Freeway Revolts!

Highways, downtowns and city growth

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Changes in the economic geography of the U.S. caused by Interstate highways

- Between 1955 and 2000, the federal Interstate highway initiative lead to the construction of about 40,000 miles of limited access highways in the U.S.
- Metropolitan growth (Duranton and Turner, 2012)
  A 10% increase in metro highways in 1983 caused a 1.5% increase in metro employment by 2003.
- Suburbanization (Baum-Snow, 2007)
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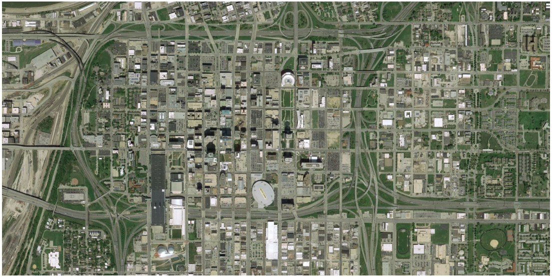
Why else? (This paper)

Kansas City, 1955 vs. 2014



Sources: USGS Earth Explorer; Google; Univ of Oklahoma IQC (`http://iqc.ou.edu/urbanchange`)

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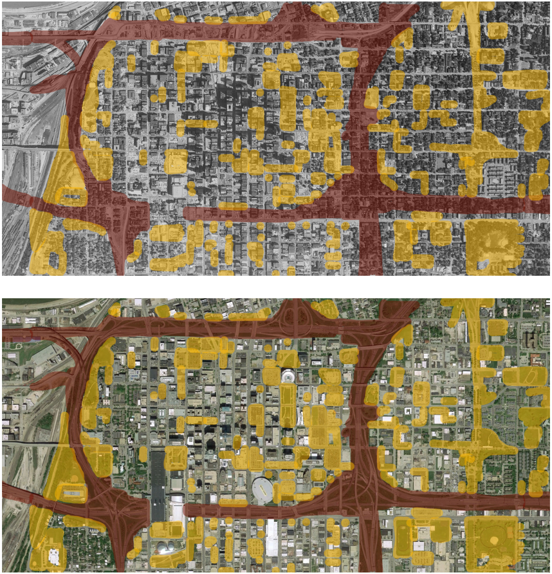

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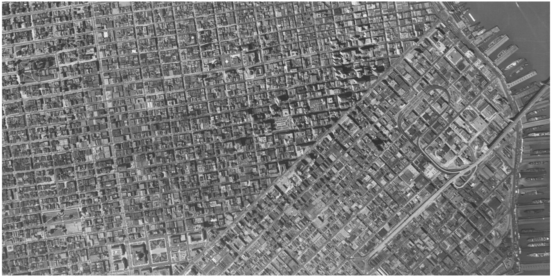
San Francisco, 1946 vs. 2014



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Freeway revolts in S.F. and across the U.S.

Source: `http://www.foundsf.org/index.php?title=The_Freeway_Revolt`

- Land use exclusion
  E.g., Philadelphia inner loop ≈11% of downtown land; Minneapolis ≈22%.
- Negative externalities
  Noise, pollution, traffic congestion.
- Barriers between neighborhoods
  $t \uparrow$ across highways.

What we do

- Theory and evidence highlighting disamenity effects of highways on cities' centers, overall structure, and growth.
- Identification using planned-route, inconsequential-unit, and historical-route instrumental variables.
- Also fuzzy RD — Variation in planned timing of highway construction and new highway legislation between 1956 and 1970 that increased success of freeway revolts in changing or cancelling planned highways. (In progress)
- Use these estimates and a calibrated city structure model to quantify the effect of successful freeway revolts on both central neighborhood and metro outcomes. (In progress)

Contributions

- Identify and quantify important margin for effects of highways — Amenities versus access (cf. Baum-Snow, 2007)
- First economics study of freeway revolts and their effects on allocation of highways.
- Alternative identification of highway effects (Chandra and Thompson, 2000; Baum-Snow, 2007; Michaels 2008; Duranton and Turner, 2012)
  - Identification based on neighborhood data, within cities.
  - Timing and planning of construction (regression discontinuity)
- Counterfactual analysis of effects of revolts using quantitative model

