Displacement and Infrastructure Provision: Evidence from the Interstate Highway System

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Infrastructure construction displaces millions

- Infrastructure projects spur economic growth and development
  - Highways expand trade and raise output in U.S. cities (Duranton et al., '14; Herzog, '21)
- Construction of such projects is associated with the displacement of residents
  - Around 20M people were displaced in 2011 alone (World Bank, '18)

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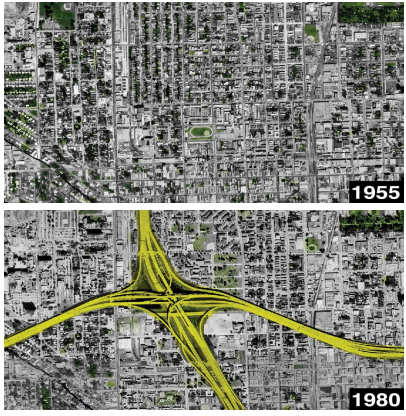
- We know little about the costs to **displaced** individuals and **nearby residents**
- Understanding the cost of displacement is crucial for policy design:
  1. These costs fall disproportionately on vulnerable populations (Penz et al., '11)
  2. Displacement concerns shape policy decisions
     - In 2021, Houston's $9B I-45 expansion was postponed amid displacement concerns

The Interstate Highway System

- Federal-Aid Highway Act of 1956
  - Federal engineers drafted routes. Washington paid 90%
  - But states held final authority over urban placement
- >4,500 km built inside cities: ≈ one million displaced (Schwartz, '75)

Overtown, Miami — before and after I–95



Source: Segregation by Design

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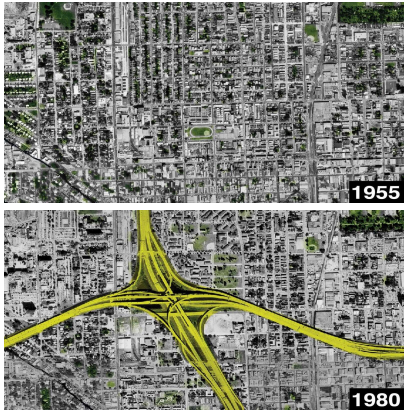

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  - "…to get rid of the local 'n*****towns' " (A. Johnson, AASHO)
- No relocation assistance until 1965
  - Owners got eminent-domain payments; most tenants got nothing

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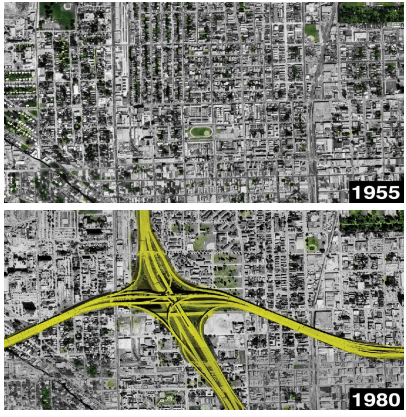

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Literature

Identifying displaced individuals

A novel method to identify who lived in destroyed homes

Identifying displaced individuals requires two steps:

1. Geocode every address in the 1950 census ⬭
   - ArcGIS's 2023 engine; exact lat/long for <u>all</u> metro areas

Neighborhoods in Cleveland, OH

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   - Routes from OpenStreetMap; opening dates from PR511 (Baum-Snow, '07)
   - From 1956 to 1972, **33,100** displaced per year

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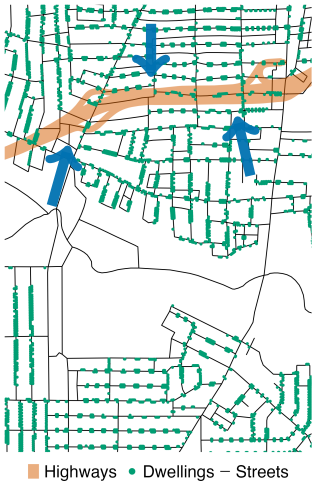

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Link the 1950 census to 1988–2007 death records

- ~26% of mortality records linked to 1950 census
- Includes longevity and the last residence at death

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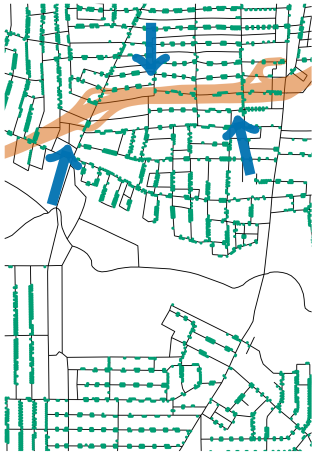

Who was displaced?

Highways built closer to Black and low-income communities

Socioeconomic characteristics by distance to the future highway

$$y_i = \beta_0 \text{ Displaced}_i + \sum_{k \in \mathcal{K}} \beta_k \text{ Bin}_i^k + \mathbf{X}_i' \Gamma + \epsilon_i$$

- Sample: within 7.5 km of a future interstate in 1950
- Displaced_i and Bin_i^k are mutually exclusive distance bins to the future highway
- $\mathbf{X}_i$ includes MSA fixed effects and distance to the city center
- ϵ_i clustered at the MSA level

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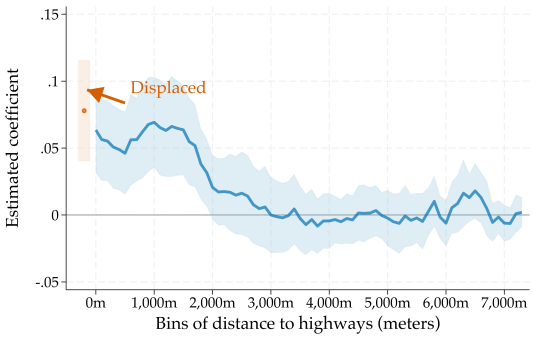
Dep. var.: Black



Highways were built closer to residents who were:

- More likely Black ≈ 7 pp

Yellow book | Census tracts

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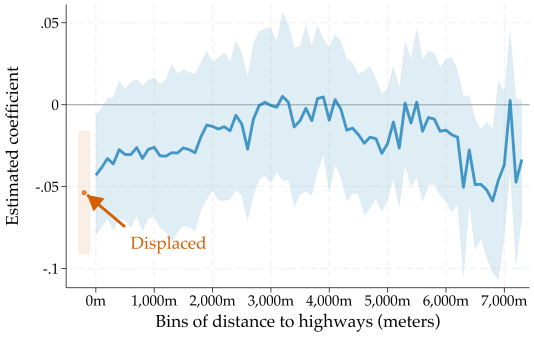
Dep. var.: Income wage (log)



Highways were built closer to residents who were:

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- Earning lower wages ≈ 0.03 log points

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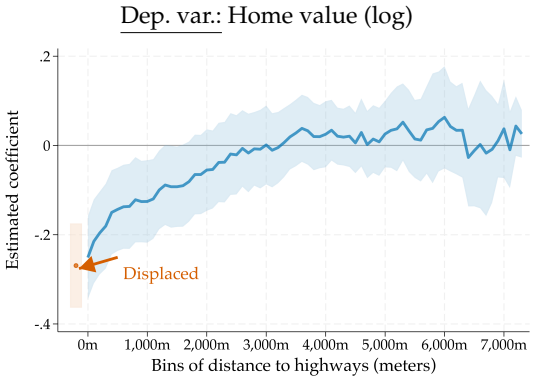

Highways were built closer to residents who were:

- More likely Black ≈ 7 pp
- Earning lower wages ≈ 0.03 log points
- Living in cheaper homes ≈ 0.17 log points

Note: 1940 home value of the dwelling, for households in the same home in 1940 and 1950.

