



Revealing Indirect Risks in Complex Systems: A Highly Detailed Multi-Model Analysis of Flood Events in Austria

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Outline

- Introduction
- Method
- Selected key results
- Conclusions

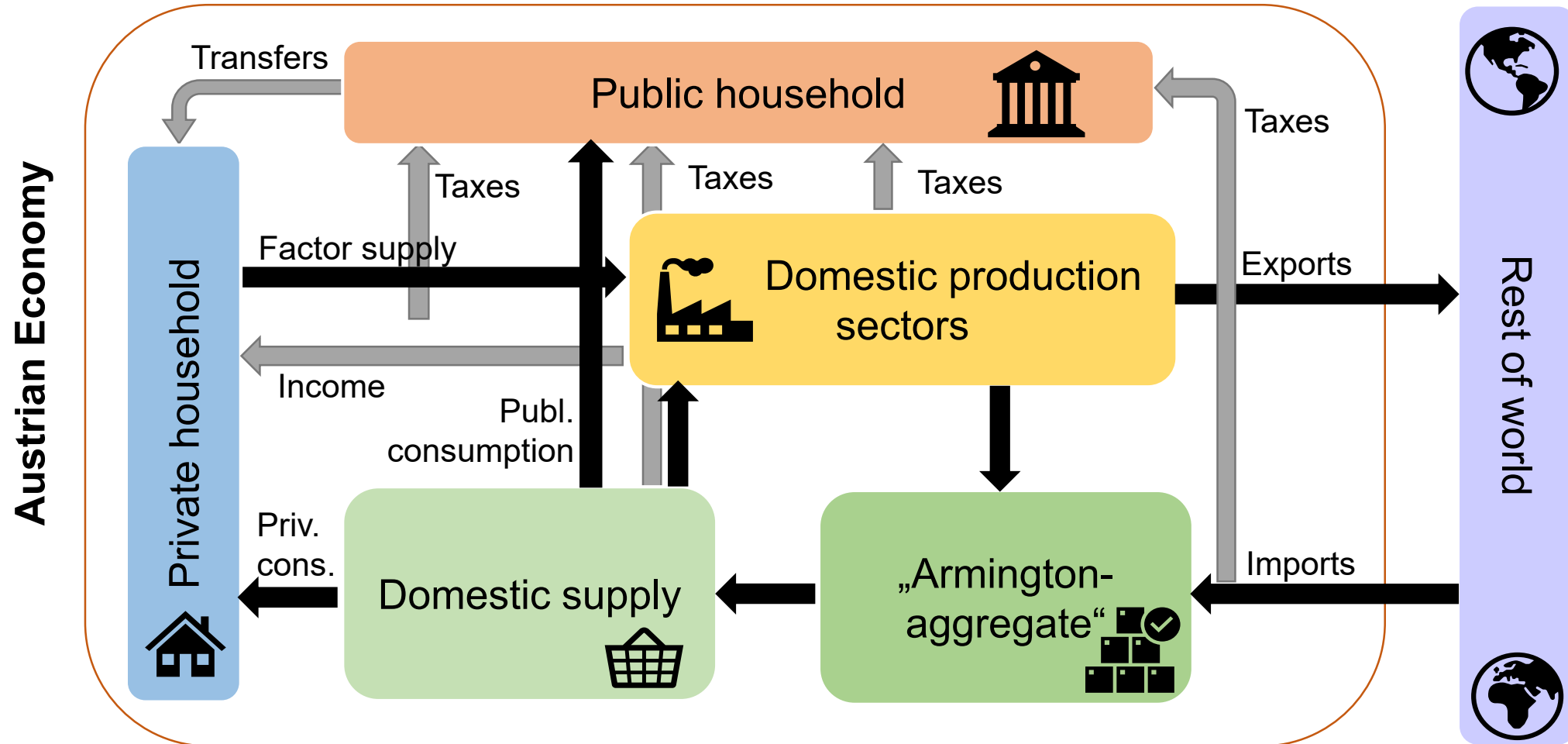
Introduction

- Natural disasters can propagate across different systems (e.g. physical, socio-economic), causing:
 - **direct** losses/damages, i.e. caused by the event itself
 - **indirect** effects, i.e. subsequently via connections between system elements
 - Indirect risks due to natural disasters are a growing concern
 - Amplified by climate change, which is expected to increase frequency and intensity of extreme events (IPCC, 2021)
- Need for quantitative modelling of such indirect risk to support decision-making

