"Location Sorting and Endogenous Amenities: Evidence from Amsterdam"

Almagro and Donínguez-Iino (WP 2021)

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Introduction

Research Question: How does two-way heterogeneity shape within-city residential sorting and inequality?

Approach:

- Build a spatial equilibrium model with two-way heterogeneity (household preferences for amenities *and* location-specific amenity provision).
- Estimate the model with incredibly rich data from Amsterdam, relying on spatial variation in tourism flows.

Contribution:

- First to model a rich multi-dimensional set of endogenous amenities
  - Find that extent of alignment in household preferences affects the change in welfare inequality
- Counterfactuals allow them to test various policies restricting the supply of AirBnB's in Amsterdam

Outline

1. Data
2. Stylized Facts
3. Dynamic Model Estimation
4. Simulations and Counterfactuals

Data

- Individual-level residential histories and socioeconomic characteristics
  - Panel of residential movements for the *universe* of individuals in the Netherlands from Centraal Bureau voor de Statistiek
  - Socioeconomic characteristics for these individuals from tax return microdata.
- Housing unit characteristics
  - Property values, geo-coordinates, quality measures, and occupant's tenancy status from tax appraisal data
  - Sale prices from the universe of house sale transactions
  - Rent data from national rent survey (impute missing rents from tax appraisal data)

Data (cont.)

- Annual neighborhood-level data from Amsterdam City Data
  - Over 700 variables including sociodemographics, consumption amenities, government-provided amenities, and non-market amenities.
  - Key for estimating the model with multi-dimensional endogenous amenities
- AirBnB listings
  - Geographic coordinates, host identifieers, price-per-night, calendar availability, and reviews at the listing level.
  - Allows them to identify commercially operated listings

Stylized Facts

1. Tourism inflows and AirBnB listings have grown dramatically in Amsterdam
2. The spatial distribution of AirBnB listings in broader than that of traditional hotels
3. Rents have increased most in neighborhoods with more AirBnB entry
4. Amenities have tilted towards tourists and away from locals
5. The composition of residents has changed heterogeneously across neighborhoods
6. The moving decisions of households are dynamic

Fact 1: Tourism inflows and AirBnB listings have grown dramatically in Amsterdam

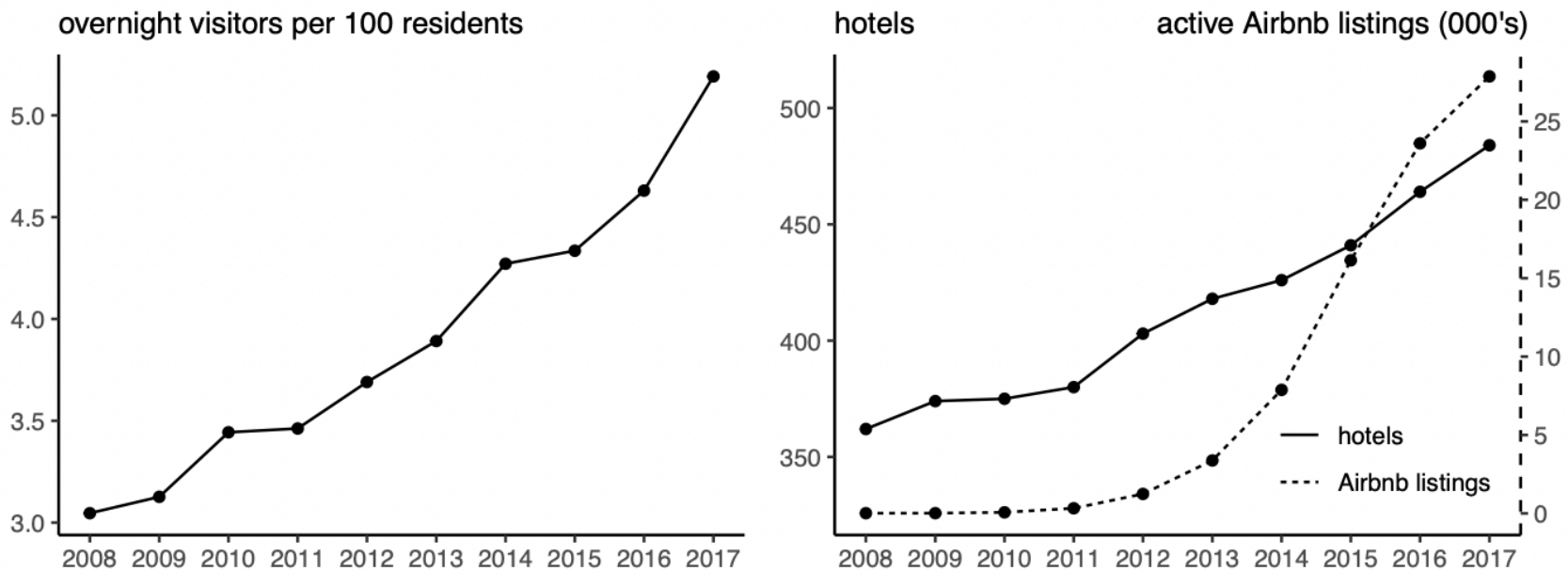


Figure 1: Tourists per resident, number of hotels, and active Airbnb listings.

Fact 2: The spatial distribution of AirBnB listings in broader than that of traditional hotels

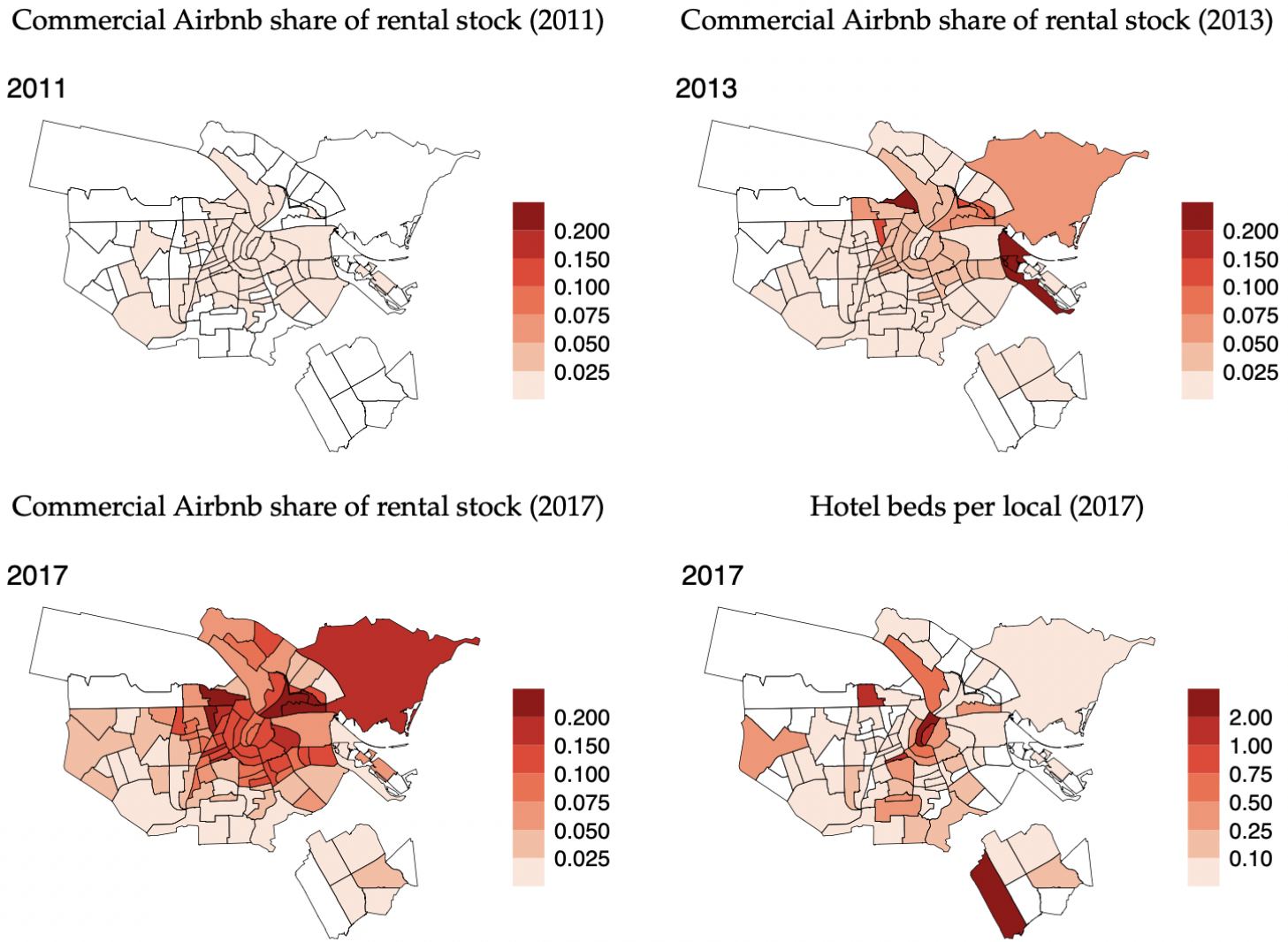


Figure 2: Evolution of commercial Airbnb listings and comparison to hotel distribution.