Yellow book | Census tracts

Long-run effects of displacement

Comparing the displaced to their unaffected neighbors

Long-run effects for those displaced by highway construction:

$$y_i = \beta_1 \text{ Displaced}_i + \beta_2 \text{ Adjacent}_i + \mathbf{X}_i' \Gamma + \epsilon_i$$

- Two treatments, with no effect beyond 100 m
  - **Displaced**: homes destroyed by construction
  - **Adjacent**: within 100 m of a new highway

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- Controls $\mathbf{X}_i$: race, gender, birth-year FE, head's occ. score, metro FE ◯

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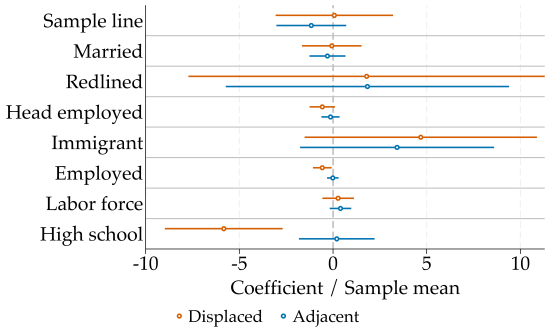
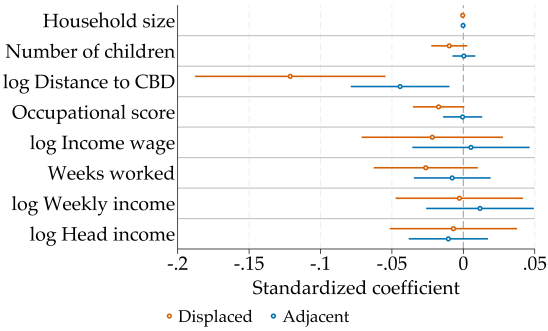
Balance on pre-construction characteristics, with controls:

Pre-trends





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- Controls $\mathbf{X}_i$: race, gender, birth-year FE, head's occ. score, metro FE ○
- Two complimentary strategies to deal with possible threats:
  - Spillovers may still affect the control → match to distant individuals ○
  - Proximity may not be random → compare to unbuilt planned routes ○

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Displaced individuals die approximately one month earlier

Long-run effects for those displaced by highway construction:

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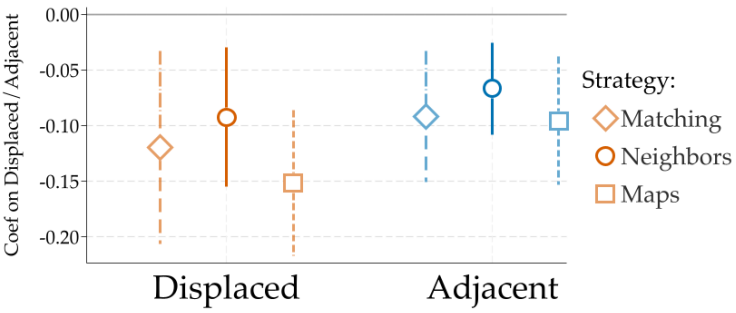
Dep. var.: Death age



Displaced and adjacent **die** younger

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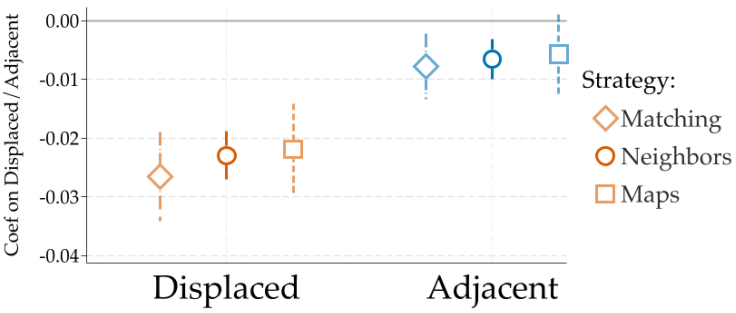
Dep. var.: Same neighborhood



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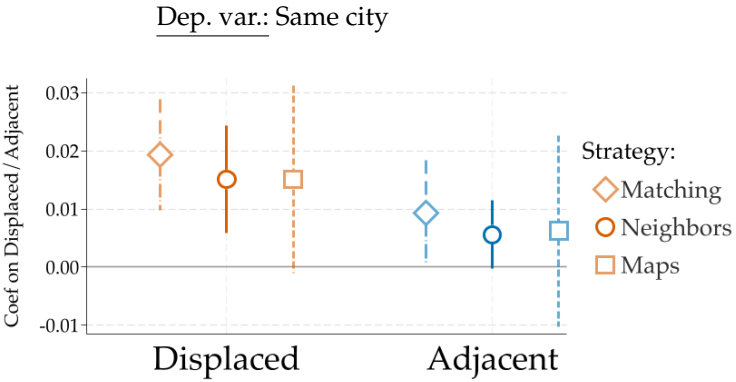

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(R) (H) (G)

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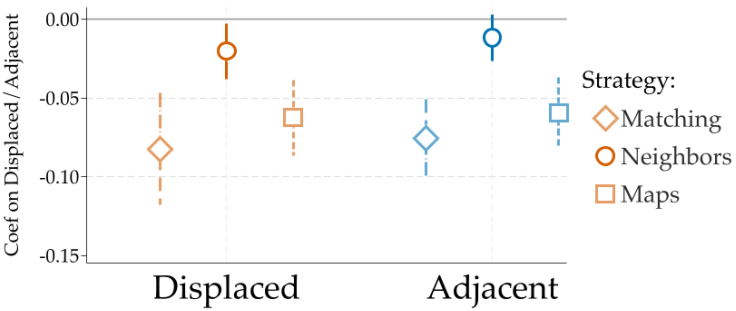
Dep. var.: Neighborhood quality index



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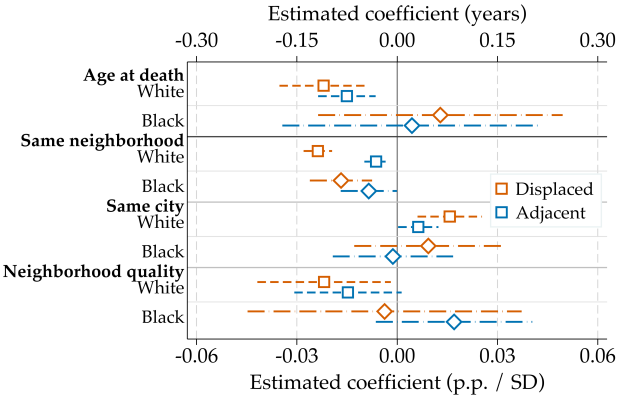
Relocate within the same city

But live in tracts with **lower** overall quality

The costs of displacement differed sharply by race

Main outcomes for displaced and adjacent, split by race:



- The mortality penalty is concentrated among **White** displaced
- No differential effect on **mobility** across race
- The neighborhood-quality decline is likewise **White**-driven

Mechanisms: it was the disruptive move, not the destination

Through what channel could displacement shorten lives decades later?

