Where to Build Affordable Housing?

Evaluating the Tradeoffs of Location

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August 19th, 2025

Affordable housing in the US

Governments often provide **affordable housing (AH)** to low-income households

- 6 million units in the US. About 15% of the rental stock (Schwartz, 2021)
- Demand outstrips supply, so units are rationed

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Q: What are the tradeoffs of providing AH in different types of neighborhoods?

This paper

Setting: Low-Income Housing Tax Credit (LIHTC)

- Largest and fastest-growing AH program (∼3 million units)
- Built and managed by *private* developers

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Data: Administrative records linked both LIHTC and market-rate units

- Annual tax returns, residential addresses, and demographics for universe of US households
  - Proxies for need: long-run income, education, household structure, childhood family income, …
  - Focus on renters in 50 largest MSAs, 2010-2018

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  - Proxies for need: long-run income, education, household structure, childhood family income, …
  - Focus on renters in 50 largest MSAs, 2010-2018
- Do **not** observe applications
  - Observe eligible pop. + allocations

This paper

Setting: Low-Income Housing Tax Credit (LIHTC)

Data: Administrative records linked both LIHTC and market-rate units

Descriptive evidence: Who lives in affordable housing?

1. Among those eligible, who lives in LIHTC *on average*? ($\rightsquigarrow$ targeting)
2. How does this vary *across neighborhoods*?

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Setting: Low-Income Housing Tax Credit (LIHTC)

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Descriptive evidence: Who lives in affordable housing?

Structural model: Residential choice with market-rate and (rationed) AH options

1. Separate role of preferences from rationing mechanism
2. Quantify value to households, distribution of assistance, segregation, …
3. Compare effects of location to other policy levers

▸ Related literature

1. Who lives in affordable housing?

2. Model & estimation

3. Tradeoffs of location

4. Conclusion

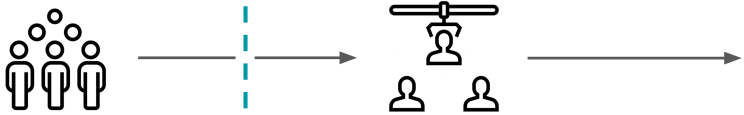
LIHTC: screening, allocation, and tenancy

Screening

Income limits (city-level)

Developer may also screen on credit score, past evictions, …

LIHTC: screening, allocation, and tenancy



Screening	Allocation
Income limits (city-level) Developer may also screen on credit score, past evictions, …	No mandated mechanism Commonly wait lists, lotteries, first-come-first-serve

LIHTC: screening, allocation, and tenancy

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Who lives in LIHTC developments?

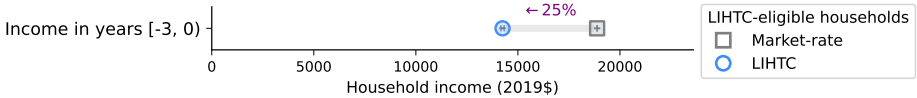
1) Among eligible, who receives a LIHTC unit on average?

   - Among LIHTC-eligible renters, regress

$$\text{Household characteristic} \sim \text{isLIHTC} + \text{MSA} \times \text{year}$$

2) How does it vary across neighborhoods?

Fact 1a: Households in LIHTC exhibit greater need



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▸ Income ▸ Demographics ▸ Prev. nbhd

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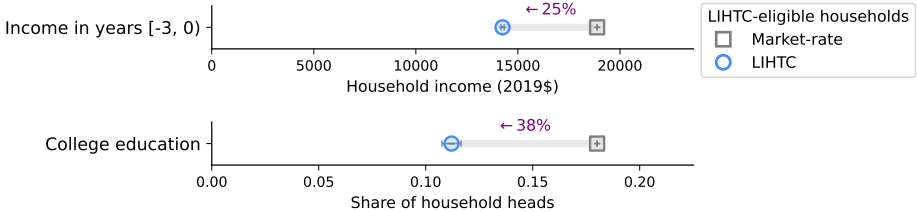

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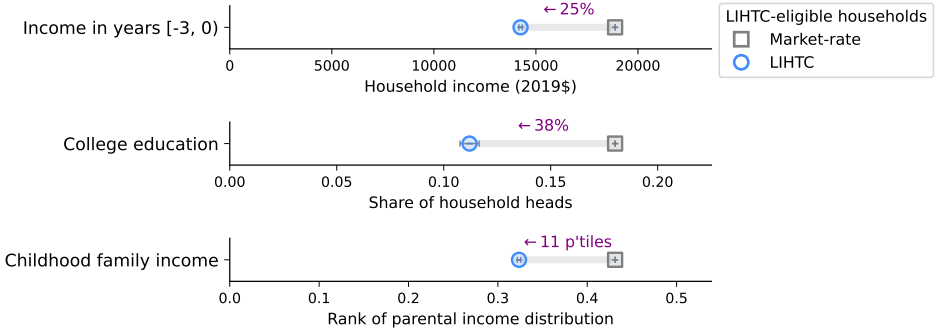

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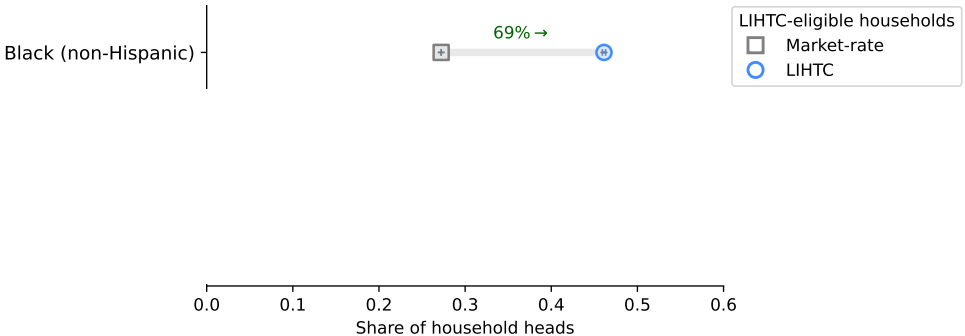
Fact 1b: LIHTC household heads more likely to be Black



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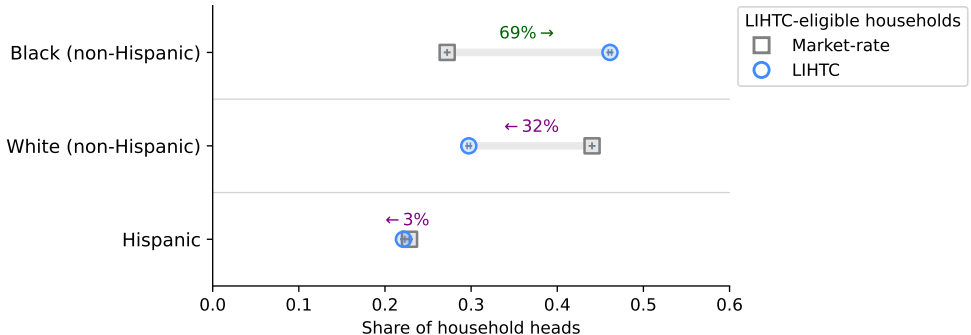

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Who lives in LIHTC developments?

1) Among eligible, who receives a LIHTC unit on average?

2) How does it vary across neighborhoods?

- Divide tracts by quartiles of neighborhood opportunity index
  - Combines measures of school quality, jobs access, transit access, poverty, and upward mobility
  - LIHTC rent and income limits are **fixed** within a city

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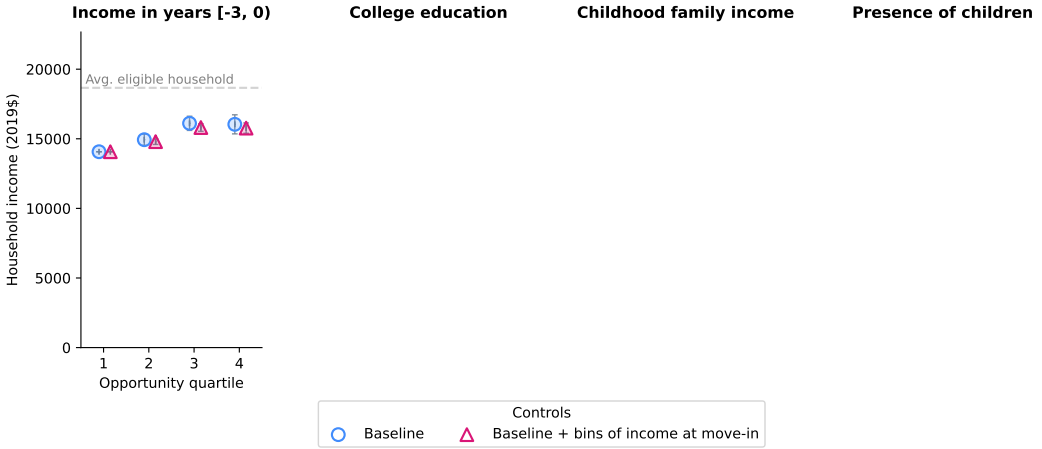
- Divide tracts by quartiles of neighborhood opportunity index
  - Combines measures of school quality, jobs access, transit access, poverty, and upward mobility
  - LIHTC rent and income limits are **fixed** within a city
- Within sample of LIHTC renters, regress

$$\text{Household characteristic} \sim \text{opportunityQuartile} + \text{MSA} \times \text{year}$$

Fact 2a: Households in high-opportunity nbhds exhibit lower need



Note: Each point is from a regression of a household characteristic on indicators for opportunity quartile. The baseline specification includes bedroom, income limit, and MSA × year fixed effects. Data include households at the time of move-in to LIHTC. Education and CFI are for the household head. Education is based on the ACS and only considered if the individual is surveyed within 3 years of move-in. 95% confidence intervals are represented by grey lines.

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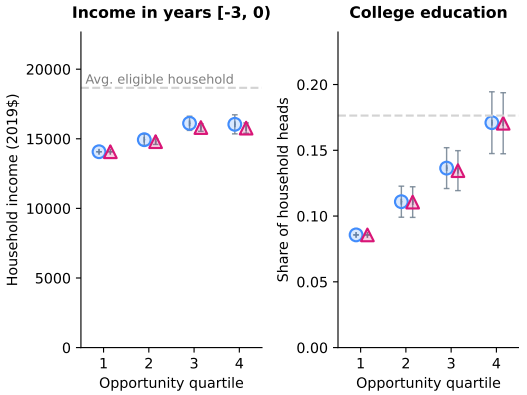

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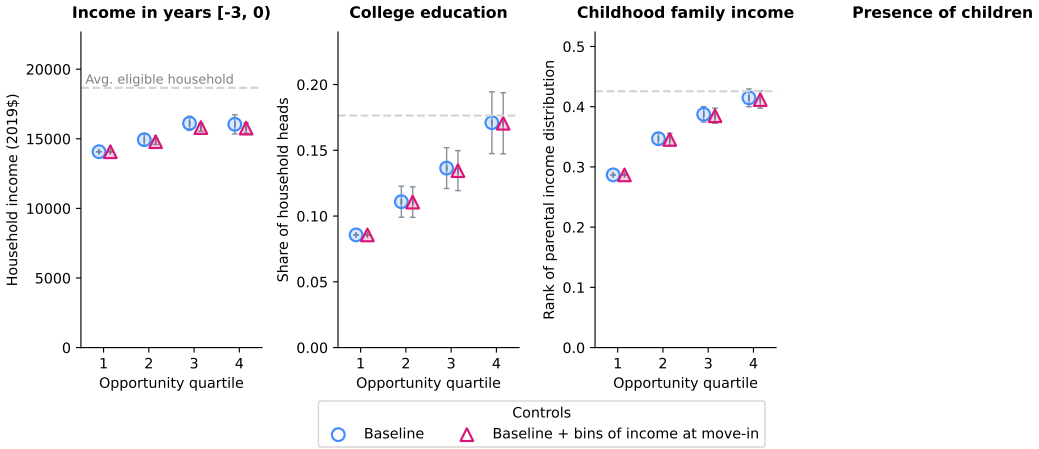

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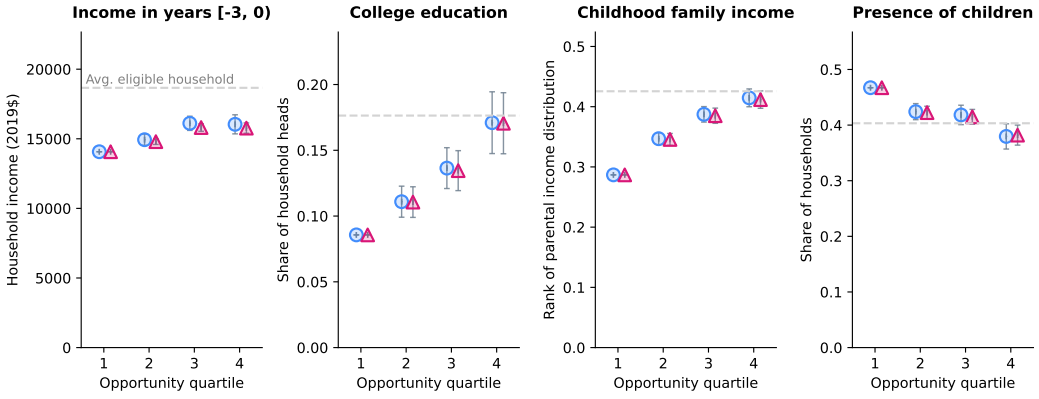

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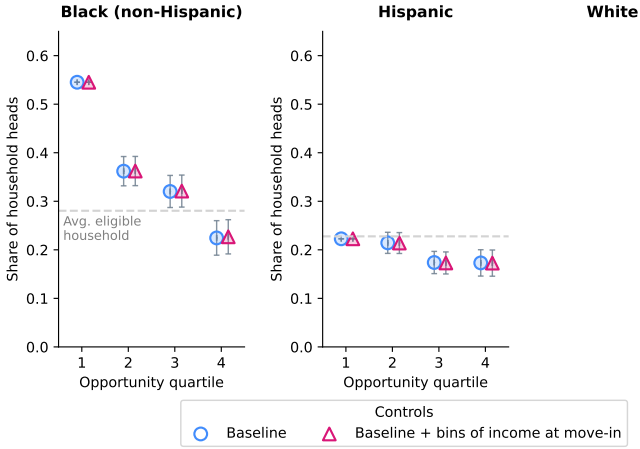
Fact 2b: Share Black/Hispanic decreasing in nbhd opportunity



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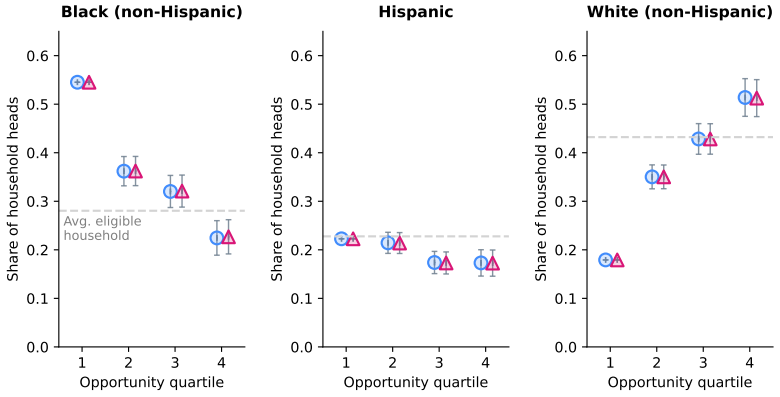

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Recap of descriptive evidence

1) Among eligible, who receives a LIHTC unit on average?

