Who Bears the Burden of Local Taxes?

Marius Brülhart
University of Lausanne

Jayson Danton
Swiss National Bank

Raphaël Parchet
Università della Svizzera italiana (USI)

Jörg Schläpfer
Wüest Partner, Zurich

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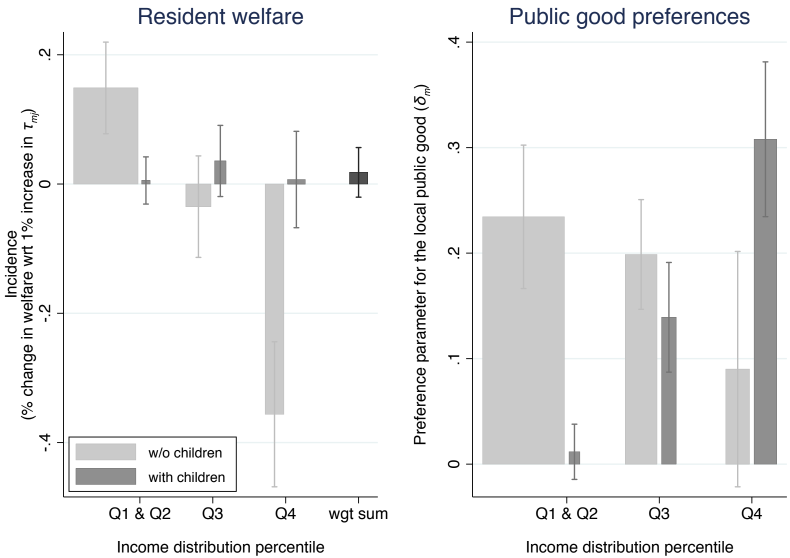
Motivation

- Our question: what are the distributional effects of changes to local (residence-based) tax rates?
  - → Focus on two channels:
    - ⋆ preferences for locally funded public goods
    - ⋆ capitalization into housing prices
  - → Exploit tax-induced migration on a small spatial scale (municipalities)
    - ⋆ Abstract from effects of labor-market responses and tax progressivity
- We consider non-homothetic preferences
  - → Preferences for locally funded public goods can vary with income and the type of public good ▸ Survey evidence
  - → High-income households have lower housing expenditure shares ▸ Expenditure shares
- We consider imperfectly mobile households
  - → Treat residential mobility as a parameter to be estimated
  - → Perfect mobility: tax differentials fully capitalized into housing prices, perfect segregation, and incidence fully on landlords

What we do

- We consider a stylized spatial equilibrium model featuring imperfectly mobile residents (renters) who are heterogeneous in their income, housing expenditure and preference for local public goods, to explore the incidence of changes in local income tax rates among residents.
- We structurally estimate income-related preference parameters for a local public good that govern households' willingness to pay higher rent for lower (or higher!) tax rates
- We estimate housing demand and supply elasticities in a simultaneous-equation IV framework, using micro-geographic data for Switzerland *(not covered in this presentation)*

Results


Resident welfare
Incidence
(% change in welfare wrt 1% increase in τ_{mj})
.2
0
-.2
-.4
w/o children
with children
Q1 & Q2
Q3
Q4
wgt sum
Income distribution percentile
Public good preferences
Preference parameter for the local public good (δ_m)
.4
.3
.2
.1
0
Q1 & Q2
Q3
Q4
Income distribution percentile

A simple model of housing demand and supply

Housing demand (renters):

- Heterogeneous households who differ in their exogenously given income (‘skills’)
- Income-specific preference for a homogeneous local public good
- Imperfectly mobile: household-specific preference for a given location

Housing supply (landlords):

- Atomistic absentee landlords
- Constant-elasticity housing supply

Local budget (municipalities):

- Municipalities levy a proportional income tax to finance a publicly funded private good (henceforth “public good”), using a balanced budget

Housing demand (1)

The indirect utility of renter household i with income m, based on their choice of location j, is

$$V^*_{imj} = \kappa + \ln\left[(1-\tau_j)w_m - p_j\nu_h\right] - \alpha\ln(p_j) + \delta_m\ln(g_j) + \ln(A_{ij}),$$

where

- we assume Stone-Geary utility over housing, non-housing consumption and a public good (ν_h = minimal level of housing consumption),
- τ_j is the local income tax rate,
- w_m is pre-tax household income,
- p_j is the rental price of housing,
- g_j is the local public good,
- α is a taste for housing
- δ_m is the income-specific preference for the public good, and
- A_{ij} are (fixed) local amenities. ▸ Household utility U_{imj}

Housing demand (2)

Local amenities:

- $\ln(A_{ij}) = \overline{A}_j + \xi_{ij}$

where

- $\overline{A}_j$: location-specific amenities valued identically by all households
- ξ_{ij}: individual-specific and location-specific idiosyncratic preference

Household mobility:

- ξ_{ij} is an i.i.d. Gumbel distribution with zero mean, variance σ^2 and scale parameter $\lambda = \pi/(\sigma\sqrt{6})$
- λ governs the degree of mobility of households

  $\rightarrow$ $\lambda \rightarrow \infty$ $\quad(\sigma = 0)$: full mobility (no idiosyncratic preference)
  $\rightarrow$ $\lambda = 0$ $\quad(\sigma \rightarrow \infty)$: no mobility

Equilibrium

$$\text{Population:} \quad N_{mj} = \frac{\exp(\lambda u_{mj})}{\sum_{j'} \exp(\lambda u_{mj'})} \quad \forall\, m \in \mathcal{M}, j \in \mathcal{J} \tag{1}$$

$$\text{Housing market clearing:} \quad H_j^d = \sum_m N_{mj} h_{mj}^* = H_j^s \quad \forall\, j \in \mathcal{J} \tag{2}$$

$$\text{Municipal budget:} \quad g_j = \tau_j \frac{\sum_m w_m N_{mj}}{N_j} \quad \forall\, j \in \mathcal{J} \tag{3}$$