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⇒ Can **relocation assistance** help mitigate this disruption?

Relocation payments offset nearly all the mortality cost

Exploiting the staggered timing of relocation payments adoption: ○

$$y_i = \gamma_1 \text{Disp}_i + \gamma_2 \text{Disp}_i \times R_i + \delta_1 \text{Adj}_i + \delta_2 \text{Adj}_i \times R_i + \lambda_{y(i)} + \mathbf{X}_i' \Gamma + \epsilon_i$$

Sample: displaced and adjacent individuals linked to mortality records

- $R_i = 1$ if construction began after the state enacted assistance
- $\lambda_{y(i)}$: fixed effect for the year construction began
- γ_2: effect of the payment on the displaced $\rightarrow$ policy test
- δ_2: effect on the ineligible adjacent $\rightarrow$ placebo

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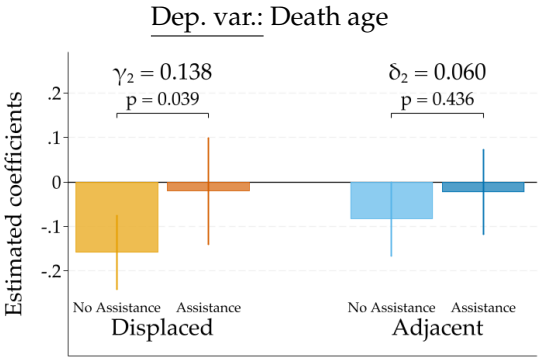

- γ_2: payments raise the longevity of the displaced by 0.138 years
- $\delta_2 \approx 0$: no effect for the ineligible adjacent (placebo)
- But no effect on *where* people ended up ○
- Each $1 spent returned **$15.40** in mortality benefits

Conclusions

Displacement is costly, but payments can offset it

- Highways disproportionately affected vulnerable communities
- Displaced die younger and relocate to worse areas in the same city
- Relocation payments offset nearly all mortality effects

Thank you! You can contact me at: pablo.valenzuela-casasempere@yale.edu

Appendix

Contribution

1. Long-run effects of displacement on individuals
   - Existing work on war and natural disasters (Nakamura et al., '21; Deryugina et al., '18)
   - This paper: focus on policy-induced displacement

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4. Racial legacy of U.S. government policies
   - Federal programs and racial inequality (Derenoncourt & Montialoux, '21; Althoff & Szerman, '25)
   - This paper: provides evidence on race in highway placement

Geocoding benchmark

Using modern locators to geocode historical addresses may lead to measurement error

1. Change in numeration
2. Changes in street names

Use historical street grids for 9 cities to benchmark the accuracy of modern locators

Albany & Buffalo, NY; Cincinnati, Cleveland & Dayton, OH; Louisville, KY; Spokane, WA; Springfield, MA; St. Louis, MO

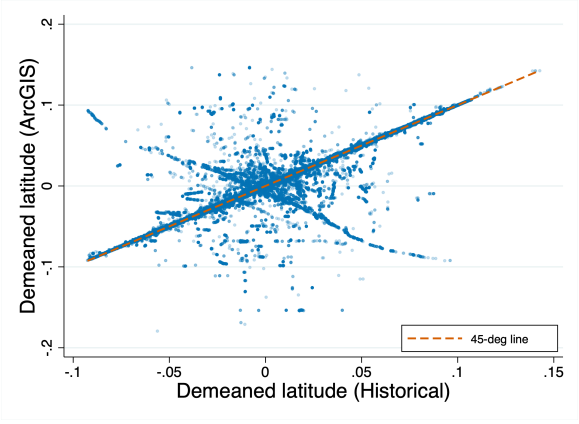
Results:

- Highly correlated treatment assignment with modern geocoding ○
- Correlation between normalized coordinates from modern and historical locators ○
- CDF of distance between the two coordinates ○
- Directional bias in the geocoding error ○

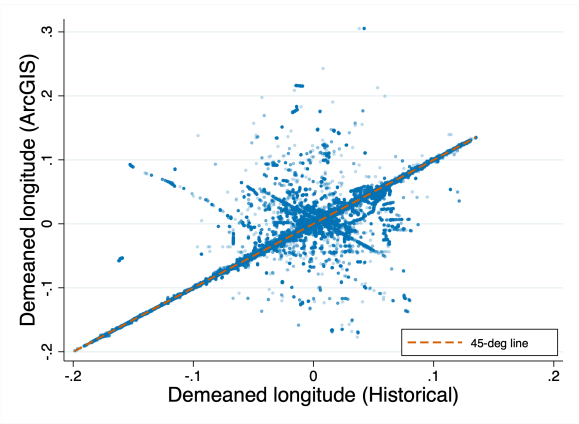
Back

Geocoding benchmark: Correlation of coordinates

Latitude

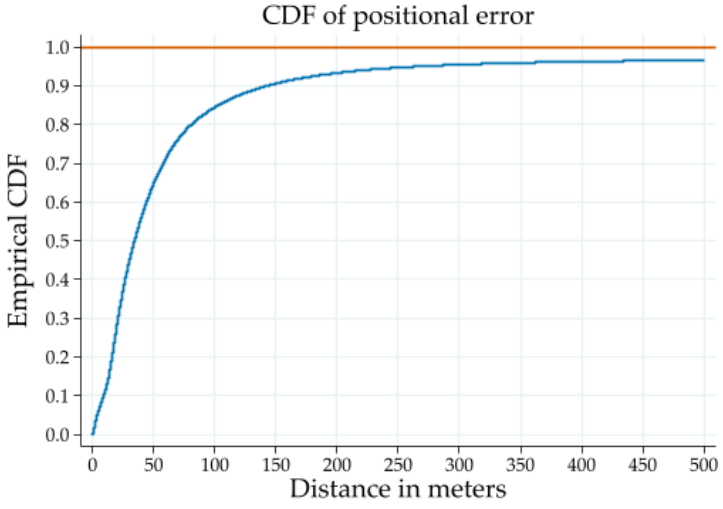


Longitude



Back

Share of addresses with both coordinates within a given distance



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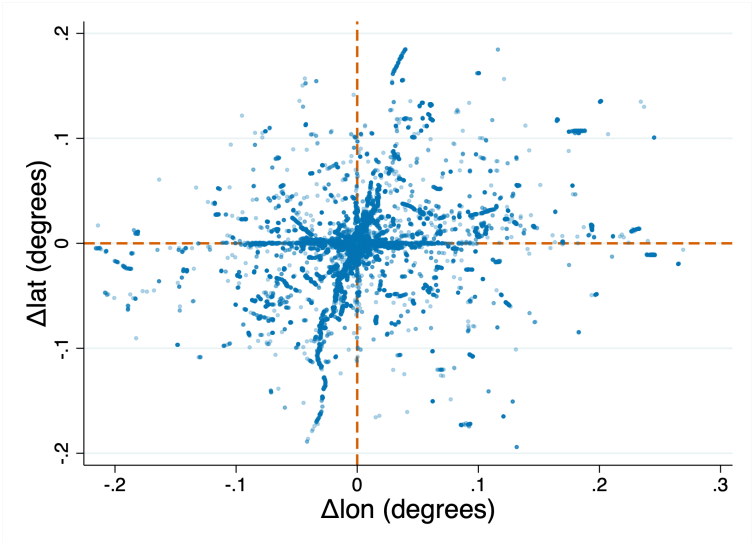
Directional bias in the error of the geocoding



