Segregation, Spillovers, and the Locus of Racial Change

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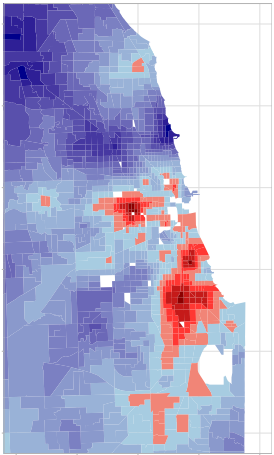
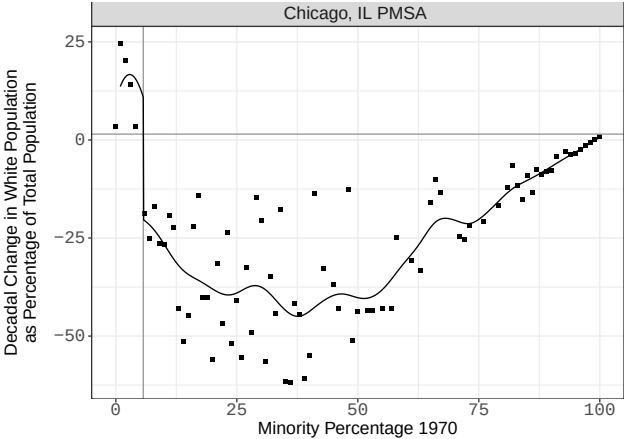
How Shall We Conceive of Racial Neighborhood Change?





Schelling (1971) Foundational for Theories

▸ Literature

	Bounded Neighborhood (*Including Tipping Model*)	**Spatial Proximity** (*Checkerboard Model*)
Partial Equilibrium	Schelling (1971), Becker and Murphy (2000), Card et al. (2008)	
General Equilibrium	Bayer and Timmins (2005), Bayer et al. (2007), Almagro et al. (2023), Weiwu (2023)	Schelling (1971), Möbius and Rosenblat (2001), Zhang (2011), Bagagli (2023)

Neighborhood Choice With or Without Racial Spillovers

Builds on Bayer et al. (2007) and Almagro et al. (2023)

- **Standard discrete location choice model:**

$$v_{ji} = -\alpha_{r(i)} \log(p_j) + \sum_k w_{jk} s_k' \beta_{r(i)} + \eta_{r(i)j} + \epsilon_{ji}$$

- Nested via spatial weights:
  - **Bounded Neighborhood** $w_{jk} = \mathbb{1}\{j = k\}$
  - **Spatial Proximity** $w_{jk} = \frac{\exp(-\kappa d_{jk})}{\sum_l \exp(-\kappa d_{jl})}$
- Asymmetric Homophily: Strong for Whites, Weak (or Zero) for Minorities

Contrasting Predictions of the Models

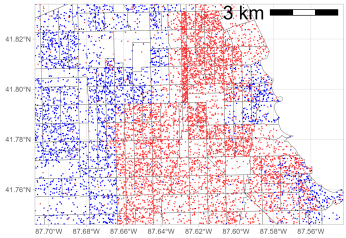
	Bounded Neighborhood	Spatial Proximity
Racial Clusters	Random	Strong Clustering
Racial composition at cluster boundaries	Precipitous Jump	Smooth Decrease
Price gradients at cluster boundaries	Precipitous Jump	Smooth Increase
Locus of Racial Change	Random	At Boundaries of Clusters

Data Description

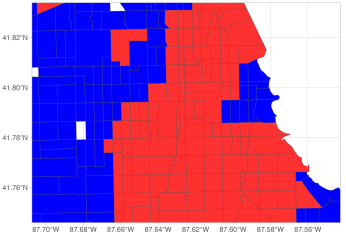
- **Neighborhood Change Database (NCDB)**
  - Same dataset as Card, Mas, Rothstein (2008)
  - Panel of census tract demographics from 1970-2000 on 2000 tract boundaries
  - Metropolitan Statistical Areas (MSAs) using 1999 definitions
  - 35,000+ tracts, 104+ MSAs across all three decades
- **Longitudinal Tract Database (LTDB)**
  - Tract-level housing price data
- **U.S. Census Tract-level Shapefiles**
  - Geographic boundaries for 2000 tracts and MSAs
- **Caveat: Just Two Groups**
  - White Non-Hispanic vs. Minority
  - Robustness: Black (Non-Hispanic) vs. Non-Black

Construction of Clusters and Distance to Boundary

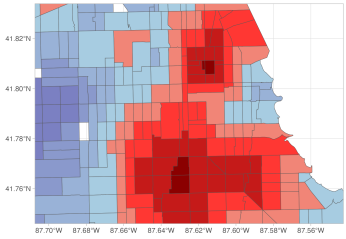
A Novel Visualization of the Data



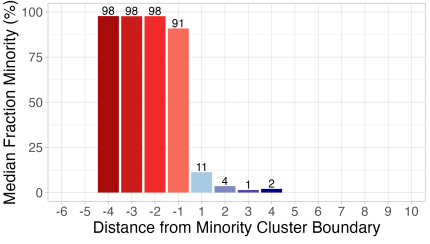
Step 1: Red are Minorities, Blue are Whites.



Step 2: Form Clusters



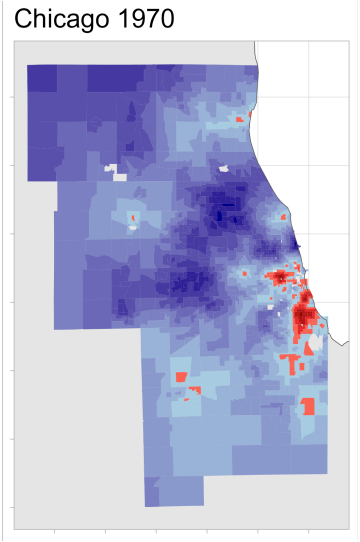
Step 3: Calculate Distance to Boundary

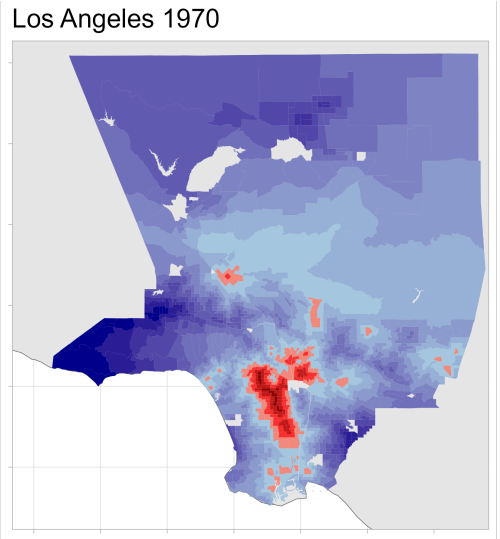


Step 4: Bar Graph of Minority Share

Racial Clusters are a Salient Feature of Individual Cities

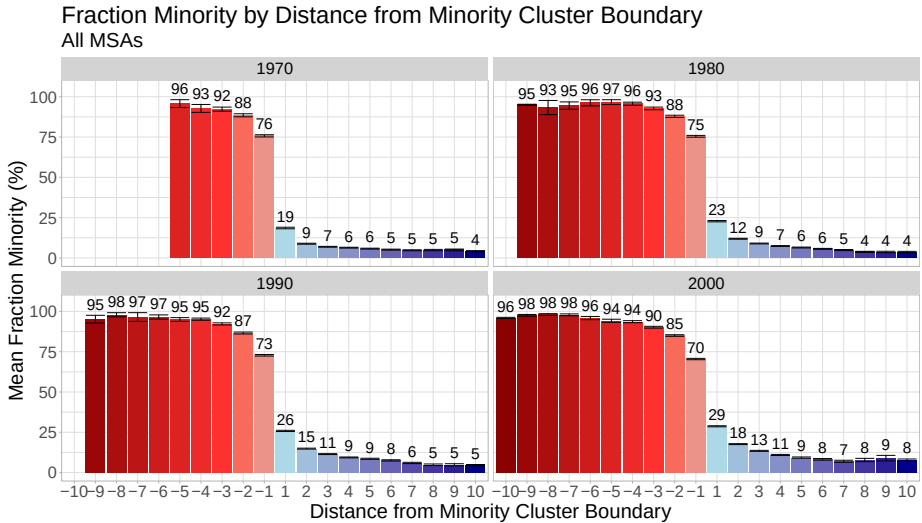
▸ Quantification





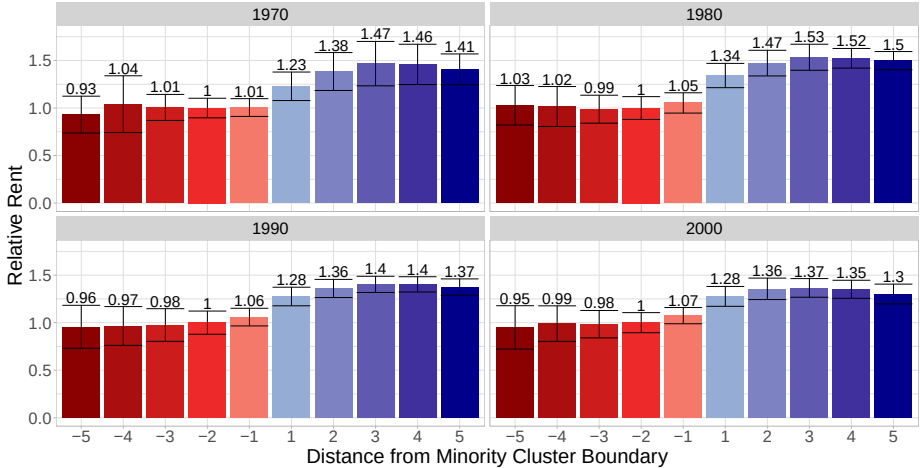
Minority Share in the Cross-Section

▸ Chicago 1970 ▸ Black / non-Black



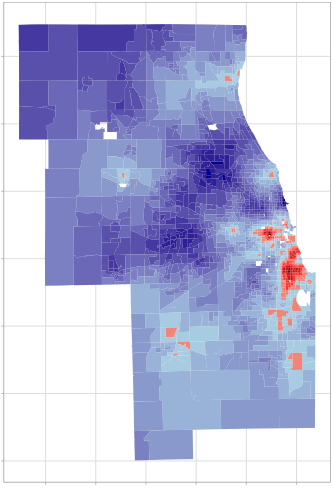
Rent Gradients at Cluster Boundaries

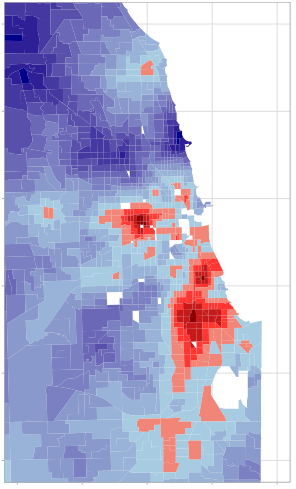
▸ Chicago 1970 ▸ Black/non-Black



Where does drastic racial change occur?