▸ Differentiation

Structural model: a two-income-class example

$$\underbrace{\begin{bmatrix} \frac{1-\delta_1(\gamma_{1j}-s_{1j})\lambda}{\alpha\lambda}\left(1-\frac{\nu_h}{h^*_{1j}}\right) & -\frac{\delta_1(\gamma_{2j}-s_{2j})}{\alpha}\left(1-\frac{\nu_h}{h^*_{1j}}\right) & 1 \\ -\frac{\delta_2(\gamma_{1j}-s_{1j})}{\alpha}\left(1-\frac{\nu_h}{h^*_{2j}}\right) & \frac{1-\delta_2(\gamma_{2j}-s_{2j})\lambda}{\alpha\lambda}\left(1-\frac{\nu_h}{h^*_{2j}}\right) & 1 \\ \pi_{1j} & \pi_{2j} & -\rho \end{bmatrix}}_{\mathbf{A_j}} \underbrace{\begin{bmatrix} \hat{N}_{1j} \\ \hat{N}_{2j} \\ \hat{p}_j \end{bmatrix}}_{\widehat{\mathbf{Y}}_\mathbf{j}} =$$

$$\underbrace{\begin{bmatrix} \frac{\delta_1}{\alpha}\left(1-\frac{\nu_h}{h^*_{1j}}\right)-\frac{\tau_j}{(1-\tau_j)S_{1j}} \\ \frac{\delta_2}{\alpha}\left(1-\frac{\nu_h}{h^*_{2j}}\right)-\frac{\tau_j}{(1-\tau_j)S_{2j}} \\ \alpha\tau_j\left(\frac{\pi_{1j}}{S_{1j}}+\frac{\pi_{2j}}{S_{2j}}\right) \end{bmatrix}}_{\mathbf{B_j}} \hat{\tau}_j$$

Structural estimation

The empirical analogue of the structural model is

$$\widehat{\mathbf{Y}}_{\mathbf{j}} = \underbrace{\mathbf{A}^{-1}\mathbf{B}}_{\eta}\,\widehat{\tau}_j + \mathbf{u}_{\mathbf{j}}$$

- where $\eta = [\eta^{N_1}, \cdots, \eta^{N_\mathcal{M}}, \eta^{P}]'$ is a vector of reduced-form theoretical moments of local income tax changes on population and housing prices.
- Matrices **A** and **B** are taken to be constant across all municipalities
- We use a minimum distance estimator to find, for a given set of calibrated parameters, the preference parameters $\theta = [\delta_1, \ldots, \delta_M]$ that best match the moments η to reduced-form estimates $\hat{\eta}$:

$$\hat{\theta} = argmin[\hat{\eta} - \eta]'\hat{\mathbf{V}}^{-1}[\hat{\eta} - \eta]$$

Data

Panel data set spanning annual observations from 2004-2014, for up to 2,352 Swiss municipalities

- Number of taxpayers in different income quantiles (bottom 50%, top 50%-75%, top 25%) and family status (with or without dependent children)
- Consolidated cantonal + municipal + church personal income tax rates Tax system Map
- Rental price postings, including dwelling characteristics ($\approx$ 1,650,000 observations) $\Rightarrow$ housing prices Map
  - → Residuals from an object-level regression of rental prices on dwelling characteristics, their interactions, municipality and year fixed effects
  - → Posted rental price very good proxy for transaction prices
  - → 64% of Swiss households live in rented accommodation
- Amenity controls (municipality level): Accessibility, sunlight, natural risk exposure and presence of architectural heritage, share of developed land (SDL), time-to-permit (REG)

Tax base and rental price elasticities (1)

We follow Parchet (*AEJ:EP*, 2019) and estimate a cross-canton pairwise spatial difference model ▸ Chart

The advantages are:

- Spatial differencing controls for common shocks between neighboring municipalities
- We can exploit upper-level (canton) tax policy as a source of exogenous variation for consolidated tax rates
- By including canton-year fixed effects, the identifying variation comes from the *neighboring* cantonal tax policy

The drawback is:

- The sample is restricted to municipalities in the vicinity of canton borders

Tax base and rental price elasticities: 3SLS

We estimate a first-difference model using a 3SLS process. The seven estimating equations are

$$\nabla\Delta \ln N_j^1 = \eta^{N_1}\nabla\Delta \ln \tau_{jc}^1 + \boldsymbol{\mu}\boldsymbol{\nabla}\boldsymbol{A_j} + \phi_c + \varepsilon_j^{N_1}$$

$$\vdots$$

$$\nabla\Delta \ln N_j^6 = \eta^{N_6}\nabla\Delta \ln \tau_{jc}^6 + \boldsymbol{\mu}\boldsymbol{\nabla}\boldsymbol{A_j} + \phi_c + \varepsilon_j^{N_6}$$

$$\nabla\Delta \ln P_j = \boldsymbol{\eta}^{\boldsymbol{P}}\boldsymbol{\nabla}\boldsymbol{\Delta} \ln \boldsymbol{\tau}_{\boldsymbol{jc}}^{\boldsymbol{P}} + \beta_1\nabla SDL_j + \beta_2\nabla REG_j + \boldsymbol{\mu}\boldsymbol{\nabla}\boldsymbol{A_j} + \phi_c + \varepsilon_j^P$$

- ∇ represents the cross-canton spatial difference between pairs of municipalities at a cantonal border
- Δ represents the long differences between the averages 2013-2014 and 2004-2005
- ϕ_c is an origin-canton fixed effect
- In all equations, the consolidate income tax rate is instrumented with canton-level tax rates.

Table: Tax base and rental price elasticities: 3SLS estimation

Equation:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Group:	Households without children			Households with children			
Dependent variable:	Bottom 50	Next 25	Top 25	Bottom 50	Next 25	Top 25	Prices
***Panel A:* unweighted regression, bootstrapped standard errors**							
Income tax rate	0.282***	-0.064	-0.633***	0.010**	0.064	0.030	-0.330***
	(0.063)	(0.077)	(0.118)	(0.005)	(0.049)	(0.075)	(0.121)
***Panel B:* weighted regression, homoskedastic disturbances**							
Income tax rate	0.298***	-0.059	-0.640***	0.011***	0.075*	0.025	-0.309***
	(0.058)	(0.067)	(0.105)	(0.004)	(0.043)	(0.065)	(0.086)
Amenity controls	YES	YES	YES	YES	YES	YES	YES
Origin canton FE	YES	YES	YES	YES	YES	YES	YES
# of observations	2,004						
# of municipalities	524						
Instrument	Cantonal income tax rate differential						

Notes: Standard errors reported in parentheses. The equations are estimated jointly using three stage least squares. The sample consists of cross-canton pairs of municipalities with a pairing road distance of 10 km. Panel A bootstraps the standard errors with 250 iterations of the unweighted 3SLS estimations. Panel B regressions are weighted by the log population in 2000 of the smallest municipality in the pair. The consolidated personal income tax rate differentials are instrumented by the cantonal personal income tax rate differentials. ***$p<0.01$, **$p<0.05$, *$p<0.1$.