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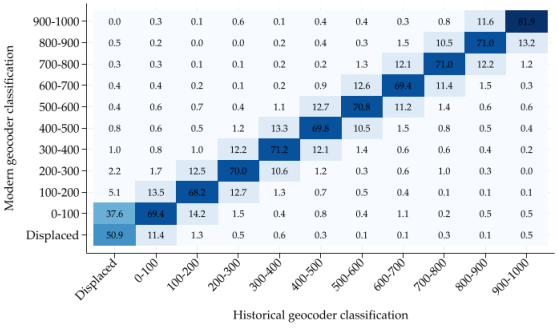
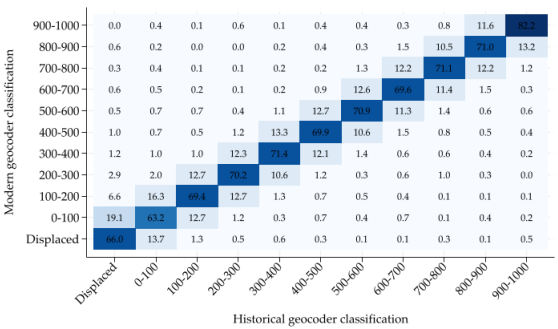
Highly correlated treatment assignment with modern geocoding

All



Excluding 25m



Back

Bounding the effect of displacement

We estimate the following equation:

$$y_i = \beta \cdot D_i^{50} + \epsilon_i$$

where D_i^{50} is a dummy if i lived in 1950 in a house destroyed by construction.

The *true* effect is given by:

$$y_i = b \cdot D_i^{56} + e_i$$

where D_i^{56} is a dummy if i was actually displaced by construction.

The estimated effect corresponds to:

$$\hat{\beta} \xrightarrow{p} \mathbb{E}(y_i|D_i^{50}=1) - \mathbb{E}(y_i|D_i^{50}=0) = b \cdot \Big(\mathbb{E}(D_i^{56}|D_i^{50}=1) - \mathbb{E}(D_i^{56}|D_i^{50}=0)\Big)$$

$$\implies b \in \left[\hat{\beta}, \frac{\hat{\beta}}{\mathbb{P}(D_i^{56}|D_i^{50}=1) - \mathbb{P}(D_i^{56}|D_i^{50}=0)}\right] \approx [\hat{\beta}, 3 \cdot \hat{\beta}]$$

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \, Plan_n + \Gamma' \, \mathbf{X}_n + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \, Plan_n + \Gamma' \, \mathbf{X}_n + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

- **Sample**: census tracts available in 1950
  - Information available for 62 metropolitan areas
  - These cities housed $\approx 2/3$ of the US population in 2010
- Coefficients are not interpreted as causal

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \, Plan_n + \Gamma' \, \mathbf{X}_n + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

- y_n: indicator if a highway was built through the tract

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \boxed{BlackShare_n} + \beta_2 \boxed{\log \mathbf{P}_n} + \beta_3 \boxed{\log DistCBD_n} + \beta_4 \; Plan_n + \Gamma' \; \mathbf{X}_n + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

- $BlackShare_n$: share of the city's Black population living in the tract
- $\mathbf{P}_n$: proxy for the median land price in the tract
  - Median home value
  - Median rent
- $DistCBD_n$: distance to the city's Central Business District

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \boxed{Plan_n} + \Gamma' \, \mathbf{X}_n + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

- $Plan_n$: indicator of planned highways in the tract

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \, Plan_n + \Gamma' \boxed{\mathbf{X}_n} + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

- $\mathbf{X}_n$: factors that affect the tract's probability of construction
  - Population density and income
  - Geographic characteristics
  - Car penetration in the state
  - Metropolitan area fixed effects

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \, Plan_n + \Gamma' \, \mathbf{X}_n + \boxed{\epsilon_n}$$

n: census tract, $c(n)$: MSA of the tract in 1950

- ϵ_n: standard errors clustered at the MSA level

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_n = \beta_1 \, BlackShare_n + \beta_2 \log \mathbf{P}_n + \beta_3 \log DistCBD_n + \beta_4 \, Plan_n + \Gamma' \, \mathbf{X}_n + \epsilon_n$$

n: census tract, $c(n)$: MSA of the tract in 1950

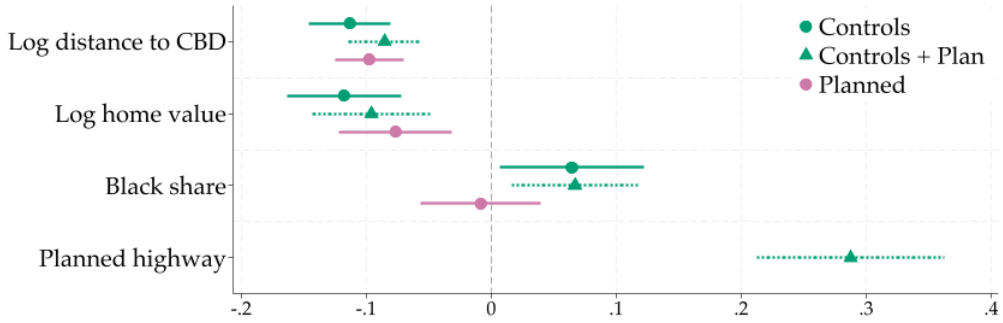
- Informative of the **routing** of built highways

Back

Where are highways built?

Probability of construction as a function of the tract's characteristics in 1950

$$y_{it} = \beta_1 \, BlackShare_{it} + \beta_2 \log \mathbf{P}_{it} + \beta_3 \log DistCBD_{it} + \beta_4 \, Plan_{it} + \Gamma' \, \mathbf{X}_{it} + \epsilon_{it}$$



Back

Was displacement of Black communities inevitable?

- Black families sorted into low-rent downtown areas (Boustan, '10)
- Highways were designed to connect city centers
  → Any counterfactual highway network might also have passed through Black neighborhoods
- I compare characteristics along the Yellow Book plans to the built network

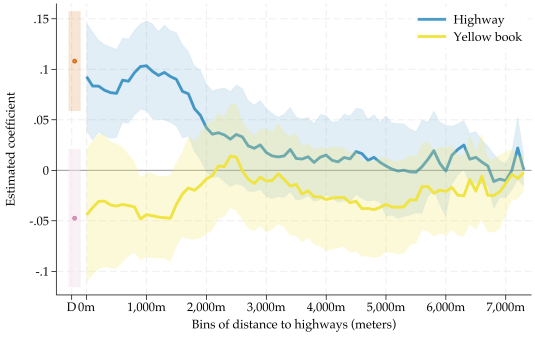
Back

Built highways targeted Black communities more than federal plans did

Socioeconomic characteristics with distance to the highway

$$y_i = \beta_0 \text{ Displaced}_i + \sum_{k \in \mathcal{K}} \beta_k \text{ Bin}_i^k + \mathbf{X}_i' \Gamma + \epsilon_i$$

Dep. var.: Black



Planned routes were:

- Less likely to affect Black residents

Back

Built highways targeted Black communities more than federal plans did

Socioeconomic characteristics with distance to the highway

$$y_i = \beta_0 \text{ Displaced}_i + \sum_{k \in \mathcal{K}} \beta_k \text{ Bin}_i^k + \mathbf{X}_i' \Gamma + \epsilon_i$$

Planned routes were:

- Less likely to affect Black residents
- The difference is statistically significant

Back

Testing for spatial spillovers

The dataset allows us to test for spatial spillovers:

$$y_i = \beta_0 \text{ Displaced}_i + \sum_{k \in \mathcal{K}} \beta_k \text{ Bin}_i^k + \mathbf{X}_i' \Gamma + \epsilon_i$$

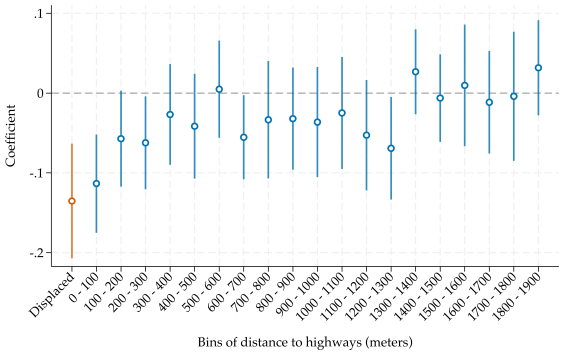
i: individual

- Sample: 1950 census linked to mortality records, within 2 km of highways
- y_i: outcomes at death (age, mobility across neighborhoods and cities)
- β_0, β_k: difference relative to those at 1,900–2,000m
- $\mathbf{X}_i$: gender, race, birth year FE, head's occupational score, city FE Proxy of wealth

Back

Displaced and nearby residents die younger; effects vanish after 100m

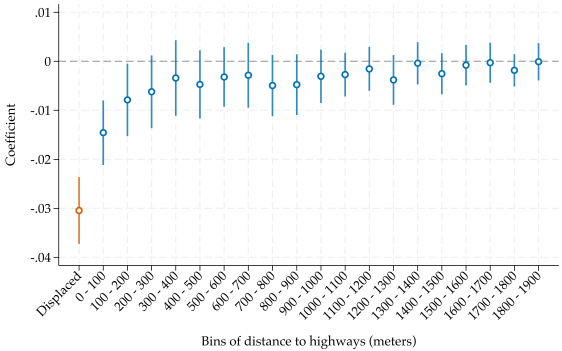
Dep. Var.: Death age



Back

Adjacent residents also leave their neighborhoods

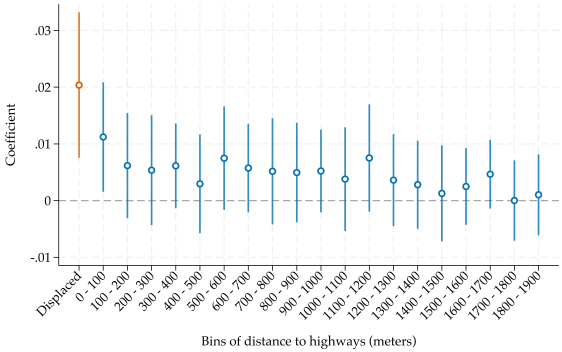
Dep. Var.: Same neighborhood in 1950 and at death



Back

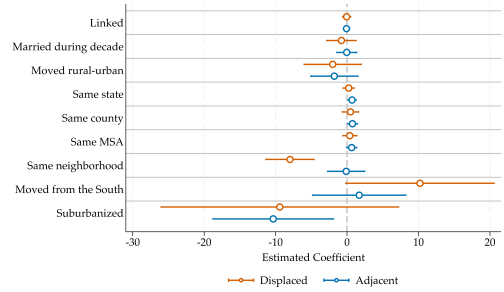
Spillovers do not push people out of the city

Dep. Var.: Same city in 1950 and at death

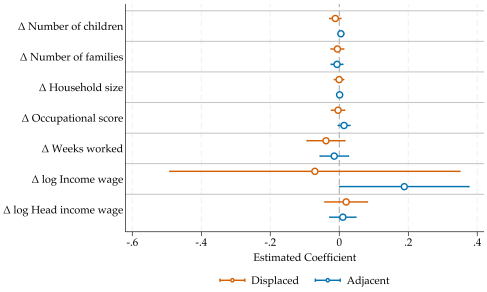


Back

Balance in pre-construction trends



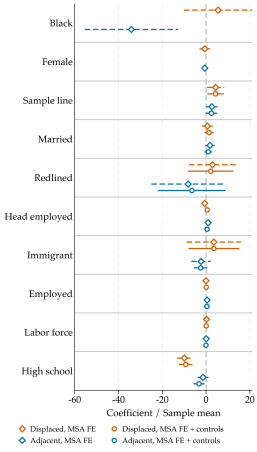
Note: results normalized by sample mean.



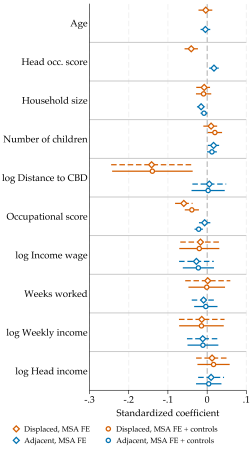
Note: vars. standardized (mean 0, sd 1).

Back

Matching: Balance in pre-construction characteristics



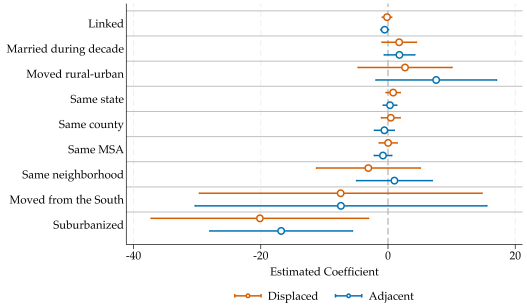
Note: results normalized by sample mean.



Note: vars. standardized (mean 0, sd 1).

Back

Matching: Balance in pre-construction trends



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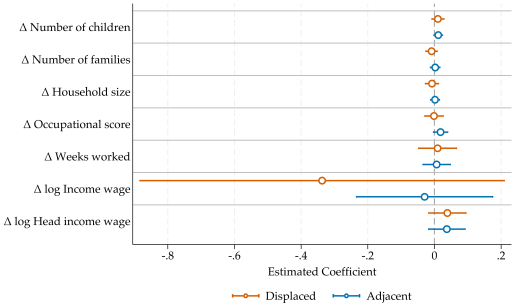
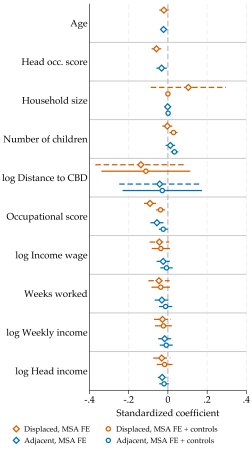


Note: vars. standardized (mean 0, sd 1).

Back

Plans: Balance in pre-construction characteristics

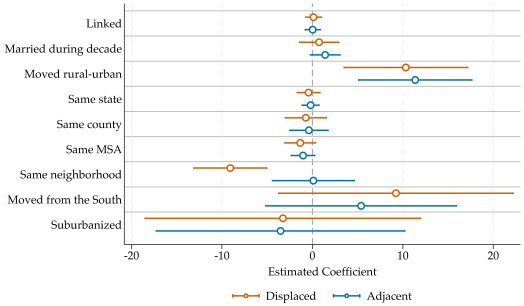
Note: results normalized by sample mean.



