Cost Distribution and Equity of Climate Policy in Switzerland

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Motivation

- Compare different policy designs:
  - actual (past) policy proposals in Switzerland
  - alternative "typical proposals by economists"
- Focus on revenue recycling
- Illustrate both efficiency and equity consequences and make trade-off using Atkinson index.

Model: Coupling

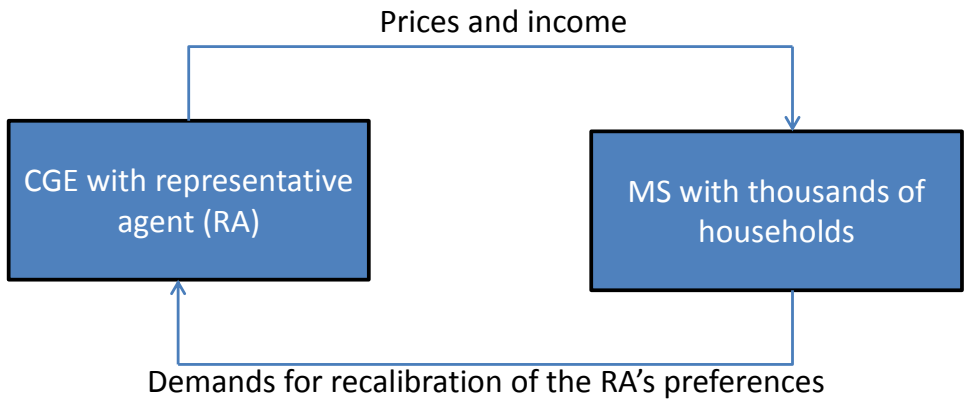
Computable General Equilibrium (CGE) model

- market interactions
- impacts on income and spending power

Micro-simulation (MS)

- heterogeneous households
- empirically established income and spending patterns

Coupling through iterative process[1]



[1] Thomas F. Rutherford and David G. Tarr (2008). "Poverty effects of Russia's WTO accession: Modeling 'real' households with endogenous productivity effects". In: *Journal of International Economics* 75.1, pp. 131–150. DOI: 10.1016/j.jinteco.2007.09.004.