▸ Fixed Effect Panel Data Model

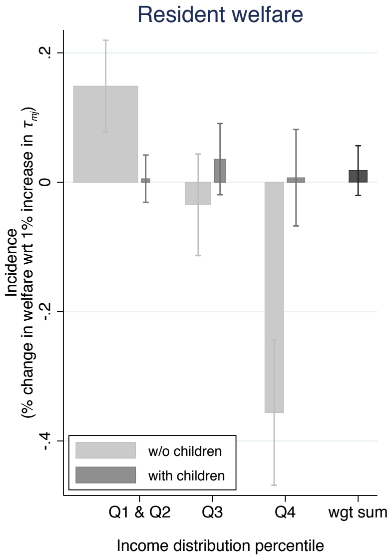
Structural estimation: calibration

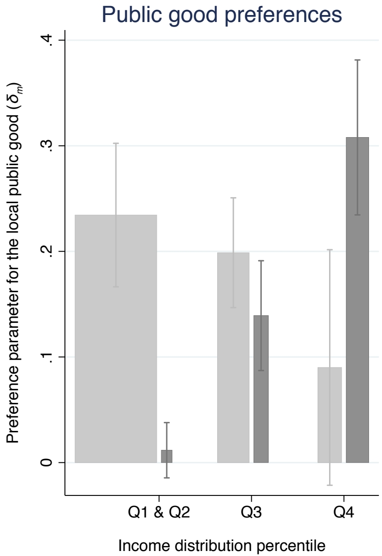
- We implement the minimum distance estimator to find, for a given set of calibrated parameters, the parameters $\theta = [\delta_1, \ldots, \delta_6]$ that best match the moments to reduced-form estimates

Table: Calibrated parameters

	(1)	(2)	(3)	(4)	(5)	(6)
Household type:	Households without children			Households with children		
Income class:	Bottom 50	Next 25	Top 25	Bottom 50	Next 25	Top 25
Swiss Household Panel						
Housing tastes (α)	0.11	0.11	0.11	0.11	0.11	0.11
Minimal housing expenditure (ν_h/h_m^*)	0.75	0.69	0.57	0.80	0.72	0.62
Expenditure share on housing (S_m)	0.38	0.24	0.17	0.36	0.26	0.19
Aggregate housing share (π_m)	0.13	0.14	0.17	0.16	0.18	0.21
Municipal Tax Rate Database						
Income tax rates (τ_m)	0.12	0.16	0.24	0.05	0.10	0.19
Simultaneous Equation IV Estimates						
Idiosyncratic location preference dispersion parameter (λ)	1.93	1.93	1.93	1.93	1.93	1.93
Housing supply price elasticity (η_s)	0.73	0.73	0.73	0.73	0.73	0.73
Tax Base Database						
Taxpayer population share (s_m)	0.44	0.17	0.13	0.06	0.08	0.12

Structural parameters and elasticity estimates





▸ Estimates table

Supplementary material

- Decomposition by income, family status and age ▸ Age
- Differential mobility costs ▸ Mobility
- Evidence for municipal balanced budget : IV estimates for total revenue, expenditure and separate spending categories ▸ Balanced budget
- Estimates of housing demand and housing supply price elasticities using a simultaneous equation IV framework ▸ SEM

Conclusions

- Using Swiss micro data we find that negative incidence of local taxes is borne by landlords and renters with above-median income and without dependent children

  → Upper-bound estimate as rents are mostly fixed during tenancy

- Incidence on renters is very heterogeneous

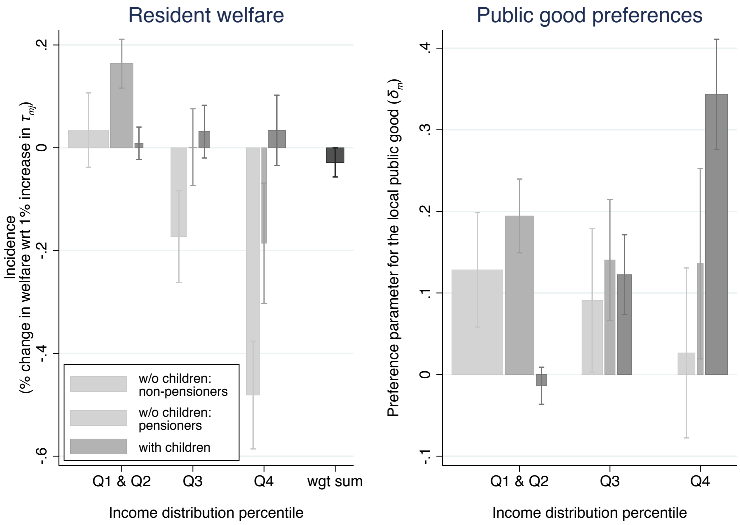
  → Bottom-50% of income distribution without dependent children benefit from a tax increase. No incidence on renters with dependent children

- Implied preferences for locally provided public good differ by income and household type:
  - Taste for public good increases with income for households with children
  - Opposite pattern for households without dependent children

Supplementary Material I

Decomposition by Age

Decomposition by income, family status and age



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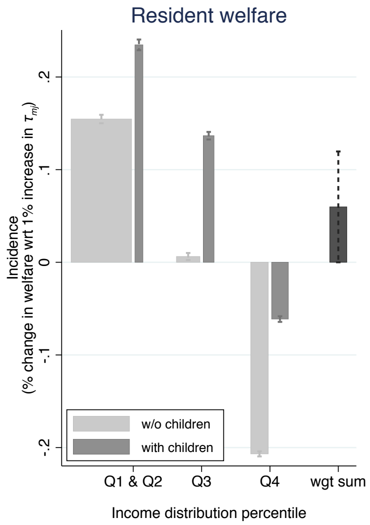
Supplementary Material II