→ Disproportionately households with higher proxied-need and Black household heads

2) How does it vary across neighborhoods?

→ Proxied-need and likelihood Black/Hispanic-led decreasing in neighborhood opportunity

1. Who lives in affordable housing?

2. Model & estimation

3. Tradeoffs of location

4. Conclusion

Empirical market design with limited information

Applications
$\mathcal{A}$

Mechanism
$\mathcal{M} : \mathcal{A} \to \mathcal{H}$

Allocations
$\mathcal{H}$

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Residential choice model

Learn preferences from
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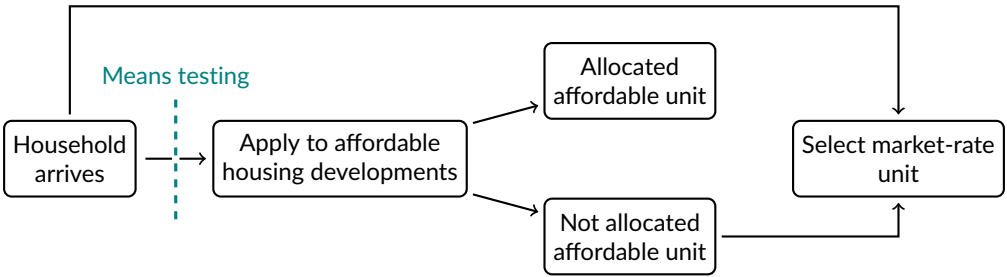
Residential choice model

Learn preferences from market-rate choices

Flexible approximation

Allow for developer discretion

Static residential choice with market-rate and AH options



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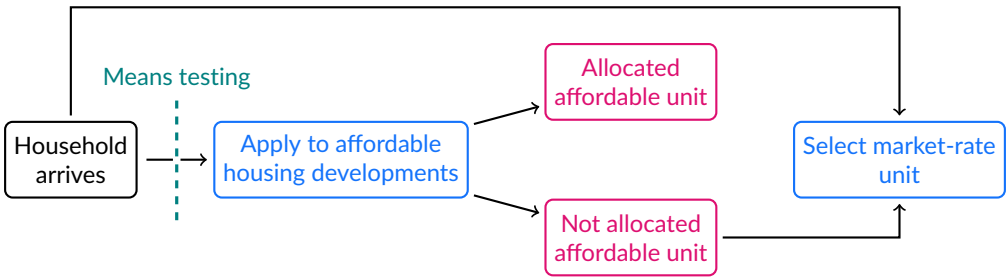

Key ingredients: household preferences & process for rationing units

Household preferences

Single city with options, $j \in \mathcal{J}^{\text{AH}} \cup \mathcal{J}^{\text{MR}}$, each with rents r_j and chars. $\mathbf{x}_j$

- Options are tuples of neighborhoods and housing types
- $\mathbf{x}_j$ include nbhd demographics & amenities, # of bedrooms, and building type

Household preferences

Single city with options, $j \in \mathcal{J}^{\text{AH}} \cup \mathcal{J}^{\text{MR}}$, each with rents r_j and chars. $\mathbf{x}_j$

Households endowed with characteristics $\mathbf{w}_i$ and current housing j_i^0

- $\mathbf{w}_i$ includes income bins, race/ethnicity, household size, family structure, …

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Household i utility for j is

$$u_{ij} = \underbrace{\gamma_i \mathbf{x}_j}_{\substack{\text{Housing \& nbhd} \\ \text{chars}}} + \underbrace{\beta_i r_j}_{\text{Rent}} + \underbrace{\xi_j}_{\substack{\text{Unobserved} \\ \text{quality}}} + \underbrace{\varepsilon_{ij}}_{\text{T1EV}}$$

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  - → Add utility specific to AH (e.g., hassle, stigma, unobserved quality)

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  - → Add utility specific to AH (e.g., hassle, stigma, unobserved quality)
  - → Add 'moving costs' to generate realistic moving rates
- Preferences vary by household observables: $\theta_i = \theta_0 + \sum_k \theta_k w_{ik}$ for $\theta_i \in \{\gamma_i, \beta_i, \alpha_i, \kappa_i\}$

Process for rationing units

1) Households apply to each development

Assumption 1 (applications). *Households can apply to each AH development without cost*

$\Longrightarrow$ Apply to $j \in \mathcal{J}^{\text{AH}}$ if better than endowed & market-rate options

Process for rationing units

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2) Developers allocate among applicants

Developers observe characteristics $\widetilde{\mathbf{w}}$ for each applicant

Assumption 2 (mechanism). *Applicant i receives an offer with probability $\pi_{ij} = \max\{\pi_j \phi_i, 1\}$ where π_j is the baseline offer probability for development j and $\phi_i = \sum_k \phi_k \widetilde{w}_{ik}$*

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3) Offer probabilities clear the market

In equilibrium, baseline offer probabilities π_j adjust to clear the market

$$\underbrace{s_j}_{\text{Supply}} = \sum_{i \in \mathcal{I}} \underbrace{P_{ij}^{\text{apply}} \times P_{ij}^{\text{offer}}(\pi_j) \times P_{ij}^{\text{accept}}}_{\text{Probability i is allocated j}}$$

Estimation overview

Details

Identification challenge: separating preferences for AH from role of mechanism

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Two step approach, estimated for Chicago MSA:

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Details

Identification challenge: separating preferences for AH from role of mechanism

Two step approach, estimated for Chicago MSA:

1) Estimate preferences for rent (β), housing/neighborhoods chars. (γ), and moving (κ)

   Data: market-rate choices from ACS

   Method: follows Bayer, Ferreira and McMillan (2007), with new instrument for rent

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2) Estimate preferences for AH (α) and lottery weights (ϕ)
   Data: ACS sample of LIHTC-eligible hhs. + Census-IRS panel of LIHTC hhs.
   Method: GMM to match moments based on move-ins and move-outs of AH

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   Data: ACS sample of LIHTC-eligible hhs. + Census-IRS panel of LIHTC hhs.
   Method: GMM to match moments based on move-ins and move-outs of AH

Intuition: Prefs. from step 1 inform who *would* move in/out, up to α and ϕ

- Preferences α affect move-ins and move-outs, developer weights ϕ affect just move-ins

Summary of key parameter estimates

1) Heterogeneity in preferences for housing/nbhd chars.

- Similar to existing estimates (Bayer, Ferreira and McMillan, 2007; Calder-Wang, 2021; Almagro, Chyn and Stuart, 2023)
  - E.g., Higher income $\rightarrow$ less sensitive to rents, more weight on amenities like school quality

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- Decreasing in household income ($\rightsquigarrow$ self-targeting)

3) Developers slightly favor higher income households (or those w/ voucher)

1. Who lives in affordable housing?

2. Model & estimation

3. Tradeoffs of location

4. Conclusion

Where to build affordable housing?

Main exercise: simulate adding additional AH units to housing stock

- Typical development: 100 units, avg. distribution of bedroom sizes ▸ LIHTC supply-side
- Vary in which neighborhood it is placed, holding fixed other options

Where to build affordable housing?

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- Vary in which neighborhood it is placed, holding fixed other options

For exposition, divide households into four types:

- **Need:** high- or moderate-need, based on predicted future income
  - Predict using observables at move-in ▸ Details
  - 'High-need' if in bottom quartile of renters, adjusted for size and age
- **Race/ethnicity:** Black/Hispanic or White/other

Social Welfare $=$

$$\text{Social Welfare} = \underbrace{\text{Value} - \text{Cost}}_{\text{Efficiency}}$$

$$\text{Social Welfare} = \underbrace{\sum_{i \in \mathcal{I}^R} \omega_i \text{Value}_i}_{\text{Distribution}} - \text{Cost}$$

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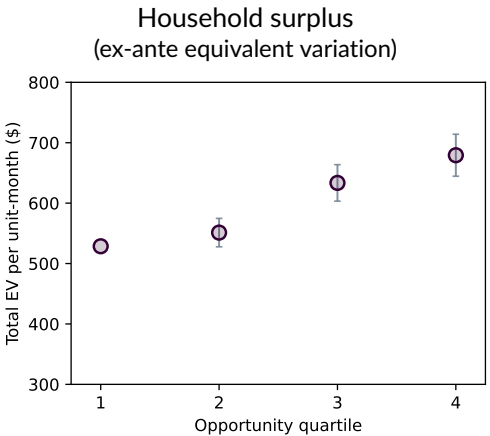
Household surplus & costs increase in neighborhood opportunity



Note: Surplus is computed as the per-unit equivalent variation in units of monthly rent for building the new development, summing across all eligible households. Costs are the difference between an estimate of the market-rate rent for the LIHTC units (estimated via a hedonic regression) and the subsidized rental rate. Gray bars represent 95% bootstrapped confidence intervals, which are for the difference from Q1 for household surplus.

▸ Market-rate prediction ▸ Other cost measures ▸ MVPF

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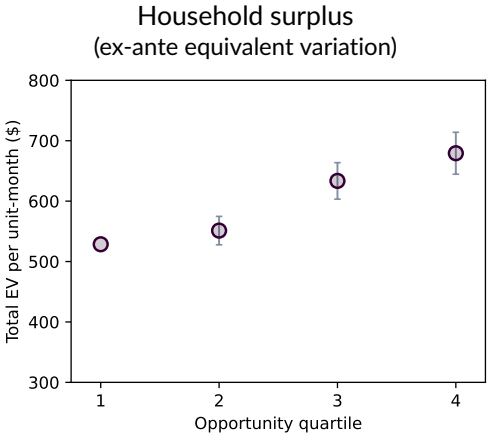

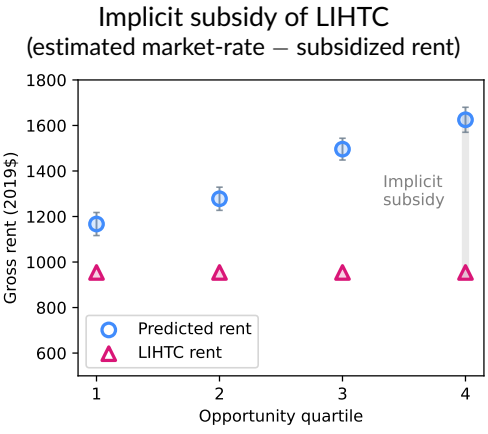

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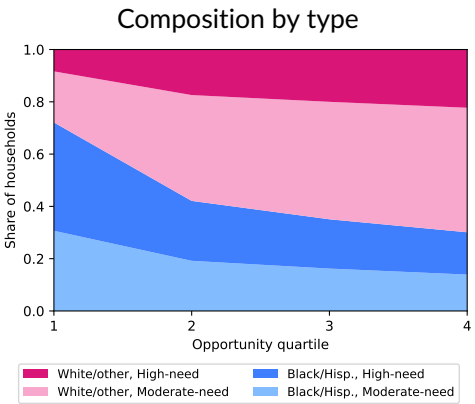
Who benefits from a new development?

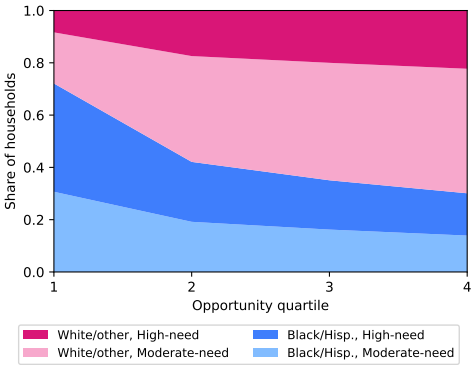


Note: Application (allocation) probabilities are for applying (being allocated) to any unit in the simulated development. Household surplus is computed as the equivalent variation in monthly rent based on differences in expected utilities pre/post-new development. 'High-need' refers to households whose predicted future income is in the bottom quartile of the nationwide distribution of renters, adjusted for household size and age. Gray bars represent 95% confidence intervals from bootstrapped standard errors.

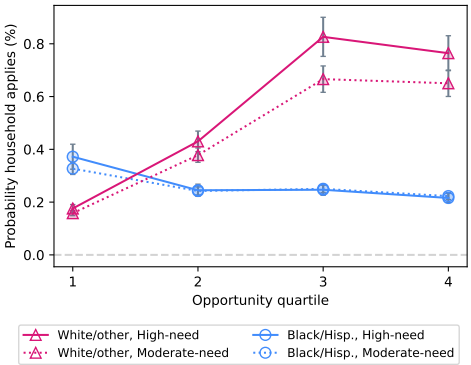
▸ Applications

Who benefits from a new development?