- Responding to this need by developing and using two highly detailed modelling approaches
 - High resolution computable general equilibrium (CGE) model “**WEGDYN-AT**”
 - Macroeconomic agent-based model (ABM)
- models fed with different flood scenario-based damage data

Method

Method: WEGDYN-AT CGE model



Method: WEGDYN-AT CGE model

Private household



- 12 private household types
 - Income: quartiles
 - Location of residence: urban/suburban/periphery
- Differences in
 - Final demand: consumption & savings (investment)
 - Income (transfers, labour, capital)

Method: scenarios

Scenario	Percent of capital stock destroyed*	Damage in million €/Characterization
20-year event		932
100-year event		7,748
1000-year event		17,349
Armageddon Scenario I	3%**	1000-year event in all basins simultaneously
Armageddon Scenario II	5%	Selected scenario for interest by stakeholders and literature
* for the 20, 100 and 1000-year event: depending on the underlying database and model ** approximately		

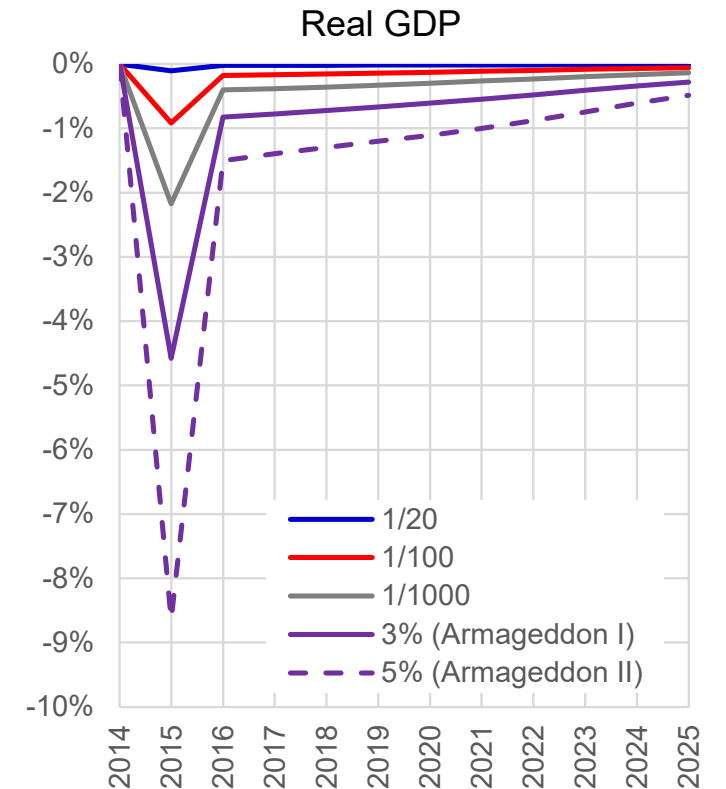
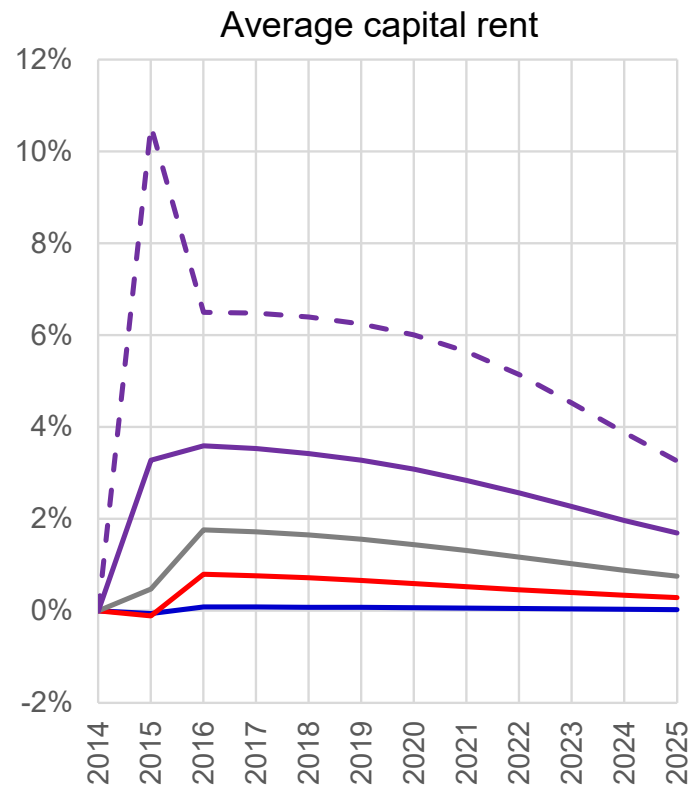
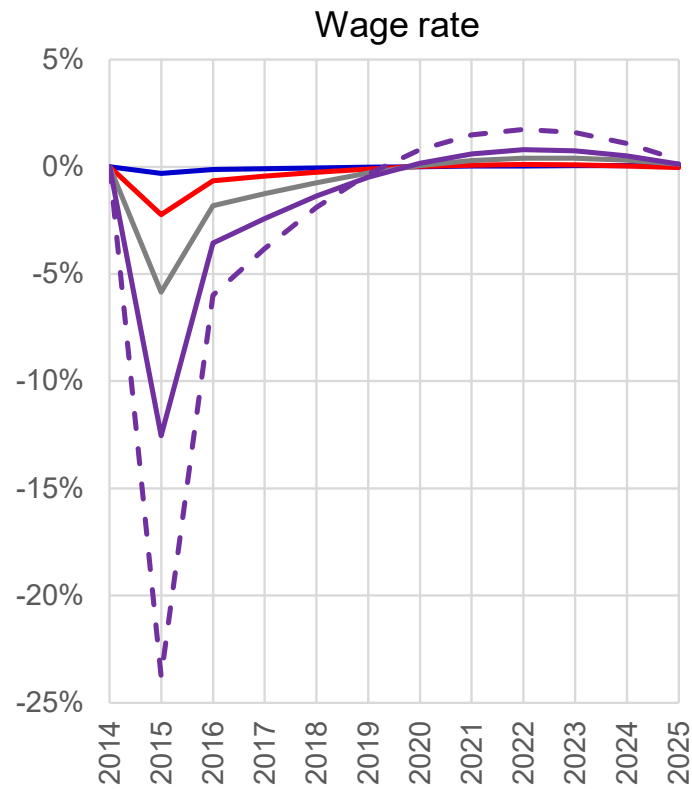
Flood event happens in second year of modelled period (2014-2025)

- Reduces productive capital stock of production sectors
- Indirect effects
- Effects compared to same period w/o flood event (“baseline scenario”)