Differential Mobility Costs

Differential mobility costs



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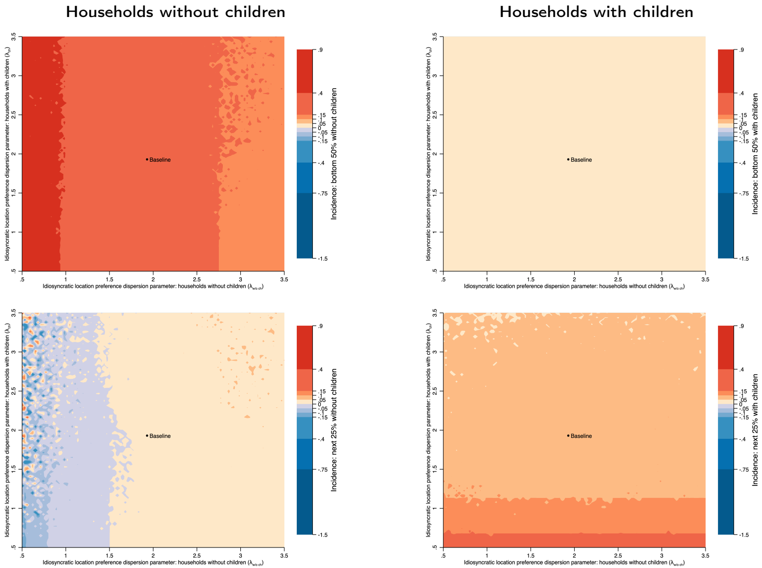
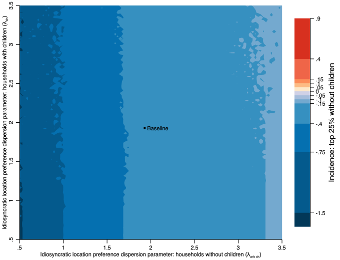
Differential mobility costs: incidence

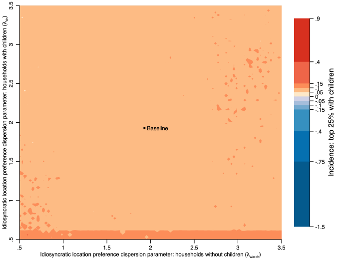


Differential mobility costs: incidence (cont'd)

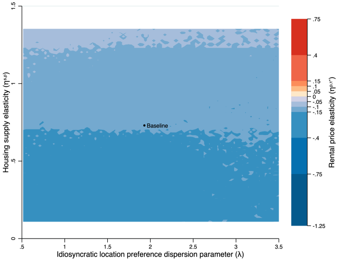
Households without children



Households with children



Landords



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Supplementary Material III

Municipal Balanced Budget

Estimates by Public Spending Category

Equation:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Group:	Total		Expenditure per category					
Dependent variable:	Revenue	Expenditure	Education	Social	Admin.	Roads	Police	Health
Fixed effect panel model								
***Panel I:* IV pairwise difference estimation on border municipalities**								
Income tax rate	-0.222	-0.231*	-0.132	-0.134	-0.078	-0.089	-0.598	-0.642
	(0.153)	(0.130)	(0.157)	(0.578)	(0.194)	(0.317)	(0.396)	(1.314)
# of observations	13,702	13,702	13,702	13,702	13,702	11,522	13,690	11,464
# of municipalities	398	398	398	398	398	325	398	325
Kleibergeb-Paap F Stat	236	236	236	236	236	224	236	222
Municipality-pair directional fixed effect	YES							
Origin canton-year fixed effect	YES							
Instrument	Cantonal income tax rate differential							
***Panel II:* IV pairwise difference estimation on border municipalities: distributed lag model**								
Income tax rate	-0.407**	-0.342**	-0.257	-0.314	-0.190	-0.002	-0.699	-0.898
	(0.190)	(0.152)	(0.196)	(0.660)	(0.248)	(0.348)	(0.456)	(1.551)
# of observations	13,702	13,702	13,702	13,702	13,702	11,522	13,690	11,464
# of municipalities	398	398	398	398	398	325	398	325
Kleibergeb-Paap F Stat	33	33	33	33	33	28	33	30
Municipality-pair directional fixed effect	YES							
Origin canton-year fixed effect	YES							
Instrument	Cantonal income tax rate differential							

Notes: Cluster robust standard errors reported in parentheses. Standard errors are two-way clustered at origin and destination municipality level. Regressions in Panel II employ a standard distributed-lag approach estimating $\nabla \ln y_{jt} = \eta^y \nabla \ln \tau_{jt} + \sum_{s=1}^{2} \beta_s \left(\nabla \ln \tau_{jt-s} - \nabla \ln \tau_{jt}\right) + \phi_{jk} + \phi_{ct} + \varepsilon_{jt}$, so that we may interpret $\hat{\eta}$ directly as the long-term effect.

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Supplementary Material IV

Housing Demand and Housing Supply Price Elasticities

Simultaneous Equation Model (1)

We estimate the following model in a cross section of municipalities:

$$\Delta \ln P_{j,c} = \frac{1}{\eta_{d,p}} \Delta \ln H_{j,c} + \boldsymbol{\eta_p \Delta} \ln \boldsymbol{\tau} + \boldsymbol{\mu A_{j,c}} + \delta_c + \epsilon_{1j,c} \tag{5a}$$

and

$$\Delta \ln P_{j,c} = \frac{1}{\eta_{s,p}} \Delta \ln H_{j,c} + \beta_2 SDL_{j,c} + \beta_3 REG_{j,c} + \boldsymbol{\mu A_{j,c}} + \delta_c + \epsilon_{2j,c} \tag{5b}$$

- Δ represents long differences between 2004-2005 and 2013-2014
- P are municipality-average residual rental prices
- H is total residential living space (net of demolitions)
- $\boldsymbol{\tau}$ is the vector of income tax rates and their interaction with binary variables for canton-level fiscal treatment of property ownership
- $\mathbf{A_{j,c}}$ is a vector of amenity controls (municipality level)
- δ_c is a canton fixed effect

Simultaneous Equation Model (2)

We estimate the following model in a cross section of municipalities:

$$\Delta \ln P_{j,c} = \frac{1}{\eta_{d,p}} \Delta \ln H_{j,c} + \boldsymbol{\eta_p \Delta} \ln \boldsymbol{\tau} + \boldsymbol{\mu A_{j,c}} + \delta_c + \epsilon_{1j,c} \tag{6a}$$

and

$$\Delta \ln P_{j,c} = \frac{1}{\eta_{s,p}} \Delta \ln H_{j,c} + \beta_2 SDL_{j,c} + \beta_3 REG_{j,c} + \boldsymbol{\mu A_{j,c}} + \delta_c + \epsilon_{2j,c} \tag{6b}$$

- *SDL* is the share of developed land in 1997
  - $\rightarrow$ developed land / developable land (slope $\leq$ 20 degrees)
  - $\rightarrow$ captures the topographical constrainedness for further construction
- *REG* is a municipality-level fixed effect coefficient from a regression of time-to-permit on permit request characteristics and backlog
  - $\rightarrow$ Individual level time-to-permit data for 1997-2003
  - $\rightarrow$ Proxy the stringency of building regulation

Demand Equation: IV

In order to instrument taxes in the demand equation, we use the IV border sample to implement our cross-cantonal instrument.