Model: CGE

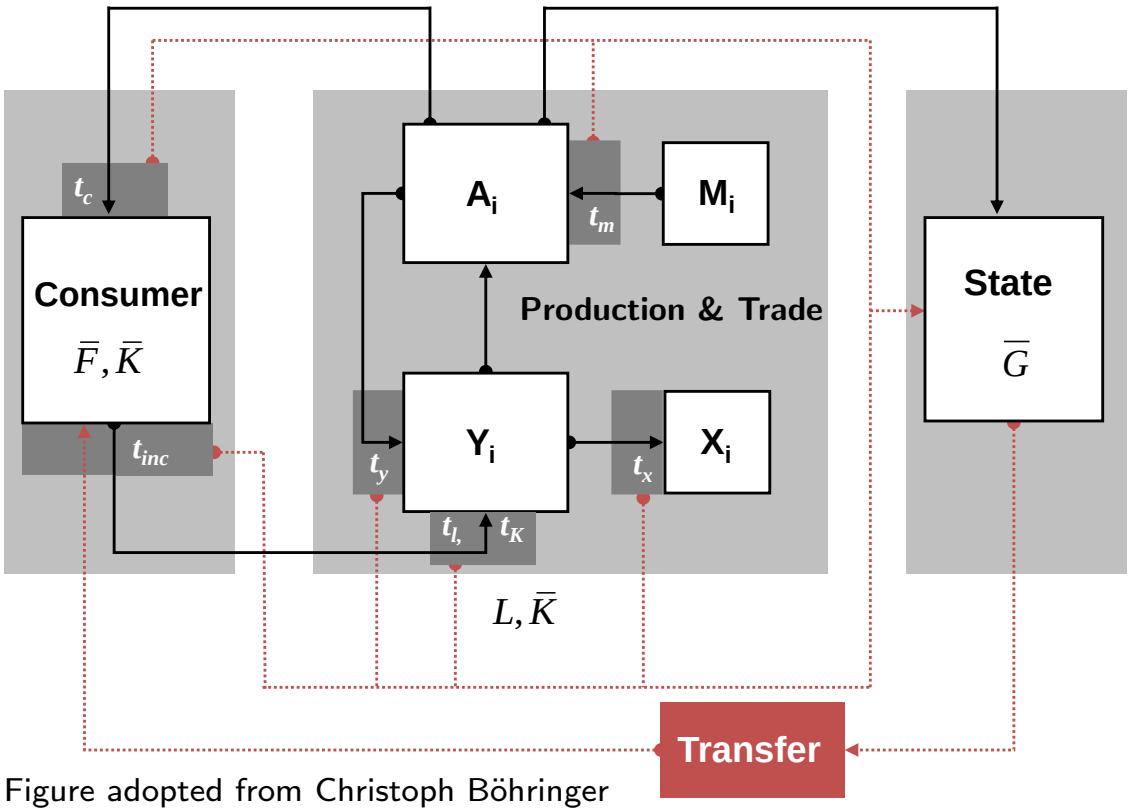


Figure adopted from Christoph Böhringer

F = time endowment
L = Labor supply
K = Capital
G = Government demand
Y_i = Production of good i
X_i = Export of good i
A_i = Armington production of good i
M_i = Import of good i

Model: Households

Data:

- survey of 9734 households (3000+ per annual wave)
- income by sources
- expenditures by categories
- household composition, house-owner dummy, etc.

Model:

- Fix supply of labor and capital
- Price responsive household demand maximizes utility from consumption at given income

Policy target

Reference scenario (BAU) in 2050:

- ETS with permit price of 280 CHF/tCO_2
- carbon tax of 120 CHF/tCO_2 on "thermal fuels" only
- national CO_2 emissions in 2050: 24.9 Mt

Policy target of 1 tonne CO_2 per capita in 2050:

- 8.1 MtCO_2
- policy instruments tax based but scenario dependent

Policy target in 2035 (interpolated):

- 21.8 MtCO_2 (from 29.5 Mt in BAU)

Policy scenarios

	uniform carbon tax	ETS + uniform carbon tax	ETS + differentiated carbon tax
lump-sum rebates	uni_LS	etsUni_LS	**etsDiff_LS**[2]
labor tax reductions	uni_LT	etsUni_LT	etsDiff_LT
VAT reductions	uni_VAT	etsUni_VAT	etsDiff_VAT

[2] **etsDiff_LS**: resembles current policy proposals

Mean equivalent income (MEI)

$$\mathrm{MEI} = \frac{\sum_h w_h s_h \frac{Y_{0,h}+EV_h}{\sqrt{s_h}}}{\sum_h w_h s_h},$$

where

- w_h are statistical weights,
- s_h household size,
- $Y_{0,h}$ household income in BAU, and
- EV_h equivalent variation

of household h.

Note: redistributing income for small to large households improves MEI.

Results: MEI in 2035

Percentage change of MEI from BAU for different scenarios:

	uniform	**etsDiff**	etsUni
LS	-0.419	-0.353	-0.414
LT	-0.269	-0.215	-0.254
VAT	-0.502	-0.438	-0.506

Note: Choices of recycling schemes and carbon tax design that yield the highest MEI are in **bold**, choices that yield the lowest MEI in gray font.

