Household Sorting, Moving Costs, and Environmental Justice:

Do Low-income Households Flee the Nuisance under Lower Moving Costs?

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Moving costs

- Any friction associated with moving
  - Out-of-pocket costs
  - Psychological costs
- In literature
  - Free mobility assumed in traditional henonic models (Rosen, 1974)
  - Non-market valuation (Bayer et al., 2009)
    - Underestimating MWTP for a non-market good when ignored
  - Housing (Quigley, 2002) and labor market (Kennan and Walker, 2011)

Motivation

Some types of households move less than others.

Household types		Moving rates	
$w \leq \$15,600$	(IncG1)	0.391	0.280
$\$15,600 < w \leq \$30,000$	(IncG2)	0.397	0.328
$\$30,000 < w \leq \$48,000$	(IncG3)	0.414	0.341
$\$48,000 < w$	(IncG4)	0.488	0.402
overall		0.414	0.329
Children		No	Yes

Source: IPUMS US Census 2000

Full

Research Question #1

Do low-income households bear higher moving costs?

- Residential sorting model built upon Bayer et al. (2009)
  - Discrete choice framework
- Allow heterogeneity in moving costs and other parameters
  - 8 different household types (4 income groups $\times$ children)

Link to Environmental Justice

- Environmental Justice (EJ) correlation
- Coming to the nuisance (Been, 1994; Been and Gupta, 1997)
  - Changes in local demographic/income (Banzhaf and Walsh, 2008)
  - Lower MWTP for clean environments (Depro et al., 2015)

Research Question #2

Does reducing moving costs of low-income households make them flee the nuisance?

- Moving costs in EJ
  - Allows to address EJ correlation by a direct policy instrument
  - With less degree of environmental gentrification
  - EJ at national scale: where moving costs are relevant
- Simulation model
  - Import parameter estimates from sorting model
  - Benchmark: predict residential location choice
  - Counterfactual: modify migration costs and predict again

Data

- IPUMS US Census 2000 (5% sample)
  - Socio-economic variables: wages, demographic information, etc.
- Center for Disease Control and Prevention (CDC)
  - county-level $PM_{2.5}$ concentrations (monitor + modeled)
  - aggregated to MSA-level

Descriptive Statistics

Random Utility Model

1. Log-transformed indirect utility:

$$\ln v_{ik} = u_{ik} = \alpha_l \ln \hat{w}_{ik} - \ln \delta_{ik} + \ln \theta_{i(l)k} + \epsilon_{ik}$$

where $\ln \theta_{i(l)k} = -\beta_l \ln p_k + \gamma_l \ln PM_k + \eta_l \ln X_k$

2. Modeling migration costs

$$\begin{aligned}\ln \delta_{ik} =& \mu_l^S d_{ik}^S + \mu_l^{R1} d_{ik}^{R1} + \mu_l^{R2} d_{ik}^{R2} \\ &+ \mathbb{I}[\text{kid} = 1] \times (\mu_l^{S,kid} d_{ik}^S + \mu_l^{R1,kid} d_{ik}^{R1} + \mu_l^{R2,kid} d_{ik}^{R2})\end{aligned}$$

Heterogeneity: Four income groups (l) by the presence of children — 4×2

3. Assuming type-I extreme value distribution on ϵ_{ik}:

$$\pi_{ik} = Prob(u_{ik} > u_{ij},\ j \neq k) = \frac{\exp(u_{ik})}{\sum_j \exp(u_{ij})}$$

Results: Moving Costs

$$u_{ik} = \alpha_l \ln \hat{w}_{ik} - \ln \delta_{ik} + \ln \theta_{i(l)k} + \epsilon_{ik}$$

	IncG1 $w \leq \$15,600$	IncG4 $\$48,000 < w$
Households *without* children		
State	-2.822	-2.223
Census region	-3.765	-3.207
Macro region	-4.264	-3.803
Households *with* children		
State	-3.113	-2.385
Census region	-3.925	-3.486
Macro region	-4.380	-3.979