The demand equation (5a) becomes

$$\nabla\Delta \ln P_{j,c} = \frac{1}{\eta_{d,p}} \nabla\Delta \ln H_{j,c} + \boldsymbol{\eta_p \nabla\Delta} \ln \boldsymbol{\tau} + \boldsymbol{\mu \nabla A_{j,c}} + \delta_c + \epsilon_{1j,c},$$

where

- ∇ indicates a cross-canton spatial difference between pairs of municipalities with a maximum road distance of 10km,
- We instrument $\nabla\Delta \ln H_{j,c}$ and $\boldsymbol{\nabla\Delta} \ln \boldsymbol{\tau}$ respectively by ($\nabla SDL_{j,c}$, $\nabla REG_{j,c}$) and $\boldsymbol{\nabla\Delta} \ln \boldsymbol{\tau_c}$,
- τ_c is the cantonal tax rate on personal income
- δ_c is an origin canton fixed effect
- Standard errors are two-way clustered, by each paired municipality

Demand Equation: IV Estimates

Dependent variable:	Spatial difference of rental price residual growth rate	
	(1)	(2)
Housing stock ($\widehat{\eta}^{d,p}$)	-1.056**	-1.084*
	(0.519)	(0.580)
Amenity Controls	YES	YES
Fiscal Controls	YES	YES
Origin Canton FE	YES	YES
# of observations	2,004	2,004
# of origin clusters	524	524
# of dest. clusters	524	524
Instrument	SDL, REG	SDL, REG and State tax differential
Kleibergen-Paap F Stat	7.37	2.00
Estimator	2SLS	2SLS

Note: ***p<0.01, **p<0.05, *p<0.1. Two-way cluster robust standard errors at origin and destination municipality level. Weighted by log municipal population in 2000. Pairing road distance of 10 km.

Supply Equation: IV

We use a two-step cross-canton spatial difference to estimate the following reduced form equations *separately*:

$$\nabla\Delta \ln H_{j,c} = \boldsymbol{\eta_s \nabla\Delta} \ln \boldsymbol{\tau} + \gamma_1 \nabla SDL_{j,c} + \gamma_2 \nabla REG_{j,c} + \boldsymbol{\mu \nabla A_{j,c}} + \delta_c + \varepsilon_{j,c}$$

$$\nabla\Delta \ln P_{j,c} = \boldsymbol{\eta_p \nabla\Delta} \ln \boldsymbol{\tau} + \phi_1 \nabla SDL_{j,c} + \phi_2 \nabla REG_{j,c} + \boldsymbol{\mu \nabla A_{j,c}} + \delta_c + \varepsilon_{j,c}$$

where

- $\boldsymbol{\nabla\Delta} \ln \boldsymbol{\tau}$ is instrumented by $\boldsymbol{\nabla\Delta} \ln \boldsymbol{\tau_c}$
- δ_c is an origin canton fixed effect

We can back out

$$\widehat{\eta}_{s,p} = \frac{\widehat{\eta}_{s,\tau}}{\widehat{\eta}_{p,\tau}}$$

Supply Equation: IV Estimates

Dependent variable:	Spatial difference of dwelling space growth rate		Spatial difference of rental price residual growth rate	
	(1)	(2)	(3)	(4)
Dwelling space elasticity of income taxes ($\widehat{\eta}^{s,\tau}$)	-1.240***	-0.695		
	(0.314)	(0.429)		
Rental price elasticity of income taxes ($\widehat{\eta}^{p,\tau}$)			-1.405***	-0.951*
			(0.388)	(0.557)
Implied Housing Supply Elasticity $(\widehat{\eta}^{s,p})_{OLS}$: 0.885*** (0.325)				
Implied Housing Supply Elasticity $(\widehat{\eta}^{s,p})_{IV}$: 0.698 (0.534)				
Amenity Controls	YES	YES	YES	YES
Fiscal Controls	YES	YES	YES	YES
Origin Canton FE	YES	YES	YES	YES
# of observations	2,004	2,004	2,004	2,004
# of origin clusters	524	524	524	524
# of dest. clusters	524	524	524	524
Instrument	–	State tax differential	–	State tax differential
Cragg-Donald Wald F Stat	–	304.52	–	307.38
Kleibergen-Paap F Stat	–	14.03	–	15.19
Estimator	OLS	2SLS	OLS	2SLS

Note: ***p<0.01, **p<0.05, *p<0.1. Two-way cluster robust standard errors at origin and destination municipality level in parentheses. Weighted by log of municipal population in 2000. Pairing road distance of 10km.

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Appendix

Household Utility

Housing demand:

$$\max_{h_{mj}, z_{mj}} U_{imj} = \alpha \ln(h_{mj} - \nu_h) + (1-\alpha)\ln(z_{mj} - \nu_z) + \delta_m \ln(g_j - \nu_g) + \ln A_{ij}$$

$$\text{s.t.} \quad z_{mj} + p_j h_{mj} = (1-\tau_j) w_m \,.$$

We assume for simplicity $\nu_z = \nu_g = 0$.

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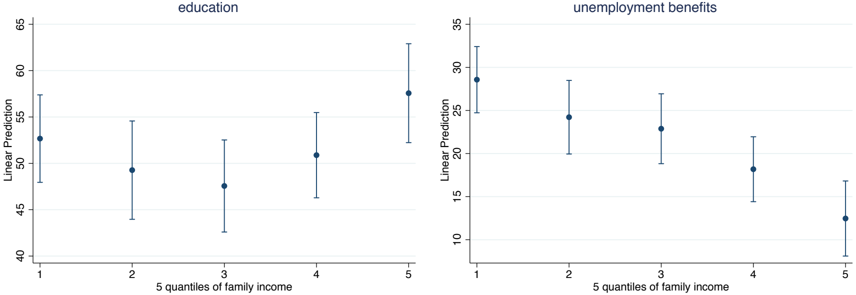
Survey evidence



Income is net monthly income of the household. Source: International Social Survey Program (ISSP), Role of Government, 1996. Switzerland.