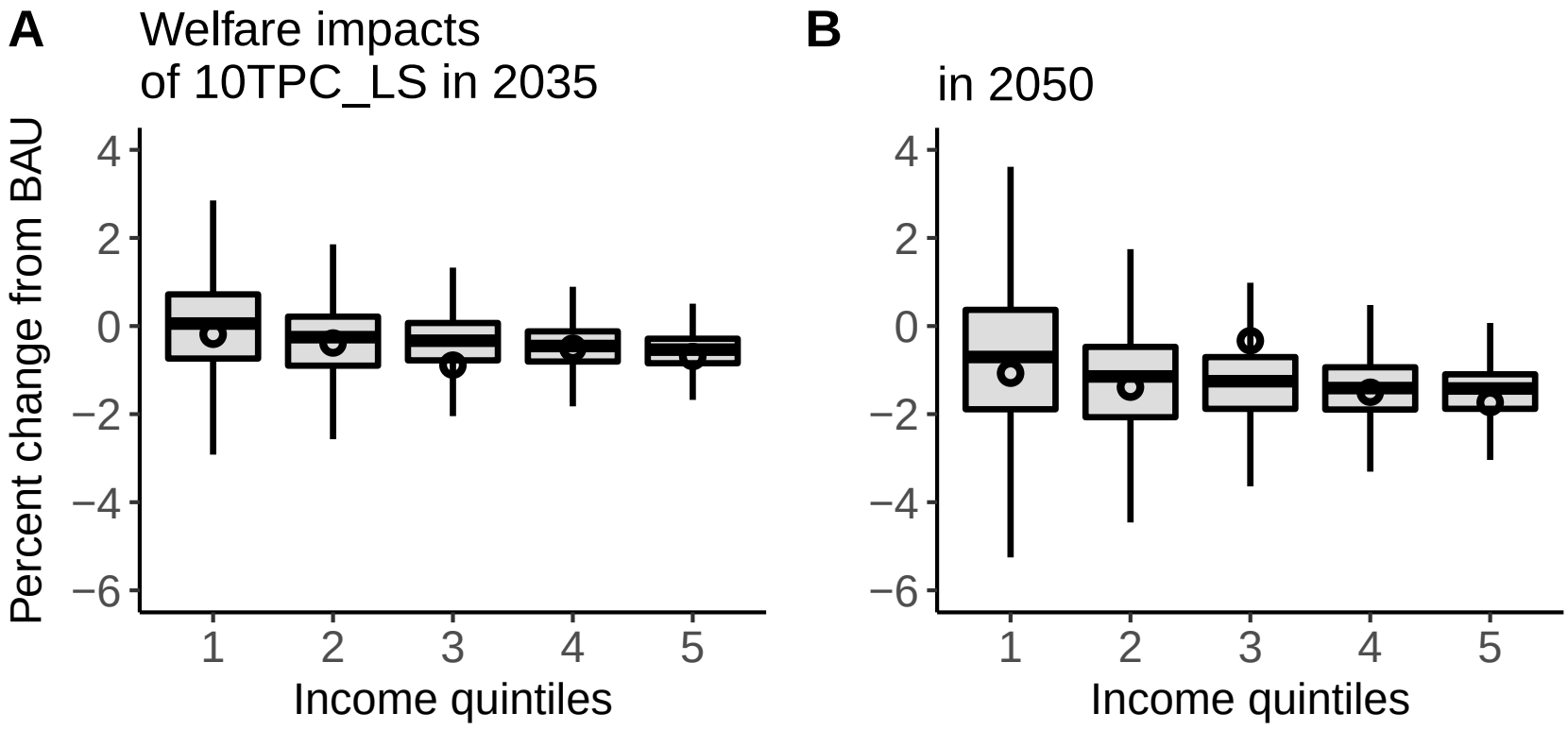
Results: MEI in 2050

Percentage change of MEI from BAU for different scenarios:

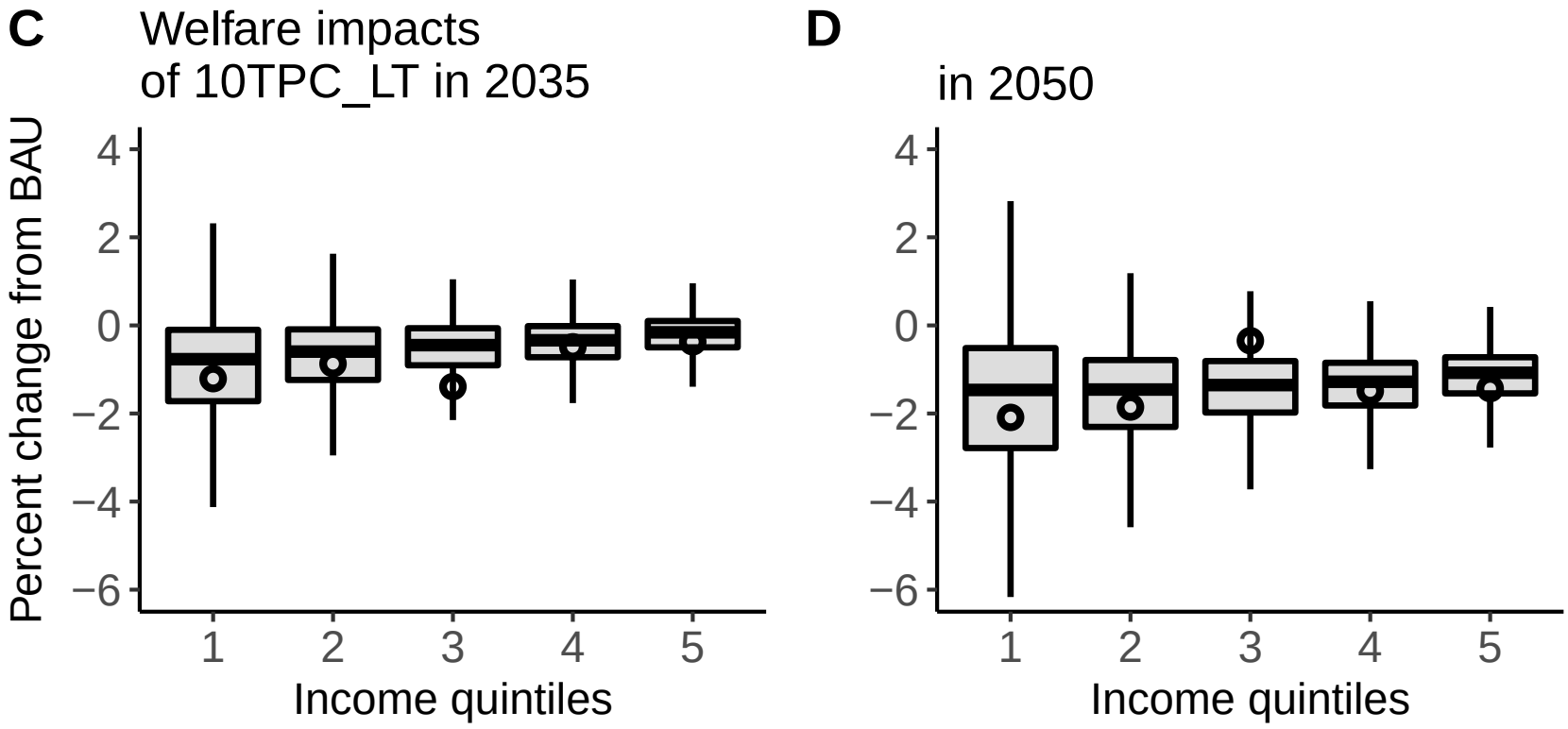
	uniform	etsDiff	etsUni
LS	-2.614	-2.814	-2.743
LT	-2.469	-2.683	-2.597
VAT	-2.414	-2.632	-2.542

Note: Choices of recycling schemes and carbon tax design that yield the highest MEI are in **bold**, choices that yield the lowest MEI in gray font.

Distribution of policy impacts – uni_LS



Distribution of policy impacts – uni_LT



Social welfare (Atkinson index)

The Atkinson index[3] allows modification of the MEI to define social welfare including inequality aversion:

$$\mathrm{SW} = \mathrm{MEI} \times (1 - A_\varepsilon),$$

where

$$A_\varepsilon = 1 - \frac{1}{\mathrm{MEI}} \left[\frac{\sum_h w_h s_h \left(\frac{Y_0 + EV_h}{\sqrt{s_h}} \right)^{1-\varepsilon}}{\sum_h w_h s_h} \right]^{\frac{1}{1-\varepsilon}}$$

and $\varepsilon = 1.25$ is a measure of inequality aversion.

[3] Anthony B. Atkinson (1970). "On the measurement of inequality". In: *Journal of Economic Theory* 2.3, pp. 244–263. DOI: 10.1016/0022-0531(70)90039-6.

Results: Social welfare in 2035

Percentage change of social welfare from BAU for different years and scenarios.

	uniform	etsDiff	etsUni
LS	-0.483	-0.534	-0.517
LT	-0.825	-0.849	-0.881
VAT	-0.812	-0.835	-0.863

Note: Choices of recycling schemes and carbon tax design that yield the highest social welfare are in **bold**, choices that yield the lowest social welfare in gray font.

Results: Social welfare in 2050

Percentage change of social welfare from BAU for different years and scenarios.

	uniform	etsDiff	etsUni
LS	-1.873	-2.154	-2.051
LT	-2.188	-2.425	-2.319
VAT	-2.128	-2.344	-2.227

Note: Choices of recycling schemes and carbon tax design that yield the highest social welfare are in **bold**, choices that yield the lowest social welfare in gray font.