Simulation Model

$$\hat{\pi}_{ik}^{\text{bmk}} = \frac{\exp(\hat{\alpha}\ln\hat{w}_{ik} - \ln\hat{\delta}_{ik}^{\text{bmk}} + \ln\hat{\theta}_k)}{\sum_j \exp(\hat{\alpha}\ln\hat{w}_{ij} - \ln\hat{\delta}_{ij}^{\text{bmk}} + \ln\hat{\theta}_j)}$$

$$\hat{\pi}_{ik}^{\text{cf}} = \frac{\exp(\hat{\alpha}\ln\hat{w}_{ik} - \ln\hat{\delta}_{ik}^{\text{cf}} + \ln\hat{\theta}_k)}{\sum_j \exp(\hat{\alpha}\ln\hat{w}_{ij} - \ln\hat{\delta}_{ij}^{\text{cf}} + \ln\hat{\theta}_j)}$$

1. For randomly drawn 10,000 low income households with children (treatment group)
2. Run simulation 1,000 times based on $\hat{\pi}_{ik}^{\text{bmk}}$ and $\hat{\pi}_{ik}^{\text{cf}}$
3. Compare mean $PM_{2.5}$ levels over 1,000 chosen locations in bmk to mean $PM_{2.5}$ in cf

Counterfactual Scenarios

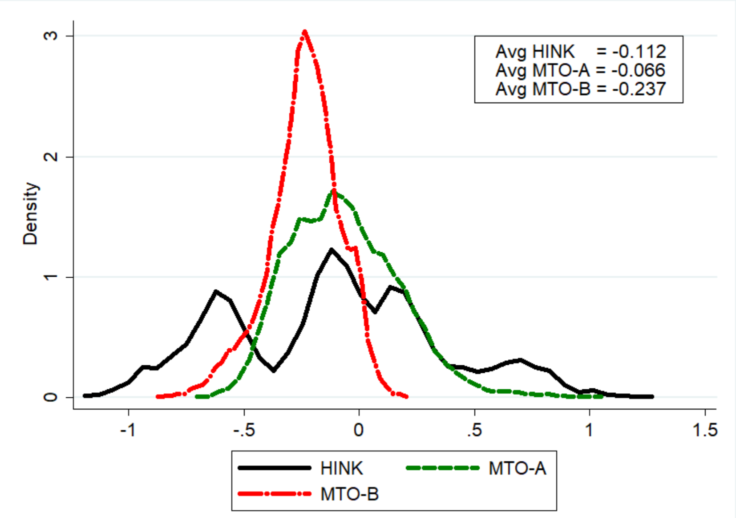
1. Counterfactual #1 (HINK)
   - Assign moving costs of Highest Income No Kids to treatment group
2. Counterfactual #2 (MTO-A)
   - Subsidize median annual rental payments ($ 5,880) if treatment group moves
3. Counterfactual #3 (MTO-B)
   - Same as CF #2, but subsidy is paid only when they move to MSAs that meet EPA's $PM_{2.5}$ standard ($12 \mu g/m^3$)

Rates of Moving

- What are the expected per-household costs of each counterfactual policy?
- Are the counterfactual moving costs low enough to encourage people to move?

	Per-hh Cost	State	Census Region	Macro Region
Benchmark	N/A	0.616	0.483	0.378
Counterfactual: HINK	$14,507	0.717	0.569	0.444
Counterfactual: MTO-A	$3,913	0.666	0.540	0.427
Counterfactual: MTO-B	$3,742	0.636	0.508	0.400

Results: $PM_{2.5}^{cf}$ - $PM_{2.5}^{bmk}$



Differences in PM2.5 Levels

	HINK	MTO-A	MTO-B
Households that reject $H_0 : \mathrm{PM}^{\mathrm{cf}}_{2.5} \geq \mathrm{PM}^{\mathrm{bmk}}_{2.5}$ (%)			
1% significance level	35.97	16.39	45.85
5% significance level	42.43	29.22	61.93
Households that reject $H_0 : \mathrm{PM}^{\mathrm{cf}}_{2.5} \leq \mathrm{PM}^{\mathrm{bmk}}_{2.5}$ (%)			
1% significance level	19.26	9.78	0.00
5% significance level	25.15	16.07	0.08