>25p.p. drop in White share. Chicago, 1970-1980

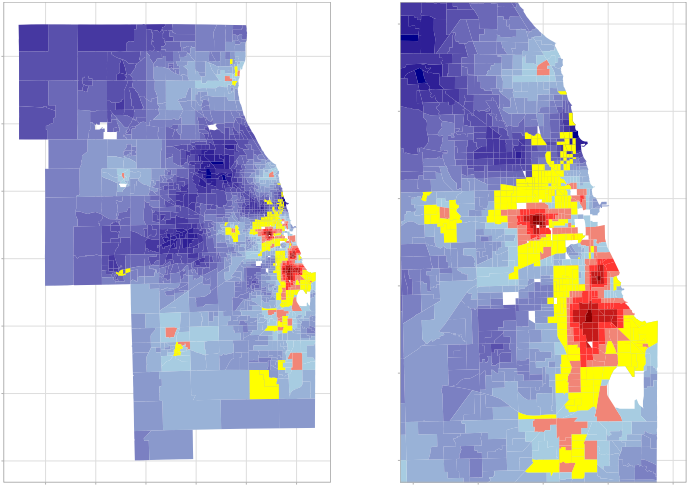




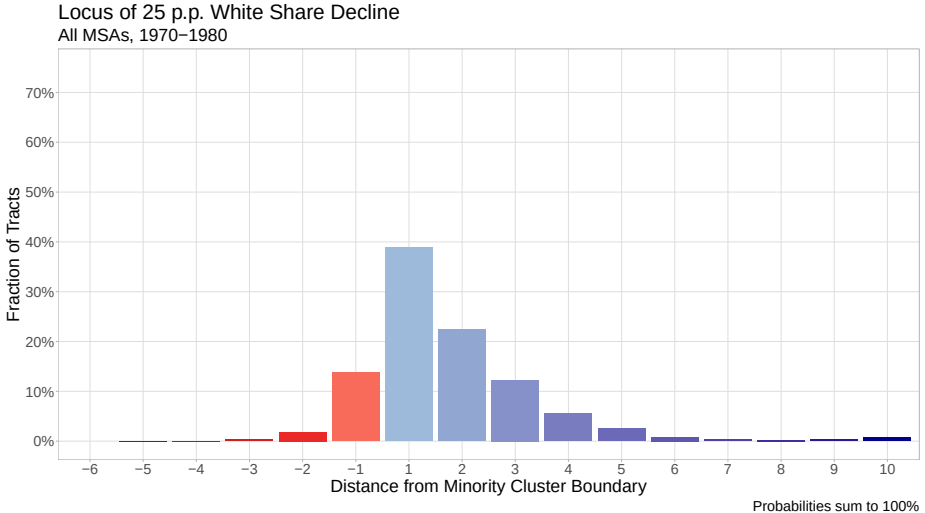
Drastic racial change occurs around racial clusters

▸ 50 p.p.

>25p.p. drop in White share. Chicago, 1970-1980



White Share Declines Concentrated in Boundary Tracts - All MSAs



The Majority of Declines is Connected to the Boundary - All MSAs

Taking Stock

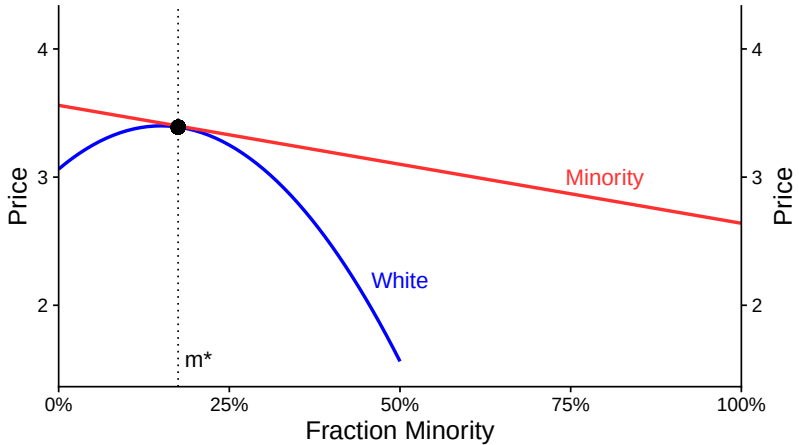
- **Results strongly support spatial proximity model**, most importantly:
  - Importance of racial clusters
  - Change at the boundary of racial clusters

- **Strongly at odds with Card, Mas, Rothstein (2008)** on the locus of racial change
  - "Taken together, [our] results are *not consistent with the predictions of the expanding ghetto model*. Tipping effects are, if anything, strongest far from the existing ghetto." (p. 205)

- **Reconciliation required**

Partial Equilibrium Theory in Card et al. (2008)

Motivation for Reduced Form Analysis



Partial Equilibrium Theory in Card et al. (2008)

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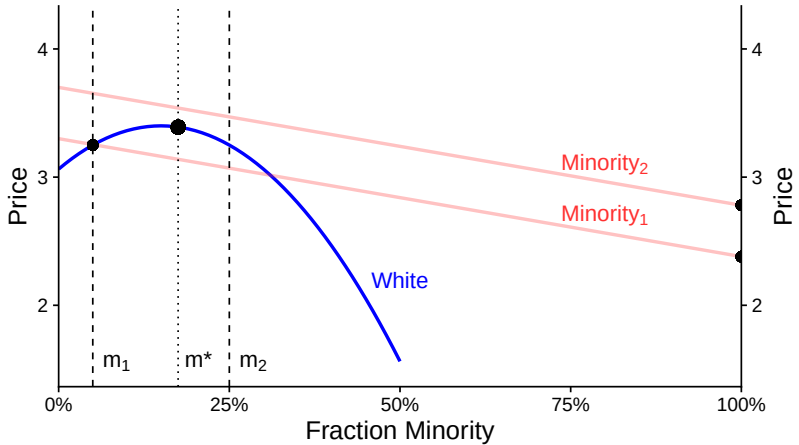


Empirical Approach in Card et al. (2008)

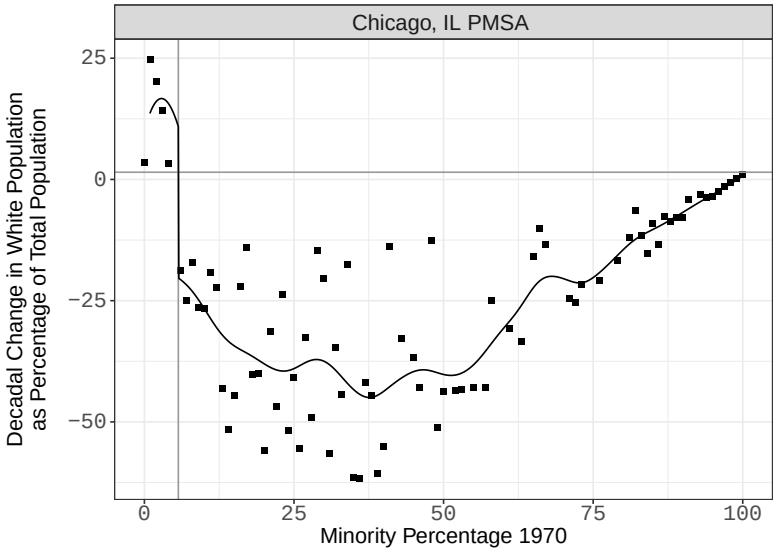
- Split census data into *training* (2/3) and *testing* (1/3)
- Use *training* to find candidate tipping points on MSA-level (s^*_{cm})
- Suggestive evidence of tipping from discontinuous local regressions on MSA-level
- Formal significance tests using global quartic polynomial $f(\cdot)$ on *pooled* data

$$y_{c(j)j} = f(s_{jm}) + \mathbb{1}\{s_{jm} > s^*_{cm}\}\beta + X_{jt}\gamma + \alpha_c + \epsilon_{jt}$$

- $y = \Delta$White Pop$_{t+1}$ / Total Pop$_t$
- Coefficient of interest β
- MSA-fixed effect α_c
- Controls X_{jt}

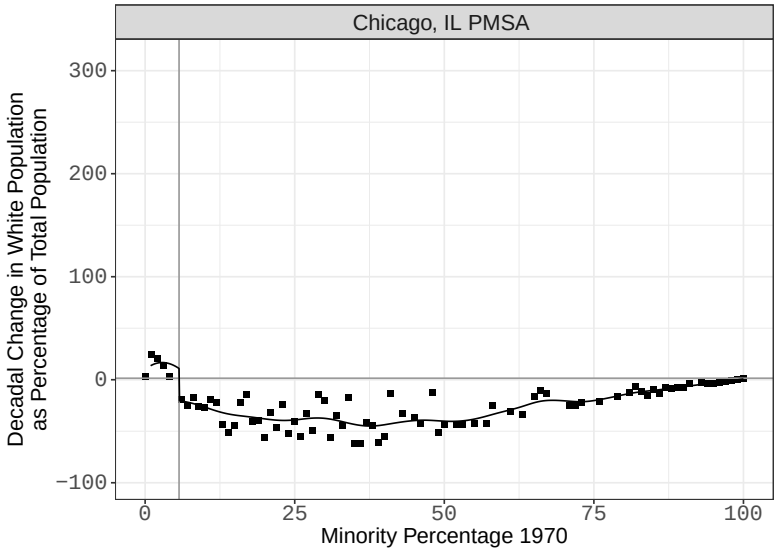
The Case of Chicago, 1970-1980 (Figure I from Card et al., 2008)