Results

Selected

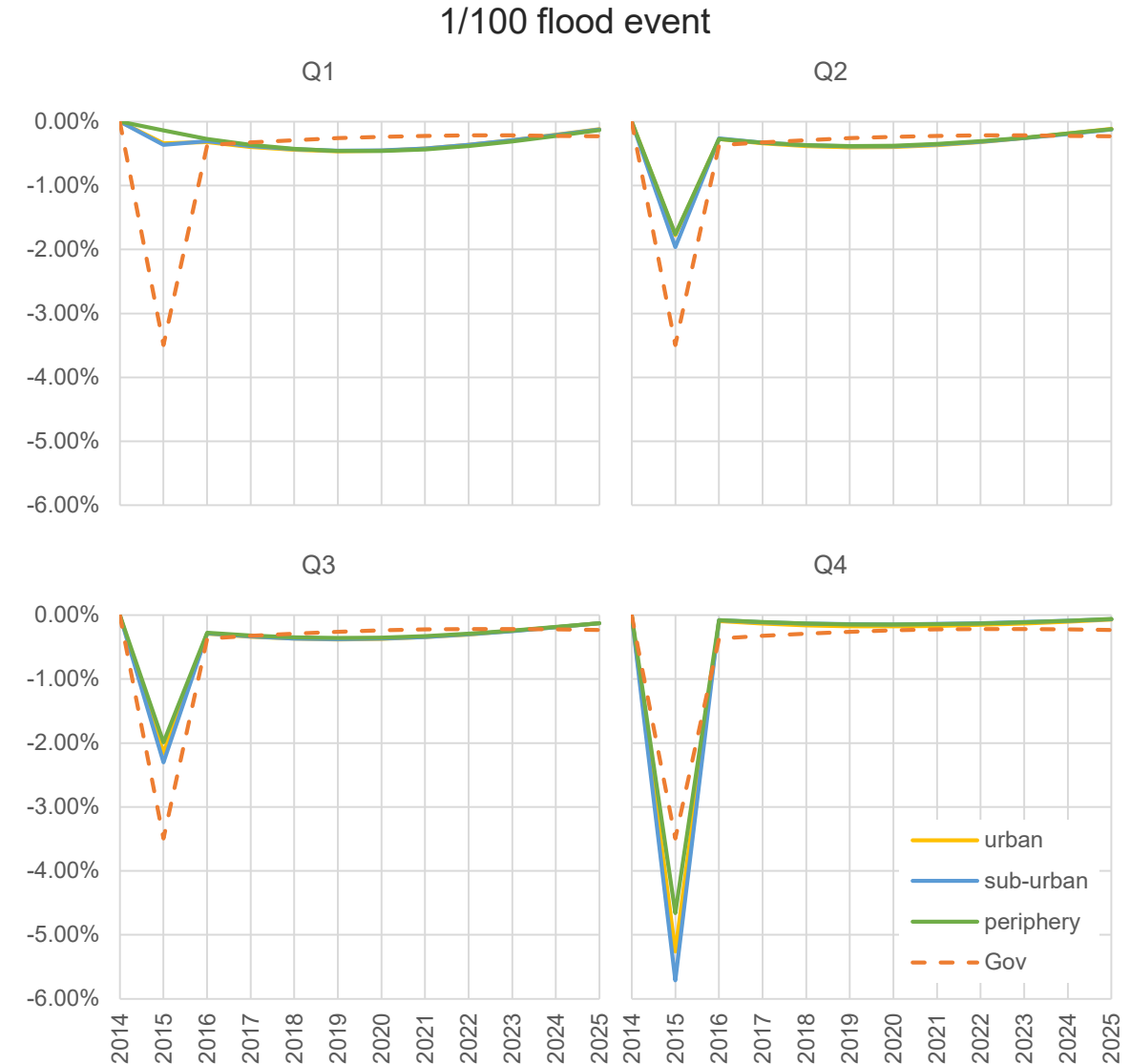
Results: macroeconomic effects



Results: distributional effects, whole period

Welfare effects = change in consumption possibilities after changing prices and income