Fact 3: Rents have increased most in neighborhoods with more AirBnB entry

Table 1: Relationship between housing market outcomes and Airbnb listings

	Ln (rent/m2)			Ln (house sale value)		
	OLS	OLS	FE	OLS	OLS	FE
Ln (commercial Airbnb listings)	**0.066*** **	**0.059*** **	**0.125*** **	**0.108*** **	**0.053*** **	**0.054*** **
	(0.008)	(0.007)	(0.017)	(0.016)	(0.006)	(0.017)
Ln (housing stock)		-0.070**	-0.125***		-0.015	-0.038
		(0.029)	(0.028)		(0.024)	(0.029)
Ln (average income)		-0.482***	-0.316***		1.003***	0.988***
		(0.087)	(0.086)		(0.053)	(0.079)
Ln (high-skill population share)		0.291***	-0.083		0.281***	0.117
		(0.058)	(0.114)		(0.034)	(0.073)
District-year FE			X			X
Observations	780	659	659	746	634	634
R2	0.154	0.423	0.578	0.124	0.768	0.898

Notes: Standard errors clustered at the wijk level in parenthesis.

Fact 4: Amenities have tilted towards tourists and away from locals

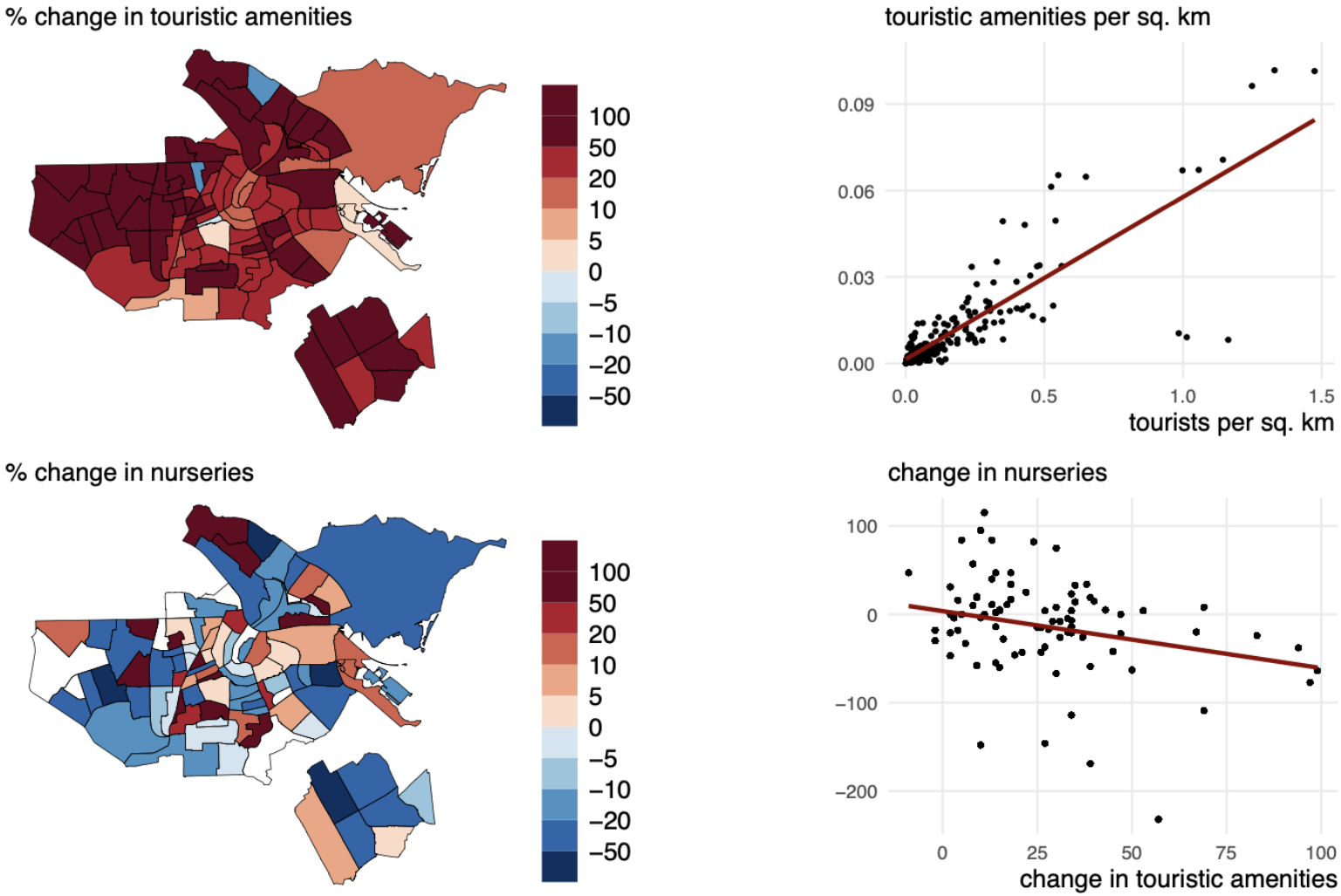


Figure 3: Growth of different consumption amenities (2011-2017).

Fact 5: The composition of residents has changed heterogeneously across neighborhoods