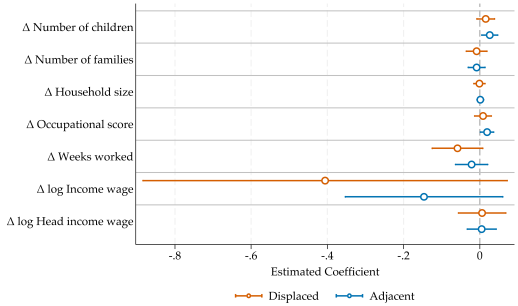
Note: vars. standardized (mean 0, sd 1).

Back

Plans: Balance in pre-construction trends



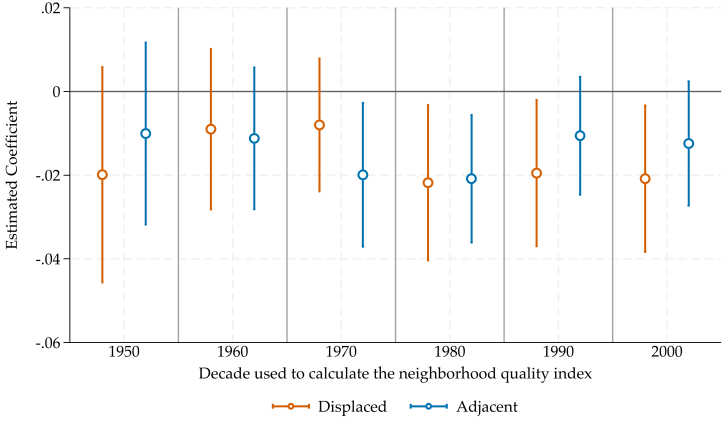
Note: results normalized by sample mean.



Note: vars. standardized (mean 0, sd 1).

Back

Evolution of neighborhood quality over time



Note: Each column runs the same regression, using characteristics of the tract of residence in a different decade.

Back Mechanisms

Robustness

Results not driven by: Robustness 1 Robustness 2

- Different underlying longevity
- Different propensity of outmigration
- Choice of comparison group
- Selective outmigration
- Imbalance in pre-treatment characteristics
- Geocoding errors
- Unrepresentative linked sample
- Mortality truncation

Back

Heterogeneities in the effects of displacement

- How the effects of displacement vary across age
  - Mortality results driven by those displaced between 36-50 years old
  - Not many differences in mobility across age groups
- Heterogeneity by race, gender, family network, and public housing availability
  - Mortality results driven by white individuals & those with high family networks
  - Not many differences in mobility across groups
- Heterogeneity by quality of the neighborhood in 1950
  - Mortality results driven by those living in *worse* neighborhoods
  - Not many differences in mobility across groups

Back

How does displacement affect mortality?

Historical accounts point to several channels:

1. Reduction in job opportunities
2. Worse neighborhood quality
3. Disrupted social networks
4. Distance from the original home
5. Moving to the fringe of cities

I use Gelbach's (2016) decomposition to quantify each channel's contribution

Results Back

Which channel explains the displacement effect?

The estimated effect of displacement on mortality is given by:

$$y_i = \beta_1^{\text{base}} \text{Displaced}_i + \beta_2^{\text{base}} \text{Adjacent}_i + \mathbf{X}_i' \, \Gamma^{\text{base}} + \epsilon_i$$

Controlling for all the channels, the effect is given by:

$$y_i = \beta_1^{\text{full}} \text{Displaced}_i + \beta_2^{\text{full}} \text{Adjacent}_i + \mathbf{X}_i' \, \Gamma^{\text{full}} + \mathbf{Z}_i' \Lambda + \epsilon_i$$

with $\mathbf{Z}_i$ the set of variables capturing the channels

Back

Each channel's contribution equals its gap times its effect on mortality

The contribution of each channel g to the displacement effect is:

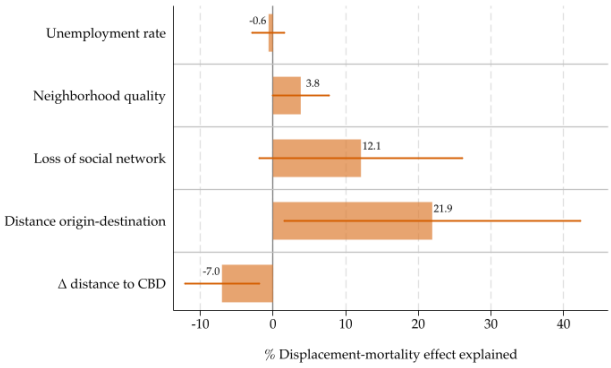
$$\hat{\beta}_1^{\text{base}} - \hat{\beta}_1^{\text{full}} = \sum_g \hat{\delta}_g \quad \text{where} \quad \hat{\delta}_g = \hat{\Pi}_g \times \hat{\Lambda}_g$$

- $\hat{\Pi}_g$: displaced vs. non-displaced gap in channel g
- $\hat{\Lambda}_g$: effect of channel g on mortality in the full model

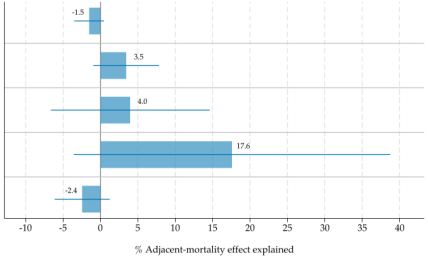
I plot $\hat{\delta}_g$ as a share of the base effect for displaced and adjacent

Back

Networks and distance explain 28% of the mortality effect



Displaced

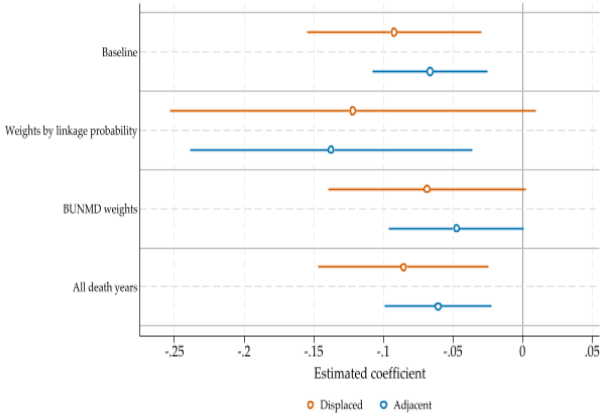


Adjacent

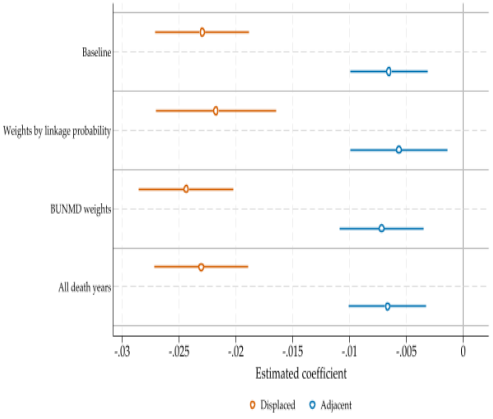
Note: Each bar corresponds to $\hat{\delta}_g / \hat{\beta}^{\text{base}}$ with 95% confidence intervals.