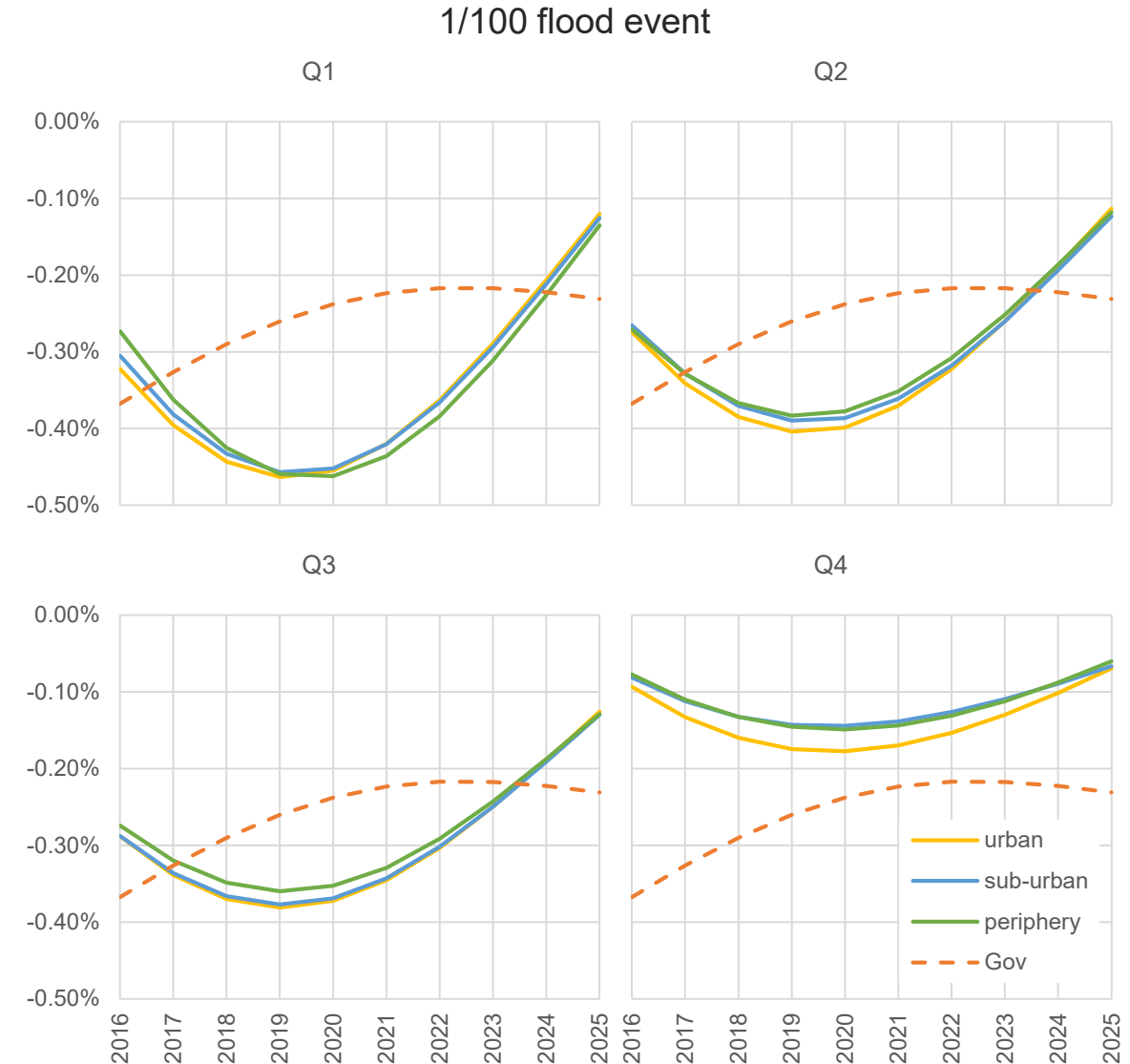
- Negative, strong differences across income quartiles (Q1-Q4)
- High-income quartile affected strongest (short-term)
 - Forced reconstruction reduces consumption possibilities
 - Capital owners lose higher share of their income
- Low-income quartile (Q1) affected least (short-term)
 - Relatively high share of income from (fixed) transfers, less via labor and capital markets;
→ weak effect via reduced wage rate
- Public consumption effects (public services) also significant



Results: distributional effects, post-event period

Welfare effects = change in consumption possibilities after changing prices and income