Counterfactual Scenarios

Welfare Analysis

1. Health benefits

$$\begin{aligned}\text{Lives saved} &= \text{Exposed population} \\ &\quad \times (\text{Baseline death rate} - \Delta \text{PM}_{2.5} \times \text{ER}) \\ \text{Marginal benefits} &= \text{Lives saved} \times \text{VSL}\end{aligned}$$

2. Changes in consumer surplus (Small and Rosen, 1981)

$$\Delta E(CS) = \frac{1}{\alpha}\left[\max_k(u_{ik}^{\text{cf}}) - \max_k(u_{ik}^{\text{bmk}})\right]$$

▸ Detail

Welfare Analysis: Results

Household level avg. (2000 $)	HINK	MTO-A	MTO-B
Health benefits	19,300	11,400	41,000
$\Delta E(CS)$	2,200	800	300
Costs	14,500	3,900	3,700

Avg size of treated household $=$ 4.43

Differences in Housing Prices

	HINK	MTO-A	MTO-B
Significant increase in housing prices (%)			
1% significance level	38.29	23.58	3.35
5% significance level	43.02	32.05	11.38
Significant decrease in housing prices (%)			
1% significance level	26.38	7.53	0.40
5% significance level	31.58	20.76	1.98

Histograms Descriptive Statistics Correlation Coefficients Results: Other Amenities

Conclusion

- Conclusion
  - Low income households with children face higher moving costs
  - Policy interventions to reduce moving costs can address environmental injustice
- Path forward
  - Sources of heterogeneity in moving costs
  - Attribute-based moving costs (Krupka, 2009)
  - MAC of PM2.5

Questions?

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Descriptive Statistics

Variables	Age ≤ 35	All ages
Census		
MSA (%)	76	73
Education (%)		
HS dropout	10	15
HS graduate	24	26
Some college	35	30
College graduate	31	28
White (%)	76	82
Male (%)	63	60
Children (%)	46	41
Income (2000 USD)		
p25	15,000	15,600
p50	26,000	30,000
p75	39,400	48,000
PM2.5 ($\mu g/m^3$)		
mean	11.29	
sd	2.64	

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Variables	Migration outside of birth: State	Census region	Macro region	n
Households *without* Children				
$w_i \leq 15,600$	0.39	0.30	0.23	110,446
$15,600 < w_i \leq 30,000$	0.40	0.31	0.24	102,585
$30,000 < w_i \leq 48,000$	0.41	0.31	0.25	101,258
$48,000 < w_i$	0.49	0.38	0.30	60,983
Overall	0.41	0.32	0.25	375,272
Households *with* Children				
$w_i \leq 15,600$	0.28	0.21	0.16	108,802
$15,600 < w_i \leq 30,000$	0.33	0.25	0.19	90,649
$30,000 < w_i \leq 48,000$	0.34	0.26	0.20	85,332
$48,000 < w_i$	0.40	0.30	0.23	59,538
Overall	0.33	0.25	0.19	344,321

▸ Move Rates

Wage Prediction

$$\ln w_{ik} = \psi_{0k} + \psi_{1k} WHITE_i + \psi_{2k} MALE_i + \sum_{m=1}^{4} \phi_{mk} EDU_{mi} + \sum_{n=1}^{23} \xi_{nk} OCCUP_{ni} + \lambda_{1k} P(R_B, R_D|EDU) + \lambda_{2k} P(R_B, R_D|EDU)^2 + \epsilon_{ik}^{WAGE}$$

1. Education
   - High school dropout, high school graduate, some college and college degree
2. Occupation
   - 23 occupations
   - Military and extraction are eliminated
3. Non-random sorting (Dahl, 2002)
   - $P(R_B, R_D|EDU) = \sum_m EDU_m P(R_B, R_D|EDU_m)$