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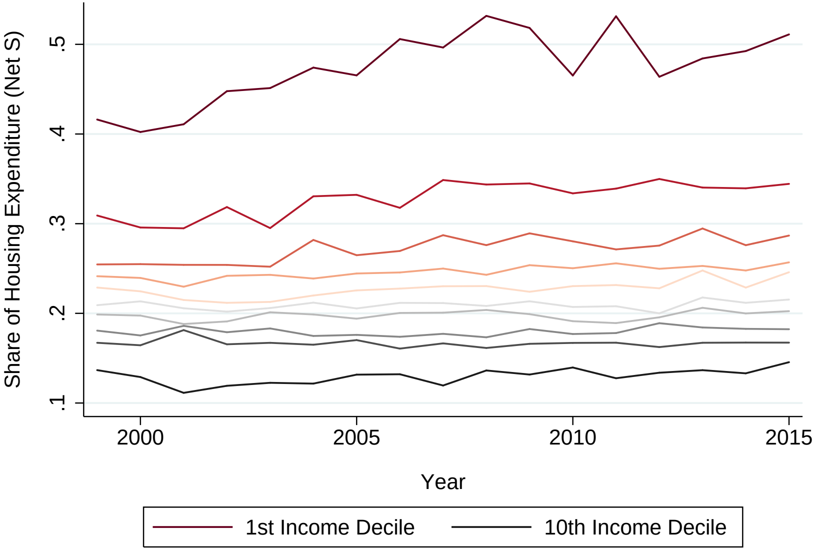
Expenditure Shares



Colour ranges follow sequentially from red to black.

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Personal Income and Property Ownership Taxation in Switzerland

Personal income taxation:

- Residence-based tax levied by cantons and municipalities
  - 63% of municipal tax revenue
  - Municipalities annually set a multiplier to the cantonal tax schedule
- Rental revenue taxed as income in the municipality where the dwelling is located

Property ownership taxation:

- Property taxes, transaction taxes and capital gain taxes defined at cantonal level
  - Some cantons allow municipalities to raise their own tax
  - Varying degree of municipal autonomy across cantons

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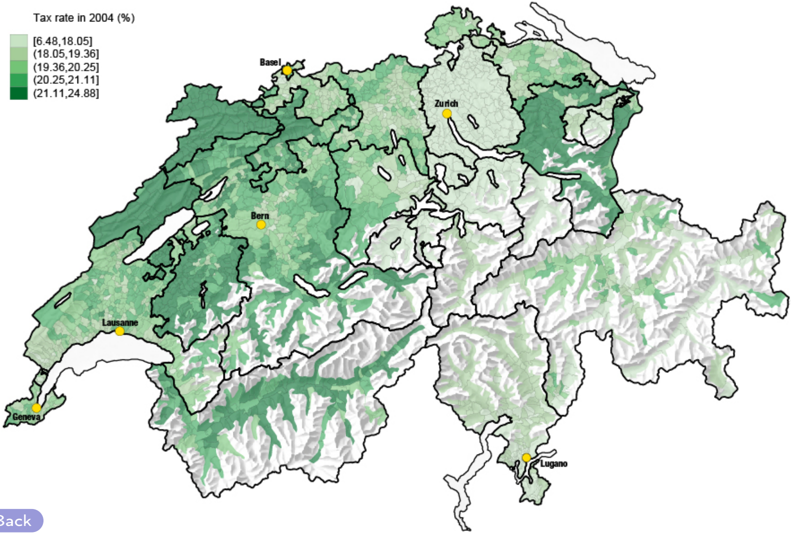
Cross-sectional Variation in Personal Income Tax Rates



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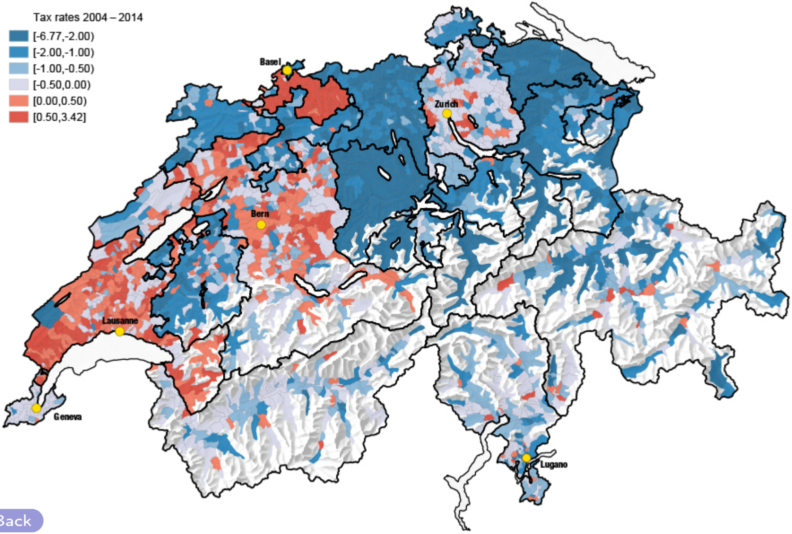
Consolidated cantonal + municipal + church tax rates (in %) for unmarried couple without dependent children in the 95th income percentile, 2004.

Time Variation in Personal Income Tax Rates



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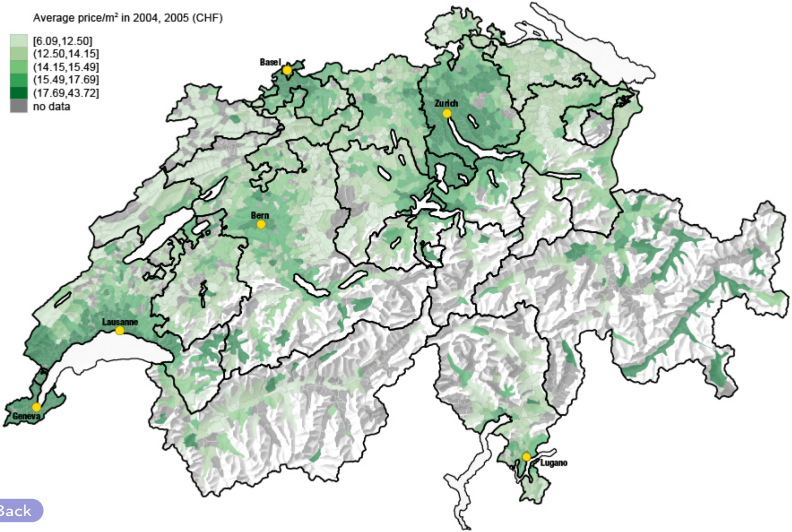
Consolidated cantonal + municipal + church tax rates (in %) for unmarried couple without dependent children in the 95th income percentile, difference 2004-2014.