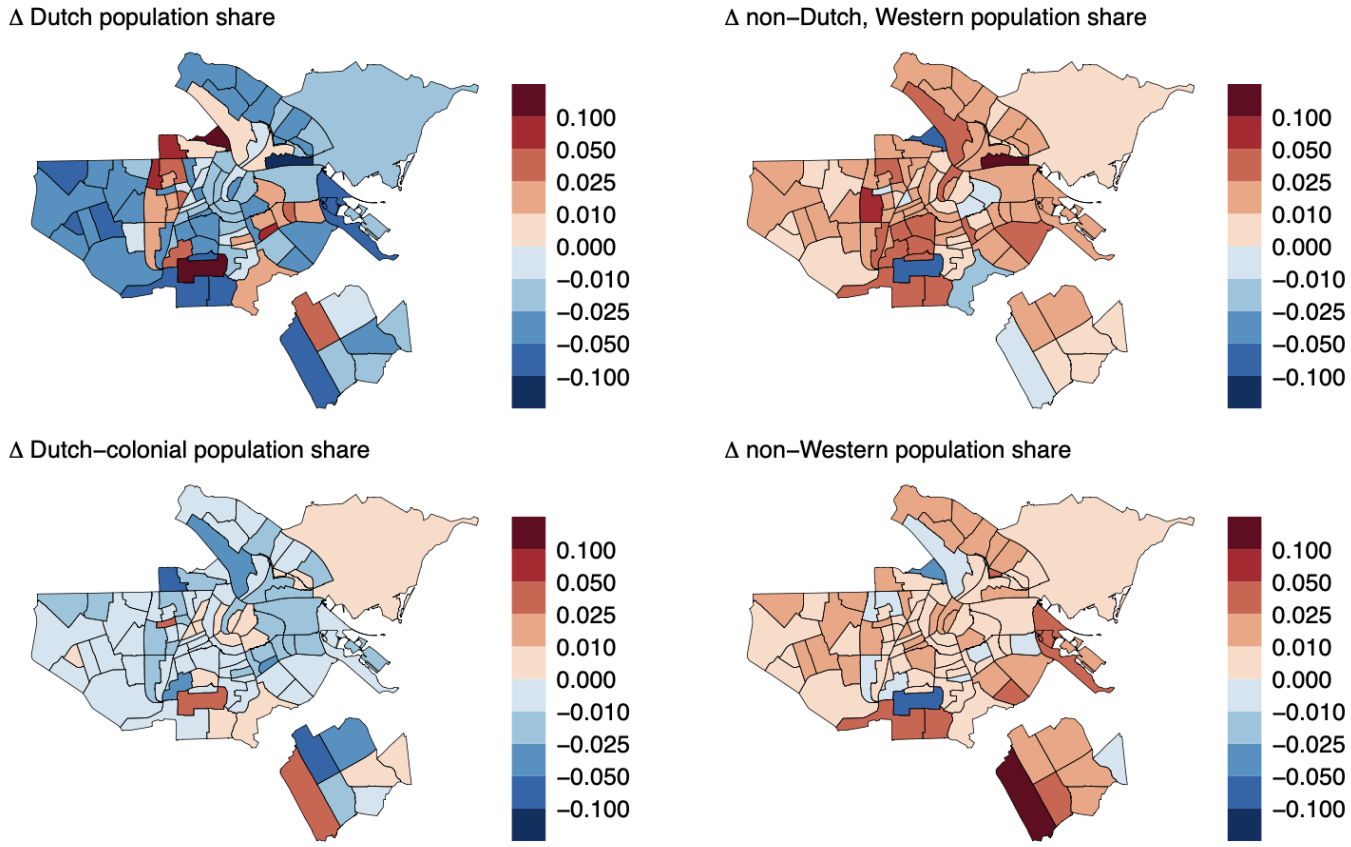


Figure 4: Changes in ethnic composition of neighborhoods (2011-2017). ACD defines "non-Western" as countries from Africa, Latin America, and Asia, and "Western" as countries from the rest of Europe, North America, Australia, and New Zealand. Our definition of "Dutch-colonial" consists of Suriname and the Netherlands Antilles.

income composition | skill and age composition | household composition

Fact 6: The moving decisions of households are dynamic

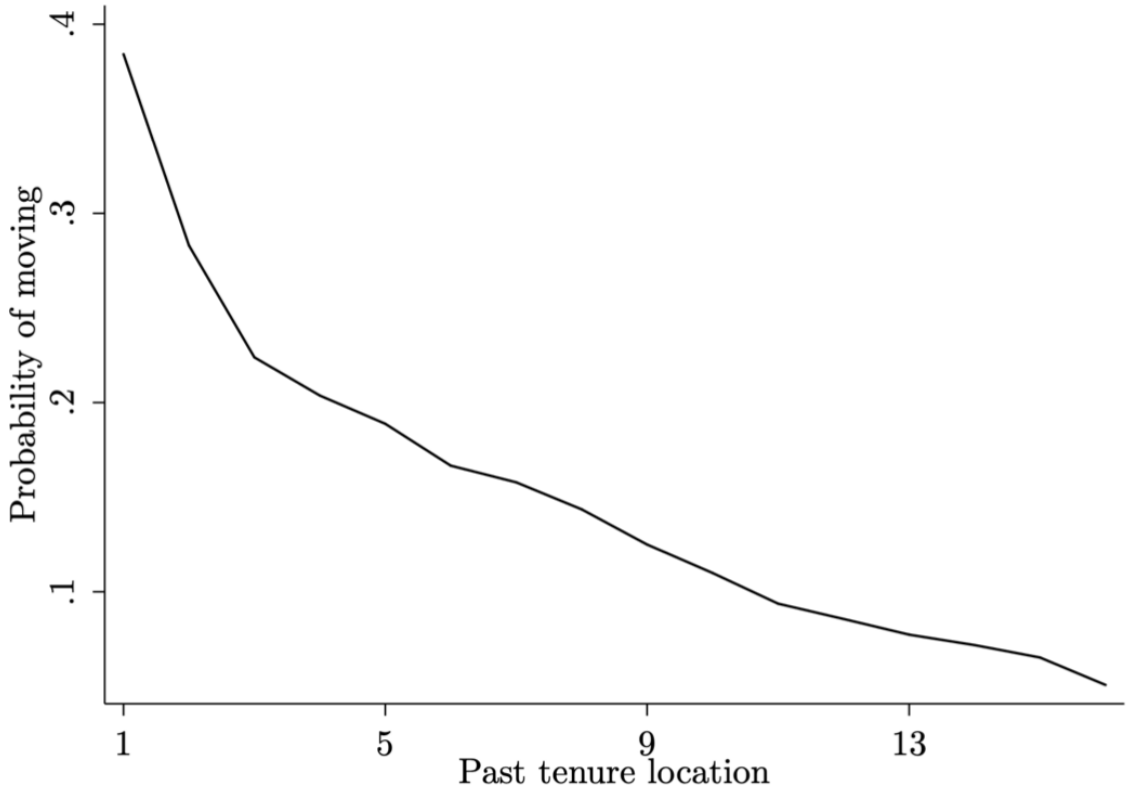


Figure 8: Probability of changing residence, conditional on past location tenure.

- Interpretation: households accumulate neighborhood-specific capital over time.

Estimation – Heterogeneous Households

Table 2: Average demographics by cluster

	Group	Name	Skill			Income				Share Children	Age	Background origin				N
			% L	% M	% H	Pctl. Tot. Inc.	Total Inc.	Pctl. Inc PP	Inc. PP			Dutch	Dutch Col.	Western	Non West.	
Home Owners	1	H skill, Young, Singles	0.01	0.03	0.95	0.34	24000	0.42	22100	0.13	32	0.57	0.08	0.17	0.18	47990
	2	L+M skill, Immigrant Families	0.40	0.58	0.01	0.50	32800	0.45	22500	0.78	47	0.37	0.22	0.11	0.29	18829
	3	H skill, High inc., Young EU Families	0.00	0.00	1.00	0.68	53700	0.67	36300	0.89	36	0.64	0.08	0.15	0.13	72568
	4	H skill, High inc., Old Dutch Families	0.01	0.00	0.99	0.77	72300	0.79	51600	0.77	55	0.79	0.09	0.08	0.04	43246
Renters	5	H Skill, Low inc., Young, EU, Singles	0.02	0.04	0.94	0.19	14900	0.23	14000	0.06	27	0.62	0.04	0.18	0.16	71805
	6	H Skill, Low inc., Young, Immigrant Families	0.04	0.07	0.88	0.33	22800	0.32	17500	0.80	31	0.50	0.06	0.22	0.22	39467
	7	H Skill, High inc., Old Dutch, Families	0.20	0.11	0.69	0.53	38400	0.56	30200	0.61	58	0.66	0.11	0.12	0.11	25740
	8	H Skill, High inc., Young, EU, Families	0.00	0.01	0.99	0.70	59000	0.74	44100	0.69	36	0.55	0.05	0.26	0.15	45855
Social Housing	9	H skill, Low inc., Young Singles	0.01	0.00	0.99	0.20	15300	0.23	13800	0.16	29	0.56	0.10	0.12	0.22	88002
	10	L skill, Low inc., Old Immigrant Families	1.00	0.00	0.00	0.40	26100	0.32	17100	0.75	50	0.17	0.12	0.10	0.61	41416
	11	M skill, Low inc., Mixed Background Families	0.00	1.00	0.00	0.37	24300	0.33	17600	0.65	40	0.29	0.37	0.06	0.28	42076
	12	H skill, Medium inc., Dutch Families	0.00	0.00	1.00	0.52	35100	0.51	25600	0.78	43	0.59	0.13	0.10	0.17	77416

Dynamic Model of City's Rental Market

Amenities

- Endogenously respond to a neighborhood's resident composition

Households

- Dynamic moving decisions across neighborhoods

Landlords

- Rent housing to either locals (long-term) or tourists (short-term)

Dynamic Model – Amenities

- S sectors of consumption amenities (bars, restaurants, retail, etc.)
- K types of consumers (many different locals, plus tourists)
- Heterogeneous preferences over consumption amenities by type
- Finite number of firms supplying differentiated varieties in each neighborhood-sector
- Monopolistic competition with free entry

Dynamic Model – Amenities Demand

Type k household in neighborhood j chooses the quantity of each variety of amenity to consume

$$\max_{\{q_{is}^k\}_{is}} \Pi_s \left[\left(\sum_{i=1}^{N_s} {q_{is}^k}^{\frac{\sigma_s - 1}{\sigma_s}} \right)^{\frac{\sigma_s}{\sigma_s - 1}} \right]^{\alpha_s^k} \quad \text{s.t.} \quad \sum_{is} p_{is} q_{is}^k = b_j^k,$$

where $b_j^k \equiv w_j^k - r_j$ is the household budget.