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Region FE: Estimates

	(1)	(2)	(3)	(4)
Top 5 cities				
1st	Washington, DC/MD/VA	Washington, DC/MD/VA	Chicago, IL	Chicago, IL
2nd	Chicago, IL	Chicago, IL	Phoenix, AZ	Washington, DC/MD/VA
3rd	Atlanta, GA	Atlanta, GA	Washington, DC/MD/VA	New York, NY/NJ
4th	Phoenix, AZ	Phoenix, AZ	Dallas-Fort Worth, TX	LA-Long Beach, CA
5th	LA-Long Beach, CA	LA-Long Beach, CA	LA-Long Beach, CA	Atlanta, GA
Bottom 5 cities				
261st	Gadsden, AL	Gadsden, AL	Janesville-Beloit, WI	Gadsden, AL
262nd	Decatur, IL	Decatur, IL	Kankakee, IL	Davenport, IA - Rock Island-Moline, IL
263rd	Alexandria, LA	Alexandria, LA	Wausau, WI	Sharon, PA
264th	Vineland-Milville -Bridgetown, NJ	Vineland-Milville -Bridgetown, NJ	Houma-Thibodoux, LA	Joplin, MO
265th	Kankakee, IL	Kankakee, IL	Barnstable-Yarmouth, MA	Rochester, MN
Heterogeneity	δ	δ, α	δ, α, θ	
Perceived by	All households		$w \leq \$15,600$	$\$48,000 < w$

Region FE: Heterogeneity

	(1) MSA	(2) Ranking	(3) Ranking	(4) Ranking	(5) Ranking
Top 5 cities (most agreement)					
1st	Houston-Brazoria, TX	10	10	10	11
2nd	Los Angeles -Long Beach, CA	5	5	5	4
3rd	Chicago, IL	2	2	1	1
4th	Denver-Boulder, CO	8	8	7	9
5th	Kansas City, MO/KS	28	28	29	30
Bottom 5 cities (least agreement)					
261st	Athens, GA	133	132	102	247
262nd	Davenport, IA - Rock Island-Moline, IL	143	141	118	262
263rd	Columbia, MO	175	175	87	251
264th	Monmouth-Ocean, NJ	112	112	216	52
265th	Portland, ME	122	122	250	85
Perceived by		$w \leq Q1$	$Q1 < w \leq Q2$	$Q2 < w \leq Q3$	$Q3 < w$

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Marginal Health Benefits: In Detail

$$\begin{aligned}\text{Lives saved} =& \text{Exposed population} \\ & \times (\text{Baseline death rate} - \Delta PM_{2.5} \times \text{ER}) \\ \text{Marginal benefits} =& \text{Lives saved} \times \text{VSL}\end{aligned}$$

- Exposed population = 15.6 million
- Baseline death rate (Pope III et al., 2015) = 0.0075
- Excess risk for mortality (Pope III et al., 2015) = 0.0063
  - Relative risk for all-cause mortality (Pope III et al., 2002) = 1.06 (1.02–1.10)
- VSL = 6.5 million in 2000

Welfare Analysis

Top and Bottom 5 cities

- 5 cities with lowest PM2.5 levels
  - Hinsdale, CO (6); Mineral, CO (6.1); San Juan, CO (6.1); Catron, NM (6.2); Ouray, CO (6.3)
- 5 cities with highest PM2.5 levels
  - Riverside, CA (30.3); San Bernardino, CA (27.6); LA, CA (26.9); Allegheny, PA (23.3); Orange, CA (22)