Composition by type



Probability *apply*



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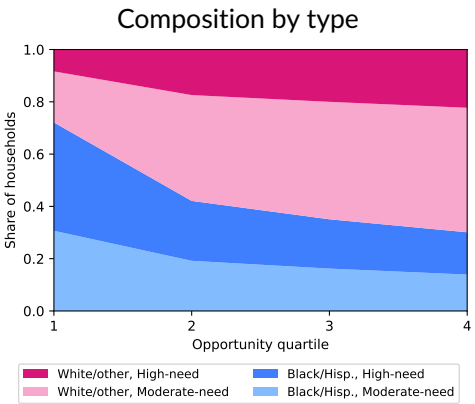

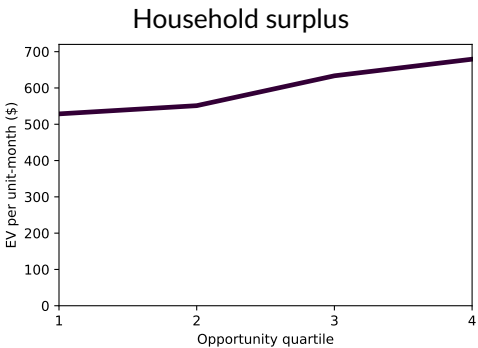

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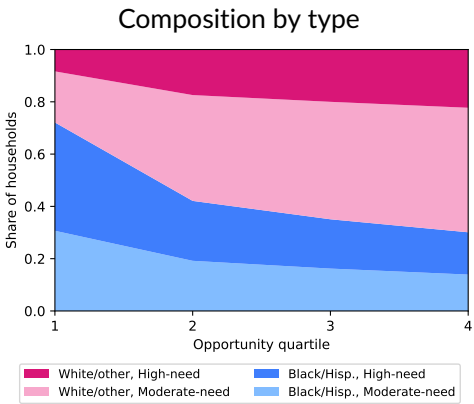

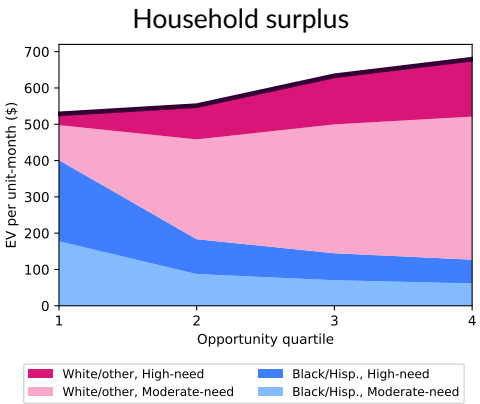

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Effects of location on segregation, children, and neighbors

Racial/ethnic and economic segregation

Details

- Building in higher-opportunity neighborhoods decreases segregation on the margin
- ... but effects dampened by changes in composition (especially for racial/ethnic)

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Long-run earnings of children in development

Details

- Chetty et al. (2022): Large causal effects of moving to 'high-opportunity' neighborhoods
- Approx. effect: +**$266 per unit-month** for Q1 vs. Q4 development (+$132,000 per child)

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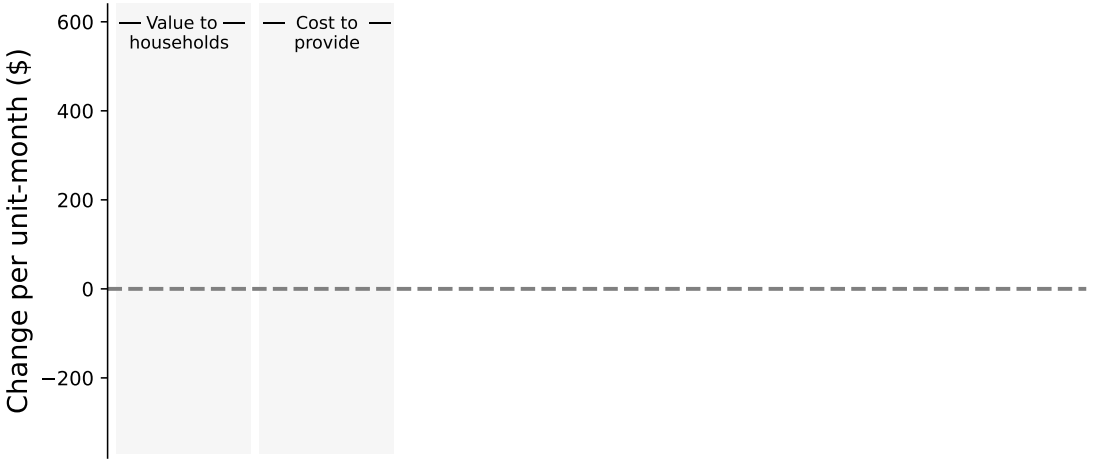
Spillovers on neighbors

Details

- Diamond and McQuade (2019): LIHTC has positive spillovers in low-income, high-minority neighborhoods and *negative* spillovers in high-income neighborhoods
- Approx. effect: $-$**$203 per unit-month** for Q1 vs. Q4 ($-$$46,000 per unit)

Effects of a new development in top vs. bottom quartile



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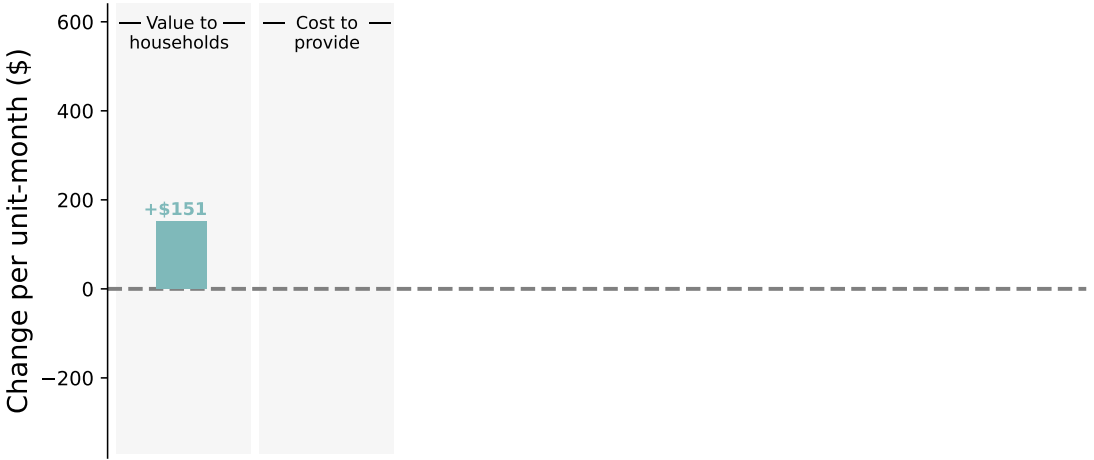
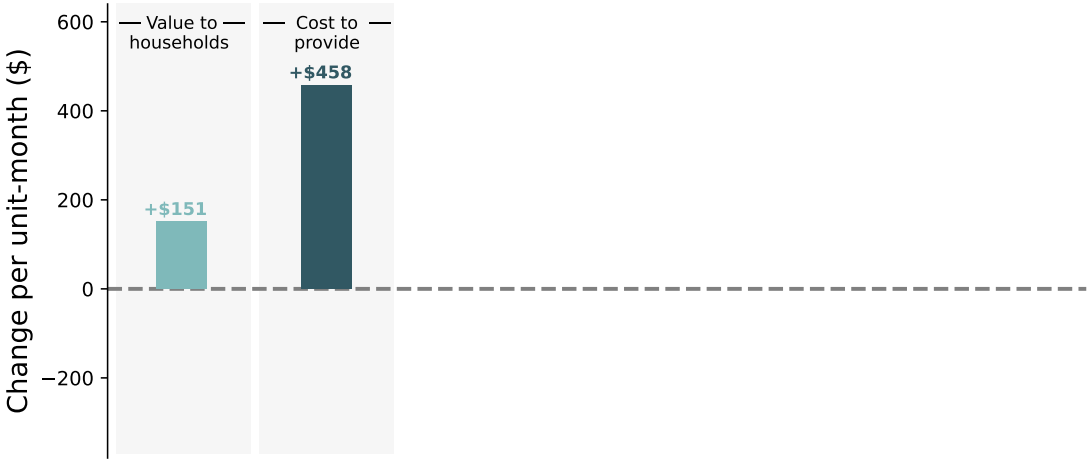
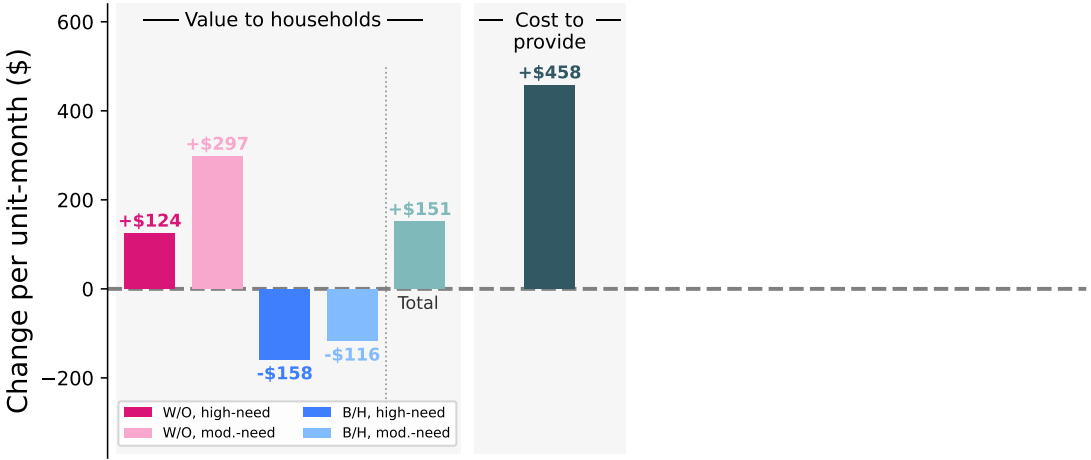


Effects of a new development in top vs. bottom quartile



Effects of a new development in top vs. bottom quartile



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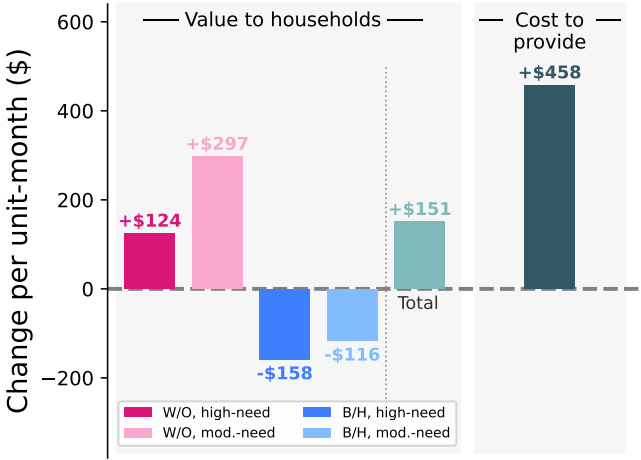

— Other policy goals —

(+) Racial/ethnic integration

(+) Economic integration

(+) Upward mobility of children
(Chetty et al., 2022)

(−) Spillovers on neighbors
(Diamond and McQuade, 2019)

1. Who lives in affordable housing?

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Conclusion

Location is a key element of many affordable housing programs

- Inclusionary zoning, HOPE VI redevelopments, LIHTC, …

Choice of location is implicitly a choice of tenants

- Building in higher-opportunity neighborhoods:

  Efficiency: household surplus ↑, but costs ↑↑

  Distribution: benefits accrue to more moderate-need and non-Black/Hispanic hhs.

  Externalities / other: reduces racial/ethnic and economic segregation

Post-construction policy changes have more limited effects ▸ Details

- E.g., lower income limits, fair lotteries, income-based rents, …

Thank you!

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Contributions to the literature

Back

Affordable housing & 'moving to opportunity'. Katz, Kling and Liebman (2001); Sinai and Waldfogel (2005); Kling, Liebman and Katz (2007); Turner, Popkin and Rawlings (2009); Baum-Snow and Marion (2009); Ellen, Horn and O'Regan (2016); Chetty, Hendren and Katz (2016); Chyn (2018); Diamond and McQuade (2019); van Dijk (2019); Derenoncourt (2022); Almagro, Chyn and Stuart (2023); Bergman et al. (2023)

→ Choice of location is implicitly a choice of tenants, which affects distribution + segregation

Redistribution via in-kind transfers. Nichols and Zeckhauser (1982); Blackorby and Donaldson (1988); Besley and Coate (1991); Currie and Gahvari (2008); Kleven and Kopczuk (2011); Mullainathan and Shafir (2013); Alatas et al. (2016); Finkelstein and Notowidigdo (2019); Lieber and Lockwood (2019); Deshpande and Li (2019); Waldinger (2021)

→ Effects of rationing process, including distortions caused by private developers

Modeling residential choices. Bayer, Ferreira and McMillan (2007); Geyer and Sieg (2013); Galiani, Murphy and Pantano (2015); Diamond (2016); Bayer et al. (2016); Bergman, Chan and Kapor (2020); Christensen and Timmins (2023); Calder-Wang (2021); Davis, Gregory and Hartley (2023)

→ Extension to include affordable housing sector + new instrument for rents

Data: LIHTC and market-rate households

Back

Panel of individual tax records, residential addresses, and demographics

- Match to rental units using addresses and combine into households Details
  - LIHTC units from HUD + market-rate units from American Community Survey (ACS)
  - Observe rents, unit characteristics, and income limits
- Proxies for persistent need: long-run income, education, 'childhood family income,' …
- **Main sample:** renter households living in 50 most populous MSAs, 2010-2018

Do **not** observe applications for LIHTC

- Instead, observe which households are eligible and which receive a unit

Tract-level index of neighborhood opportunity

- Combine indices of jobs access, school quality, transit access, and poverty from HUD + index of upward mobility from Chetty et al. (2022) Correlations AH locations

Data linkage

Back

Building panel of LIHTC households

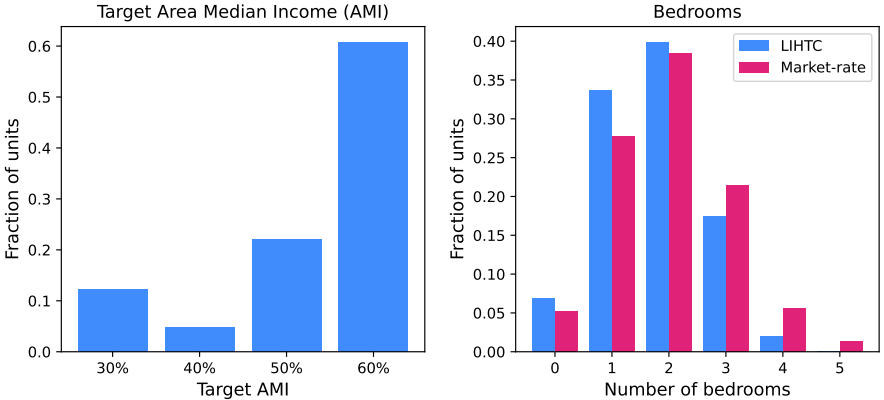
1. Link each individual to LIHTC address IDs (MAFIDs) to identify individuals in each unit
2. For each building, define a graph where individuals are nodes and edges are formed when they are married, claimer-dependent, or have shared other addresses.
3. Define households as all connected sets of the graph. Include claimed dependents not matched to building that year.
4. Define the household head as the highest wage earner (with age as tie breaker)

Building panel of market-rate households

1. Subset ACS households to market-rate renters by excluding homeowners or renters in LIHTC, public housing, or project-based section 8
    - Note: that these excluded ACS renters are used to infer demand for affordable housing during estimation and counterfactuals
2. Merge on tax records, demographics, childhood family income, etc. to have equivalently defined characteristics as in LIHTC panel

Unit types in LIHTC and market-rate

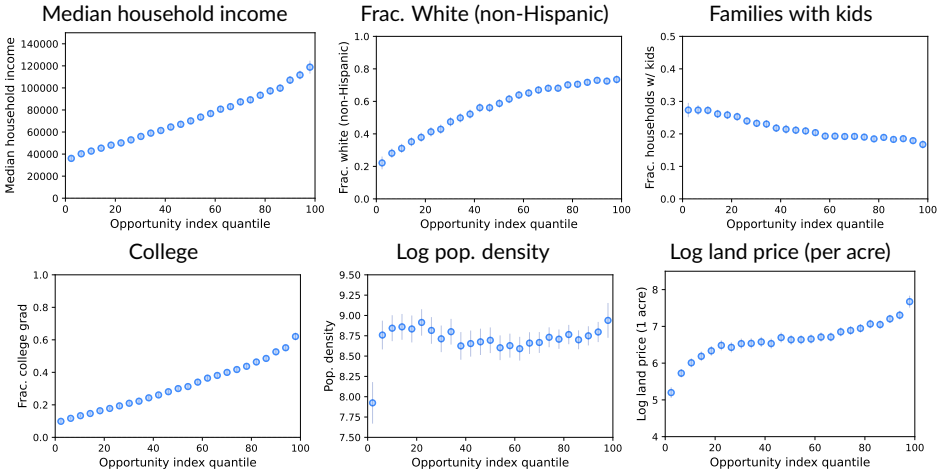
Back



Note: Sample includes all LIHTC units in the 50 sample CBSAs that were built between 1995-2019 and do not target any special population. Market-rate units are from the ACS, 2010-2018.