Conclusions

- Taking inequality aversion into account changes policy ranking:
  - MEI suggest differentiating taxes in 2035 and advises against per-capita lump-sum redistribution
  - Social welfare with equity preference suggests taxing carbon uniformly and recommends per-capita lump-sum transfers
- Efficiency–equity trade-off in revenue recycling alone
- Sensitivity analysis suggests that for $\varepsilon \in (0.85, 1.85)$[4] the policy ranking for the 1 tonne per capita target and the years 2035 and 2050 does not change.
- Recycling of revenue is similarly important as tax differentiation.

[4] R. Layard, G. Mayraz and S. Nickell (2008). "The marginal utility of income". In: *Journal of Public Economics*. Special Issue: Happiness and Public Economics 92.8, pp. 1846–1857. DOI: 10.1016/j.jpubeco.2008.01.007.

Thank you for your attention

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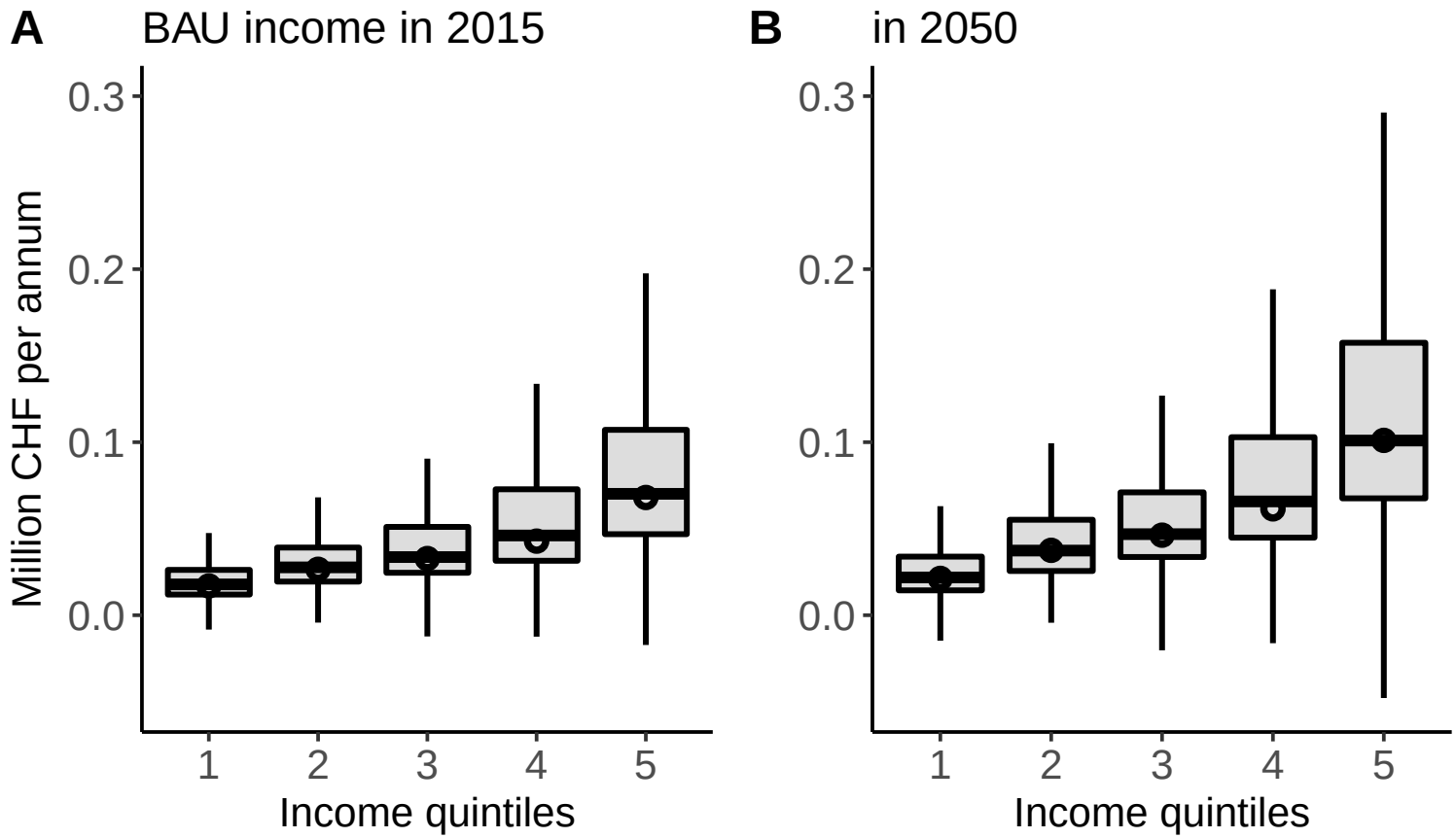
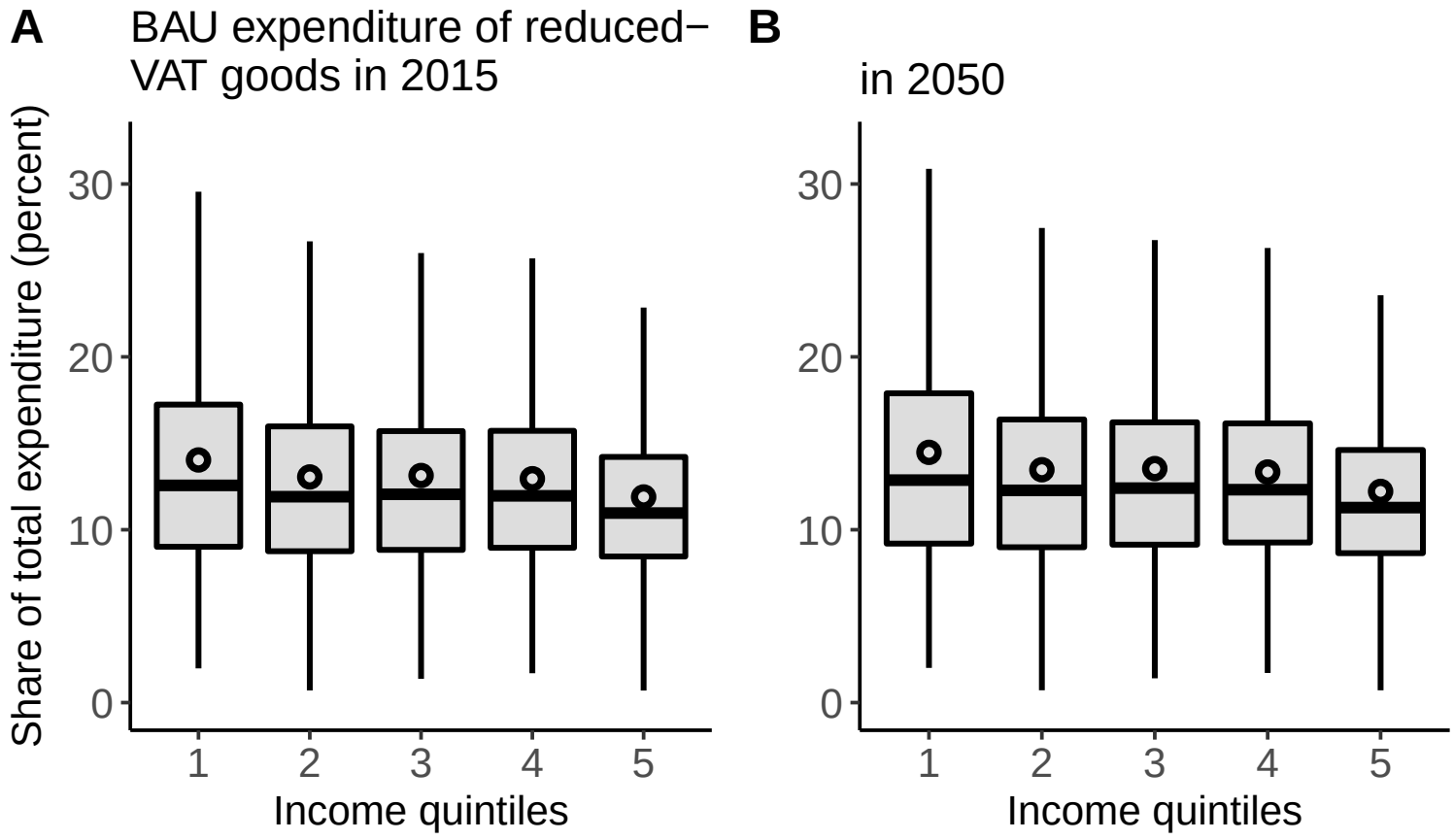
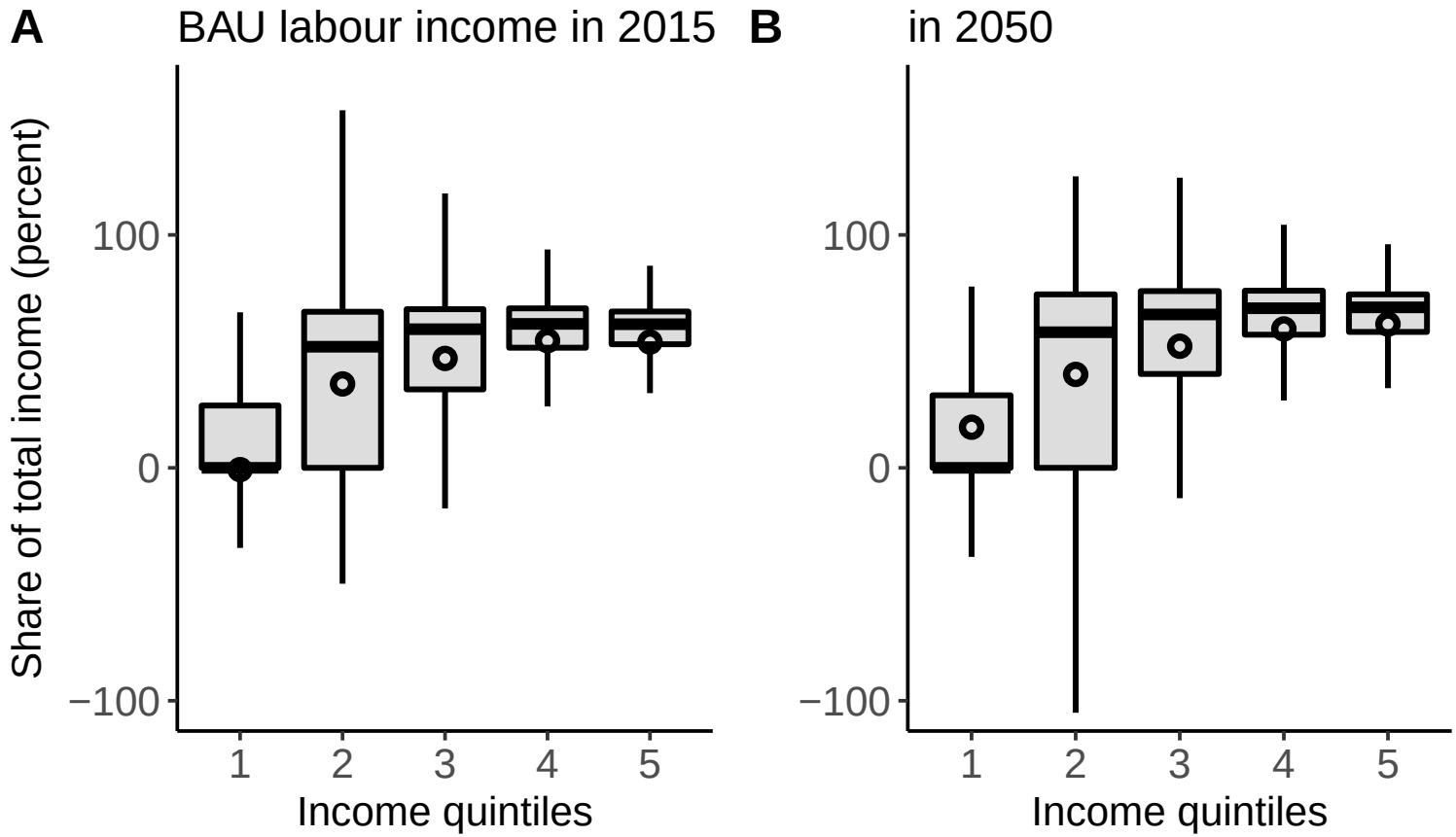
Income


A
BAU income in 2015
B
in 2050
Million CHF per annum
0.3
0.2
0.1
0.0
1
2
3
4
5
Income quintiles
Income quintiles

Expenditure shares for reduced-VAT goods



Labor share in income



Household size