▸ Theory



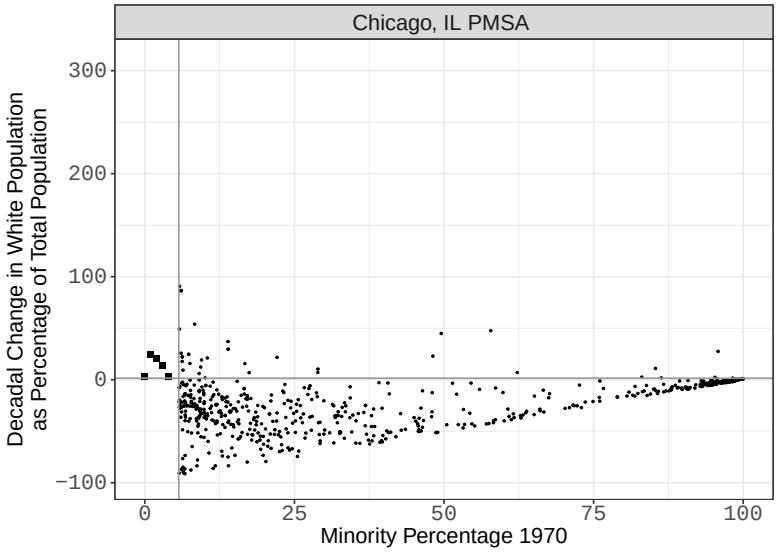
The Case of Chicago, 1970-1980

Theory



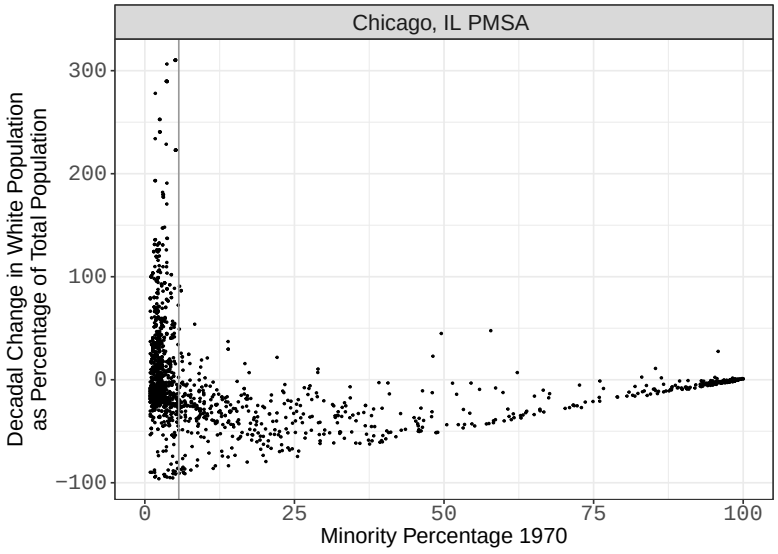
The Case of Chicago, 1970-1980

▸ Theory



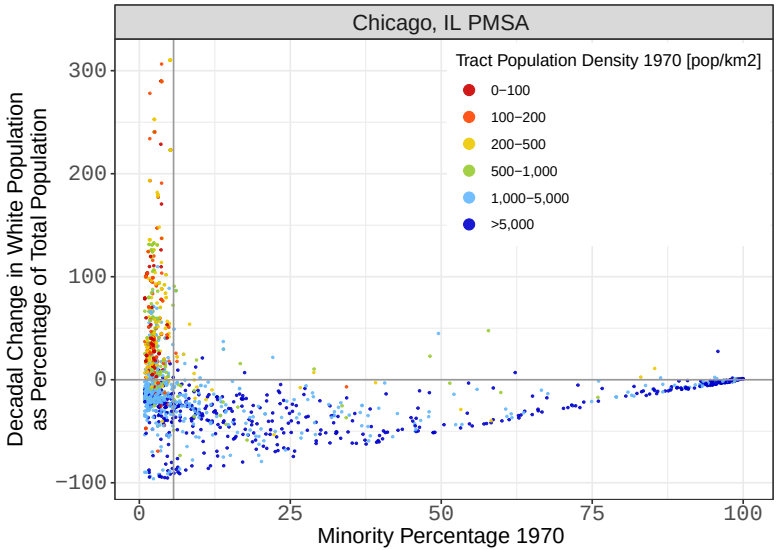
The Case of Chicago, 1970-1980

Theory

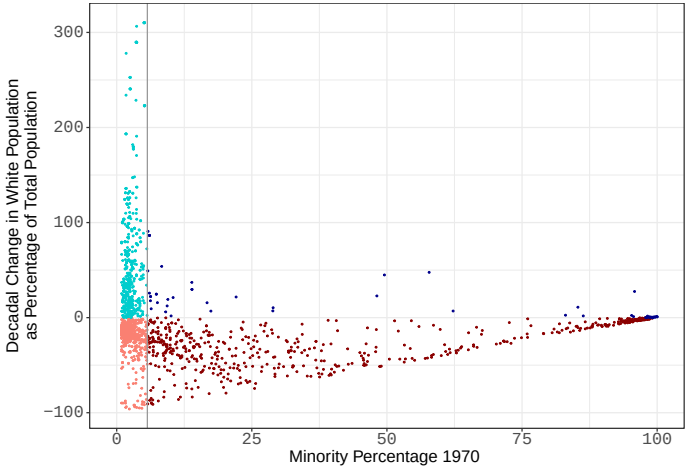


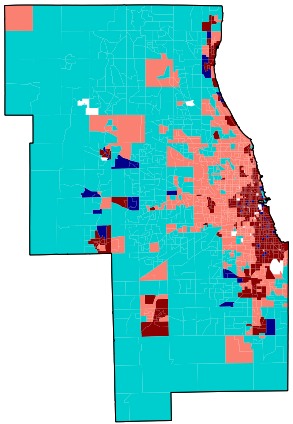
The Case of Chicago, 1970-1980

▸ Initial Population



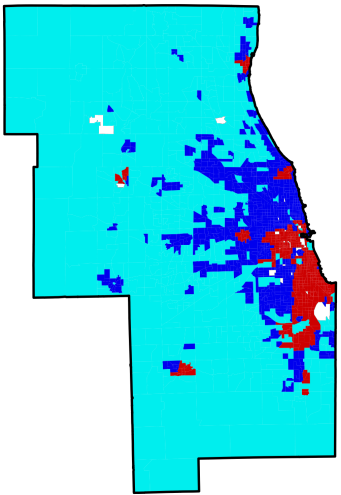
Space in the Case of Chicago (1970-1980)



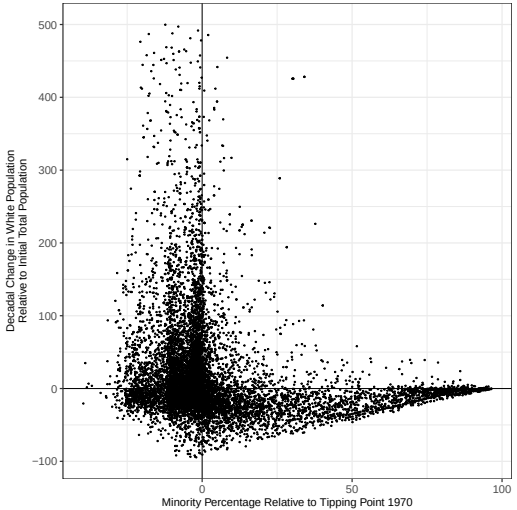


Spatial Stratification for Estimation

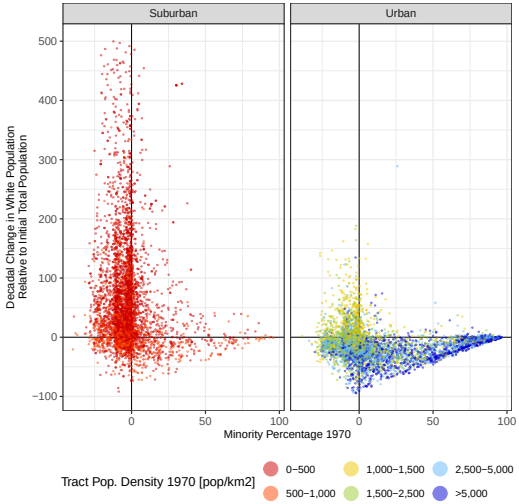
- Approach parallels Card et al. (2008):
  - Global polynomial regression
  - Pool MSAs using fixed effects and controls
- Split sample:
  - **Urban** $\geq$ 1,000 people per km^2
  - **Suburban** $<$ 1,000 people per km^2
- Split urban
  - **More Exposed** $l \leq 2$ (Spatial proximity)
  - **Less Exposed** $l > 2$ (Bounded neighborhood)



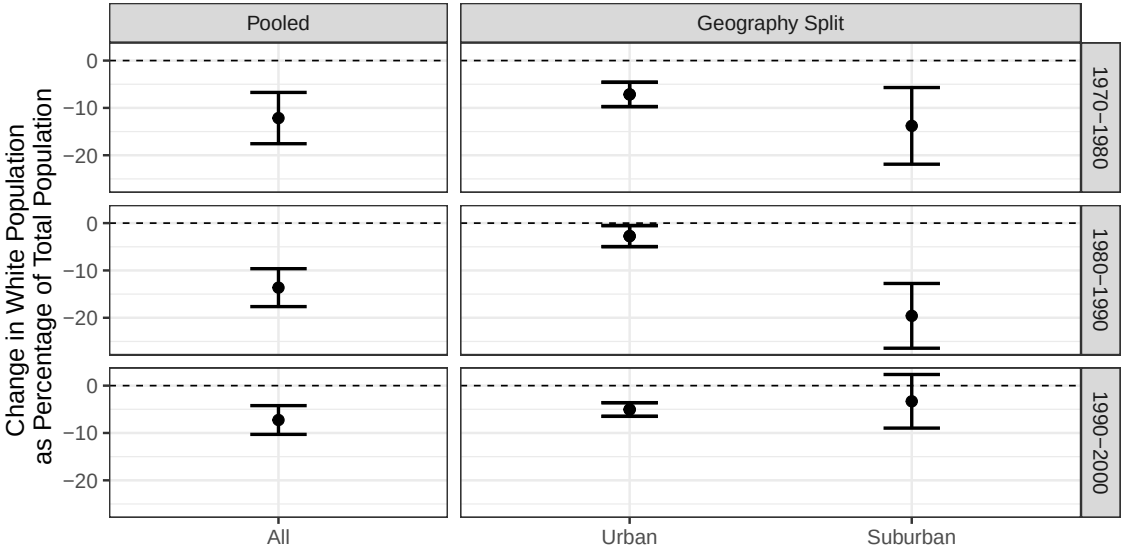
All MSAs Unbinned, 1970-1980



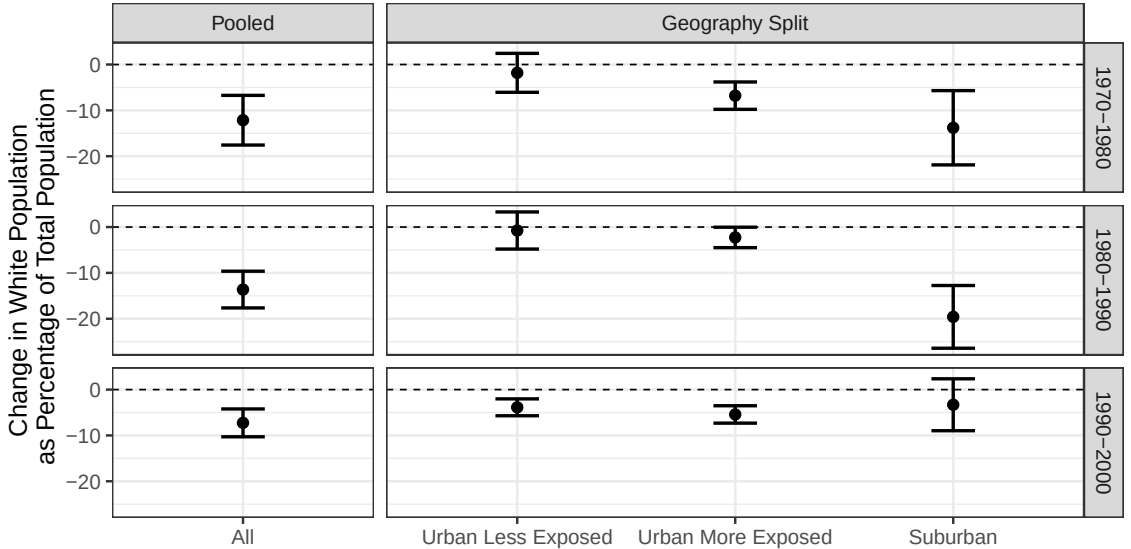
All MSAs Unbinned, Suburban vs. Urban, 1970-1980