Back

Robustness data



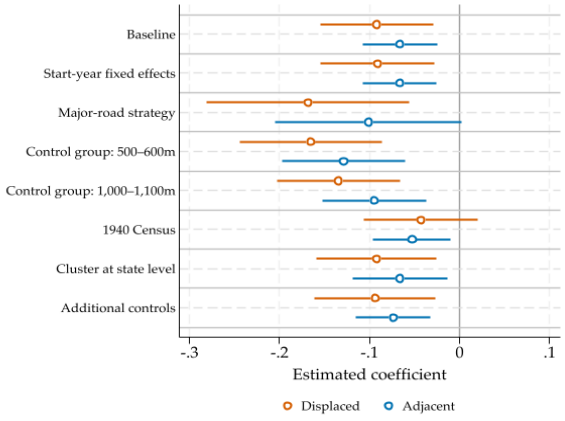
Dep. var.: Death age



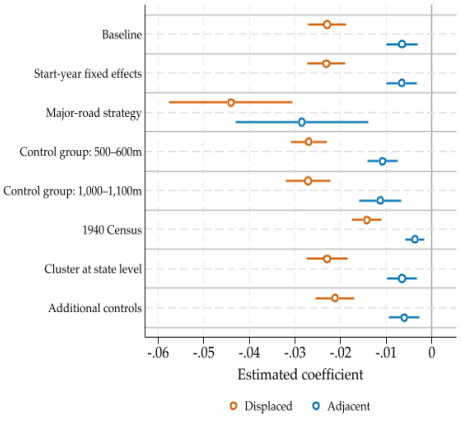
Dep. var.: Same neighborhood

Back

Robustness results



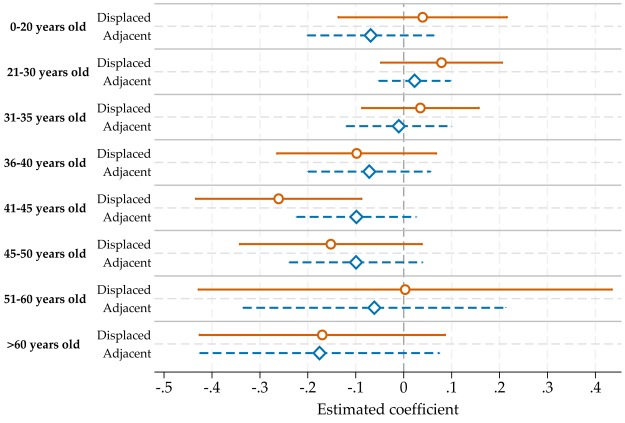
Dep. var.: Death age



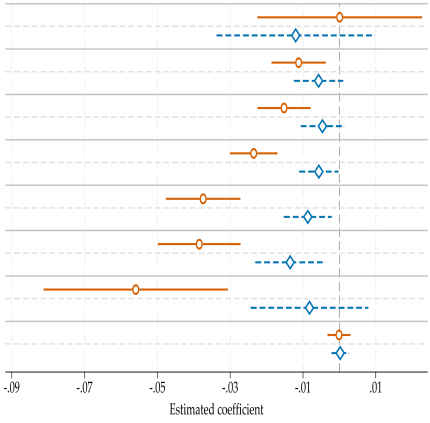
Dep. var.: Same neighborhood

Back

Heterogeneity by age



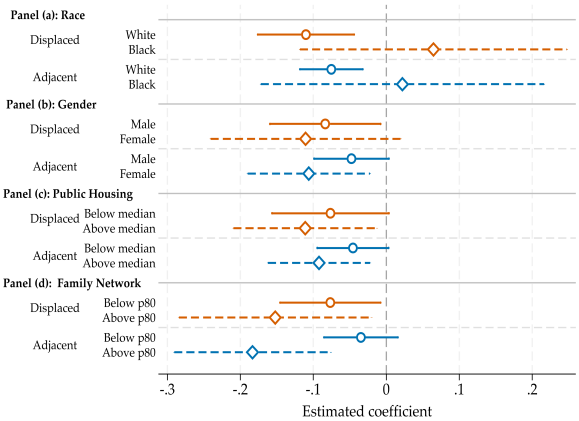
Dep. var.: Death age



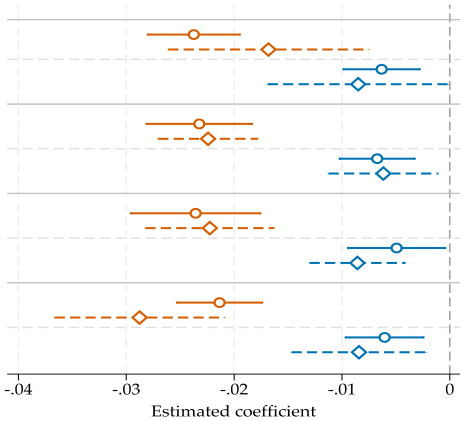
Dep. var.: Same neighborhood

Back

Heterogeneity by race, gender, public housing, and family network



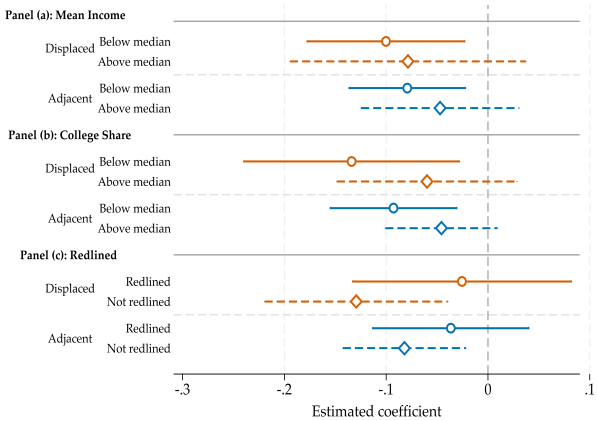
Dep. var.: Death age



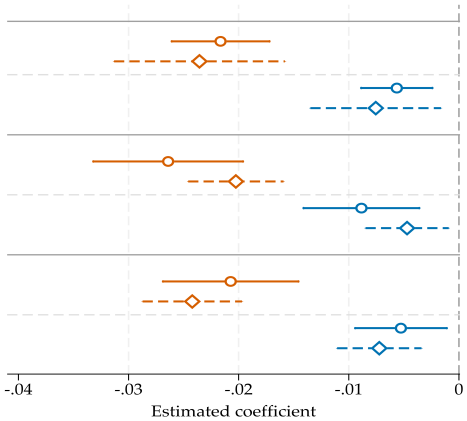
Dep. var.: Same neighborhood

Back

Heterogeneity by neighborhood quality in 1950



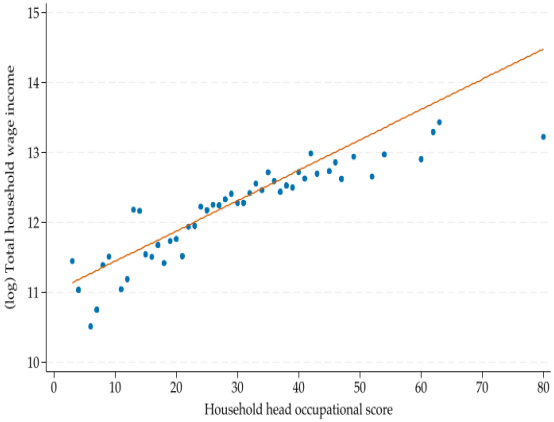
Dep. var.: Death age

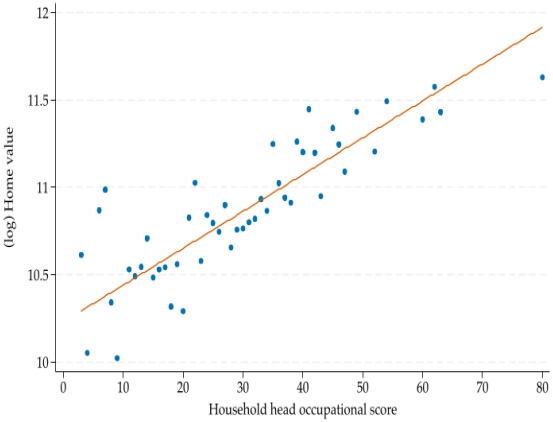


Dep. var.: Same neighborhood

Back

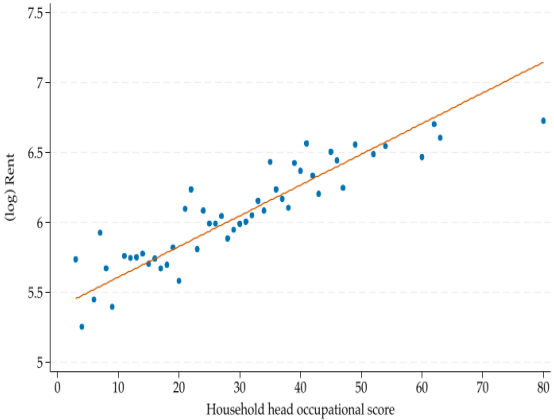