This generates household-level demand for variety i in sector s at price p_i of

$$q_i^k = \frac{\alpha_s^k b_j^k}{p_i} j \left(\frac{p_i}{P_s} \right)^{1-\sigma_s}, \quad \text{with} \quad P_s \equiv \left(\sum_{i \in s} p_i^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}}$$

Dynamic Model – Amenities Supply

Assumption: every firm within a sector-neighborhood (sj) faces the same marginal cost c_{sj}

- Price for variety i is $p_i = \frac{c_{sj}}{1-\frac{1}{\sigma_s}} \; \forall i \in sj$.

Assumption: every firm must pay fixed cost F_{sj} in each period they wish to operate

- Endogenous number of firms given by zero-profit condition, $(p_i - c_{sj})q_i = F_{sj}$

Dynamic Model – Amenities Equilibrium

Symmetric equilibrium where each firm in a sector-neighborhood (sj) has the same price and faces the same demand

$$q_i = q_s \text{ and } p_i = p_s \ \ \forall i \in sj$$

Given this symmetry, the equilibrium number of firms is given by

$$N_{sj} = \frac{1}{\sigma_s F_{sj} \sum_k \alpha_s^k b_j^k M_j^k}$$

where M_j^k is the total number of consumers of type k in neighborhood j.

Lastly, they define a location's consumption amenities as its vector of firms in each sector,

$$a_j \equiv [N_{1j}, N_{2j}, \ldots, N_{Sj}] = \mathcal{A}(M_j^1, \ldots, M_j^K, M_j^T)$$

where $\mathcal{A}(.)$ is a mapping from neighborhood j's residential composition to its amenities.

Estimation – Amenities

From the amenities equilibrium in the model, we can obtain the following equation for logged number of firms in sector s, neighborhood j, and time t

$$\log N_{sjt} = \lambda_s + \lambda_{jt} - \log F_{sjt} + \log \left(\sum_k M_{jt}^k \alpha_s^k (w_t^k - r_{jt}) \right) + \psi_{sjt}$$

where $\lambda_s = -\log \sigma_s - \log \Lambda_s$ and $\lambda_{jt} = -\log \Lambda_{jt}$.

Estimating this requires the identification assumption that unobservables ψ_{sjt} are not correlated with the budget allocation of household k to service s for residents of location j.

Estimation – Amenities

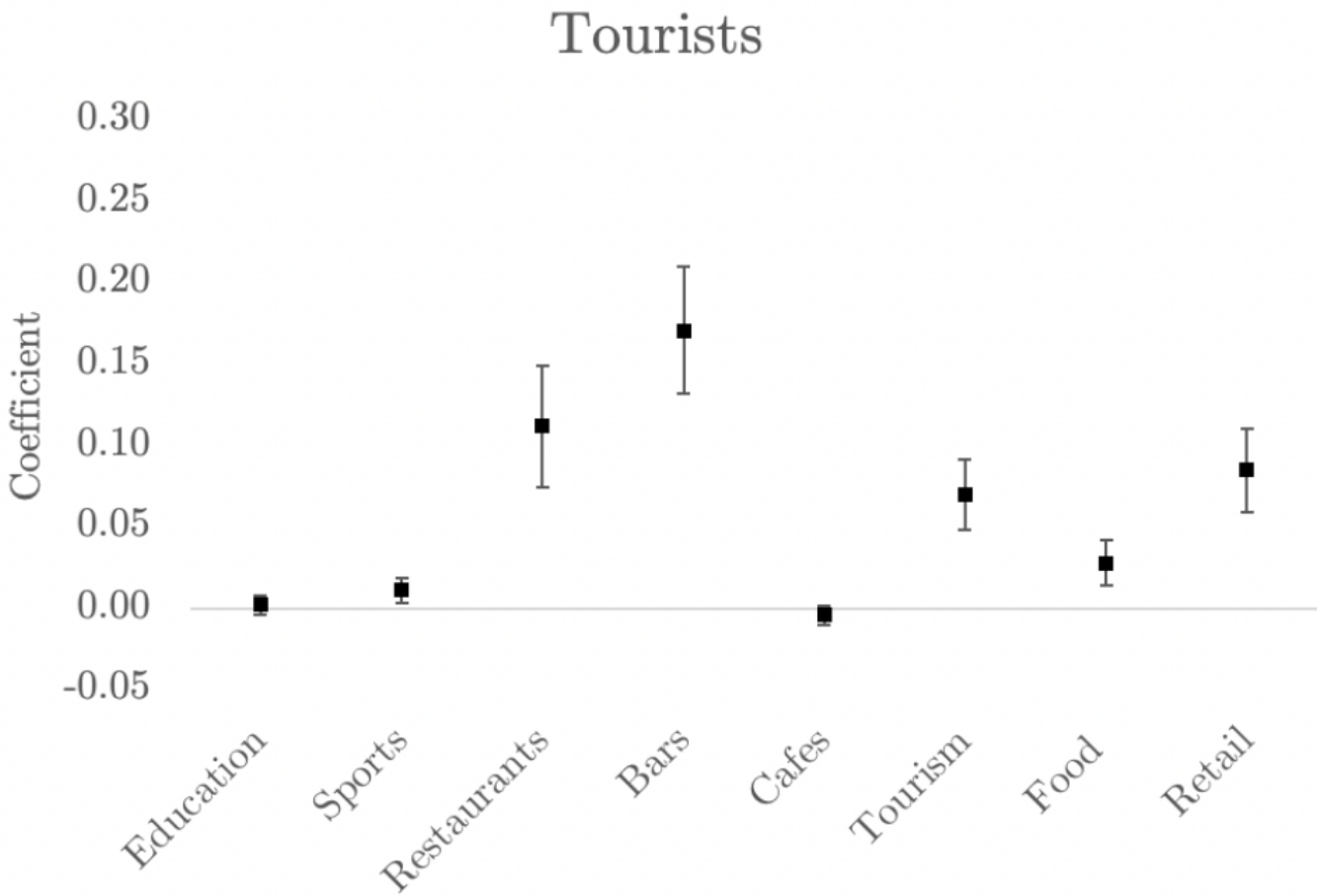
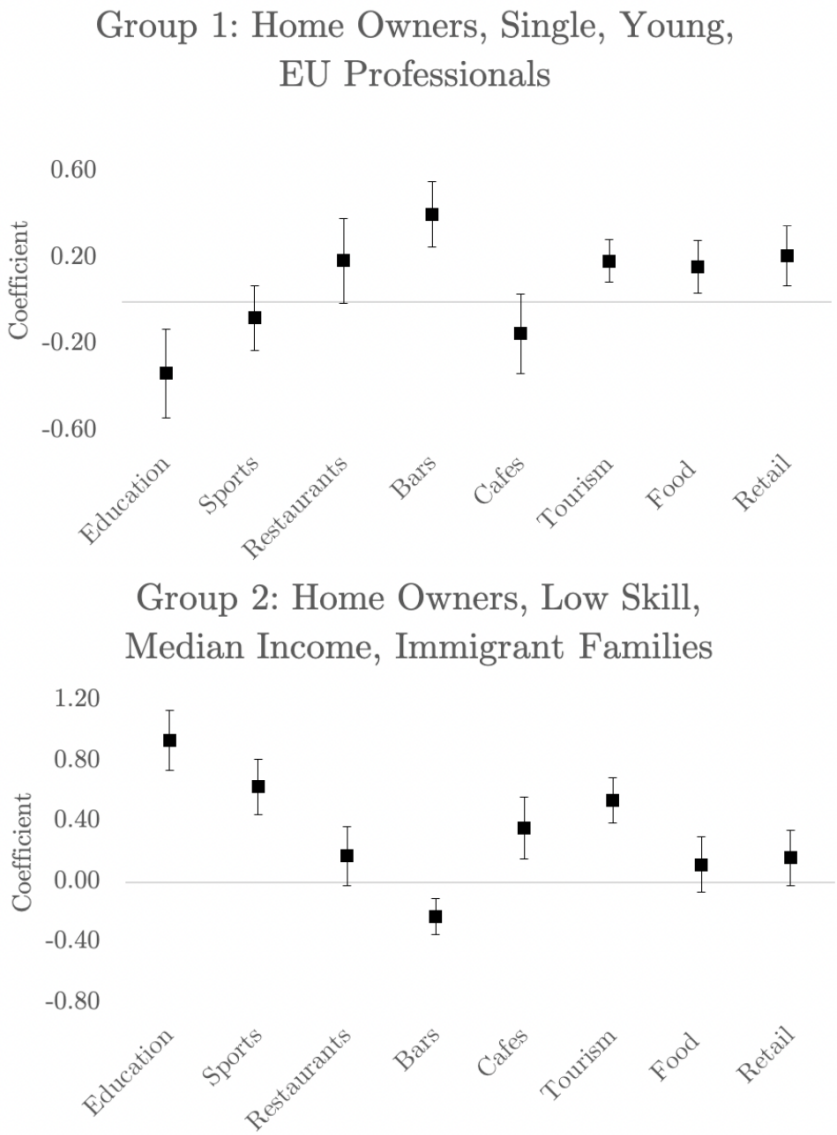
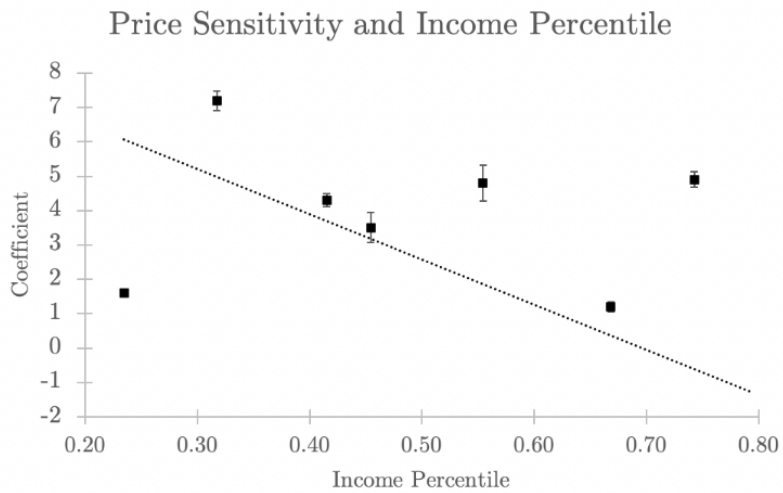