A simple model of freeways in cities

Geography

- Employment located at the center of the city, $(x, y) = (0, 0)$
- Workers live in the city and commute to the CBD, where they earn a wage $w(0, 0)$.
- A freeway may be added along a line defined by $y = d_F$, with a speed v_F.
- The wage delivered to a location is the wage minus commuting costs (net wage).
- The net wage at any location depends on the (1) distance to the CBD, (2) distance to the freeway, (3) speed of the freeway, and is written $w(x; d_F, v_F)$

Preferences, amenities, and population density

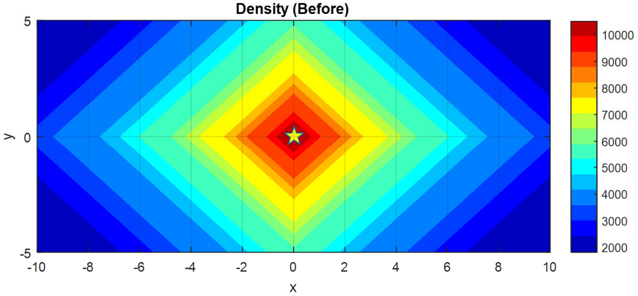
- Workers have preferences over land, l, consumption, c, and a location-specific amenity, $z(x; d_F, v_F)$.

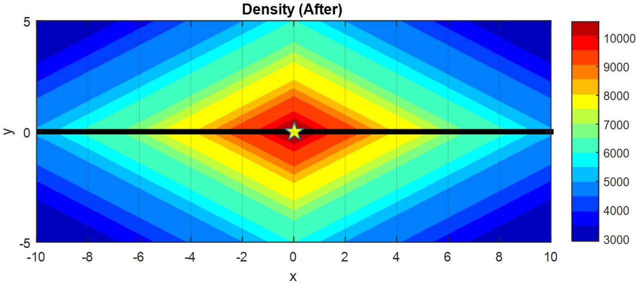
$$U(c, l) = z(x; d_F, v_F)^\gamma c^\beta l^{1-\beta}$$

- The amenity function depends on distance to the CBD, but also distance to the highway.
- In equilibrium, log density is the following

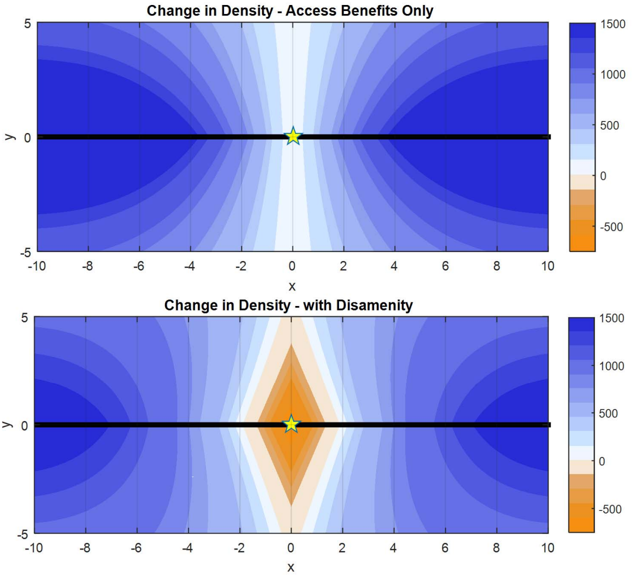
$$\ln n(x; d_F, v_F) = \ln C_n + \frac{1}{1-\beta}\left(\beta \ln w(x; d_F, v_F) + \gamma \ln z(x; d_F, v_F)\right)$$