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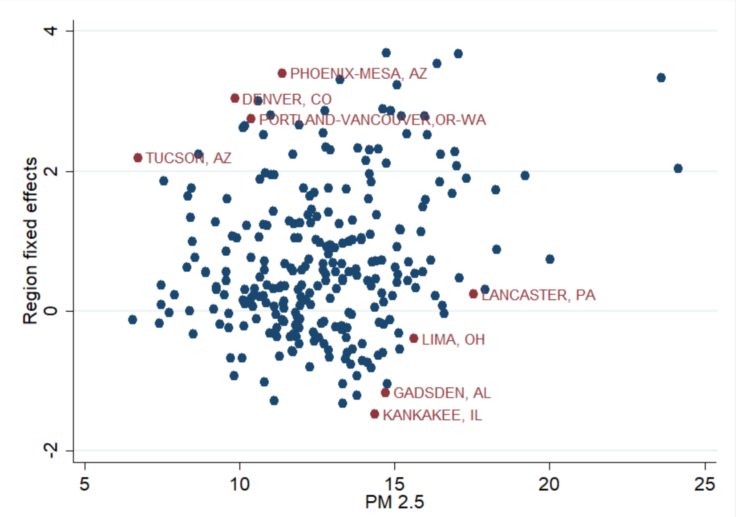
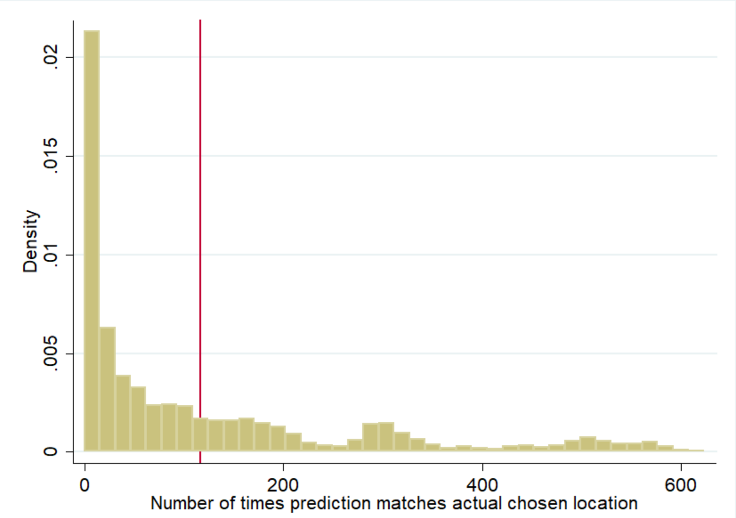
θ and PM2.5



Goodness of Fit



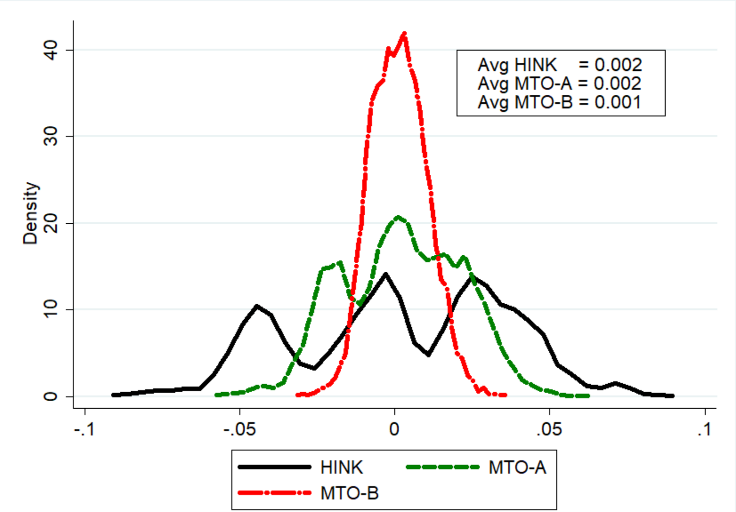
Changes in Other Amenity Values

Relocation decision is multifaceted (Kling et al., 2007; Ludwig et al., 2013; Davis et al., 2017)