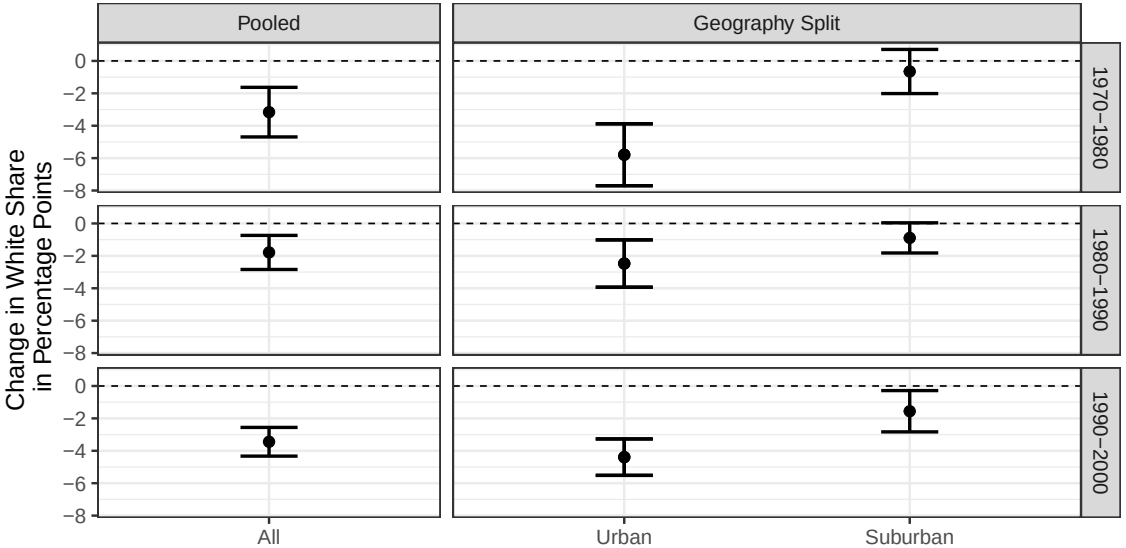
All MSA Regression Results, Urban vs. Suburban, Levels



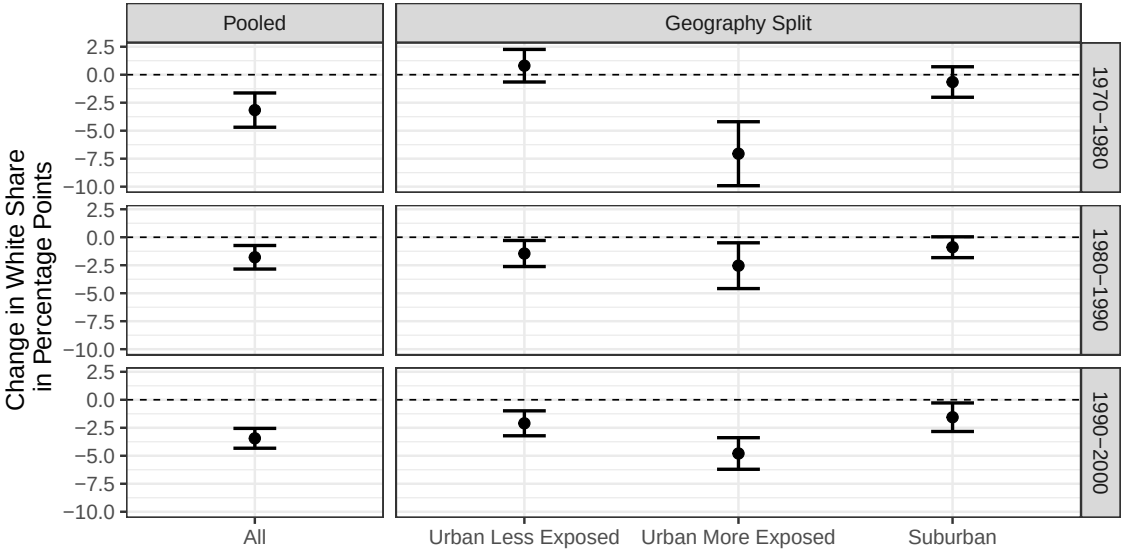
All MSA Regression Results, Levels



All MSA Regression Results, Urban vs. Suburban, Shares



All MSA Regression Results, Shares



Conclusions

Strong support for Schelling's spatial proximity model:

- Importance of racial clusters
- Racial change happens at the boundary of clusters

Tipping framework *seemed* to give strong results, but

- Results actually *highly spatial*
- Prior tipping results largely driven by White *entry* (not exit!) in suburbs
- White exit is concentrated at boundaries of clusters

A *spatial* approach to understanding racial neighborhood change is crucial

Appendix

Related Literature

Back

- Racial segregation patterns in the United States
  Cutler et al. (1999), Boustan (2010), Glaeser and Vigdor (2012), Logan and Parman (2017)
- Theoretical literature on tipping and checkerboard models
  Schelling (1969, 1971); Möbius and Rosenblat (2001); OSullivan (2009); Zhang (2004), Zhang (2011)
- Discrete Choice Models of Neighborhood Sorting
  - Static Models in Urban IO: Bayer and Timmins (2005); Bayer et al. (2007, 2014); Christensen and Timmins (2021), Almagro et al. (2023), Bayer et al. (2022)
  - Static Quantitative Spatial Models:
    Tsivanidis (2023); Couture et al. (2023); Weiwu (2023), Bagagli (2023)
  - Dynamic Models: Bayer et al. (2016); Caetano and Maheshri (2023); Davis et al. (2023)
- Estimation of tipping points
  - Reduced-form approaches: Card et al. (2008), Easterly (2009)
  - Structural approaches: Caetano and Maheshri (2017); Blair (2023)

Parameters for Simulation

Back

Symmetric:

- Price sensitivity $\alpha_m = \alpha_w = 20$
- Location parameters $\eta_{rj} = 0$

Asymmetric:

- Group sizes: $N_m = 30$ and $N_w = 70$
- Racial preferences $\beta_m = 0$ vs. $\beta_w = 8$
- Spatial weights
  - No spillovers (100% own location):

$$w_{jk} = \mathbb{1}\{j = k\}$$

  - Spillovers (45% own, 45% neighbors, 10% remaining locations):

$$w_{jk} = \exp(-\kappa d_{jk}) / \sum_l \exp(-\kappa d_{jl}) \quad \text{with} \quad \kappa = 15$$

- White racial preferences imply semi-elasticity: 1 pp increase in Minority share is compensated with 0.4% price decrease

Simulations and Equilibrium Solver

Back

Solver mimics frictionless dynamic and myopic movement of households:
(similar to Almagro et al., 2023)

1. Randomly initiate Minority shares: $s_j^{(0)} \overset{iid}{\sim} \text{Uniform}(0, 1)$.
2. Given $s_j^{(t)}$, find prices $p_j^{(t)}$ that equilibrate aggregate demand D_j and housing supply H_j at each location. (Contraction Mapping)
3. Given $s_j^{(t)}$ and $p_j^{(t)}$, update racial compositions $s_j^{(t+1)}$.
4. Repeat steps 2 and 3 until convergence.

Simulated Equilibrium Minority Shares

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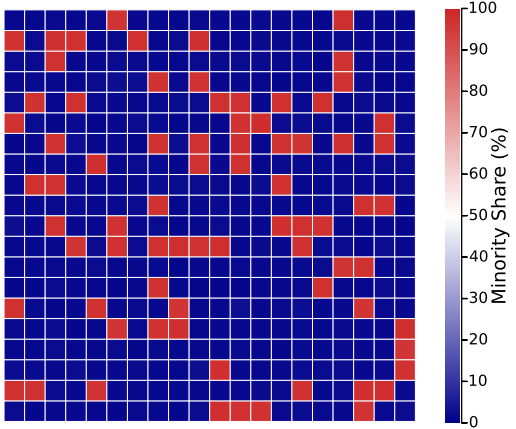
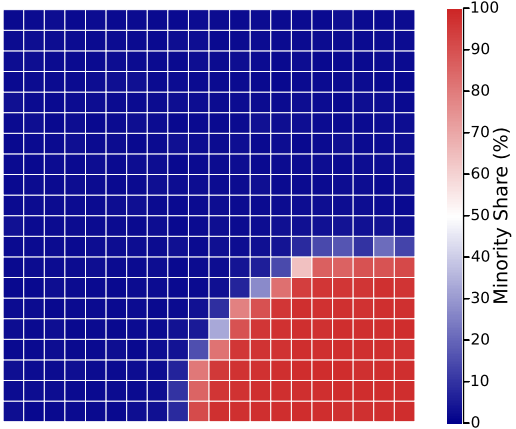
Random vs. Strong Minority Clustering





Simulated Equilibrium Minority Shares

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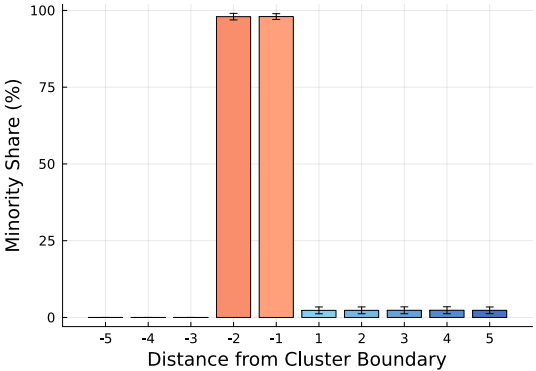
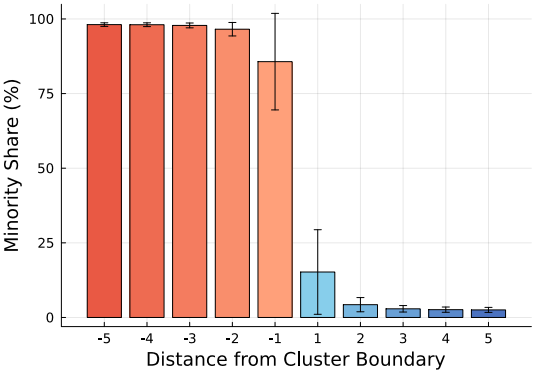
Precipitous vs. Smooth Gradients