Classic monocentric model





The effect of disamenities



Highway construction — Predictions of the model

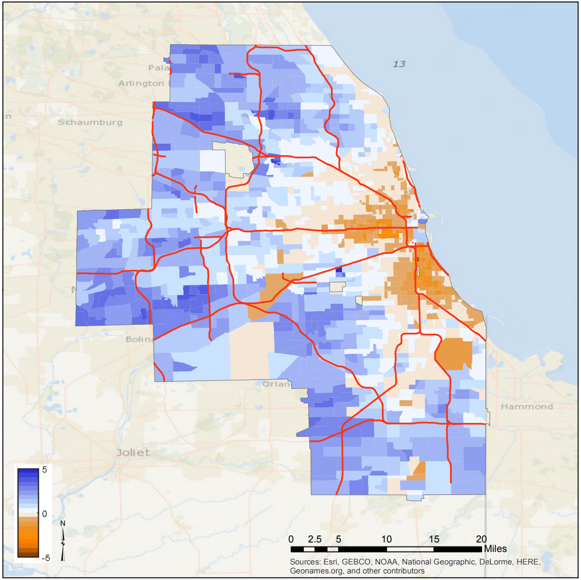
Decline in transportation costs

- Population gains in the suburbs.
- Population gains in the suburbs are highest closest to highways (interaction term).

Disamenity from freeways

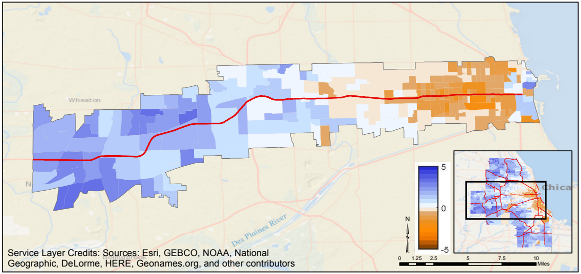
- Population declines near the CBD.
- Population declines near the CBD are smaller (increases larger) for neighborhoods further from the highway (interaction term).

Population change in Chicago, 1950–2010

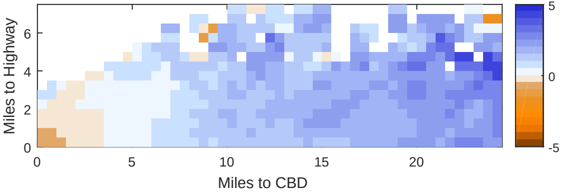


Change in log density, 1950–2010

Chicago — I-290 / I-88 Corridor



All metropolitan areas and highways



Data

- Population, income, amenities, etc. for consistent tract boundaries, 1950–2010 (Lee and Lin, 2015)
- City centers from 1982 Census of Retail Trade (Fee and Hartley, 2013)
- Limited access highways: National Planning Highway Network

- National planned routes (1947)
- Intracity planned routes (1955 "Yellow Book")
- Historical rail routes (Atack, 2013)
- PR-511 database: Planning, construction, opening dates for Interstate segments (Provided by Nate Baum-Snow)
- Planning dates/revolts for routes not built (in progress)

Consider the following regression of long-run changes in log population density:

$$\Delta n_{g[m]} = \alpha_m + \beta_1 d_F + \beta_2 x + \beta_3 d_F x + Z_g' \gamma + \epsilon_g$$

Predicted signs of coefficients:

- β_1 positive - highway disamenity
- β_2 positive - more transportation benefits further from CBD
- β_3 negative - interaction

Causal identification

However, the location of highways is not random — IV strategy.

- Planned routes — 1947 plan was designed to improve intercity travel and defense objectives.
- Inconsequential units — shortest path to nearby MSA
- Historical routes — Railroads constructed before 1898

Estimation

- Census tract level regressions — 53 large MSAs
- Changes in log population — other outcomes/specifications
- Period of extensive highway construction in U.S. (1950-2010)

Change in Log Density, 1950–2010

	μ [σ]	(1) OLS	(2) IV1	(3) IV2	(4) IV3	(5) All IV
Distance to nearest highway	1.06 [0.97]	0.200^c (0.044)	0.732 (0.468)	0.921^b (0.397)	1.743^c (0.302)	1.220^c (0.359)
Cross term	10.60 [19.20]	-0.016^c (0.004)	-0.042^b (0.018)	-0.045^c (0.017)	-0.067^c (0.014)	-0.052^c (0.016)
Distance to CBD	8.42 [6.39]	0.143^c (0.023)	0.169^c (0.034)	0.165^c (0.029)	0.169^c (0.032)	0.164^c (0.029)
R^2		0.307	0.257	0.209	-0.201	0.094
Weak IV test			25.9	34.3	34.5	26.3
Over ID test (p)						0.25