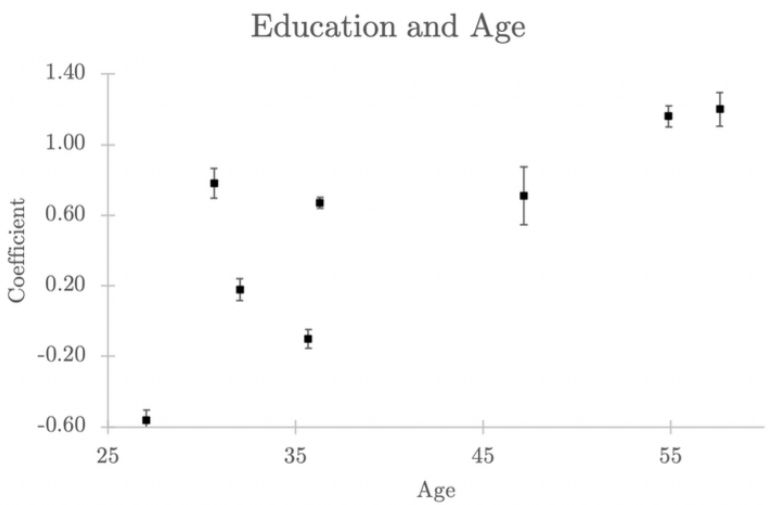
Figure 13: Amenities supply in response to tourists

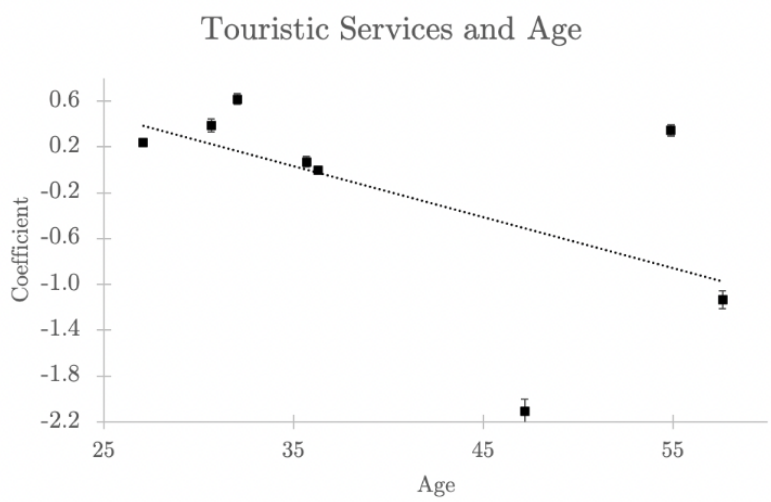
Estimation – Amenities



Estimation – Housing Demand







Estimation – Housing Demand

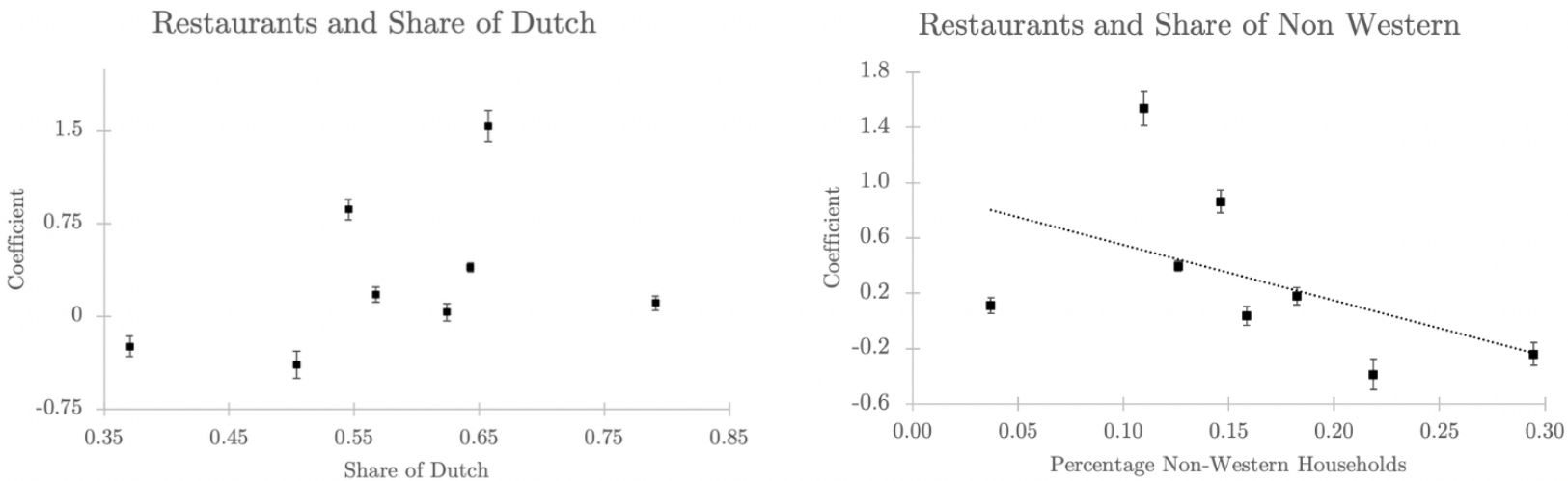


Figure 15: Relationship between demand estimation coefficients and demographics

full results

Dynamic Model – Landlords

Landlords face the following maximization problem

$$\max_{h \in \{L,S\}} \{\alpha r_{jt} + \varepsilon_L, \;\; \alpha p_{jt} - \kappa_{jt} + \varepsilon_S\},$$

where κ_{jt} captures the unobserved (to the econometrician) operating costs of short-term rental units, α is the landlord's marginal utility of income, and ε_L and ε_S are type I EV-distributed shocks.