Simulated Prices

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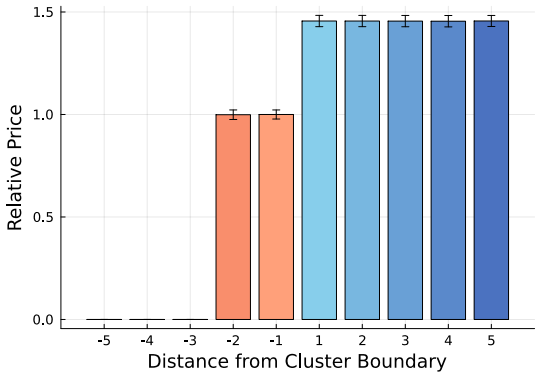
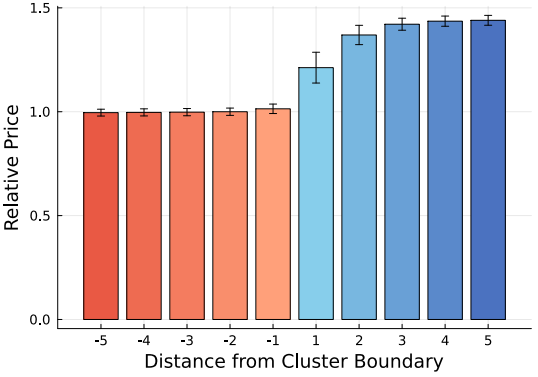
Whites Pay a Premium Rising Sharply vs. Smoothly From Cluster Boundary





Segregation Dynamics in Simulated Spatial Proximity Model

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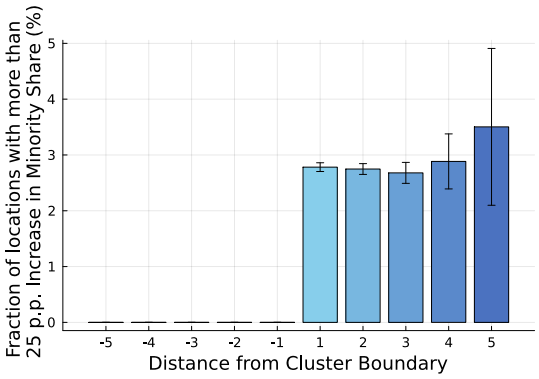
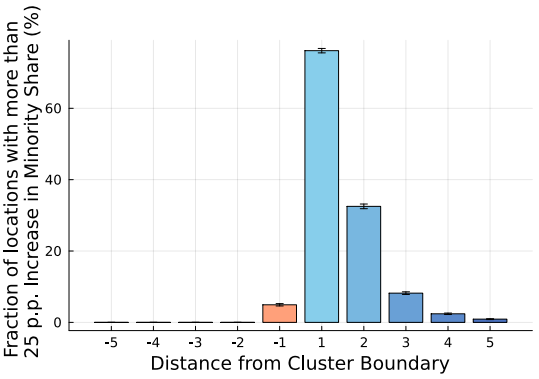
Racial Change Concentrated at Cluster Boundary





Clusters Central to Life in US Cities as a Whole

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Percentage Population living in Own-Race Clusters by Minimum Cluster Size

Year	Minority Share	5 Tracts	10 Tracts	20 Tracts
1970	18	89	88	86
1980	24	86	85	84
1990	29	83	83	81
2000	36	80	79	78

Note: All numbers in %

By race

Clusters are Ubiquitous Feature of US Cities

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Percentage Population living in Own-Race Clusters by Minimum Cluster Size

Year	Minority Share	5 Tracts			10 Tracts			20 Tracts		
		All	W	M	All	W	M	**All**	W	M
1970	18	**89**	96	54	88	96	49	**86**	96	42
1980	24	**86**	95	58	85	95	55	**84**	95	49
1990	29	**83**	94	58	83	93	56	**81**	93	52
2000	36	**80**	90	62	79	90	60	**78**	89	57

Note: All numbers in %

Minority Share in the Cross-Section - Chicago 1970

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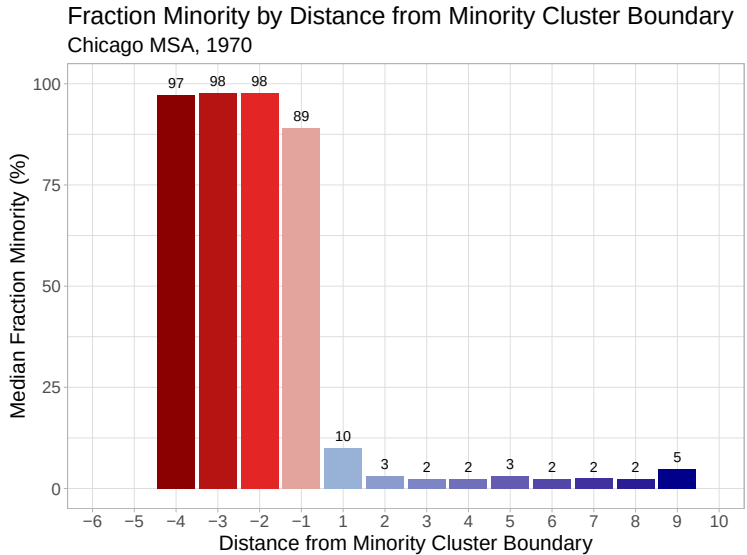
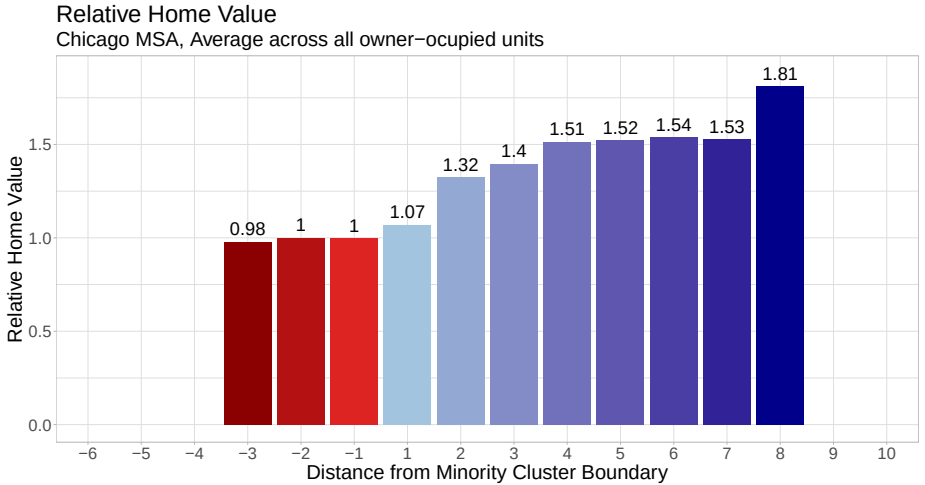


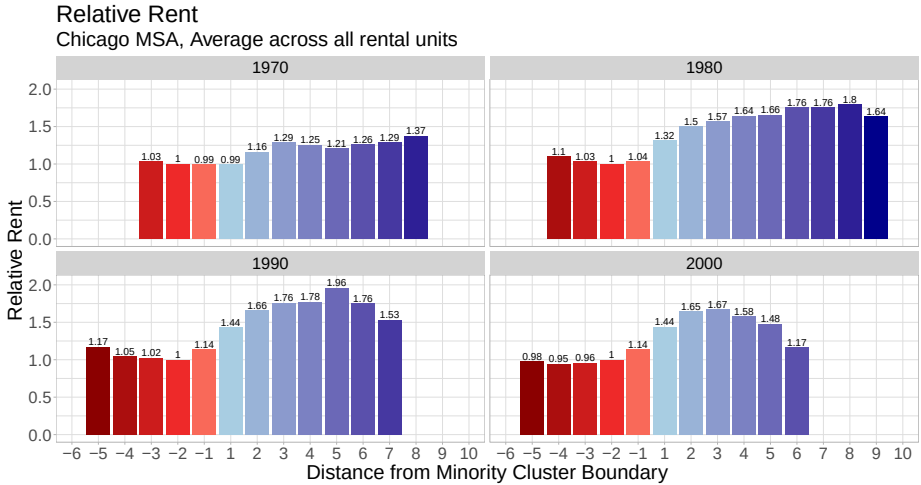
Price Gradients at Cluster Boundaries - Chicago 1970

Back



Rent Gradients at Cluster Boundaries - Chicago

Back

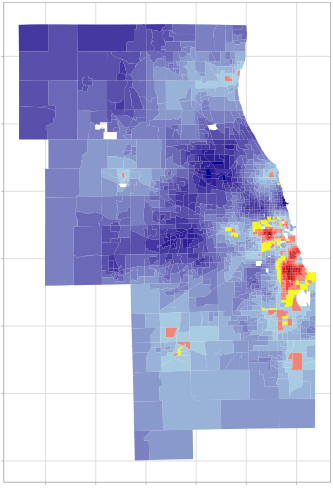


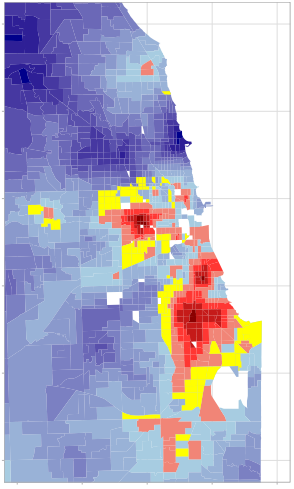
Average median rent normalized by rents at a distance of −2.
Bars based on less than 10 observations dropped.

Drastic racial change occurs around racial clusters

Back

>50p.p. drop in White share

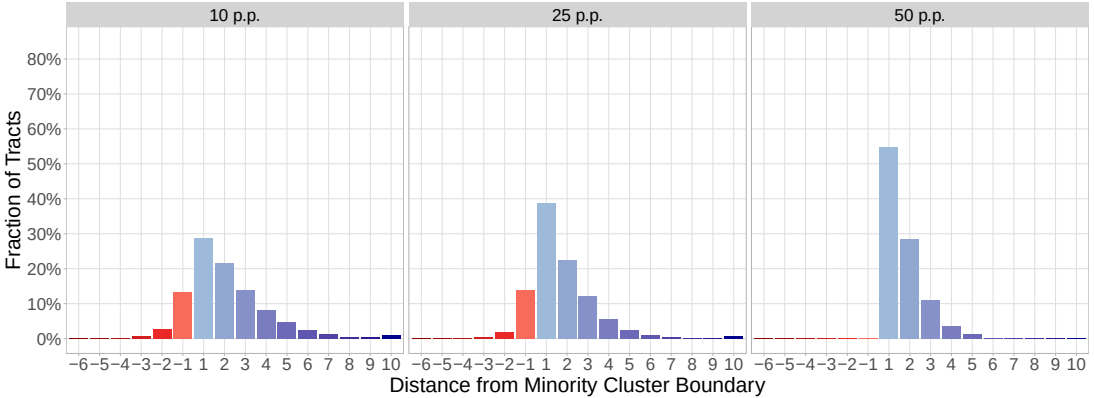




White Share Declines Concentrated in Boundary Tracts - All MSAs

Back

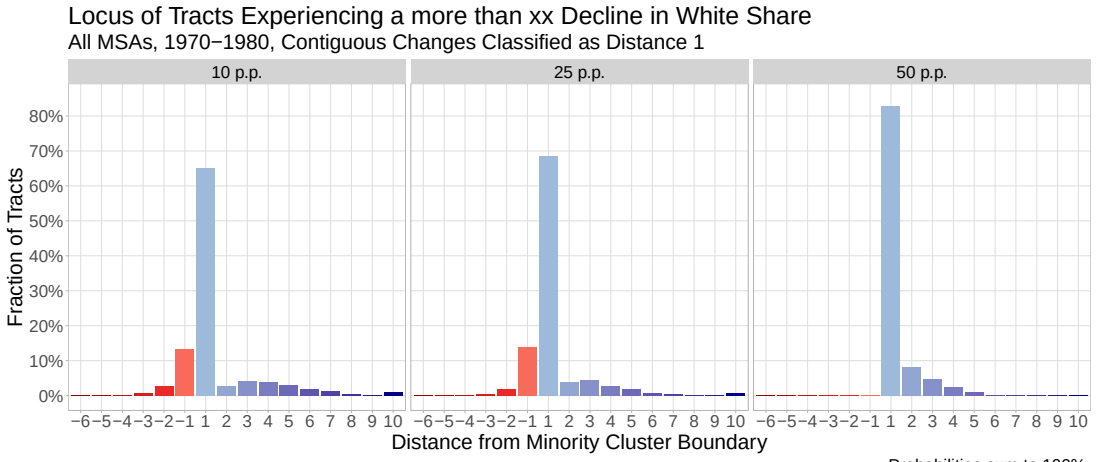
Locus of Tracts Experiencing a more than xx Decline in White Share
All MSAs, 1970−1980



Probabilities sum to 100%.