Cross-sectional Variation in Rental Prices



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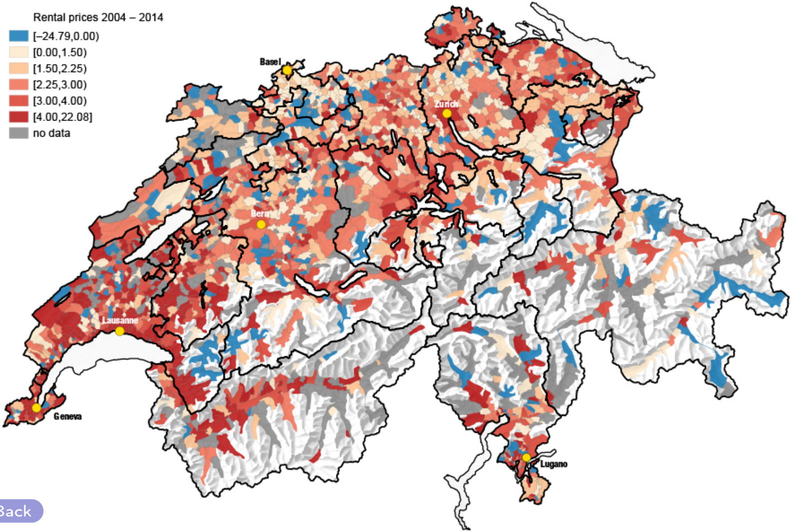
Average Rental Price (CHF/m^2) in 2004/2005.

Time Variation in Rental Prices



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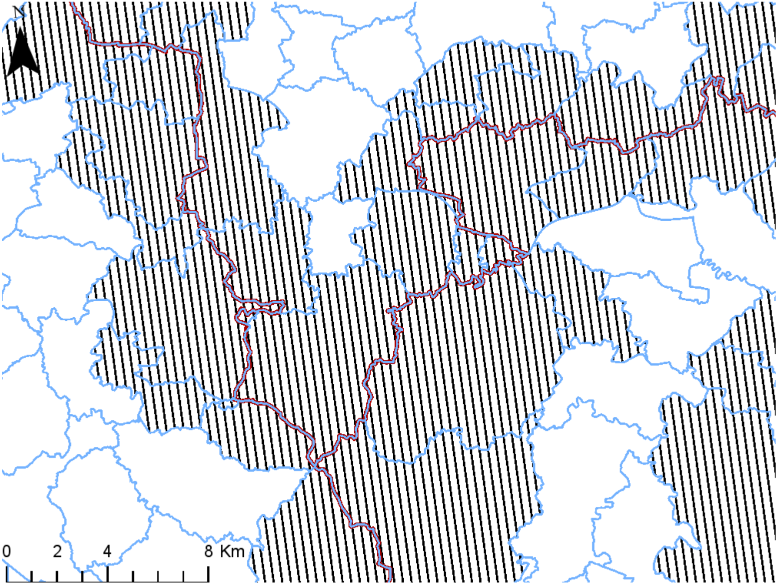
Average Rental Price (CHF/m²), difference 2004-2014.



Black lines are cantonal borders. Shaded area are municipalities adjacent to and with a population centroid within a 10km distance from a cantonal border.

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Tax base and rental price elasticities

Tne baseline estimating equation is

$$\nabla \ln y_{jt} = \eta \nabla \ln \tau_{jt} + \phi_{jk} + \phi_{ct} + \varepsilon_{jt} \tag{2}$$

- ∇ represents the cross-canton spatial difference between pairs of municipalities at a cantonal border
- y_{jt} is either the count of taxpayers or rental prices in pair j at time $t \in [2004, ..., 2014]$
- ϕ_{jk} with $j \neq k$ is a municipality-pair directional fixed effect
- ϕ_{ct} is an origin-canton fixed effect
- Consolidated tax rates ($\nabla \ln \tau_{jt}$) are instrumented with the corresponding spatial difference of cantonal tax rates $\nabla \ln \tau_{ct}$
- Estimation weighted by the log municipal population in 2000
- Standard errors are clustered two ways, at origin and destination municipality level

Tax base and rental price elasticities: baseline results

Equation:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Group:	Households without children			Households with children			
Dependent variable:	Bottom 50	Next 25	Top 25	Bottom 50	Next 25	Top 25	Prices
***Panel A:* OLS pairwise difference estimation on border municipalities**							
Income tax rate	-0.035	-0.264***	-0.540***	0.005	0.085*	-0.082	-0.171***
	(0.043)	(0.061)	(0.077)	(0.008)	(0.046)	(0.066)	(0.041)
***Panel B:* IV pairwise difference estimation on border municipalities**							
Income tax rate	-0.001	-0.168*	-0.345***	0.008	0.079	-0.036	-0.095
	(0.084)	(0.088)	(0.123)	(0.008)	(0.056)	(0.080)	(0.076)
Kleibergen-Paap F Stat	10.50	79.86	294.39	571.49	26.86	231.40	274.13
***Panel C:* IV pairwise difference estimation on border municipalities: distributed lag model**							
Income tax rate	0.048	-0.326***	-0.526***	0.013	0.034	-0.071	-0.157*
	(0.109)	(0.114)	(0.150)	(0.011)	(0.069)	(0.099)	(0.086)
Kleibergen-Paap F Stat	2.98	47.36	65.03	113.69	8.93	108.00	62.41
# of observations	22,044	22,044	22,032	22,040	22,028	22,044	19,802
# of municipalities	524	524	524	524	524	524	524
Municipality-pair directional fixed effect	YES						
Origin canton-year fixed effect	YES						

Notes: Cluster robust standard errors reported in parentheses. Standard errors are two-way clustered at origin and destination municipality level. Regressions in panel C employ a standard distributed lag approach estimating $\nabla \ln y_{jt} = \eta^y \nabla \ln \tau_{jt} + \sum_{s=1}^{2} \beta_s (\nabla \ln \tau_{jt-s} - \nabla \ln \tau_{jt}) + \phi_{jk} + \phi_{ct} + \varepsilon_{jt}$, so that we may interpret $\hat{\eta}$ directly as the long-term effect.