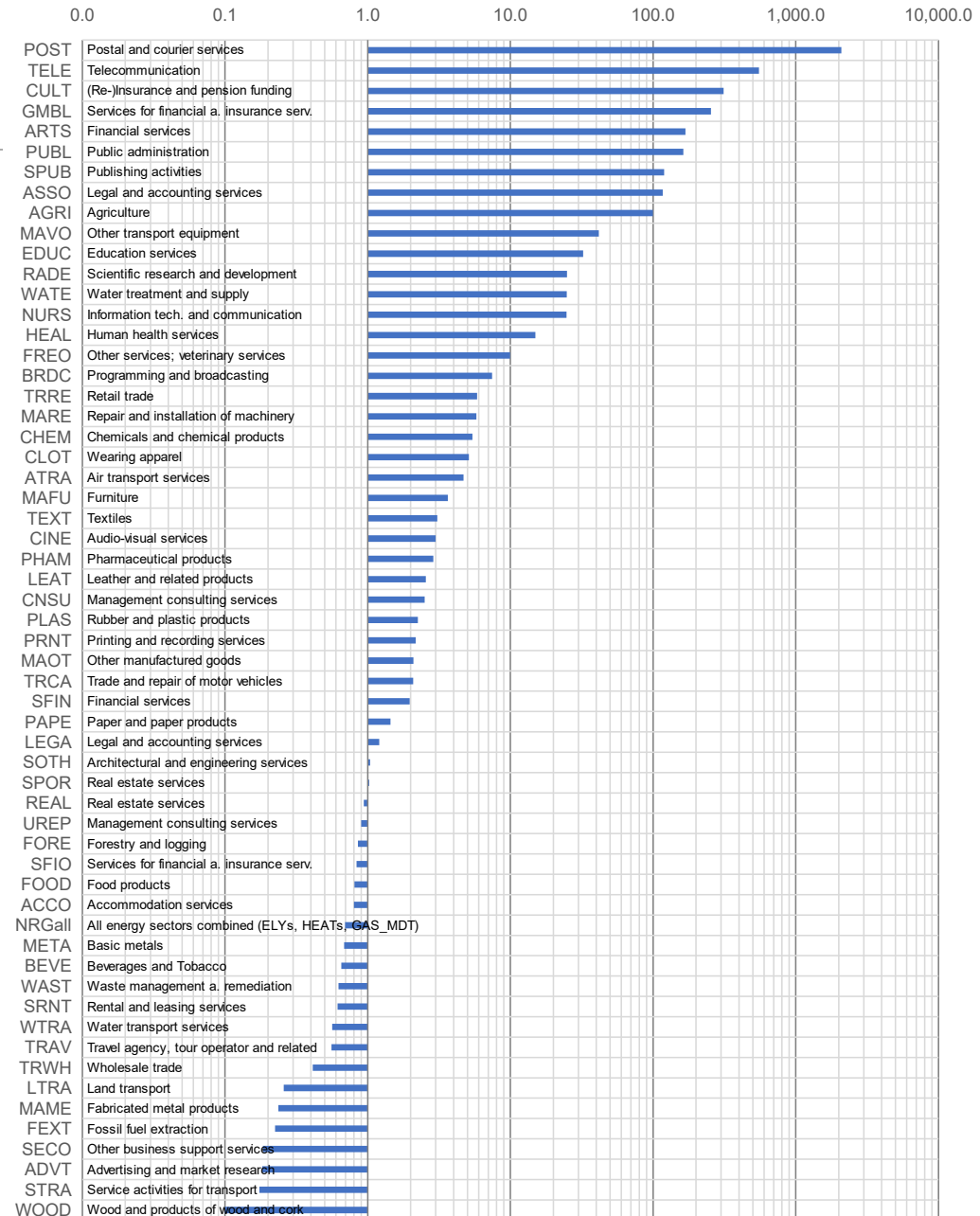
- Remains under baseline level for all households
- Low-income (Q1) households affected stronger
 - Expenditure structure
 - Income structure
- Not much spread across location of residence (urban slightly less affected)