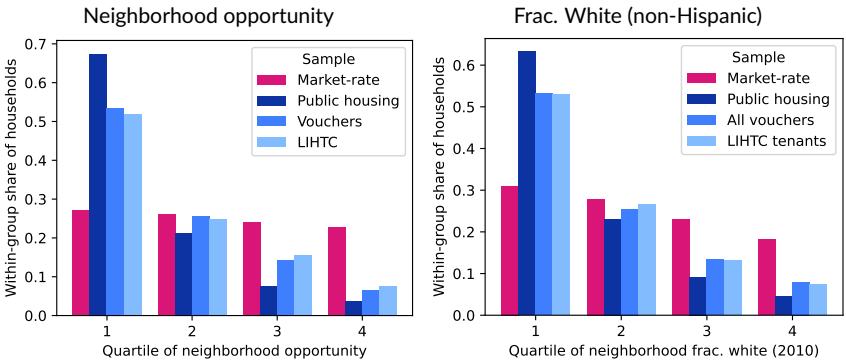
Correlates of neighborhood opportunity

Back



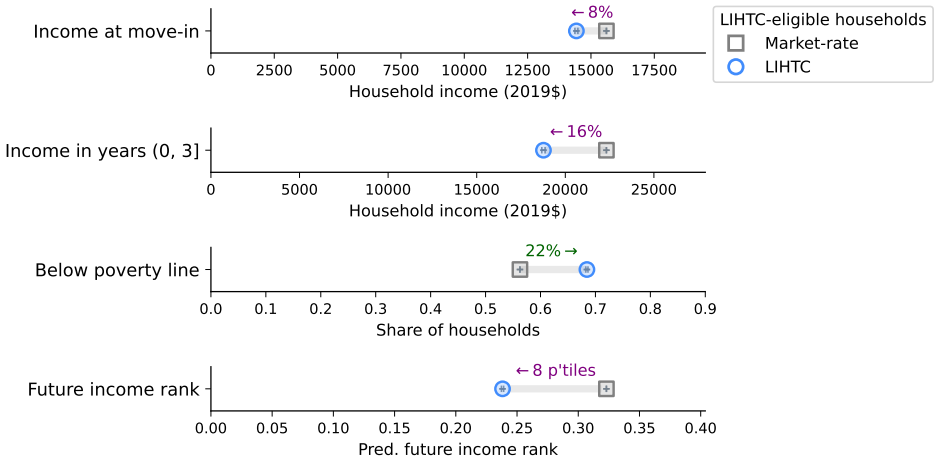
Note: Each figure documents the correlation between the within-CBSA percentile of our tract-level index of opportunity against different neighborhood characteristics for the 50 sample CBSAs. All characteristics except for land prices are sourced from the 2010 Census or 5-year ACS. Land values for each tract are estimated using data on historical land sales.

Affordable housing by neighborhood characteristics



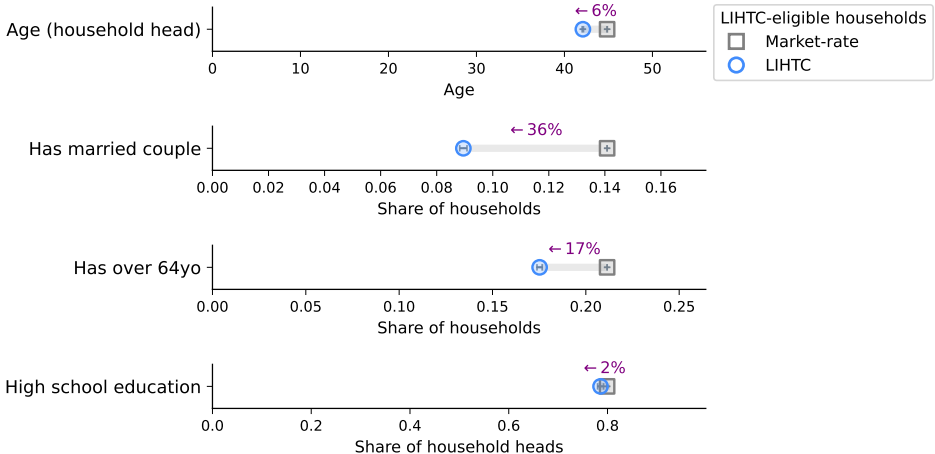
Note: Each bar is the fraction of households in the ACS in each within-MSA quartiles of neighborhood characteristics for the 50 sample CBSAs (2010-2018). Public housing and voucher data come from the HUD PICTRAC data.

Average differences: income



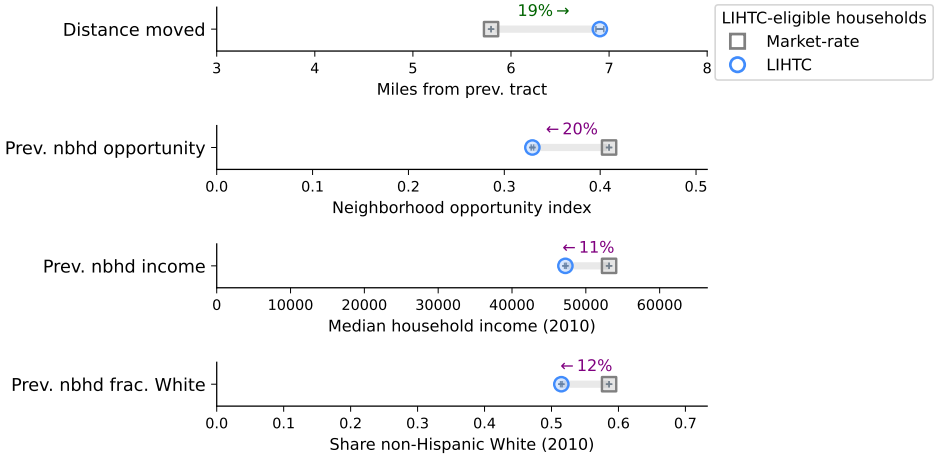
Note: Each point is based on coefficient from a regression of a household characteristics on an indicator for living in LIHTC with MSA × year fixed effects. Data include all households eligible for LIHTC. Outcomes are at the time surveyed (for market-rate) or time of move-in (for LIHTC). 95% confidence intervals are represented by grey lines.

Average differences: demographics



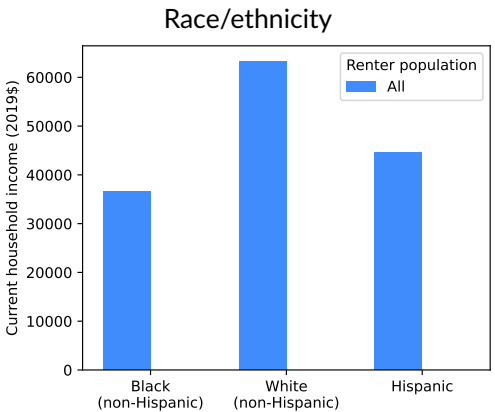
Note: Each point is based on coefficient from a regression of a household characteristics on an indicator for living in LIHTC with MSA × year fixed effects. Data include all households eligible for LIHTC. Outcomes are at the time surveyed (for market-rate) or time of move-in (for LIHTC). 95% confidence intervals are represented by grey lines.

Average differences: previous neighborhood characteristics

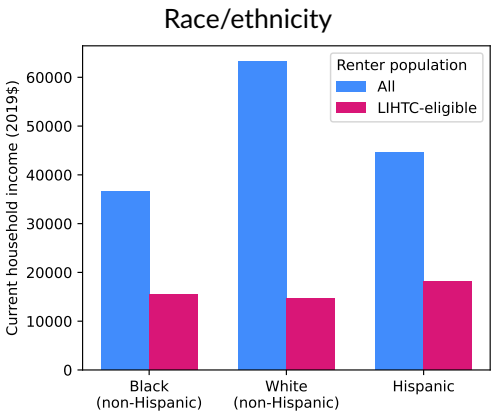


Note: Each point is based on coefficient from a regression of a household characteristics on an indicator for living in LIHTC with MSA × year fixed effects. Data include all households eligible for LIHTC. Outcomes are at the time surveyed (for market-rate) or time of move-in (for LIHTC). 95% confidence intervals are represented by grey lines.

Current income is a weak proxy for other characteristics

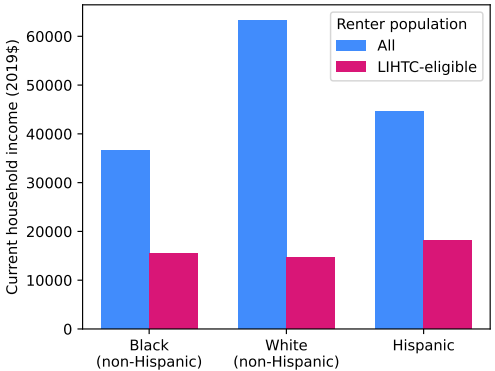


Current income is a weak proxy for other characteristics

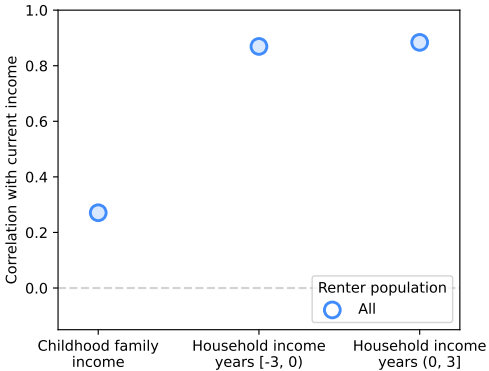


Current income is a weak proxy for other characteristics

Race/ethnicity



Childhood/past/future income



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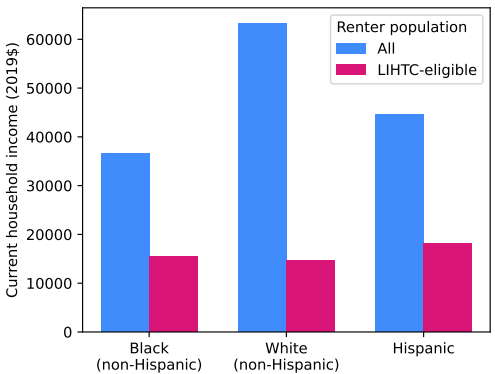
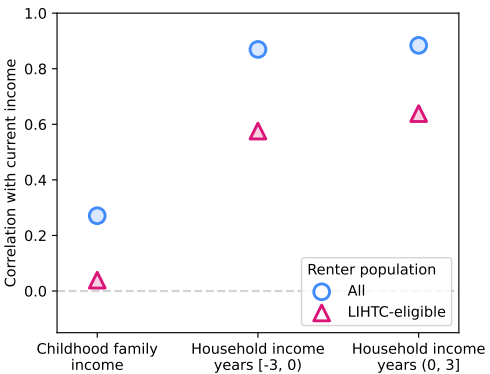


Past/future/childhood income

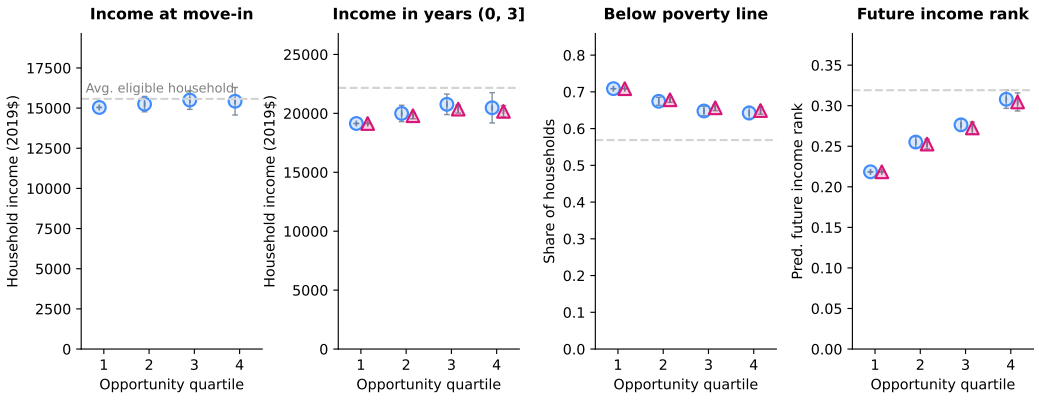


Current household income correlations

Household characteristic	All renters	All LIHTC-eligible renters
Correlations: current AGI		
Avg. AGI in years [-3, 0)	0.8694	0.5756
Avg. AGI in years (0, 3]	0.8840	0.6385
Predicted future income rank	0.6760	0.3391
Childhood family income rank (household head)	0.2709	0.03903
Average current AGI by char.		
Black (non-Hispanic)	$36,560	$15,420
White (non-Hispanic)	$63,290	$14,640
Hispanic	$44,680	$18,070
Graduated college (household head)	$89,660	$18,120
No college degree (household head)	$37,780	$15,050
Graduated high school (household head)	$58,970	$16,850
No high school degree (household head)	$22,810	$11,180
Household has children ($<$18yo)	$56,360	$21,330
Household does not have children	$51,750	$11,420
Household has seniors ($>$64yo)	$33,000	$8,434
Household does not have seniors	$57,620	$17,600
Household has joint filers	$92,180	$28,680
Household has no joint filers	$41,910	$13,520

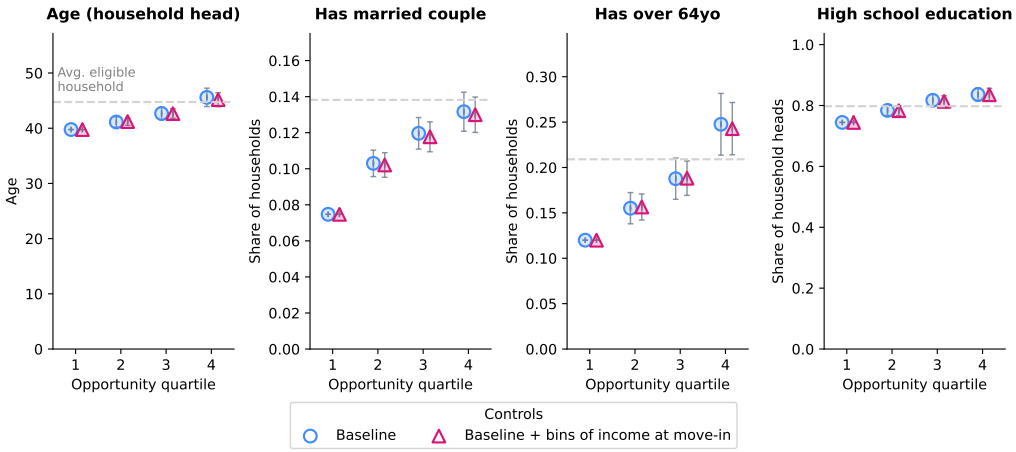
Note: This table documents the relationship between current Adjusted Gross Income (AGI) and other household characteristics for all renters and for all LIHTC-eligible renters in the ACS. The first three rows are correlations, while the remainder are the average AGI for the group indicated in the left column.