The Majority of Declines is Connected to the Boundary - All MSAs

Back

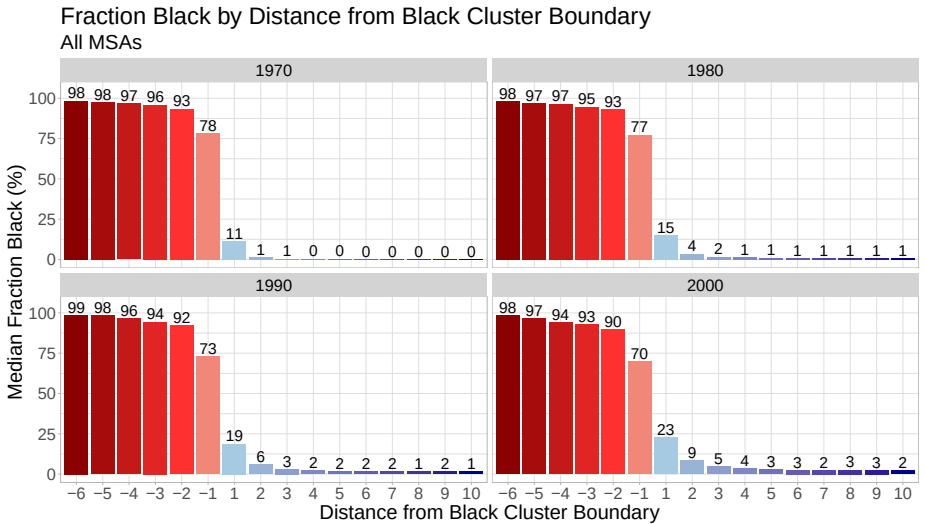


Probabilities sum to 100%.

Black/non-Black Compositions in the Cross-Section - All MSAs

Based on LTDB

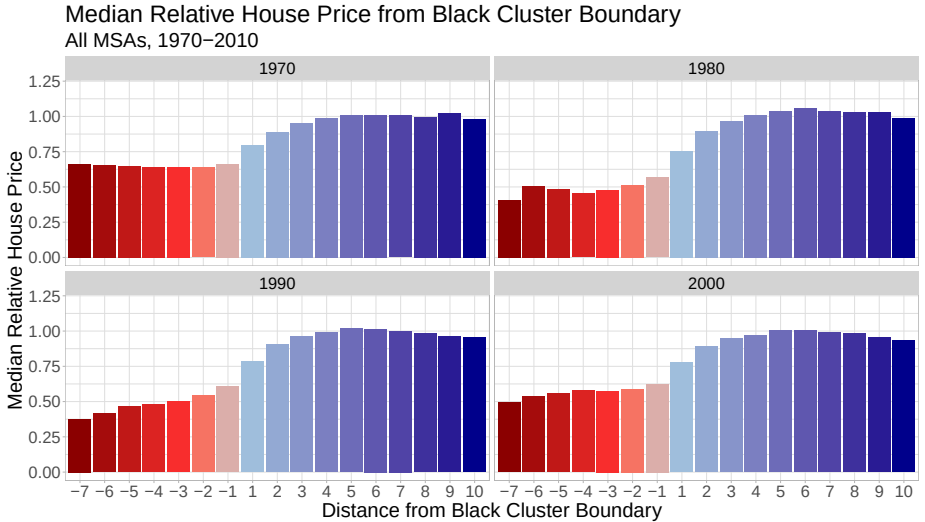
Back



Black/non-Black House Price Gradients - All MSAs

Based on LTDB

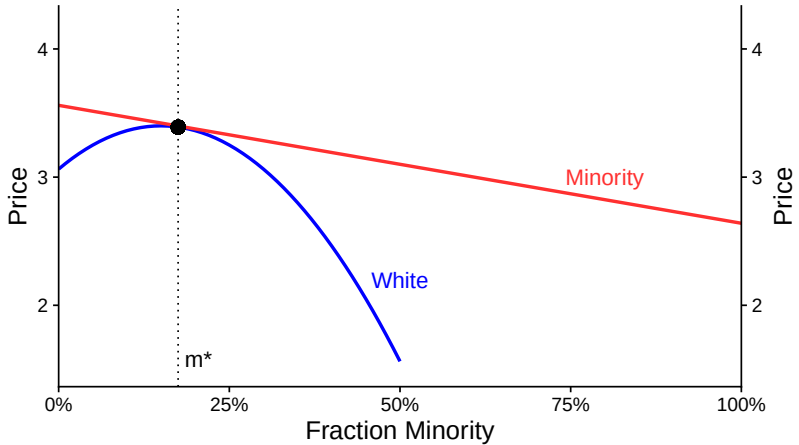
Back



Partial Equilibrium Theory in Card et al. (2008)

Back

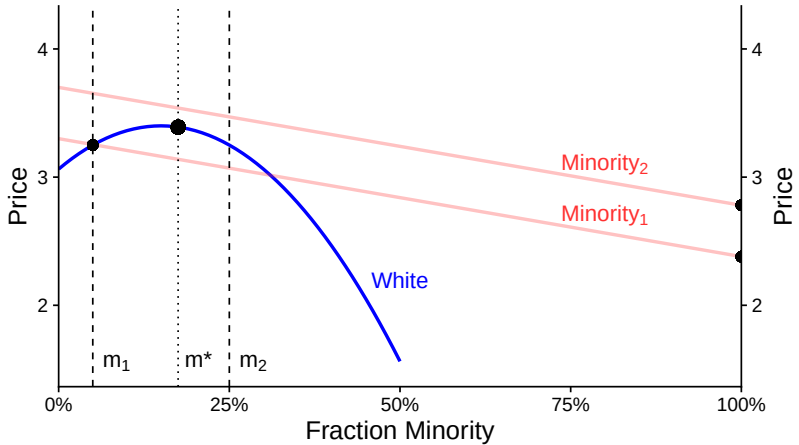
Motivation for Reduced Form Analysis



Partial Equilibrium Theory in Card et al. (2008)

Back

Motivation for Reduced Form Analysis



Empirical Approach in Card et al. (2008)

Back

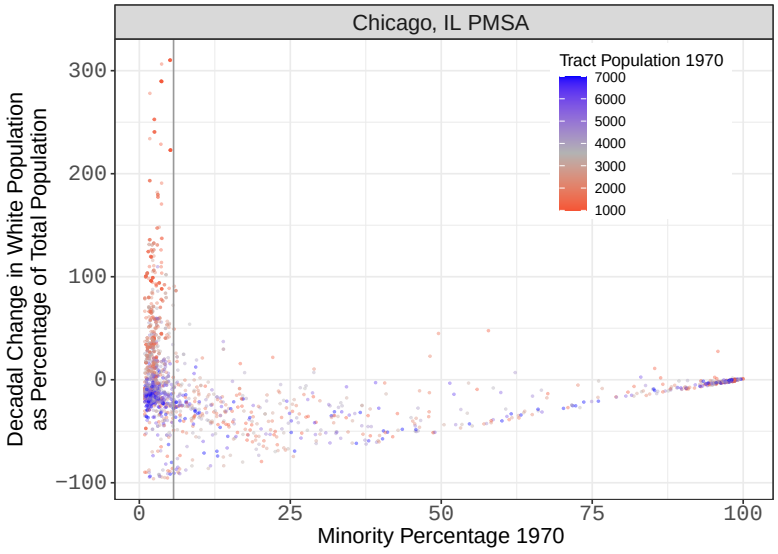
- Split census data into *training* (2/3) and *testing* (1/3)
- Use *training* to find candidate tipping points on MSA-level
- Suggestive evidence of tipping from discontinuous local regressions on MSA-level (s^*_{cm})
- Formal significance tests using global quartic polynomial $f(\cdot)$ on *pooled* data

$$y_{c(j)j} = f(s_{jm}) + \mathbb{1}\{s_{jm} > s^*_{cm}\}\beta + X_{jt}\gamma + \alpha_c + \epsilon_{jt}$$

- $y = \Delta\text{White Pop}_{t+1}/\text{Total Pop}_t$
- Coefficient of interest β
- MSA-fixed effect α_c
- Controls X_{jt}

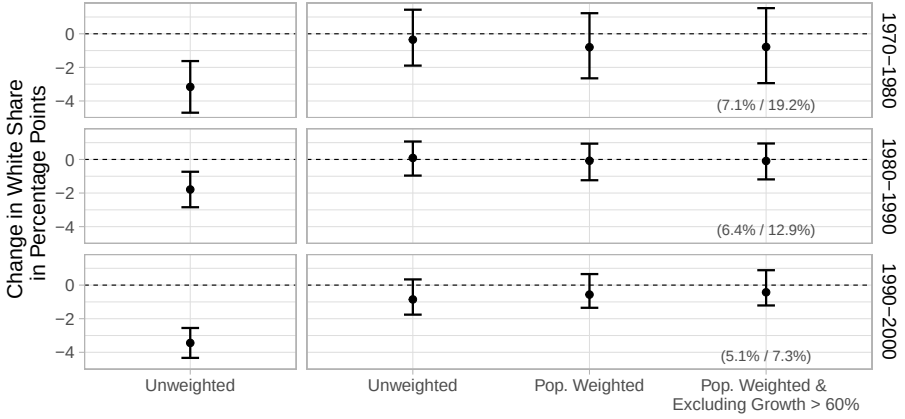
The Case of Chicago (1970-1980), Initial Population