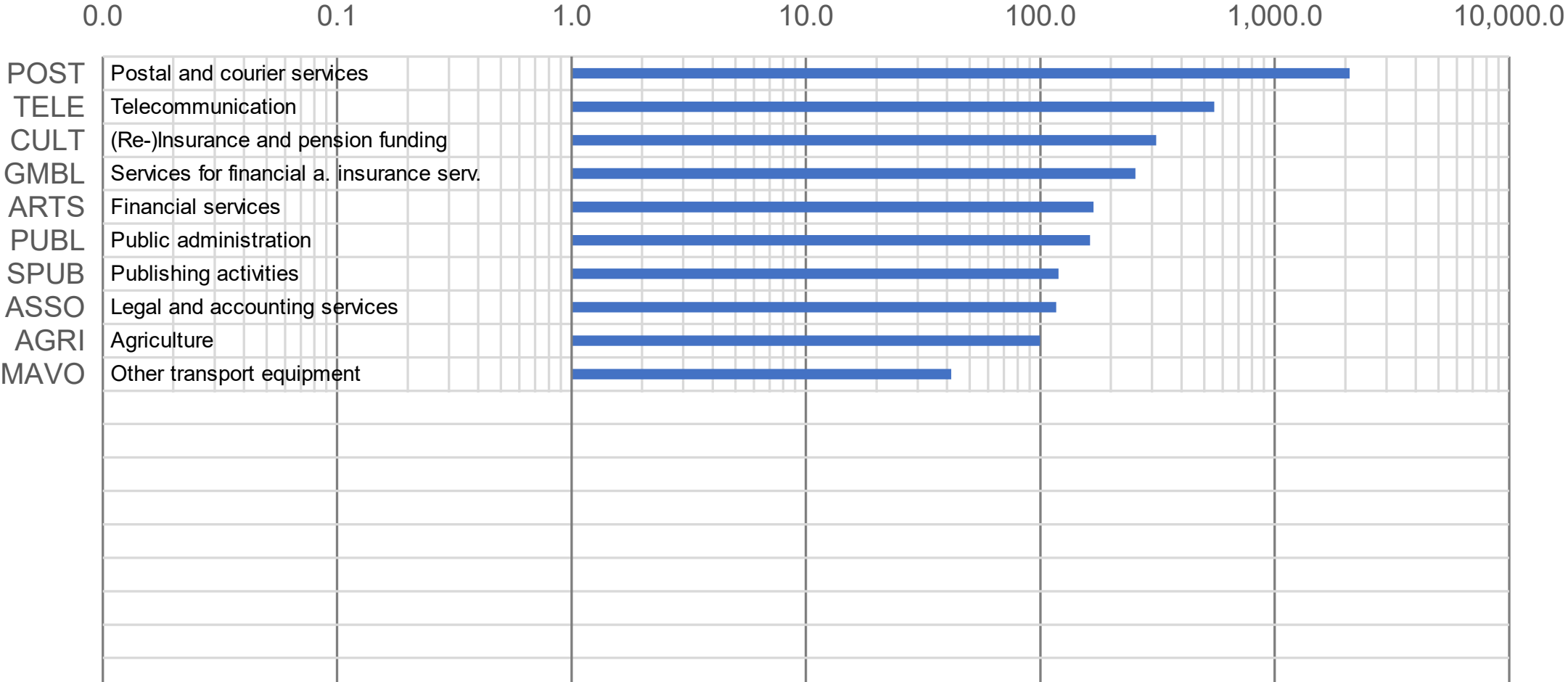
Sectoral indirect risk

$$IR_i = dGVA_i / KD_i$$

- In year of event
- Lost sectoral value added relative to direct sectoral capital damage



Sectoral indirect risk, top 10



Conclusions

Summary and conclusions

- capital owners and high-income households are more strongly affected in the short-term
 - low-income households suffer relatively more from increased price levels in the long-term
 - All income quartiles, except for the highest one, are more strongly affected by a reduction of the provision of public services than by changes in private consumption possibilities
- ➔ Targeted, group-specific adaptation necessary; differentiated by long and short-term effects
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- Indirect sectoral risk can be measured as lost sectoral GVA relative to the sectoral direct capital damage.
 - Besides publicly provided goods and services, this indirect risk is particularly high for sectors producing goods and services for the final demand
- ➔ Risk management should take indirect long-term effects into account

Thank you

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