The share of housing stock for each type of rentals is thus

$$s_{jt}^L = \frac{\exp(\alpha r_{jt})}{\exp(\alpha r_{jt}) + \exp(\alpha p_{jt} - \kappa_{jt})} \text{ and } s_{jt}^S = \frac{\exp(\alpha p_{jt} - \kappa_{jt})}{\exp(\alpha r_{jt}) + \exp(\alpha p_{jt} - \kappa_{jt})}$$

Estimation – Housing Supply

The authors estimate the following regression

$$\ln s_{jt}^{L} - \ln s_{jt}^{S} = \alpha(r_{jt} - p_{jt}) + \gamma_j + \gamma_t + \nu_{jt}$$

where γ_j and γ_t are fixed effects which parametrize the operation cost of short-term rentals, $\kappa_{jt} = \gamma_j + \gamma_t$

Table 5: Dependent variable: Log long-term share - Log short-term share

	OLS		IV	
Price gap	0.919***	(0.077)	1.646***	(0.232)
Location FE	✓		✓	
Time FE	✓		✓	
R^2	0.849		0.828	
Observations	655		655	
F Statistic	453.042***		352.12***	
1 stage F Stat	-		1033.82***	
Note:	*p<0.1; **p<0.05; ***p<0.01. SE clustered at zipcode-level.			

Simulations and Counterfactuals

1. The role of heterogeneous preferences for endogenous amenities
2. Short-term rentals entry as a reduction in hosting costs
3. Regulating prices vs. quantities

Heterogeneous Preferences

Objective: evaluate the role of endogeneity of amenities and consumer heterogeneity for the model's equilibrium outcomes.

Setup:

- Two types of agents, high (H) and low (L)
- Two types of amenities, also high (H) and low (L)
- Agent H earns 25% more than agent L and are 33% less sensitive to rental prices
- There are two locations (L1 and L2), with L1's exogenous characteristics being more desirable for both agents
- Agent H prefers amenity H four times as much as amenity L