Back



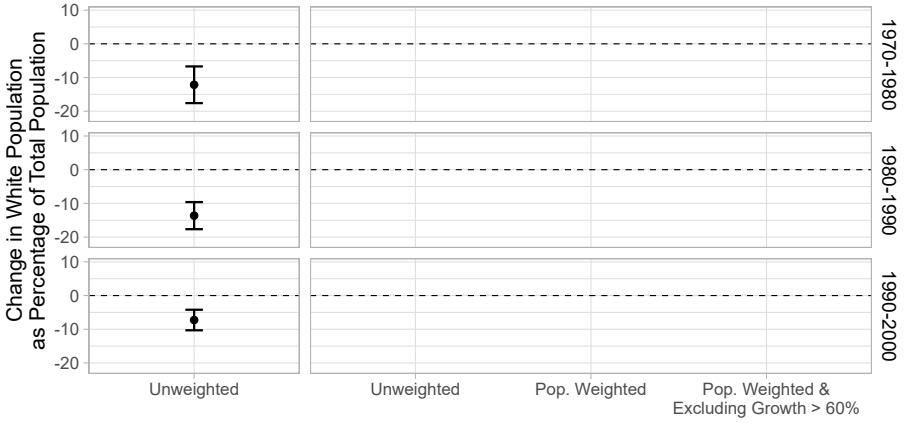
Replication Results

Changing the Outcome Variable to p.p. Share Changes



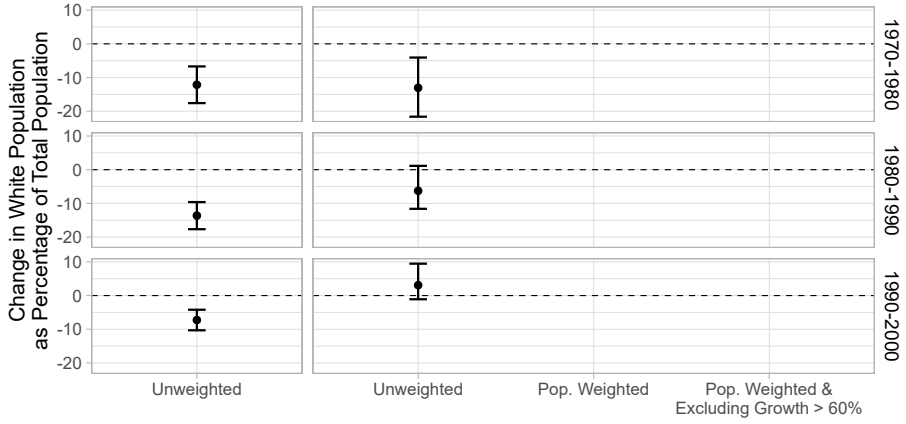
Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970−80, 1980−90, and 1990−2000, respectively.
Numbers in parantheses display fraction of population / tracts removed.

Replication Results



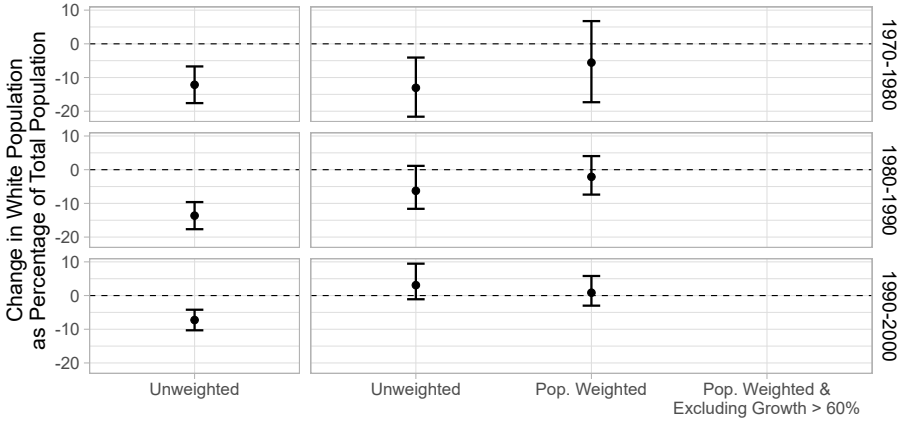
Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970-80, 1980-90, and 1990-2000, respectively. Numbers in parantheses display fraction of population / tracts removed.

Replication Results



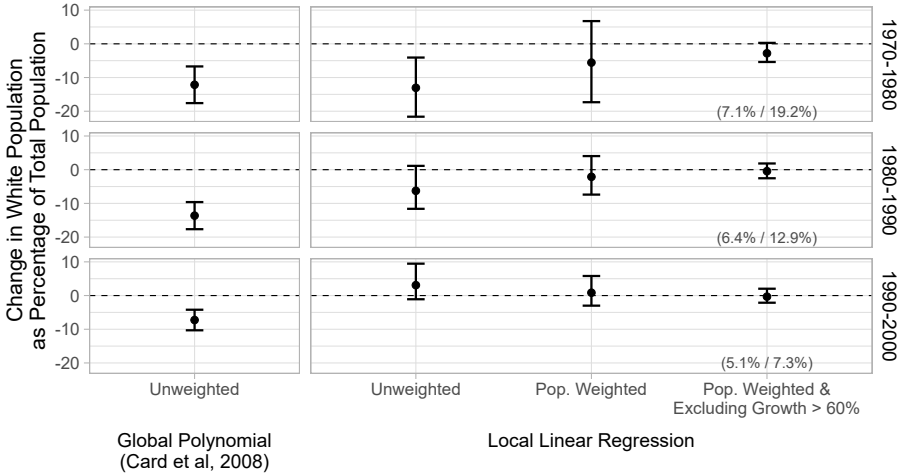
Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970-80, 1980-90, and 1990-2000, respectively. Numbers in parantheses display fraction of population / tracts removed.

Replication Results



Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970-80, 1980-90, and 1990-2000, respectively.
Numbers in parantheses display fraction of population / tracts removed.

Replication Results



Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970-80, 1980-90, and 1990-2000, respectively.
Numbers in parantheses display fraction of population / tracts removed.

Gelman and Imbens (2018) Provide a Helpful Title

Back

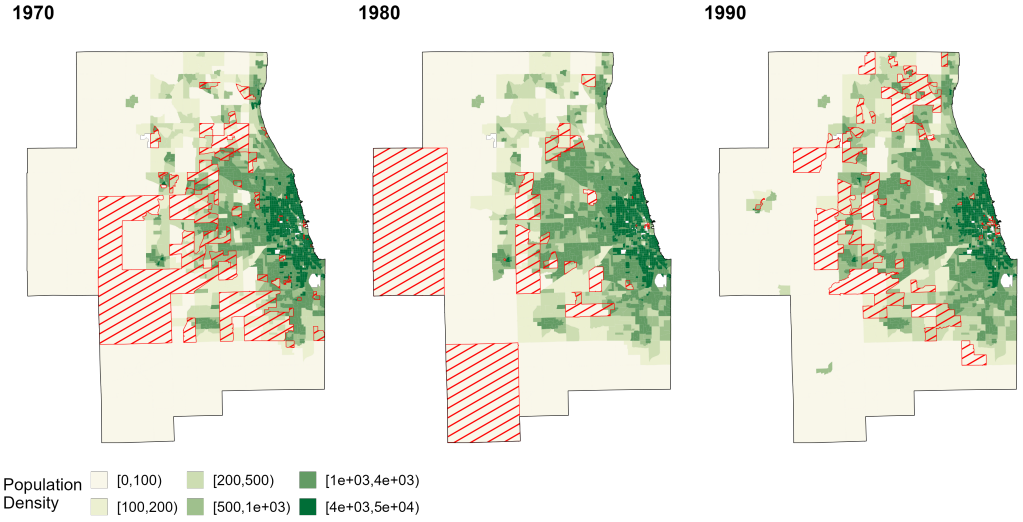
"Why High-Order Polynomials Should Not Be Used in Regression Discontinuity Designs"

> *It is common in regression discontinuity analysis to control for third, fourth, or higher-degree polynomials of the forcing variable. There appears to be a perception that such methods are theoretically justified, even though they can lead to evidently nonsensical results.* ***We argue that controlling for global high-order polynomials in regression discontinuity analysis is a flawed approach*** *with three major problems: it leads to noisy estimates, sensitivity to the degree of the polynomial, and poor coverage of confidence intervals.* ***We recommend researchers instead use estimators based on local linear or quadratic polynomials or other smooth functions.***

Replication Results - Excluded Tracts with Growth > 60%

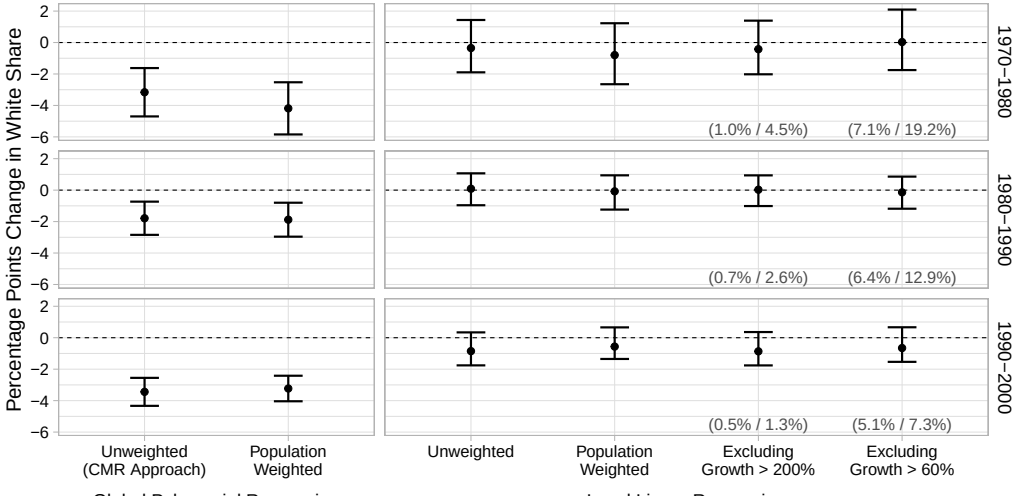
Back

Chicago MSA



Replication Results - Share Changes

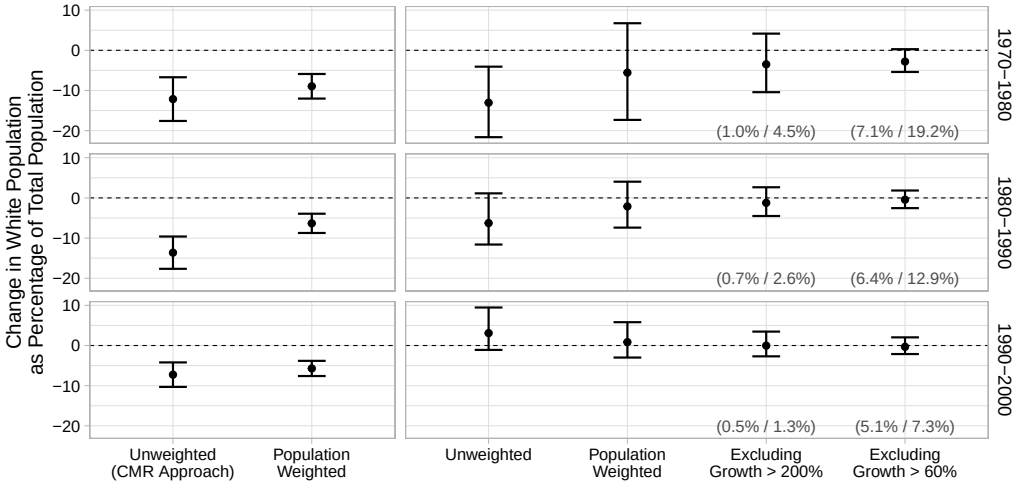
Back



Selected optimal bandwidths are 4.1%, 5.4%, and 7.4% for 1970–80, 1980–90, and 1990–2000, respectively.
Numbers in parantheses display fraction of population / tracts removed.