IV1 is 1947 highway plan; IV2 is Inconsequential Routes; IV 3 is historical railroads. Distances in miles. Robust standard errors clustered on metropolitan area in parentheses.
^{a}—$p < 0.10$; ^{b}—$p < 0.05$; ^{c}—$p < 0.01$.

Change in Log Density, 1950–2010 — Robustness

	(1) All IV	(2) With controls	(3) Excl. NY,LA	(4) Pop. wts.	(5) Eq. MSA Wts.	(6) Dist. Dumm.†
Distance to nearest highway	1.220^c (0.359)	1.699^c (0.236)	1.562^c (0.220)	1.046^c (0.143)	1.107^c (0.147)	3.682^c (0.658)
Cross term	-0.052^c (0.016)	-0.069^c (0.012)	-0.082^c (0.014)	-0.049^c (0.008)	-0.059^c (0.008)	-2.195^b (1.013)
Distance to CBD	0.164^c (0.029)	0.141^c (0.031)	0.225^c (0.025)	0.112^c (0.022)	0.145^c (0.019)	1.931^c (0.511)

Distances in miles. Robust standard errors clustered on metropolitan area in parentheses.
^{a}—$p < 0.10$; ^{b}—$p < 0.05$; ^{c}—$p < 0.01$.
Results use all instrumental variables. †—Dummy variables used in place of distance to CBD (1 if Distance to CBD$\geq$10 miles) and highway (1 if Distance to Highway$\geq$1 mile).

Change in Log Density — By decade of construction (Ten-year effects)

	(1) 1950s	(2) 1960s	(3) 1970s	(4) 1980s	(5) 1990s	(6) 2000s
Distance to nearest highway	0.063 (0.062)	0.082[c] (0.029)	0.080[c] (0.022)	0.010 (0.026)	0.021 (0.018)	0.009 (0.014)
Cross term	-0.002 (0.001)	-0.003[c] (0.001)	-0.002[c] (0.001)	0.000 (0.001)	-0.001 (0.000)	-0.000 (0.000)
Distance to CBD	0.056[c] (0.010)	0.040[c] (0.006)	0.022[c] (0.007)	0.010[c] (0.003)	0.007[c] (0.002)	0.006[c] (0.002)
R^2	-0.211	0.061	0.096	0.082	0.021	0.013
Total interstate miles (100s)	83	309	399	429	434	434

Each column represents changes over the previous decade. Robust standard errors clustered on metropolitan area in parentheses.
[a]—$p < 0.10$; [b]—$p < 0.05$; [c]—$p < 0.01$.
Results use all instrumental variables.

Change in Log Density, 1950–2010 — Oceans and Great Lakes

	μ [σ]	(1) OLS	(2) IV1	(3) IV2	(4) IV3	(5) All IV
Distance to nearest highway	1.07 [0.99]	0.182^c (0.052)	1.289^c (0.240)	1.323^c (0.246)	1.341^c (0.258)	1.344^c (0.202)
Cross term	6.21 [14.52]	-0.011 (0.007)	-0.033^a (0.019)	-0.035^a (0.018)	-0.040^b (0.016)	-0.038^b (0.017)
Distance to coastline	4.86 [6.26]	0.118^c (0.033)	0.120^c (0.038)	0.124^c (0.036)	0.132^c (0.032)	0.128^c (0.033)

IV1 is 1947 highway plan; IV2 is Inconsequential Routes; IV 3 is historical railroads. Distances in miles. Robust standard errors clustered on metropolitan area in parentheses.

^{a}—$p < 0.10$; ^{b}—$p < 0.05$; ^{c}—$p < 0.01$.