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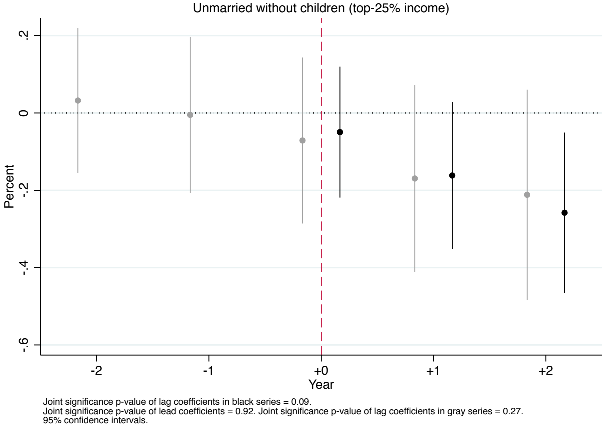
Cumulative elasticities over time



The figure shows the cumulative effect of a change in the local tax rate (instrumented) on the number of taxpayers without children and top-quartile income. It plots the sum of the coefficients (and their corresponding standard errors) from estimating a distributed lag model with 2 lags (in black) and 2 lags and 2 leads (in gray).

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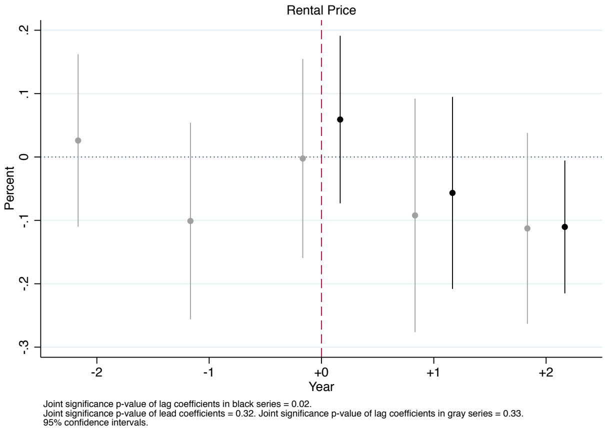
Cumulative elasticities over time



The figure shows the cumulative effect of a change in the local tax rate (instrumented) on rental prices. It plots the sum of the coefficients (and their corresponding standard errors) from estimating a distributed lag model with 2 lags (in black) and 2 lags and 2 leads (in gray).

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Equilibrium

Log-differentiating each of the equations:

$$\hat{N}_{mj} = \lambda \left[-\alpha \left(\frac{h^*_{mj}}{h^*_{mj} - \nu_h} \right) \hat{p}_j - \alpha \frac{\tau_j}{S_{mj}} \left(\frac{h^*_{mj}}{h^*_{mj} - \nu_h} \right) \hat{\tau}_j + \delta_m \hat{g}_j \right]$$

$$\sum_m \pi_{mj} \hat{N}_{mj} = \rho \hat{p}_j + \alpha \tau_j \left(\sum_m \frac{\pi_{mj}}{S_{mj}} \right) \cdot \hat{\tau}_j$$

$$\hat{g}_j = \hat{\tau}_j + \sum_m (\gamma_{mj} - s_{mj}) \hat{N}_{mj}$$

with $\pi_{mj} \equiv H^d_{mj} / H^d_j$, $\rho \equiv \left(\sum_m \pi_{mj} \left[1 - (1-\alpha) \frac{\nu_h}{h^*_{mj}} \right] + \eta_{s,p} \right)$, and $\gamma_{mj} \equiv \frac{w_m N_{mj}}{\sum_m w_m N_{j,m}}$

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Baseline model

In a simple model with 'myopic' households, we assume that households do not anticipate the effect of their own location decision nor the decision of all other households on the provision of the public good, that is,

$$\hat{g}_j = \hat{\tau}_j \, .$$

The structural model is given by

$$\begin{bmatrix} \frac{1}{\alpha\lambda}\left(1-\frac{\nu_h}{h^*_{j,\mathbf{1}}}\right) & 0 & 1 \\ 0 & \frac{1}{\alpha\lambda}\left(1-\frac{\nu_h}{h^*_{j,\mathbf{2}}}\right) & 1 \\ \pi_{1j} & \pi_{2j} & -\rho \end{bmatrix} \begin{bmatrix} \hat{N}_{j,1} \\ \hat{N}_{j,2} \\ \hat{p}_j \end{bmatrix} = \begin{bmatrix} \frac{\delta_{\mathbf{1}}}{\alpha}\left(1-\frac{\nu_h}{h^*_{j,\mathbf{1}}}\right) - \frac{\tau_j}{(1-\tau_j)S_{j,\mathbf{1}}} \\ \frac{\delta_{\mathbf{2}}}{\alpha}\left(1-\frac{\nu_h}{h^*_{j,\mathbf{2}}}\right) - \frac{\tau_j}{(1-\tau_j)S_{j,\mathbf{2}}} \\ \pi_{1j}\frac{\alpha\tau_j}{S_{j,\mathbf{1}}} + \pi_{2j}\frac{\alpha\tau_j}{S_{j,\mathbf{2}}} \end{bmatrix} \hat{\tau}_j$$

and the aggregate housing demand price elasticity is

$$|\eta_{d,p}| = \sum_m \pi_{mj}\left(1-(1-\alpha)\frac{\nu_h}{h^*_{j,m}}\right) + \alpha\lambda\sum_m\left(\frac{h^*_{mj}}{h^*_{mj}-\nu_h}\right)$$

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Structural Estimation - Results

	(1)	(2)	(3)	(4)	(5)	(6)
Group:		No Children			Children	
Income class:	Bottom 50	Next 25	Top 25	Bottom 50	Next 25	Top 25
Panel A: Structural parameters						
Preference for public goods (δ_m)	0.234***	0.199***	0.090	0.012	0.139***	0.308***
	(0.035)	(0.039)	(0.057)	(0.013)	(0.027)	(0.037)
Panel B: Structural elasticities						
Tax base elasticities	0.287***	-0.067	-0.687***	0.011***	0.069	0.013
	(0.058)	(0.067)	(0.102)	(0.004)	(0.043)	(0.065)
Marginal willingness to pay rent	0.209***	-0.246**	-1.563***	-0.135***	-0.051	-0.121
	(0.083)	(0.112)	(0.226)	(0.025)	(0.071)	(0.134)
Resident incidence	0.149***	-0.035	-0.356***	0.006	0.036	0.007
	(0.036)	(0.040)	(0.057)	(0.019)	(0.028)	(0.038)
Overall renter incidence			0.018			
			(0.020)			
Landlord incidence ($\eta^{p,\tau*}$)			-0.146***			
			(0.025)			

Notes: Standard errors reported in parentheses. Overall renter incidence is the weighted sum of the income class specific incidences using the corresponding relative population shares. ***p<0.01, **p<0.05, *p<0.1.

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