LIHTC households by neighborhoods: income



Note: Each point is based on coefficient from a regression of a household characteristics on indicators for neighborhood opportunity quartile. The baseline specification includes bedroom, income limit, and MSA × year fixed effects. Data include households at the time of move-in to LIHTC. 95% confidence intervals are represented by grey lines.

LIHTC households by neighborhoods: demographics



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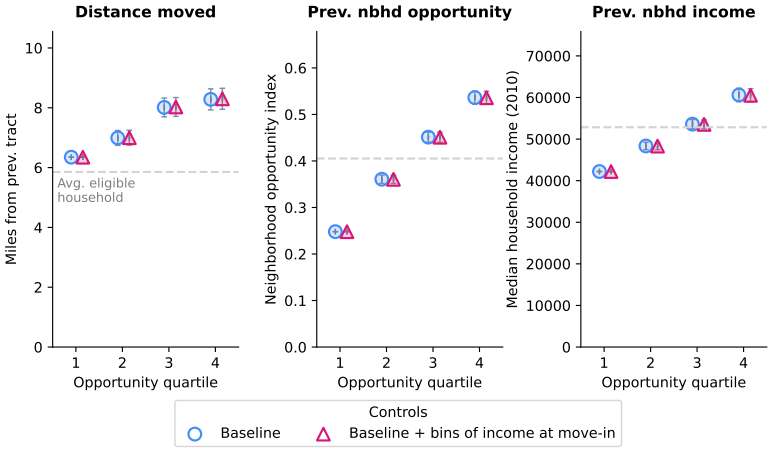
LIHTC households by neighborhoods: prev. nbhd



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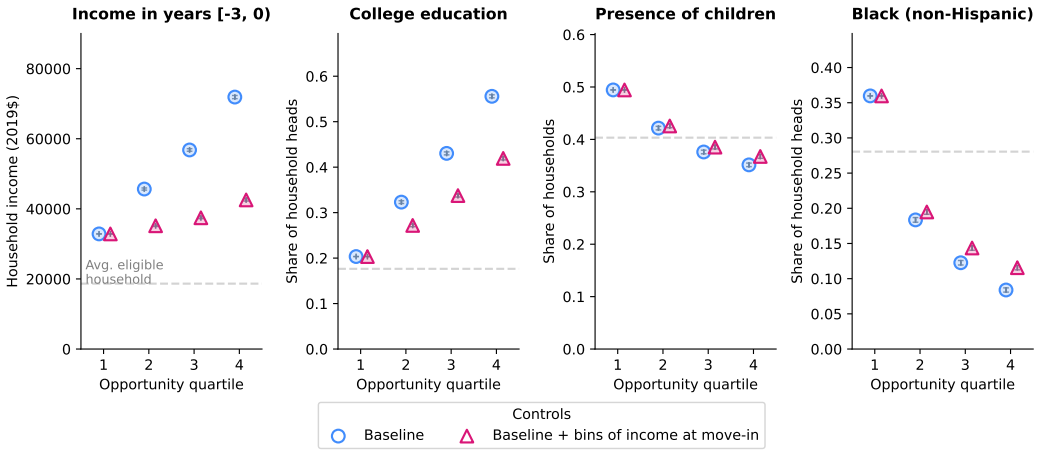
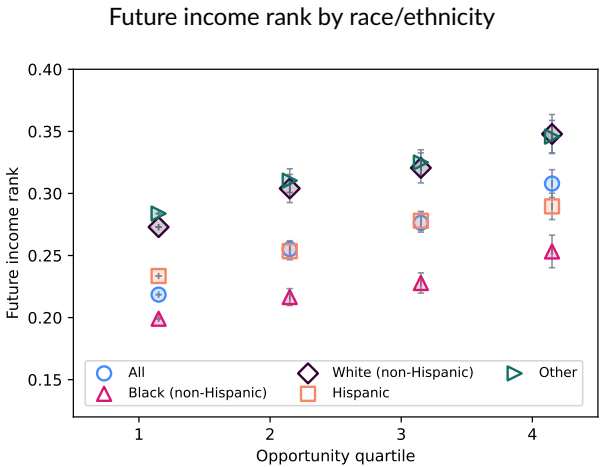
Market-rate households by neighborhoods



Note: Each point is based on coefficient from a regression of a household characteristics on indicators for neighborhood opportunity quartile. The baseline specification includes bedroom, income limit, and MSA × year fixed effects. Sample is ACS renters living in market-rate units. 95% confidence intervals are represented by grey lines.

Future income by race/ethnicity and opportunity



Note: Each point is based on coefficient from a regression of a household characteristics on indicators for neighborhood opportunity quartile and controls for bedrooms, income limit, and MSA × year fixed effects. Outcome is predicted future income rank based on observables at move-in. Sample is ACS renters living in market-rate units. 95% confidence intervals are represented by grey lines.

Predicting future income

Back

1. Predict average income in 3-years after ACS survey
   - **Method:** XGBoost (Chen and Guestrin, 2016)
   - **Variables:** average household income and wages in 3 prior years, household income and wages in current year, indicator for any income, number of W2s, race/ethnicity of household head, number of household members, whether any children, whether any seniors, head of household age (and age squared), whether any joint filers, and characteristics of previous tract (median income, fraction White, and neighborhood opportunity index)
   - R^2 on holdout sample of 0.861
2. Adjust using equivalence scale from Census

$$ES = \begin{cases} N_{\text{adults}}^{0.5} & \text{One and two adults} \\ (N_{\text{adults}} + 0.8 + 0.5(1 - N_{\text{children}}))^{0.7} & \text{Single parents} \\ (N_{\text{adults}} + 0.5N_{\text{children}})^{0.7} & \text{Other families} \end{cases}$$

3. Rank within distribution of renter households for 5-year age bins
   - Age bin based on head of household. Renter distribution is for all 50 sample MSAs.

Characteristics used for model

- **Housing:** indicators for bedrooms and building type (single-family, small apartment, big apartment)
- **Neighborhood:** race/ethnicity shares (2010 Census); share college-educated, median household income, and population density (2010 Census); HUD indices of school quality, jobs access, transit access, and poverty; number of parks within a mile
- **Households:** race/ethnicity, presence of children, presence of seniors, presence of married couple, indicators for household size, whether has voucher, and bins of household income

Step 1: MLE + contraction map details

Back

For a candidate vector of parameters $\widetilde{\boldsymbol{\theta}}^{\text{MR}} = \left\{\widetilde{\boldsymbol{\delta}}, \widetilde{\boldsymbol{\gamma}}_\ell, \widetilde{\beta}_\ell, \widetilde{\boldsymbol{\kappa}}\right\}$, the pseudo log-likelihood is:

$$\ell = \sum_t \sum_{i \in \mathcal{I}_t^{\text{MR}}} \sum_{j \in \mathcal{J}_t^{\text{MR}}} \mathbb{1}_{j_i = j} \times \log\left(P_{ij}^{\text{MR}}(\widetilde{\boldsymbol{\theta}}^{\text{MR}})\right)$$

Use a contraction mapping to recover the mean utilities ($\widetilde{\boldsymbol{\delta}}$):

$$\widetilde{\delta}_{jt}^{new} = \widetilde{\delta}_{jt}^{old} - \log\left(\frac{\sum_{i \in \mathcal{I}_t} P_{ij}^{\text{MR}}(\widetilde{\boldsymbol{\theta}}^{\text{MR}})}{s_{jt}}\right)$$

Regress mean utilities on characteristics:

$$\widehat{\delta}_{jt} = \boldsymbol{\gamma}_0 \mathbf{x}_{jt} - \beta_0 r_{jt} + \xi_{jt}$$

Step 1: Estimating preferences using market-rate choices

Back

Estimation similar to Bayer, Ferreira and McMillan (2007) Details

1. Aggregate to three-year periods, indexed by t
2. MLE to estimate heterog. pref. parameters; contraction map to get mean utilities (δ)
3. Regress mean utilities on characteristics:

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Need instrument for rent (r_{jt}), which is endogenous with unobserved quality (ξ_{jt})

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- **Standard approach:** use characteristics of other neighborhoods (∼BLP instruments)
  - Potential issues if unobservables spatially correlated Spatial corr.

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Back

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Need instrument for rent (r_{jt}), which is endogenous with unobserved quality (ξ_{jt})

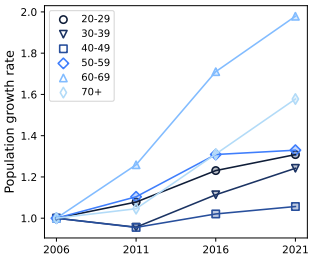
- **Standard approach:** use characteristics of other neighborhoods (∼BLP instruments)
  - Potential issues if unobservables spatially correlated Spatial corr.
- **Our approach:** isolate shifts in residual supply due to broad trends in demographics
  - Similar in spirit to Waldfogel instruments (Waldfogel, 2003; Berry and Haile, 2016)

Step 1: Instrument for rent

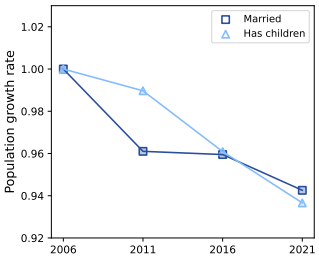
Back

Large changes in the demographic and industry composition of cities over time

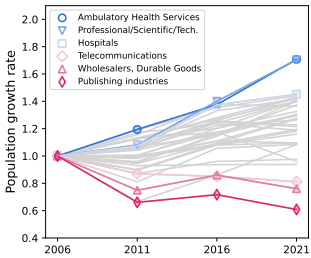
Age



Family structure



Industries



Note: Data are 5-year Public Use Microdata Samples (PUMS) from the ACS and include all individuals $\geq$20yo living in one of the sample MSAs. Industry is 3-digit NAICS.

Step 1: Instrument for rent

Back

Large changes in the demographic and industry composition of cities over time

Instrument leverages how exposed a housing option is to these shifts

- Intuition: options popular among growing groups $\rightarrow$ increasing rent over time
  - Housing supply is inelastic (Saiz, 2010; Baum-Snow and Han, 2024)

Step 1: Instrument for rent

Back

Large changes in the demographic and industry composition of cities over time

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- Implement as a shift-share Details
  - **Shares:** Using pre-period choices to estimate share of individuals (including homeowners) of each type choosing each option
    - Individual types based on (age bin, family structure, industry)
  - **Shifts:** Changes in empirical distribution of individual characteristics
    - Use other cities population changes over time

Step 1: Instrument for rent

Back

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    - Use other cities population changes over time
- Add neighborhood fixed effects to isolate within-neighborhood differences Nbhd chars

$$\widehat{\delta}_{jt} = \boldsymbol{\gamma}_0 \mathbf{x}_{jt} - \beta_0 r_{jt} + \psi_{g(j)} + \xi_{jt}$$

Estimated parameters: OLS vs. IV

Back

	OLS
Gross rent ($00s)	0.0309
	(0.009)
2 bedrooms	0.4368
	(0.0574)
3+ bedrooms	-0.2814
	(0.0701)
Small apartment building	0.5061
	(0.0529)
Big apartment building	-0.4886
	(0.0532)
Neighborhood fixed effects	✓
F-statistic (first-stage)	
N	1800

Note: The dependent variable is the mean utility of each housing option in each period ($\widehat{\delta}$). Neighborhood characteristics do not vary over time, so are absorbed into the fixed effects. For the BLP-style instruments we use four characteristics in a 3-6 mile ring around the focal neighborhood: the level of development and the fraction of land that is forested in the 2011 National Land Cover Database, the fraction of land defined as 'flat plains' from the US Geological Survey's National Elevation Database, and the share of units that are single-family in the 2010 5-year ACS. The sample size is rounded per Census disclosure requirements. Standard errors are clustered at the PUMA level and are reported in parentheses.

Estimated parameters: OLS vs. IV

Back

	OLS	IV
Gross rent ($00s)	0.0309	-0.2577
	(0.009)	(0.1173)
2 bedrooms	0.4368	1.254
	(0.0574)	(0.3371)
3+ bedrooms	-0.2814	1.181
	(0.0701)	(0.6009)
Small apartment building	0.5061	0.1029
	(0.0529)	(0.1718)
Big apartment building	-0.4886	-0.4348
	(0.0532)	(0.0778)
Neighborhood fixed effects	✓	✓
F-statistic (first-stage)		16.33
N	1800	1800

Note: The dependent variable is the mean utility of each housing option in each period ($\widehat{\delta}$). Neighborhood characteristics do not vary over time, so are absorbed into the fixed effects. For the BLP-style instruments we use four characteristics in a 3-6 mile ring around the focal neighborhood: the level of development and the fraction of land that is forested in the 2011 National Land Cover Database, the fraction of land defined as 'flat plains' from the US Geological Survey's National Elevation Database, and the share of units that are single-family in the 2010 5-year ACS. The sample size is rounded per Census disclosure requirements. Standard errors are clustered at the PUMA level and are reported in parentheses.

Estimated parameters: OLS vs. IV

Back

	OLS	IV	BLP-style IV
Gross rent ($00s)	0.0309	-0.2577	-0.197
	(0.009)	(0.1173)	(0.1031)
2 bedrooms	0.4368	1.254	1.082
	(0.0574)	(0.3371)	(0.3004)
3+ bedrooms	-0.2814	1.181	0.8815
	(0.0701)	(0.6009)	(0.5327)
Small apartment building	0.5061	0.1029	0.1906
	(0.0529)	(0.1718)	(0.1569)
Big apartment building	-0.4886	-0.4348	-0.4364
	(0.0532)	(0.0778)	(0.0734)
Neighborhood fixed effects	✓	✓	
F-statistic (first-stage)		16.33	20.30
N	1800	1800	1800

Note: The dependent variable is the mean utility of each housing option in each period ($\widehat{\delta}$). Neighborhood characteristics do not vary over time, so are absorbed into the fixed effects. For the BLP-style instruments we use four characteristics in a 3-6 mile ring around the focal neighborhood: the level of development and the fraction of land that is forested in the 2011 National Land Cover Database, the fraction of land defined as 'flat plains' from the US Geological Survey's National Elevation Database, and the share of units that are single-family in the 2010 5-year ACS. The sample size is rounded per Census disclosure requirements. Standard errors are clustered at the PUMA level and are reported in parentheses.