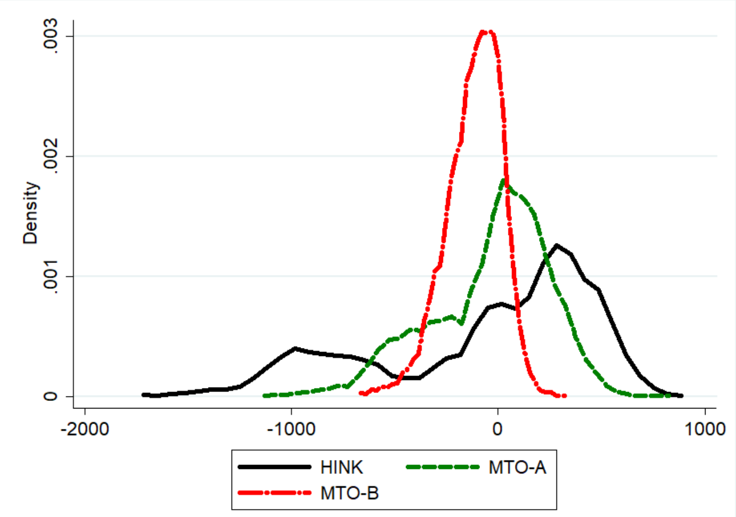
- MTO achieved:
  - exposure to crime & poverty
  - mental health of female children
- but at the same time, MTO failed to improve:
  - child ability
  - educational attainment
  - physical health

Does treatment group experience improvements in amenity values other than $PM_{2.5}$?