Heterogeneous Preferences

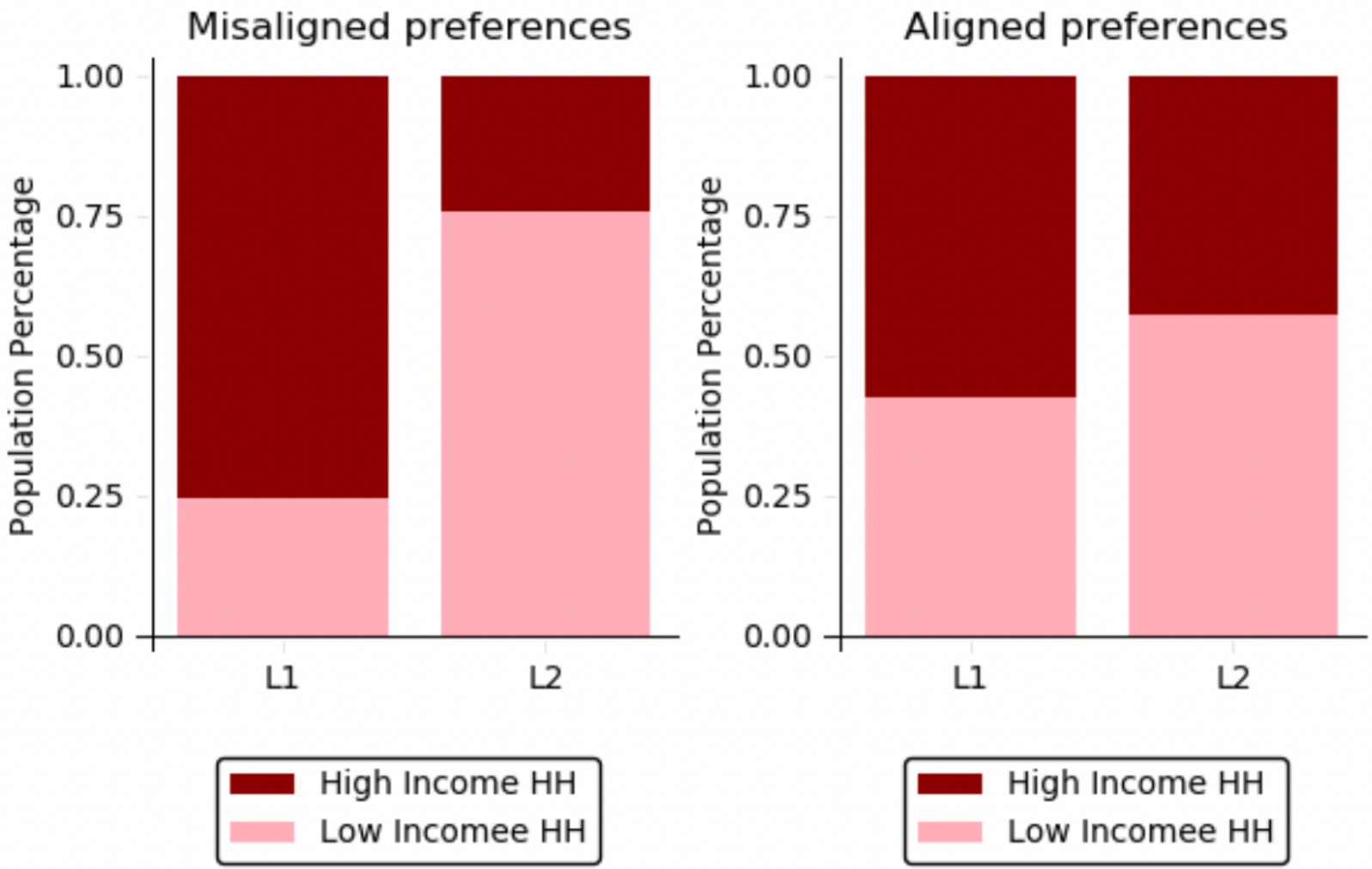


Figure 16: Population composition

Heterogeneous Preferences

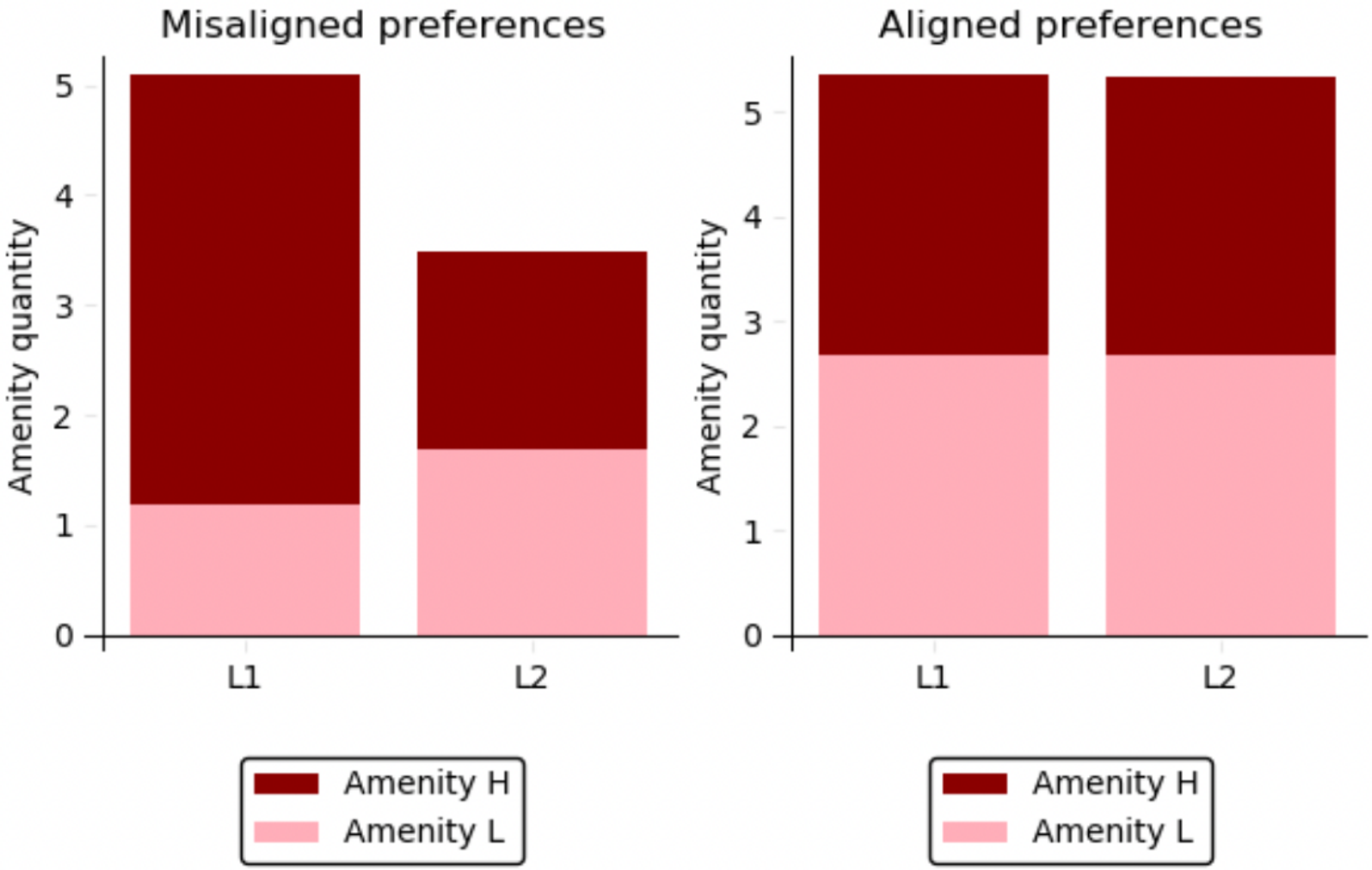


Figure 17: Amenities

Heterogeneous Preferences

- Previous work, such as Diamond (2016) finds that when amenities are endogenous the welfare gap between high and low skill agents increases
- This paper shows that depends on the heterogeneity or homogeneity of preferences across types of agent
- If preferences are sufficiently misaligned, then endogenous amenities will decrease the welfare gap due to the interaction with location sorting

Reducing Hosting Costs

Objective: understand the welfare effects of the entry of AirBnB on households and landlords.

Setup:

- Model the entry of AirBnB as a reduction in the costs of matching hosts with tourists
- Compare the case where amenities are allowed to adjust with the case when amenities fixed

Reducing Hosting Costs

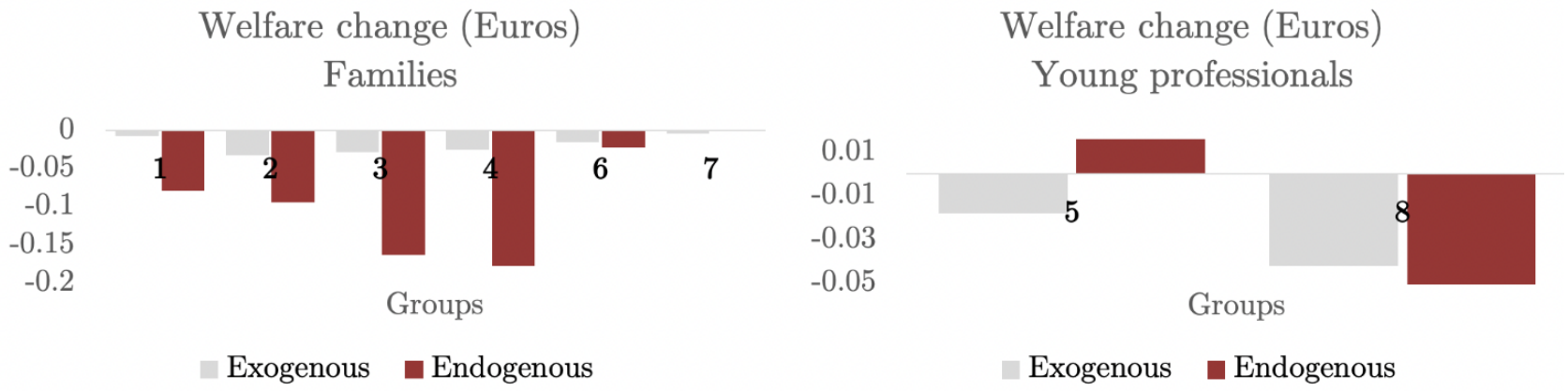


Figure 18: Welfare (Consumption Equivalent in Euros) changes of short-term rental entry

- With no adjustment of amenities, all households are worse off due to reduction of the housing supply
- With endogenous amenities, households with similar tastes to locals will benefit

Appendix

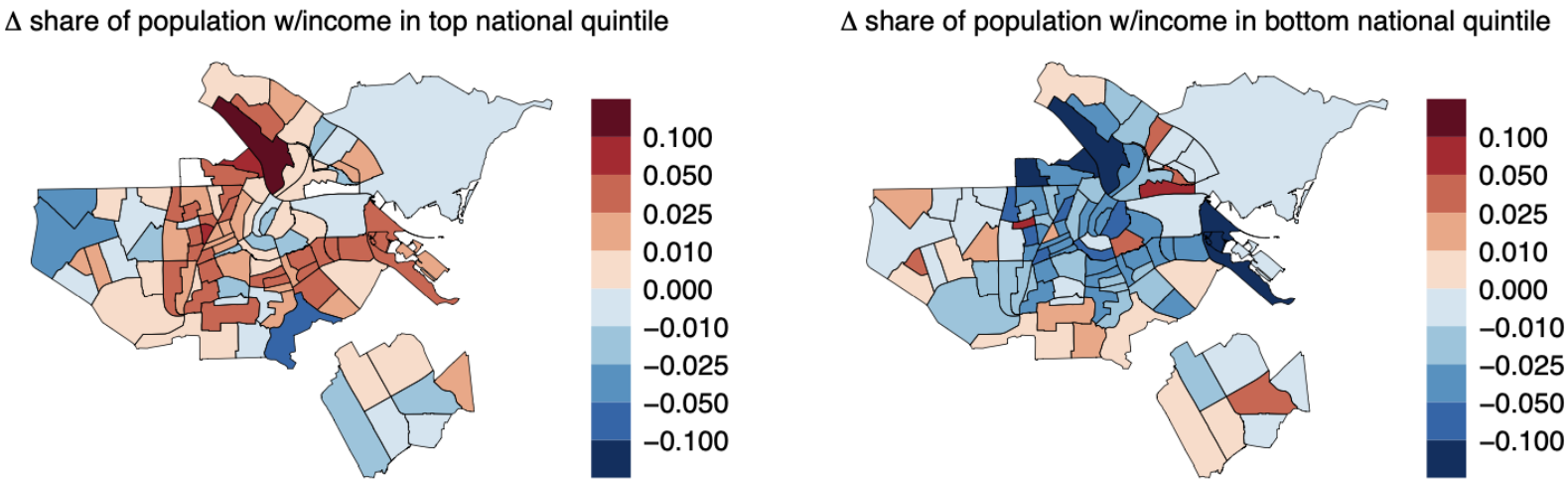


Figure 5: Changes in income composition of neighborhoods (2011-2017).