Step 2: Estimating AH utility (α) and lottery weights (ϕ)

Back

Step 1 estimates $\rightarrow$ who *would* live in AH, up to α and ϕ

- α: which *households* prefer AH, relative to similar market-rate unit
- ϕ: which types of households do *developers* prefer

Move-out rates Illustration

Step 2: Estimating AH utility (α) and lottery weights (ϕ)

Back

Step 1 estimates $\rightarrow$ who *would* live in AH, up to α and ϕ

α: which *households* prefer AH, relative to similar market-rate unit

ϕ: which types of households do *developers* prefer

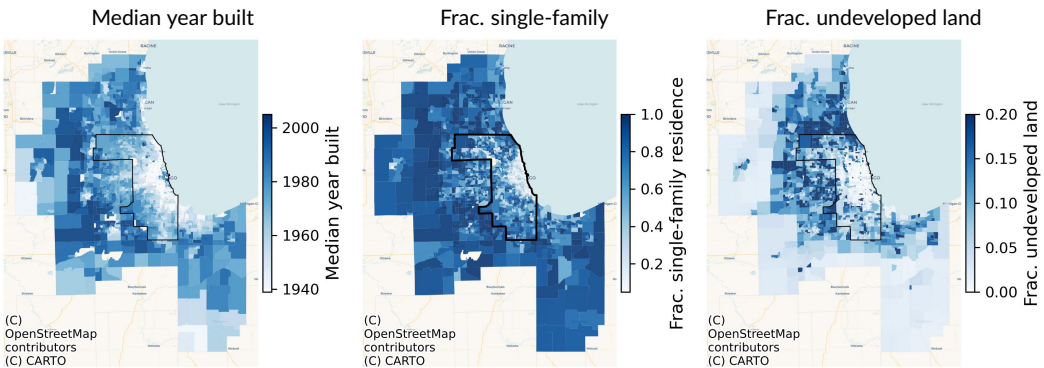
Use GMM to match moments based on moves in and out of AH

- **Move-in moments** Details
  - Average of each household characteristic in **w**
- **Move-out moments** Details
  - Average move-out rates from AH
  - Covariance between household characteristics (**w**) and moving out
- Intuition: developers (ϕ) affect move-ins, household preferences (α) affect both

Move-out rates Illustration

Spatial correlation in common instruments

Back



Note: This figure maps neighborhood characteristics that are commonly used to form instruments for rent. Median year built and fraction single-family residences are sourced from the 2019 5-year ACS. The fraction of undeveloped land is sourced from the National Land Cover Database (NLCDB).

Instrument implementation

Back

Index each unique combination of the (discrete) individual characteristics with b. Utility is:

$$\begin{aligned} v_{ij} &= \theta_b^{\text{beds}} * \text{bedrooms}_j + \theta_b^{\text{PUMA}} * \text{PUMA}_j + \theta_b^{\text{building}} * \text{buildingType}_j + \varepsilon_{ij} \\ &= v_{b(i)j} + \varepsilon_{ij} \end{aligned}$$

We parameterize each θ_b as: $\theta_b = \theta_{b,industry} + \theta_{b,age}^{\text{beds}} + \theta_{b,married} + \theta_{b,kids}$

The probability an individual with characteristics b selects option j is then given by:

$$P_{jb} = \frac{\exp\left(v_{bj}\right)}{\sum_{j' \in \mathcal{J}} \exp\left(v_{bj'}\right)}$$

Define N_b as the baseline number of individuals with characteristics v and g_{bt} as the growth relative to the baseline. Construct instrument as follows, then take Z-score:

$$z_{jt} = \frac{\sum_b g_{bt} N_b \widehat{P}_{jb}}{\sum_b N_b \widehat{P}_{jb}}$$

Instrument: potentially endogenous amenities

Back

Outcome	Outcome mean	Coef. on instrument
Grocery stores per sq. mi.	2.82	-0.0299
		(0.012)
Department stores and supercenters per sq. mi.	0.66	-0.012
		(0.0061)
Civil, social, and religious places per sq. mi.	2.139	-0.0076
		(0.0045)
Restaurants per sq. mi.	13.29	0.2974
		(0.1341)
Entertainment places per sq. mi.	0.5593	0.0014
		(0.0031)
Frac. White (non-Hispanic)	0.5672	0.0005
		(0.0005)
Frac. Hispanic	0.1946	-0.0007
		(0.0004)
Frac Black (non-Hispanic)	0.1643	-0.0003
		(0.0003)
Frac with college degree	0.4168	0.003
		(0.0014)
Median household income	74190	371.9
		(150.2)
Median year structure built	1960	-4.05
		(2.053)
Population density	7868	39.48
		(26.4)

Note: Establishment counts are based on the Business Register. Other neighborhood characteristics are based on the ACS. The first column is the mean across Chicago MSA neighborhoods. The second column regresses the outcome on the z-score of our instrument for market-rate rents with fixed effects for neighborhood and year. Standard errors are presented in parentheses.

Computing offer acceptance probabilities

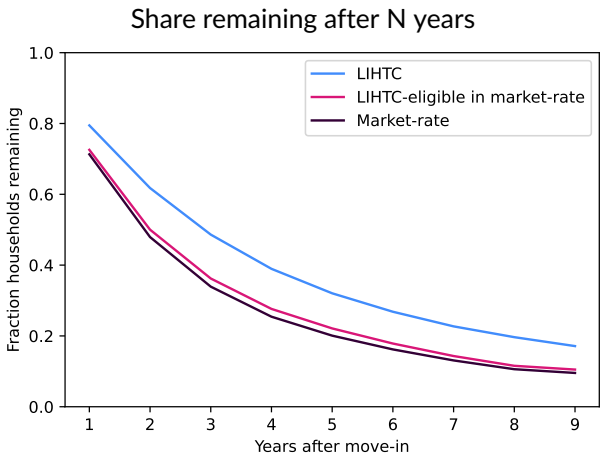
Back

- Households accept one offer at random. Acceptance probability depends on number of other offers received, conditional on offer at j
- Probabilities of applying and receiving an offer at each j are iid Bernoulli
- By Le Cam's theorem, we can approximate distribution of number of offers as Poisson with rate $\rho_{ij} = \sum_{j' \in \mathcal{J}^{AH}, j \neq j'} P_{ij'}^{\text{Apply}} \times P_{ij'}^{\text{Offer}}$
- Conditional probability is then

$$P_{ij}[\text{accepts} \mid \text{offered}] \approx \sum_{n=0}^{\infty} \underbrace{\left(\frac{e^{-\rho_{ij}} \rho_{ij}^{n}}{n!}\right)}_{\substack{\text{Prob of n} \\ \text{other offers}}} \underbrace{\left(\frac{1}{1+n}\right)}_{\substack{\text{Prob accept if} \\ \text{n other offers}}}$$

Move-out rates

Back



Note: This figure documents the fraction of households remaining in a unit each year by the time since move-in, split by whether they are in a LIHTC unit, a market-rate unit, or in a market-rate unit and are LIHTC-eligible.

Intuition for GMM moments

Back

Move-in moments

- Average of each household char. ($\mathbf{w}_i$)

Move-out moments

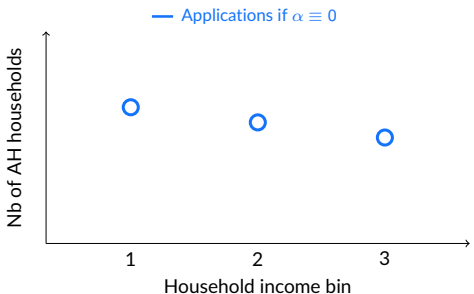
- Average move-out rate
- Covariance with household chars ($\mathbf{w}$)

Intuition for GMM moments

Back

Move-in moments

- Average of each household char. ($\mathbf{w}_i$)



Move-out moments

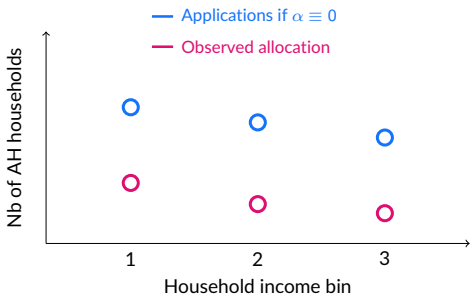
- Average move-out rate
- Covariance with household chars ($\mathbf{w}$)

Intuition for GMM moments

Back

Move-in moments

- Average of each household char. ($\mathbf{w}_i$)



Move-out moments

- Average move-out rate
- Covariance with household chars ($\mathbf{w}$)

Intuition for GMM moments

Back

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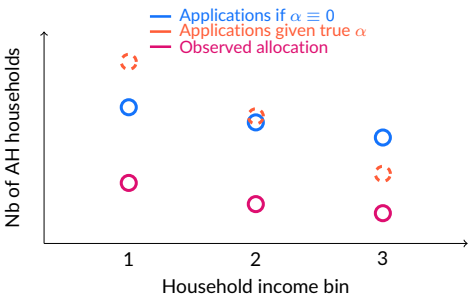

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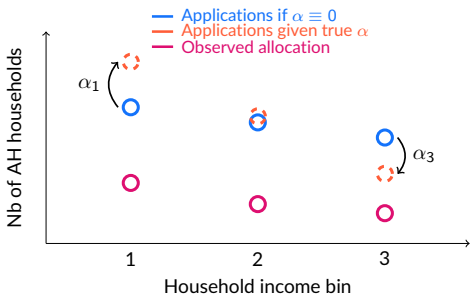

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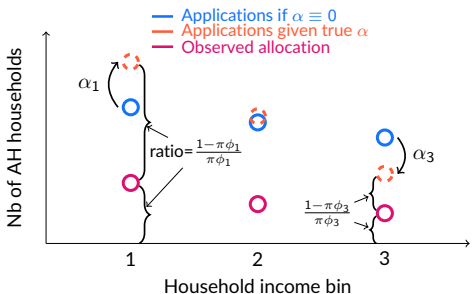

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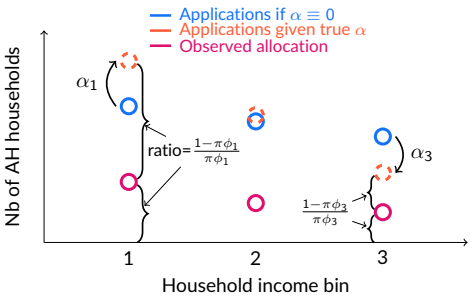

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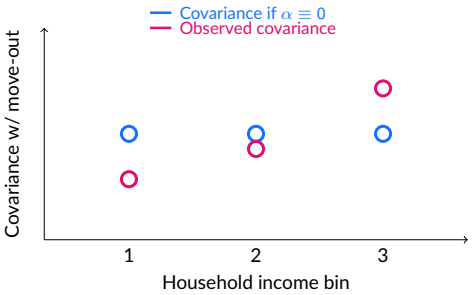

Intuition for GMM moments

Move-in moments

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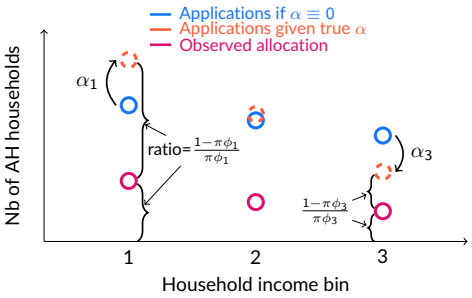

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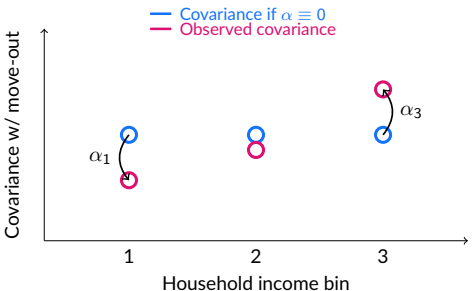


GMM details: move-in moments

Back

Compute model-predicted average **w** across AH households each period

$$\widehat{m}_t^{(q)} = \frac{\sum_{i \in \mathcal{I}_t} \left(w_i \times \sum_{j \in \mathcal{J}_t^{\text{AH}}} P_{ijt}^{\text{alloc}} \right)}{\sum_{i \in \mathcal{I}_t} \sum_{j \in \mathcal{J}_t^{\text{AH}}} P_{ijt}^{\text{alloc}}}$$

where w_i is an element of either $\mathbf{w}_i$ or $\widetilde{\mathbf{w}}_i$ and $P_{ijt}^{\text{alloc}} = P_{ijt}^{\text{apply}} \times \pi_{jk(i)t} \times P_{ijt}^{\text{accept}}$ is the equilibrium probability that household i is allocated to affordable housing option j in period t.

For P_{ijt}^{accept}, approximate distribution of # other offers a household receives conditional on offer at j as a Poisson with arrival rate $\rho_{ijt} = \sum_{j' \in \mathcal{J}_t^{\text{AH}}, j' \neq j} (P_{ij't}^{\text{apply}} \times \pi_{j'k(i)t})$ (Le Cam, 1960), such that

$$P_{ijt}^{\text{accept}} \approx \sum_{n=0}^{|\mathcal{J}_t^{\text{AH}}|-1} \underbrace{\left(\frac{e^{-\rho_{ijt}} \rho_{ijt}^n}{n!} \right)}_{\substack{\text{Prob of n} \\ \text{other offers}}} \underbrace{\left(\frac{1}{1+n} \right)}_{\substack{\text{Prob accept if} \\ \text{n other offers}}}$$

GMM details: move-out moments

Back

For households endowed with an AH unit $j_i^0 \in \mathcal{J}^{\text{AH}}$, their move out probability is

$$P_{it}^{\text{moveout}} = \frac{\sum_{j \in \mathcal{J}_t^{\text{MR}}} \exp\left(\delta_{jt} + \lambda_{ijt}\right)}{\exp(\delta_{j_i^0 t} + \lambda_{ij_i^0 t}) + \sum_{j \in \mathcal{J}_t^{\text{MR}}} \exp\left(\delta_{jt} + \lambda_{ijt}\right)}$$

For moments, we compute the mean probability of moving out each period, as well as the covariance with household characteristics:

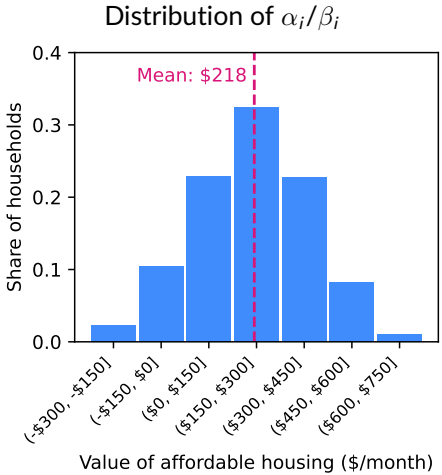
$$\text{Means:} \qquad \widehat{m}_t^{(q)} = \frac{1}{|\mathcal{I}_t|} \sum_{i \in \mathcal{I}_t} P_{it}^{\text{moveout}}$$