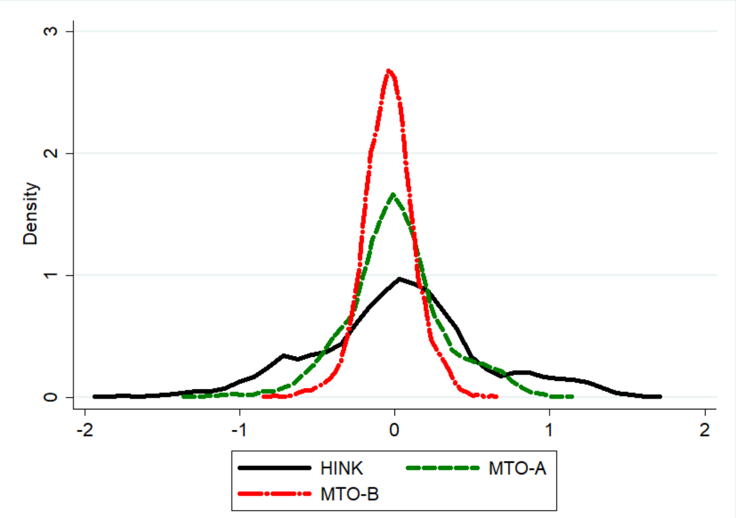
Housing Prices



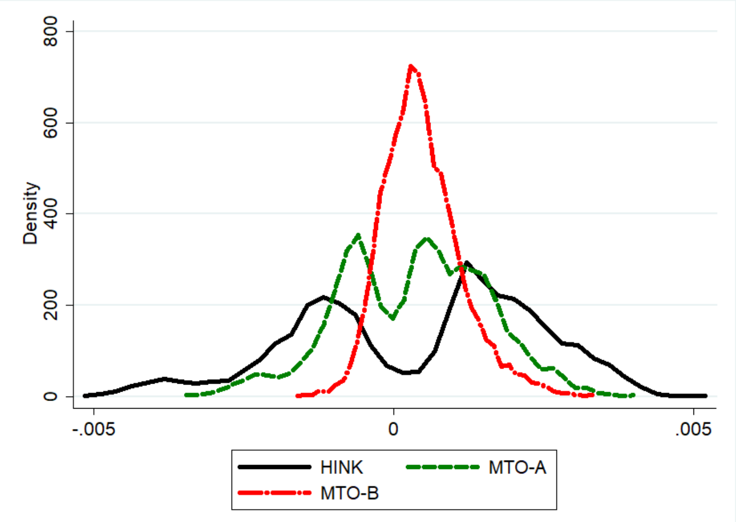
manufacturing establishment



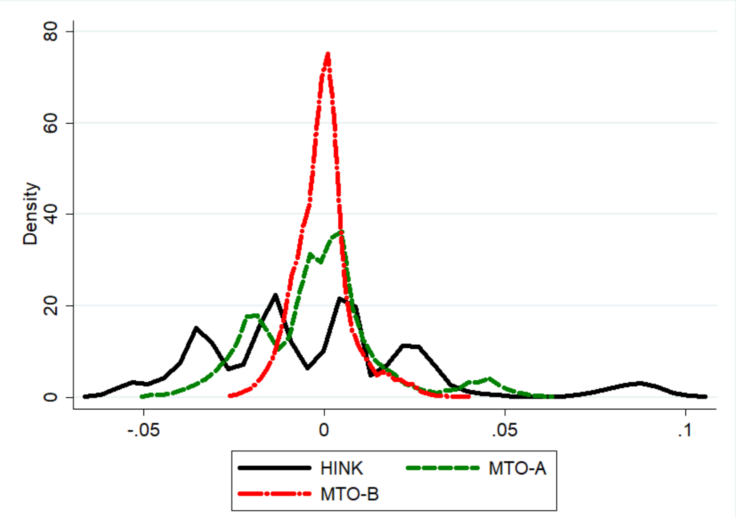
Per-capita income



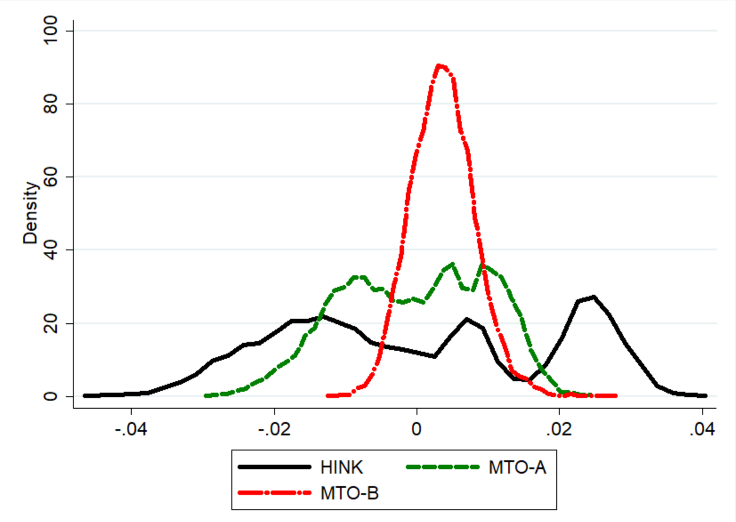
Per-capita crime rate



Property tax rates



Proportion of population that is white



Differences in Other Amenity Levels

		HINK	MTO-A	MTO-B
Housing prices	+	38.29	23.58	3.35
	-	26.38	7.53	0.40
Manufacturing establishment	+	30.16	11.88	0.01
	-	19.30	5.50	2.27
Property tax rates	+	29.97	16.60	3.62
	-	45.14	28.04	4.00
Per-capita income	+	19.20	9.31	0.29
	-	15.97	4.74	0.96
Per-capita crime	+	47.89	28.63	14.14
	-	28.10	12.10	0.13
Proportion of White	+	35.52	12.20	5.77
	-	34.35	19.38	0.06

Notes: Results are reported based on 1% significance levels.

Housing Prices

Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max
Manufacturing establishment	991.279	1914.301	66.000	17915.000
Property tax rates	0.743	0.159	0.268	0.993
Per-capita income	25.300	4.745	11.064	45.229
Per-capita crime	0.042	0.015	0.000	0.086
Proportion that is White	0.791	0.115	0.469	0.976

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Correlation Coefficients

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
(A) $PM_{2.5}$	1.000						
(B) Housing prices	-0.032	1.000					
(C) Manuf. est.	0.372	0.460	1.000				
(D) Prop. tax	-0.058	0.207	0.073	1.000			
(E) Per-capita income	0.059	0.661	0.421	0.251	1.000		
(F) Per-capita crime	-0.239	-0.037	-0.049	-0.281	-0.125	1.000	
(G) White	-0.170	-0.247	-0.257	0.312	0.013	-0.462	1.000

Go back

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