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Appendix

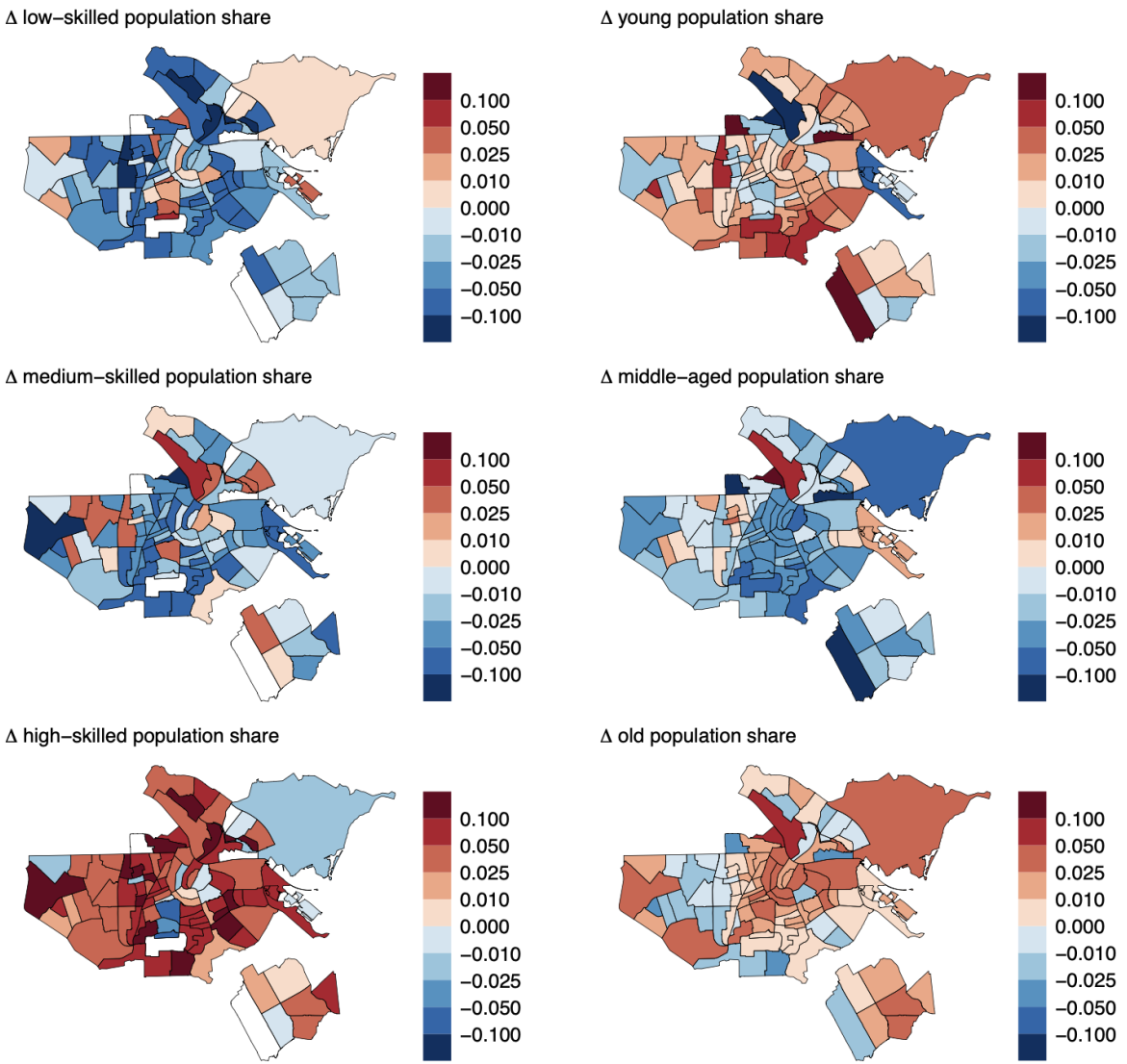

Figure 6: Changes in skill and age composition (2011-2017). Age groups are 15-34, 35-64, and 65+. Skill groups are divided into less than high school, complete high school, and complete college.

Appendix

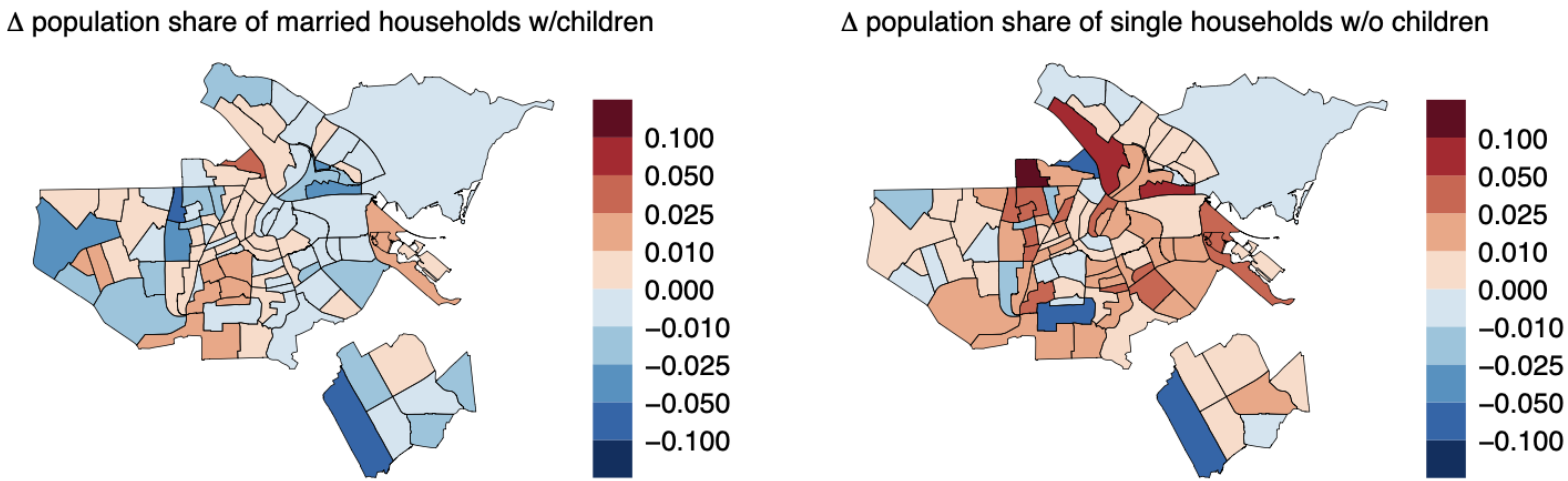

Figure 7: Changes in household composition of neighborhoods (2011-2017).

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Appendix

Table 4: Dep. var.: Log likelihood ratio of action paths for eight household groups

	Home owners				Renters			
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Adjusted Income	4.325***	3.511***	1.234***	−9.301***	1.564***	7.185***	4.834***	4.874***
Education est.	0.176***	0.708***	0.668***	1.164***	−0.561***	0.781***	1.209***	−0.098***
Sport Est.	−0.023	0.645***	0.238***	1.000***	0.319***	0.286***	0.380***	0.124***
Hotel	0.181***	−0.737***	0.285***	0.137***	0.314***	0.158***	0.554***	0.211***
Restaurant	0.179***	−0.240***	0.398***	0.109***	0.036	−0.387***	1.538***	0.864***
Bars	−0.140***	−0.168***	−0.203***	−0.089***	0.160***	0.381***	0.068**	0.097***
Cafes	0.237***	−0.044**	0.014*	0.409***	0.171***	−0.170***	−1.057***	−0.023
Touristic services	0.617***	−2.104***	−0.005	0.343***	0.236***	0.389***	−1.136***	0.070***
Food stores	−0.115***	−2.135***	0.094***	−1.14***	0.148***	0.910***	0.580***	0.453***
Retail	−0.292***	−1.86***	−0.047***	−0.502***	−0.903***	0.036	0.912***	−0.949***
Pop. Density	−1.88***	13.846***	−2.624***	−1.337***	1.819***	−2.855***	1.887***	−1.891***
Congestion Hotels	−0.007**	0.034***	0.036***	0.112***	−0.050***	−0.002	0.035***	−0.047***
Congestion Airbnb	−0.147***	−0.077***	0.100***	0.134***	−0.046***	−0.196***	−0.185***	0.005
Share social housing	0.163***	0.776***	0.228***	−0.323***	0.058***	−0.224***	−0.145***	0.024***
$MC_{0,O}$	−1.164***	−2.123***	−2.081***	−2.937***	−4.430***	−3.781***	−2.527***	−1.845***
$MC_{0,I}$	−1.912***	−1.648***	−2.564***	−3.228***	−3.370***	−3.243***	−2.303***	−2.765***
$MC_{1,dist}$	−0.093***	−0.183***	−0.135***	−0.185***	−0.288***	−0.135***	−0.142***	−0.075***
Dummy τ_2	2.380***	1.216***	2.053***	1.118***	0.454***	0.700***	0.966***	1.610***
Dummy τ_3	2.374***	1.183***	1.517***	0.672***	0.711***	0.860***	0.902***	1.337***
Location FE	✓	✓	✓	✓	✓	✓	✓	✓
R^2 1st-stage	0.041	0.091	0.037	0.078	0.054	0.081	0.055	0.063
Note:								*p<0.1; **p<0.05; ***p<0.01

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