Replication Results - Details

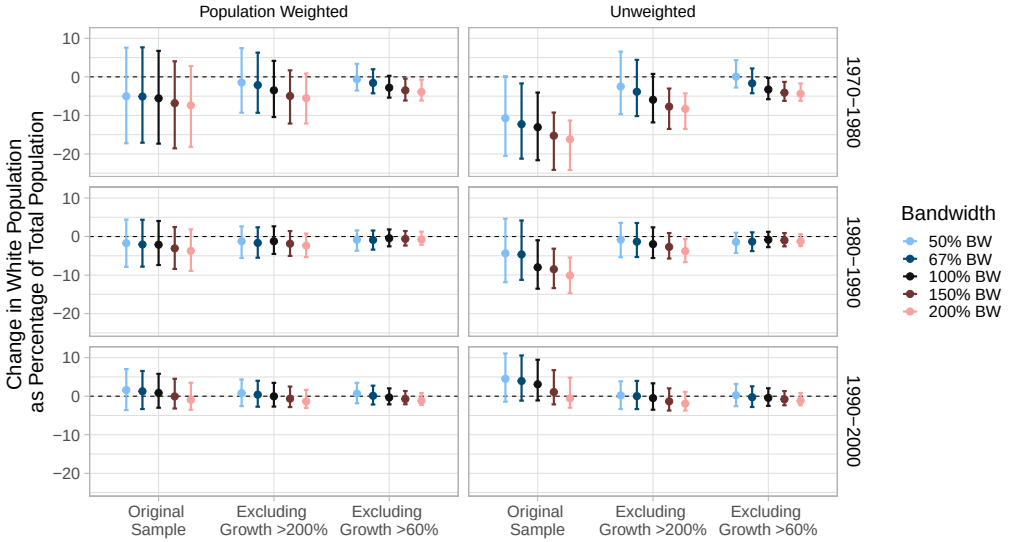
Back



Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970–80, 1980–90, and 1990–2000, respectively.
Numbers in parantheses display fraction of population / tracts removed.

Replication Results - Local Regressions Bandwidth Choice

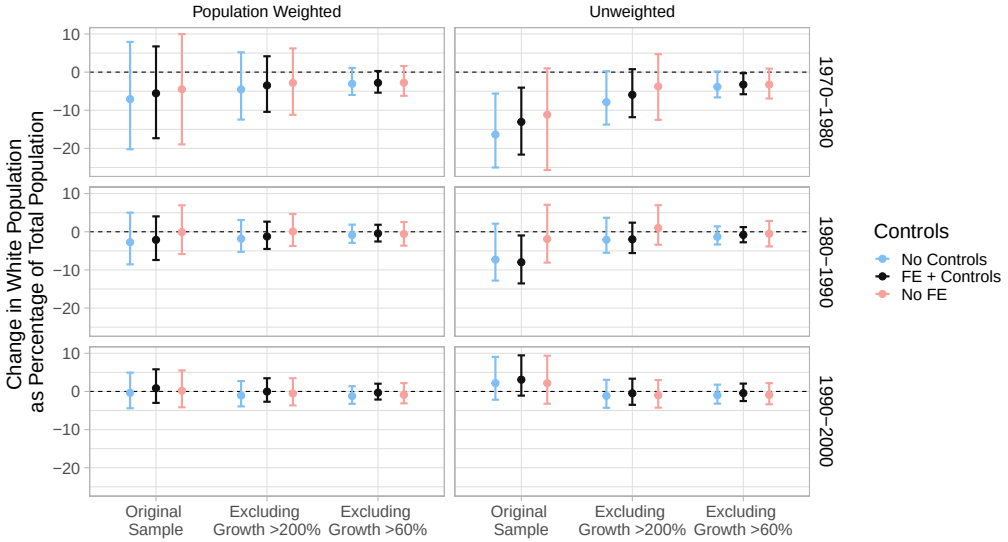
Back



Selected optimal bandwidths for the baseline 100% BW are 4.4%, 7.5%, and 5.0% for 1970–80, 1980–90, and 1990–2000, respectively.

Replication Results - Robustness Control

Back



Selected optimal bandwidths are 4.4%, 7.5%, and 5.0% for 1970–80, 1980–90, and 1990–2000, respectively.

Tipping and Geography in the Bounded Neighborhood Model

Back

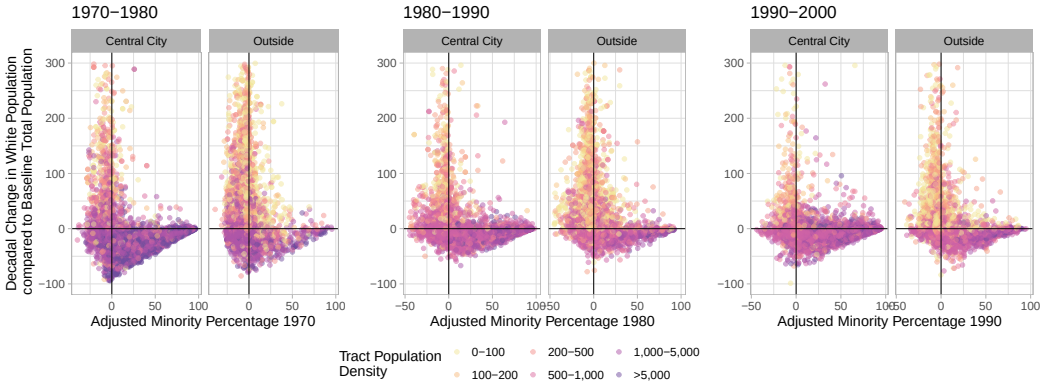
Card, Mas, Rothstein (2008) provide three splits of the data to rule out a crucial role for geography

- **Central city vs. Outside**
- Distance to nearest high minority tract
- Indicator for a neighbor past the tipping point

Robustness Exercises Vulnerable to Similar Critique

Back

Across all MSAs, suburban growth still drives discontinuity results



Robustness Replication Results

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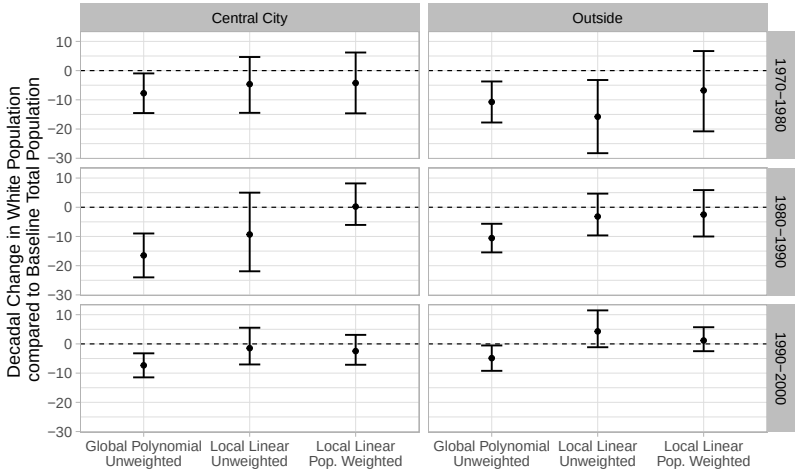
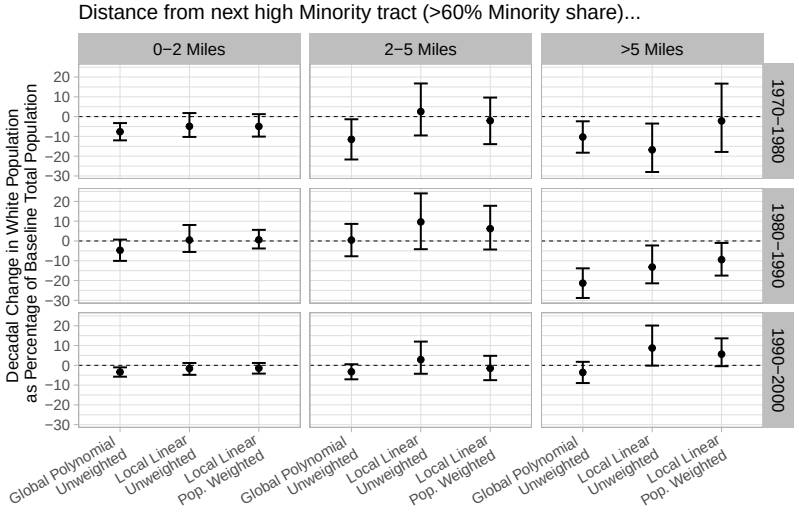
Central City vs. Outside



Robustness Replication Results

Back

Distance to High Minority Share Tract



Robustness Replication Results

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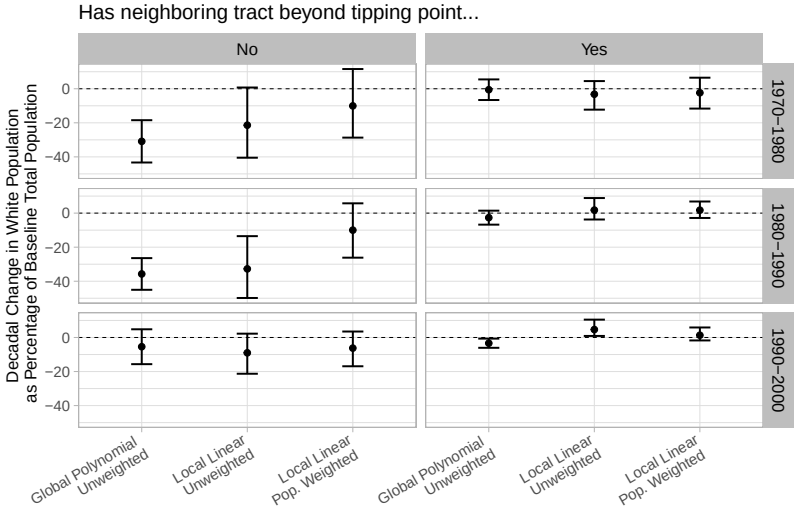
Has a neighboring tract beyond tipping point



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