Head occupation score as a proxy for wealth

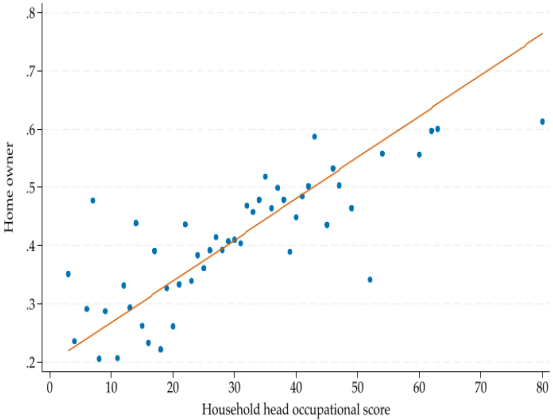




Strategy Spillovers Results

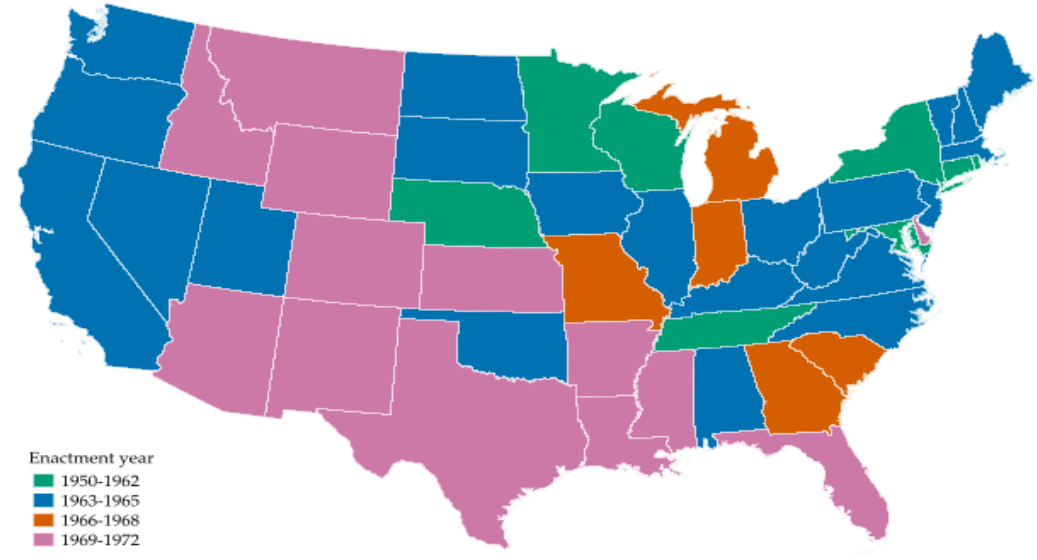
Head occupation score as a proxy for wealth





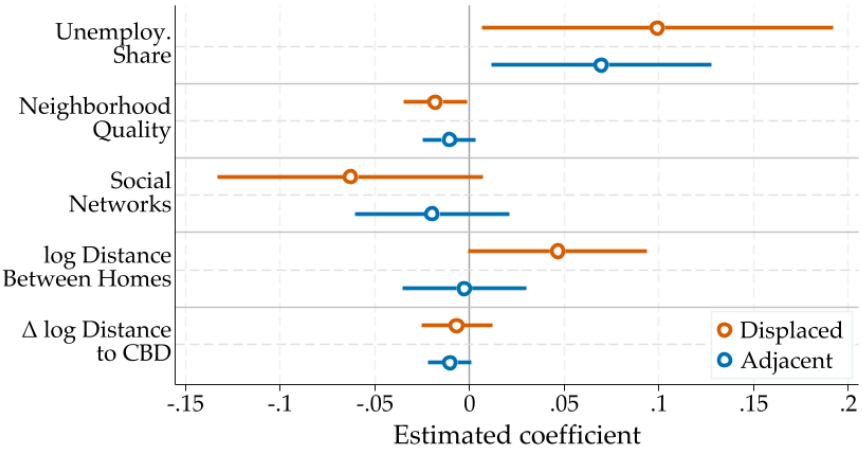
Strategy Spillovers Results

Year of enactment of relocation payment laws



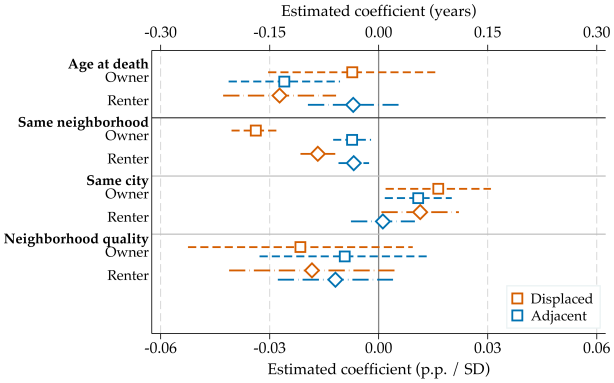
Back

Mediators of the displacement effect on mortality



Back

Not lost wealth: the uncompensated move



- Renters got **no** compensation, yet bear the **entire** penalty ($\approx$0.14 yr)
- Owners: no significant mortality effect, though they leave at 2$\times$ the rate
- Within owners, the home's value is irrelevant
- For adjacent individuals, the destruction of wealth seems to be the main channel

Back

The payment did not change where people ended up

Payments raised longevity but left mobility and destination quality unchanged — easing the *move*, not the destination.

Back