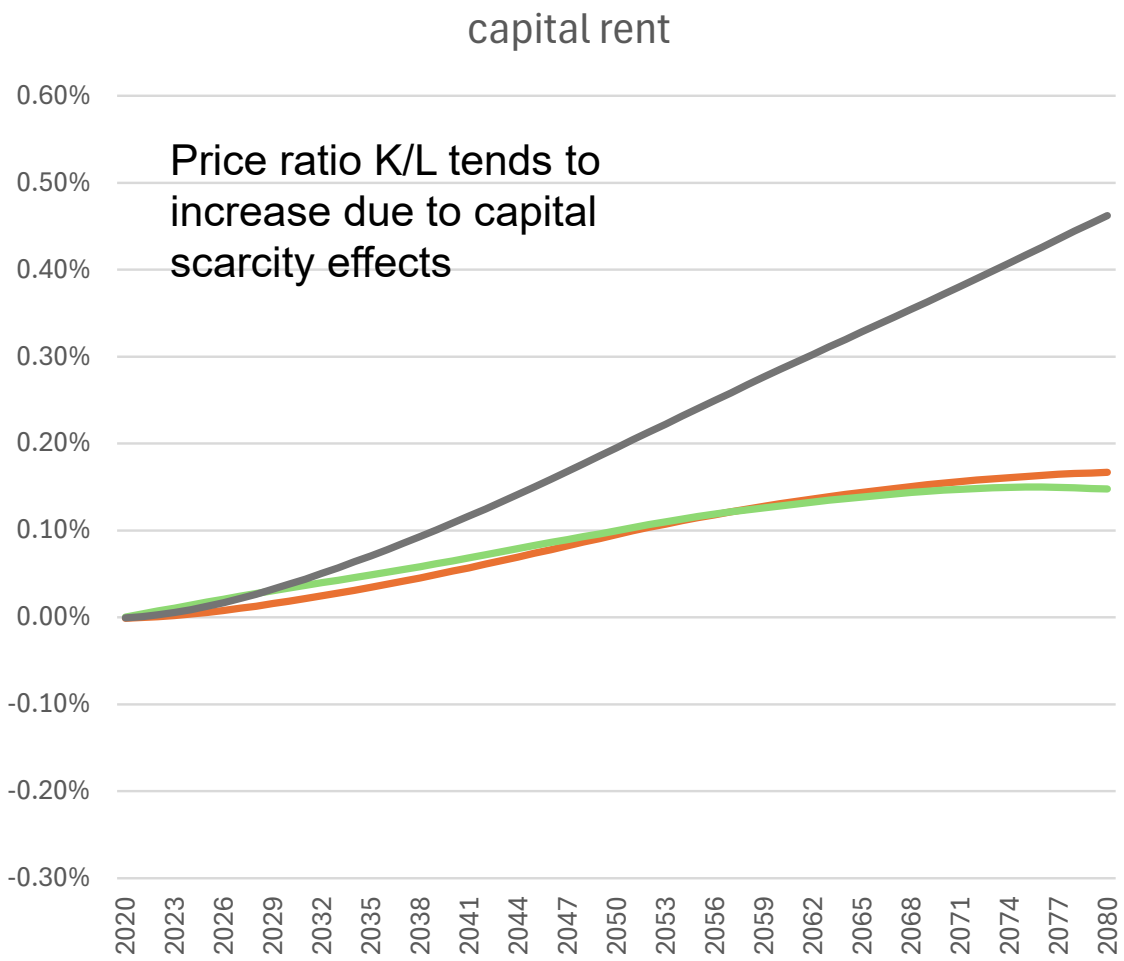
Results: macro indicators





Results: macro indicators





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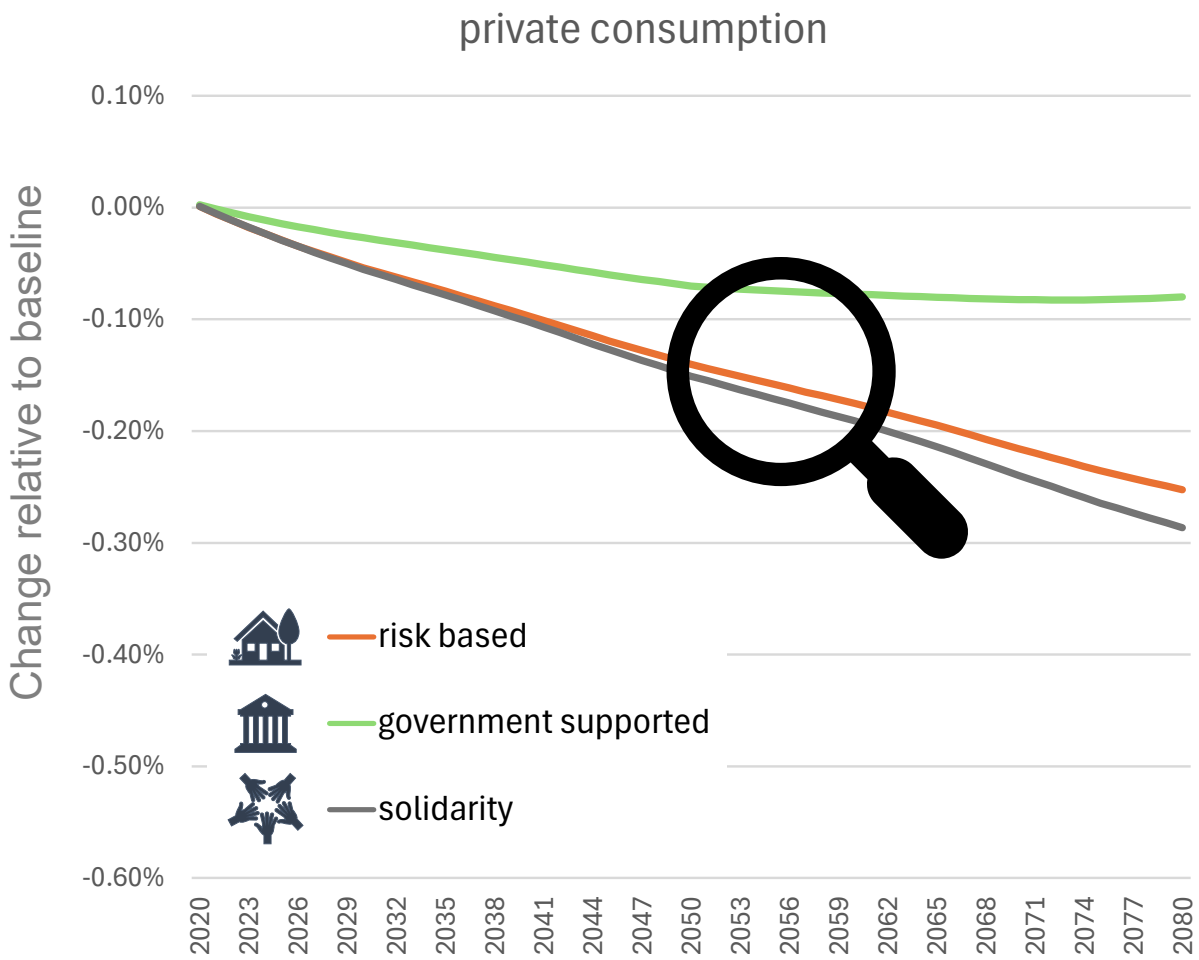
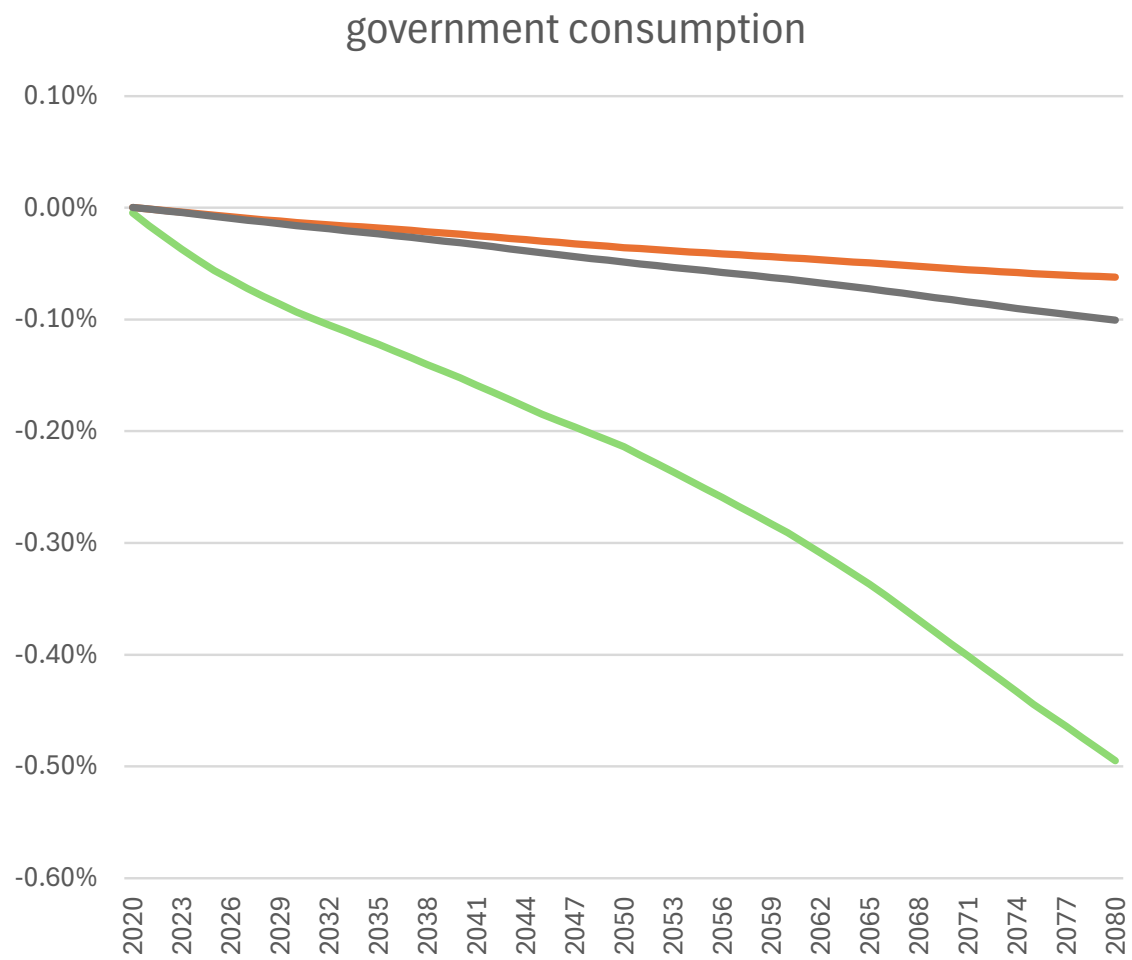
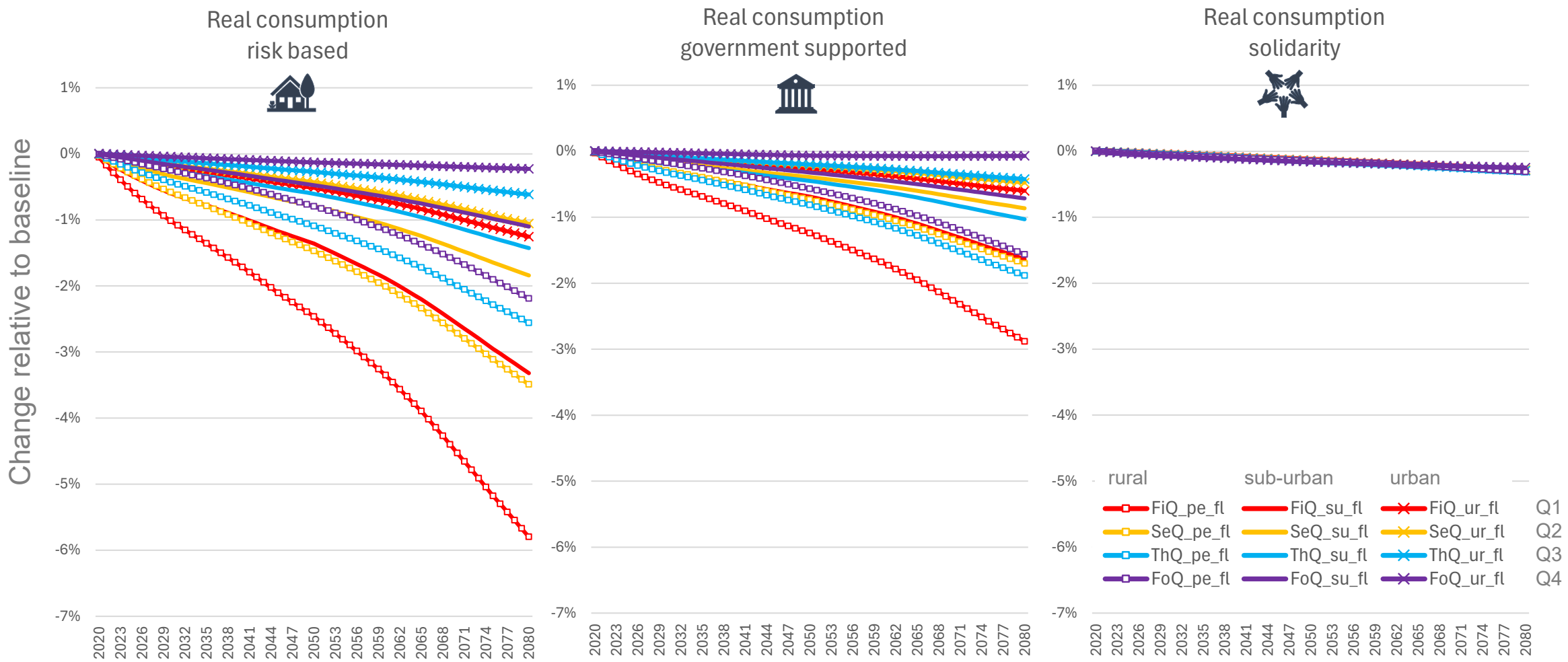
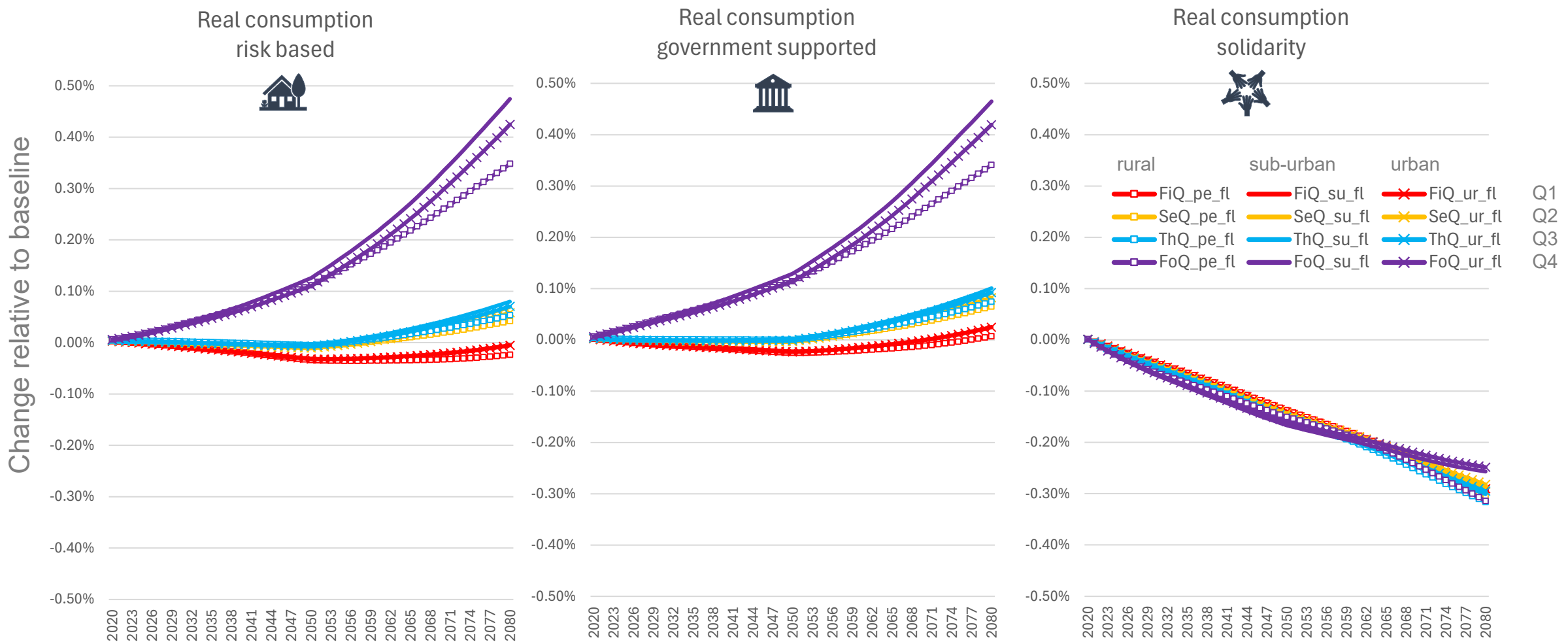




Results: distributional effects – exposed HHs



Results: distributional effects – non-exposed HHs



Conclusions

Conclusions

- Moderate aggregate GDP and welfare effects due to flood damages, but strong differentiation across households → Provides leverage point for targeted adaptation
- Strong indirect effects via capital accumulation
- Efficiency-equity trade-off: more equity at the expense of economic growth
  - Solidarity system performs worst at aggregate level
- Central role of government in setting policy; this can also avoid substantial macro losses (increasing again fiscal space) → Switching from risk-based to government-supported clearly pays off
- Going beyond 2050 shows much stronger effects

Discussion

- As a society, how do we weigh the welfare losses of different household types? → Welfare economics
- Modelling: discussion on how to treat private “capital stock”

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Thank you for your attention

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