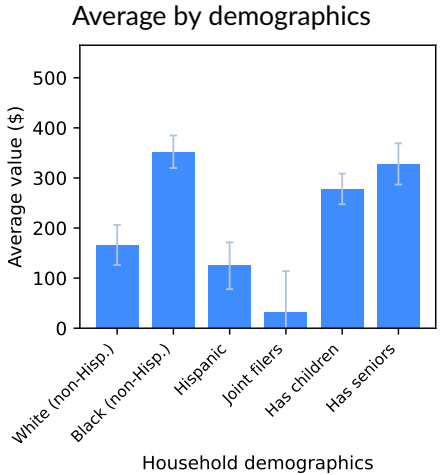
$$\text{Covariances:} \qquad \widehat{m}_t^{(q)} = \frac{1}{|\mathcal{I}_t| - 1} \sum_{i \in \mathcal{I}_t} (\mathbf{w}_i - \overline{\mathbf{w}}_i) \left(P_{it}^{\text{moveout}} - \overline{P}_{it}^{\text{moveout}} \right)$$

We use annual move-out rates to match the construction of the ACS

Value of LIHTC unit compared to similar market-rate

Back

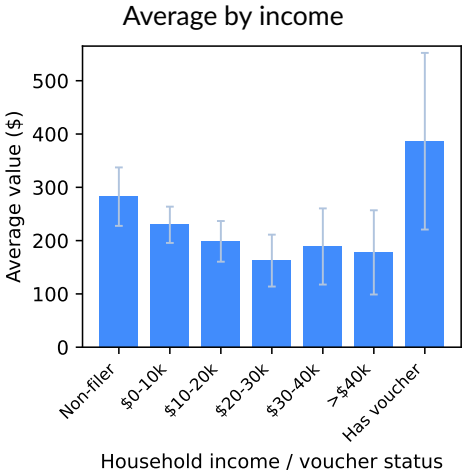


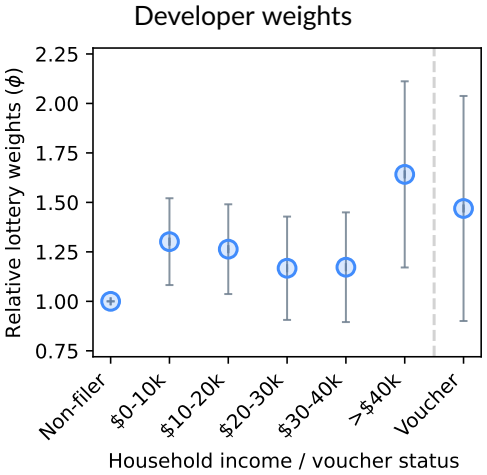


Note: These figures document the value of affordable housing relative to a similar market-rate unit in units of monthly rent (α_i/β_i). The distribution is over all eligible households. Gray bars are bootstrapped 95% confidence intervals.

Value of LIHTC units by income & developer lottery weights

Back





Note: The first figure documents the value of affordable housing relative to a similar market-rate unit in units of monthly rent (α_i/β_i). The second plots the estimated developer weights. Gray bars are bootstrapped 95% confidence intervals.

LIHTC supply-side

Subsidies awarded through competitive allocation process

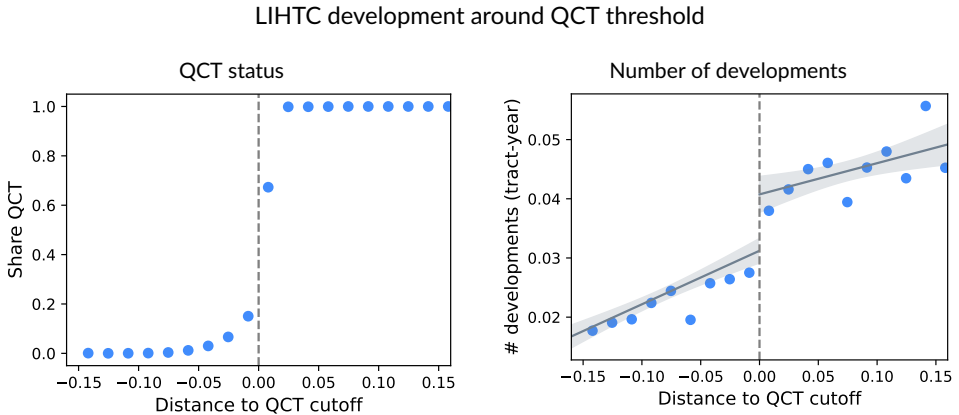
1. State specifies scoring criteria (e.g., points for nbhd chars.)
2. Developers submit applications
3. Credits awarded to highest-scoring applications

Size of subsidy depends on 'qualified basis'

- Baseline: all non-land construction costs and a development fee (usually 15%)
- Spatial variation: $+30\%$ if in Qualified Census Tract (QCT) or Difficult to Develop Area (DDA)
  - QCTs defined using poverty rate and share of households eligible
  - DDAs defined using ratio of LIHTC to market-rate rent

  $\rightarrow$ Useful variation at threshold

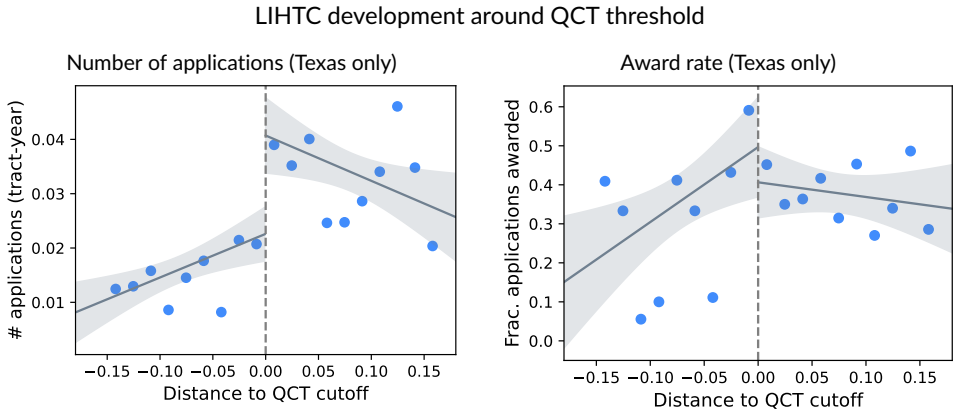
LIHTC supply-side: developments around QCT thresholds



Note: These figures document the distance to the threshold HUD uses to define Qualified Census Tracts (QCTs). Developments built in QCTs receive a 'basis boost' or 30%. The sample covers developments built in the 100 most populous metro areas between 2000 and 2015. Gray shading represents the 95% confidence interval.

LIHTC supply-side: Texas applications

Back Back



Note: These figures document the distance to the threshold HUD uses to define Qualified Census Tracts (QCTs). Data cover LIHTC applications for credits in Texas between 2000 and 2015. Gray shading represents the 95% confidence interval.

Housing quality in American Housing Survey (AHS)

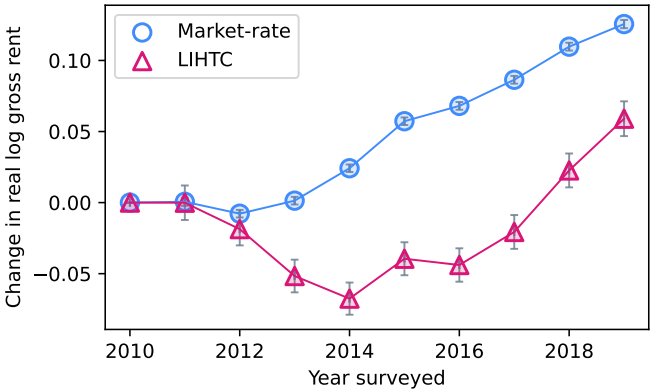
Back

	Market-rate mean	LIHTC coefficient	Public housing coefficient
Has maintenance issue	0.2127	-0.0223 (0.0151)	0.0424 (0.0155)
Seen rodents last 3mo	0.1123	-0.0087 (0.0166)	0.0523 (0.0213)
Seen roaches last 3mo	0.1536	-0.0298 (0.0179)	0.0506 (0.0173)
Has barred windows	0.1837	-0.0883 (0.0335)	-0.0739 (0.0228)
Unit square feet	1323	-378.4 (64.23)	-373.9 (91.42)
Year built	1960	42.9 (0.6901)	9.447 (0.7544)

Note: Sample includes 2013 and 2015 American Housing Survey, subset to units in the 50 sample CBSAs. The coefficients are from a regression of a housing characteristic on indicators for whether the unit is LIHTC or public housing (with market-rate being the holdout group) and fixed effects for neighborhood (PUMA) and year. Market-rate means are weighted by the number of LIHTC units in the PUMA. Standard errors are presented in parentheses.

Rent growth: LIHTC and market-rate

Back



Note: This figure documents the growth in real rents between 2010 and 2019 in the American Community Survey, split by LIHTC and market-rate. Each point is a coefficient from a regression of log gross rent on indicators for the year of the survey. 95% confidence intervals are represented by gray bars.

Cost of new development #1: implicit subsidy

Back

Goal: estimate the 'implicit subsidy,' or the opportunity cost of using a unit for LIHTC instead of market-rate

Method: compare LIHTC rent to estimate of market-rate rent for same unit

- Hedonic regression to predict rent for each LIHTC unit as if it were a market-rate unit
  - **Training data:** ACS market-rate units (2016-2018, Chicago MSA)
  - **Characteristics:** PUMA*year fixed effects, bedroom fixed effects, rooms per bedroom, year built bins, building type fixed effects (SFR, small apartment, big apartment)
- Key assumption: difference in unobserved characteristics between LIHTC and market-rate is constant across neighborhoods

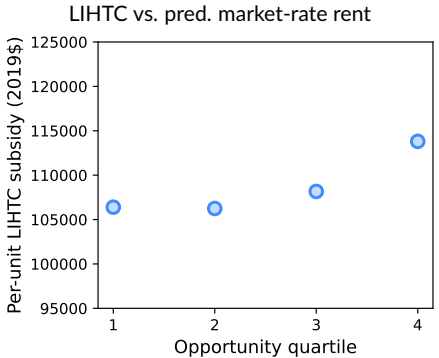
Cost of new development #2: tax credit amount

Back

Goal: estimate # tax credits that would be awarded for given neighborhood

Method: data on past allocations + XGBoost to predict awards based on neighborhood and development chars. ($R^2 = 0.54$ on holdout)

- **Development chars.:** # units, whether fully affordable, target population (if any), for vs. non-profit, target AMI, and indicators for receiving other sources of funding (e.g., a state bond).
- **Neighborhood chars.:** predicted land price, WRLURI (with an indicator if missing), housing vacancy rate, log population density, log median household income, fraction White, fraction with college, fraction below poverty, log number of offices within 1 mile, log number of parks within 1 mile, and whether the tract is a Qualified Census Tract or Difficult Development Area.



Marginal Value of Public Funds (MVPF)

Back

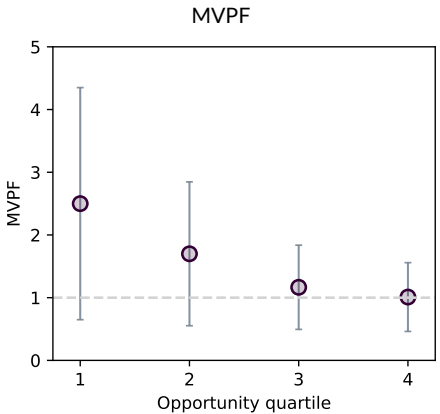
MVPF: ratio of marginal benefits and costs

(Hendren and Sprung-Keyser, 2020)

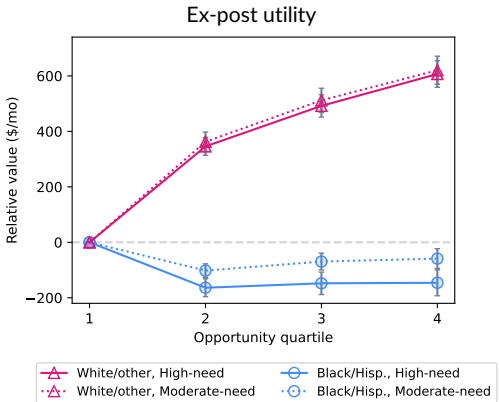
- Compute as ratio of household surplus to implicit subsidy
- Set aside potential fiscal or other externalities

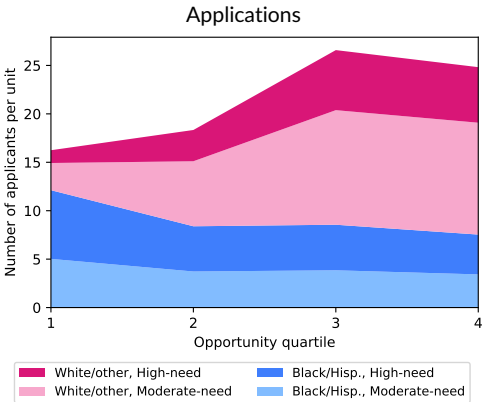
MVPF is decreasing in nbhd opportunity

- Uncertainly primarily from uncertainty in level of surplus, not differences by quartile



Ex-post utility & simulated applications





Effects of location on segregation

Back

Long history of court cases on whether AH perpetuates segregation

- 2015 Supreme Court case specifically on effects of LIHTC
  - → Increased policy focus on building in less segregated nbhds (Owens and Smith, 2023)

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Measure marginal effect of siting on racial/ethnic and economic segregation

- Isolation index from Cutler, Glaeser and Vigdor (1999)
- For groups A and B:

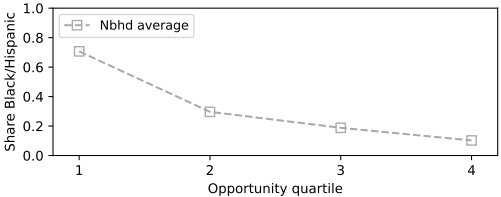
$$\text{Isolation} = \underbrace{\frac{1}{|\text{A}|}\sum_{i\in\text{A}} \text{fracA}_{g(i)}}_{\text{Avg. exposure to A by A}} - \underbrace{\frac{1}{|\text{B}|}\sum_{i\in\text{B}} \text{fracA}_{g(i)}}_{\text{Avg exposure to A by B}}$$

Impact of siting on integration

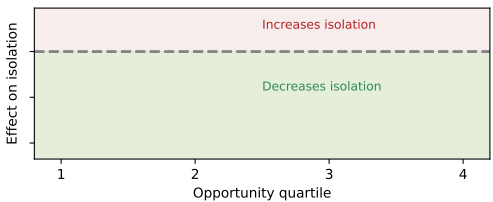
Back

Racial/ethnic integration

Frac. Black/Hispanic: nbhd vs. development



Contribution to racial/ethnic isolation index



Economic integration

Impact of siting on integration

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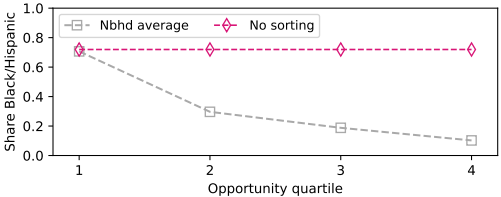

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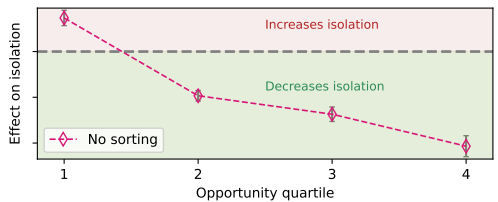