Change in Log Median Income, 1950–2010

	μ [σ]	(1) OLS	(2) IV1	(3) IV2	(4) IV3	(5) All IV
Distance to nearest highway	1.06 [0.97]	0.046 (0.031)	-0.065 (0.254)	0.141 (0.181)	0.454^c (0.063)	0.253^a (0.132)
Cross term	10.60 [19.20]	0.001 (0.002)	-0.002 (0.010)	-0.005 (0.008)	-0.004 (0.003)	-0.004 (0.007)
Distance to CBD	8.42 [6.39]	0.021^c (0.006)	0.033^c (0.011)	0.028^c (0.010)	0.010 (0.007)	0.019^b (0.009)
R^2		0.092	0.010	0.080	-0.340	0.006
Weak IV test			25.7	34.0	34.4	26.1
Over ID test (p)						0.19

IV1 is 1947 highway plan; IV2 is Inconsequential Routes; IV 3 is historical railroads. Distances in miles. Robust standard errors clustered on metropolitan area in parentheses.
^{a}—$p < 0.10$; ^{b}—$p < 0.05$; ^{c}—$p < 0.01$.

Next steps: New identification strategy

History: Interstate highway construction and freeway revolts

- Before the 1940s planning mostly at the state and local level — Planning on capacity and efficiency.
- 1950s — planning for a national highway system had begun.
  - 1947 Highway Plan — Broad mapping between cities
  - 1955 "Yellow Book" — routing within cities
- Federal Highway Act of 1956 — federal funding authorized.
- Mass construction led to protests known as "freeway revolts."
  - San Francisco and New York
  - 200 controversial freeway projects across 50 different cities.
- Series of legislative changes in 60s and 70s that increased the likelihood of successful revolts — Public hearings, community involvement, environmental protection, historical preservation.

Next steps: New identification strategy

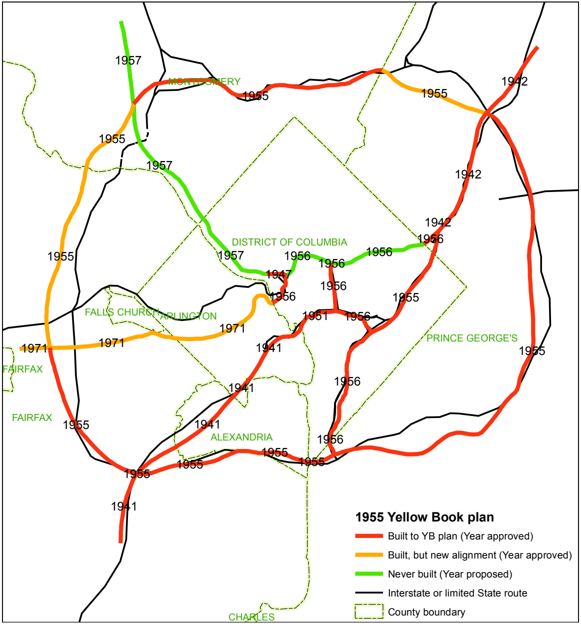
Exploit breaks across time in likelihood of successful revolts.

- e.g. Federal Highway Act of 1956, etc.

Heterogeneous Treatment Regression Discontinuity

- Condition on tracts near the 1955 Yellow Book plan
- Use 2-stage approach and compare highway segments that were "shovel ready" before discontinuity to others along the planned route.

Washington, DC: Proposed Interstates and planning dates



Next steps: Quantitative analysis

Use calibrated quantitative model to explore the effects of freeway revolts in cities.

- Following Ahlfeldt, Redding, Sturm, and Wolf (2015 ECMA) with highway disamenities
- Endogenous firm and residential location — Endogenous productivity and amenities.
- Decompose access and amenity effects for various outcomes: City size, central city population loss, rents, wages, etc.

Summary

Previous research has focused on broad issues of growth and centralization caused by the reduced transportation costs and access benefits of highways, with the assumption that costs dispersed.

In this paper, we show that finer geographic analysis is important to understand the spatial costs of highway construction. Our results imply that the construction and routing of freeways can have important implications at a neighborhood level, and that both the cost and benefits to particular neighborhoods may vary.