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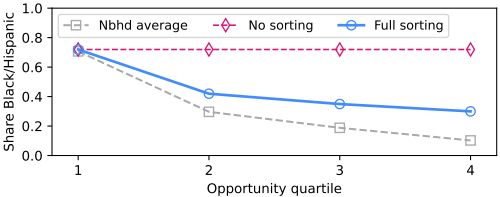

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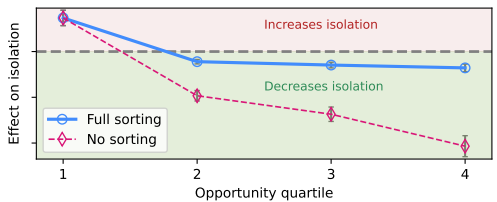

Economic integration

Impact of siting on integration

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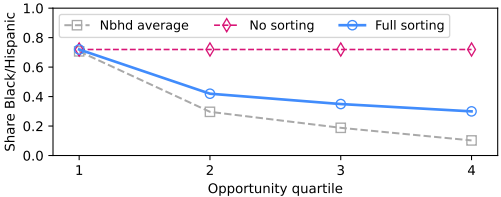

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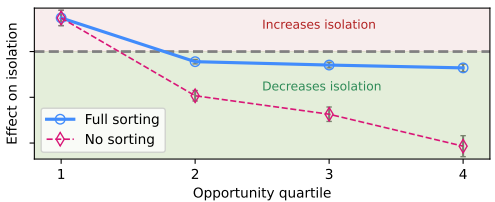
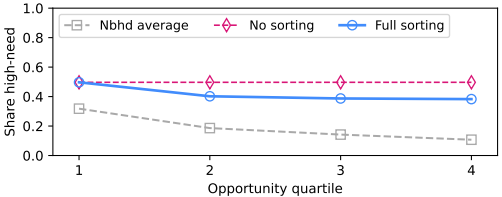


Economic integration

Frac. high-need: nbhd vs. development



Impact of siting on integration

Back

Racial/ethnic integration

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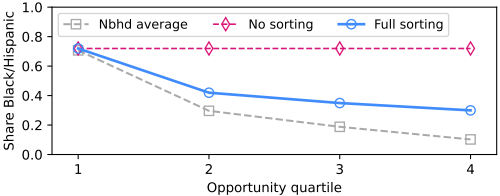
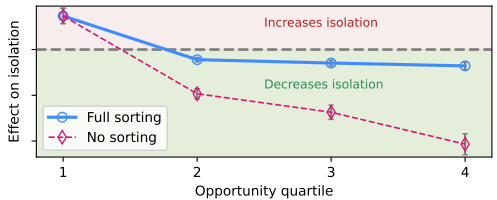


Contribution to racial/ethnic isolation index



Economic integration

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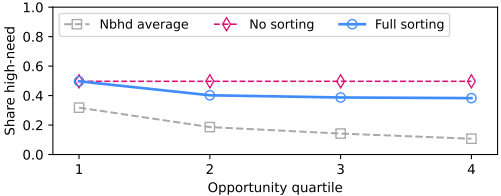
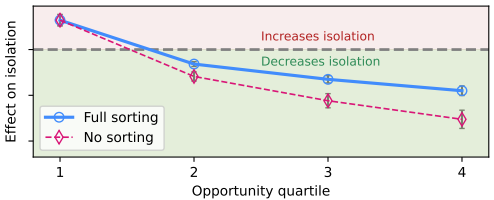


Contribution to economic isolation index



LIHTC Supreme Court case

Back

Recent Supreme Court case on LIHTC siting and segregation

2008 Texas sued over LIHTC siting by a community organization
- *"...perpetuates racial segregation"* because of its *"failure to correct the disproportionate allocation of housing tax credits to low income minority areas"*

2012 District court agrees; mandates Texas prioritize 'opportunity' in future siting criteria

2015 On appeal, Supreme Court upholds validity of 'disparate impact' argument, but sets high bar of proof

2016 District court reverses decision; insufficient causal evidence

> *"CHIEF JUSTICE ROBERTS: Take two proposals. One is a proposal to build new housing in a low income area, it would benefit primary minorities; new housing, good thing. The other proposal is to build housing in a more affluent area. It would help promote integration of housing; also a good thing. Which one gets credit [...]? The one that is revitalizing a low income area or the one that is integrating a high income area?"*

Quantifying potential effects on children

Back

Use estimates from the Opportunity Atlas (Chetty et al., 2022) to approximate the causal effect on lifetime earnings of children, following steps from (Bergman et al., 2023)

1. Compute change in upward mobility rank between two neighborhoods
2. Multiply by 62% to approximate the *causal* effect of earnings rank at age 26 if moved at birth
3. Convert ranks into an estimate of lifetime individual earnings using ACS to compute lifetime income trajectory
4. Multiply by average number of children per LIHTC household in each quartile
5. Compute per unit-month value as present discounted effect (3% discounting) on earnings, divided by 18*12 to convert to monthly

Final estimate: +$182 per unit-month for units in Q1, +$449 per unit-month in Q4

Quantifying potential spillovers on the neighborhood

Back

Use estimates from (Diamond and McQuade, 2019) to estimate effects on neighboring renters, homeowners, and landlords

- Map their eight classifications of Census block groups onto our measure of neighborhood opportunity
  - They split by above/below 50% Black/Hispanic residents + quartiles of median income (in distribution of block groups with LIHTC development)
  - Key assumption: constant effects within each of their neighborhood classifications
- Use their per-household estimates for each group, inflated to 2019$ and multiplied by number of renters, homeowners, and landlords within 1.5 miles
- Divide by 82 to get per-unit number, then amortize over 15 years at a 3$ discount rate

Final estimate: $-$248 per unit-month in Q1, $-$451 per unit-month in Q4

Counterfactual policies that may complement choice of location

Back

What policy levers are available post-construction?

Counterfactual policies that may complement choice of location

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1. **Lower income limits.** Set at 30% Area Median Income (AMI); also reduces rents

Counterfactual policies that may complement choice of location

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1. **Lower income limits.** Set at 30% Area Median Income (AMI); also reduces rents
2. **Income-based rents.** Set rents at 30% of household income at move-in
   ⇝ Mirrors how public housing rents are set

Counterfactual policies that may complement choice of location

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What policy levers are available post-construction?

1. **Lower income limits.** Set at 30% Area Median Income (AMI); also reduces rents
2. **Income-based rents.** Set rents at 30% of household income at move-in
   ⇝ Mirrors how public housing rents are set
3. **Local preferences.** Give households from the neighborhood priority for 50% of units
   ⇝ NYC was sued for this policy

Counterfactual policies that may complement choice of location

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2. **Income-based rents.** Set rents at 30% of household income at move-in
   ⇝ Mirrors how public housing rents are set
3. **Local preferences.** Give households from the neighborhood priority for 50% of units
   ⇝ NYC was sued for this policy
4. **Fair lotteries.** Equalize the lottery weights
   ⇝ Removes any influence of private developers

Effect of post-construction policy changes

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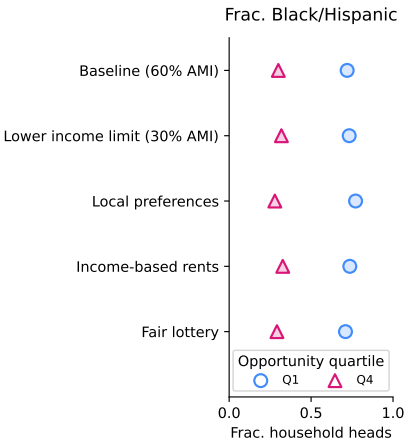

Note: This figure documents the effects of counterfactual processes or parameters on a range of outcomes for developments built in the bottom quartile (Q1) versus top quartile of neighborhood opportunity (Q4). 'Income-based rents' charges households 30% of their income at the time of application. 'Local preferences' requires that at least 50% of new tenants come from the surrounding neighborhood. 'Fair lottery' sets developer lottery weights to zero.

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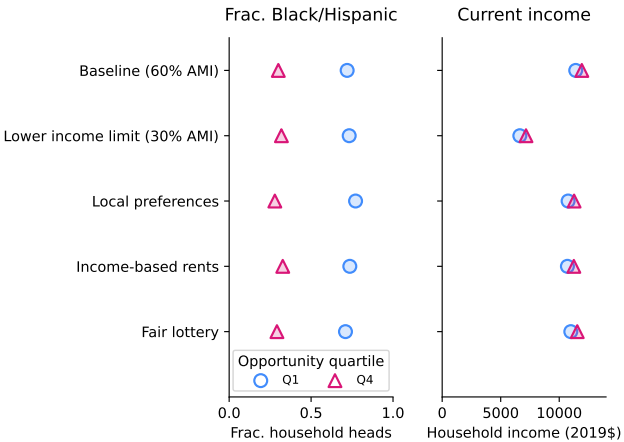

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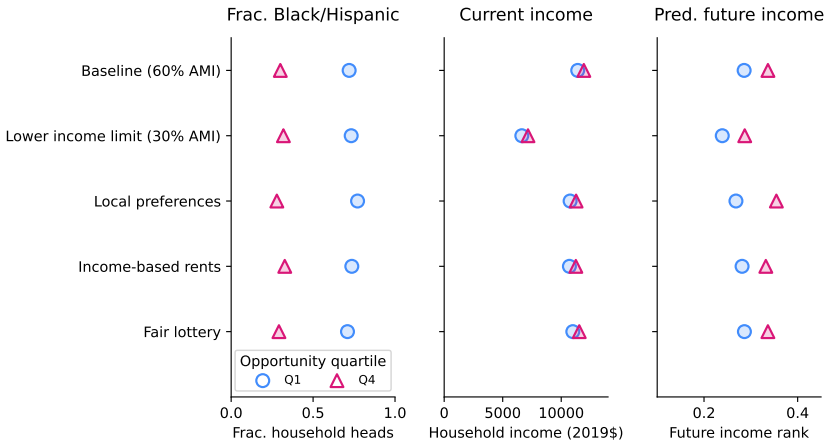

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Effects of counterfactuals on integration

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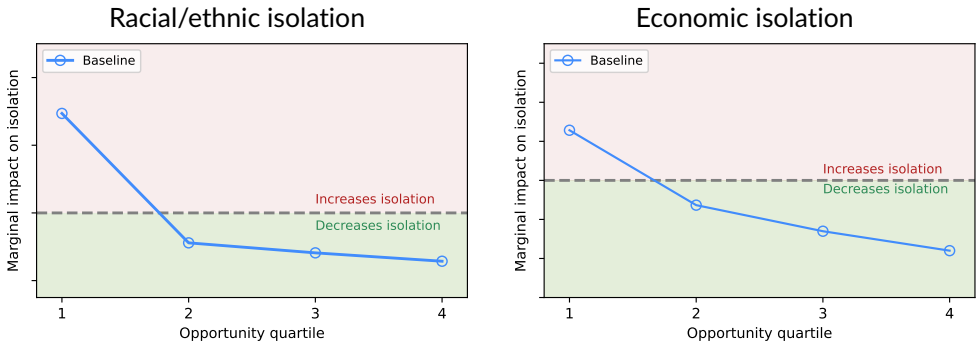

Note: This figure documents the effects of counterfactual processes or parameters on residential integration. 'Income-based rents' charges households 30% of their income at the time of application. 'Local preferences' requires that at least 50% of new tenants come from the surrounding neighborhood. 'Fair lottery' sets developer lottery weights to zero.

Effects of counterfactuals on integration

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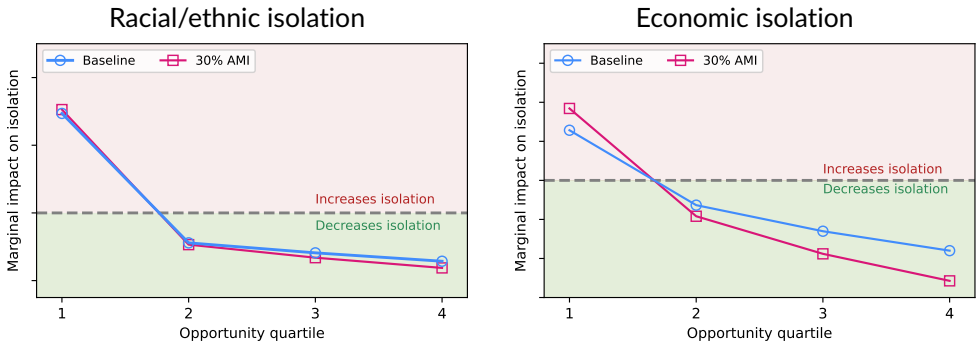

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Effects of counterfactuals on integration

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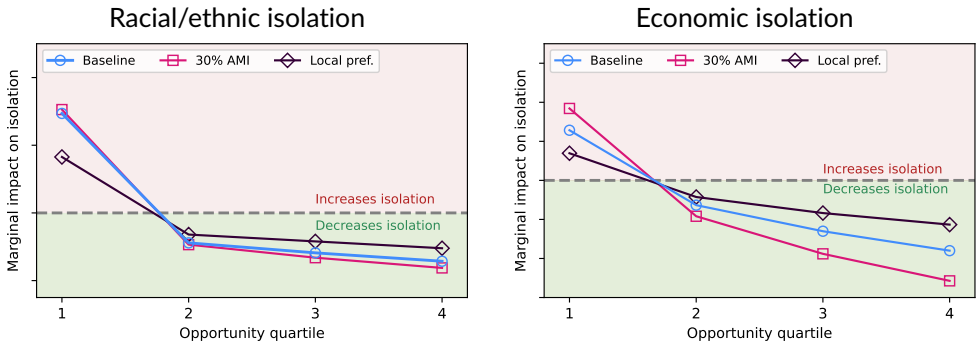

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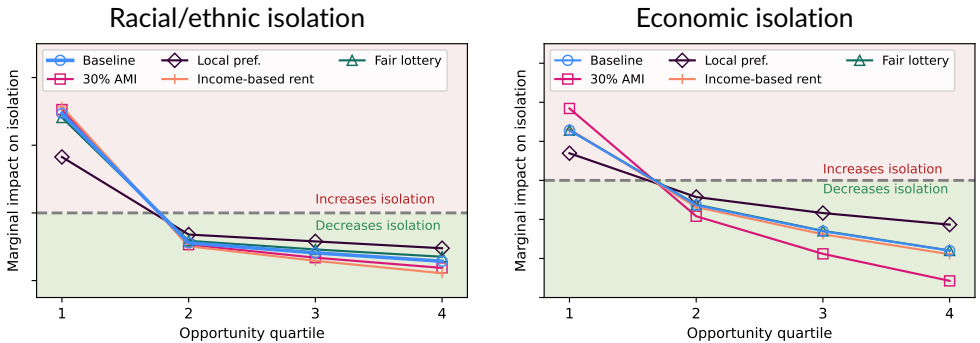

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