Expecting an Expressway

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If moving is costly $\longrightarrow$ HHs care about current & future conditions.

If spillovers $\longrightarrow$ Future conditions depend on others' choices.

If everyone expects that a neighborhood will be attractive in the future (because of its larger size) $\longrightarrow$ it will attract households today, proving expectations correct.

Our approach

Identifying this expectations channel is challenging.

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Expectations may be correlated with unobserved neighborhood factors, including realizations of expected future shocks.

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- Expectations may be correlated with unobserved neighborhood factors, including realizations of expected future shocks.

Our approach: Historical planned highway segments in US cities.

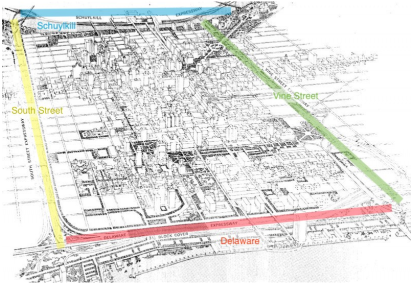
- Broad support and few constraints in mid-1950s. Widely understood disamenities from noise, pollution, barrier effects.
- Federal and state reforms led to cancellation of some projects & dependent segments, esp. after 1973. Expected future disamenities never materialized. In many cases, which segments were planned and cancelled depended on idiosyncratic factors.

Example: The South Street Expressway

By 1953, SSX plan widely known & expected.

1950–1970: SSX plan blocks declined vs. neighboring blocks.

Despite cancellation in 1977, SSX plan block declines persisted.



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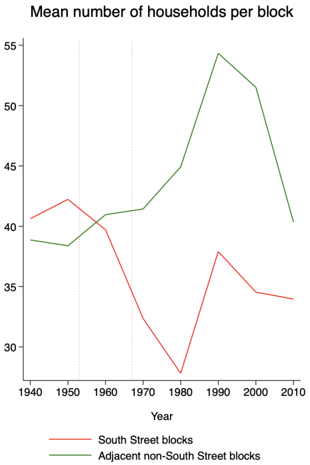

We study similar persistent neighborhood declines around cancelled highway segments across many US cities.

What we do: Theory & evidence of self-fulfilling expectations in spatial structure

Dynamic model where large, temporary shocks to expectations cause permanent neighborhood change.

- Self-fulfilling expectations: Expected *future* decline in neighborhood QOL leads to neighborhood decline *today*.
- Strong externalities can lock in declines, even when expected decline in QOL is unrealized.

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Dynamic model where large, temporary shocks to expectations cause permanent neighborhood change.

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Strong externalities can lock in declines, even when expected decline in QOL is unrealized.

Evidence from 42 US central cities that planned highways caused decline & declines persisted after plans were canceled.

Simple contrast, regression, matching.

IV: intercity plan, historical rtes.; canceled dependent segments.

Related literature 1

Dynamic quantitative spatial model of Allen & Donaldson (2020)

- Rationalize persistence & path dependence in spatial structure.

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- If historical $\rightarrow$ multiple steady states, but *nature & history alone* uniquely determine future spatial structure.

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- Rationalize persistence & path dependence in spatial structure.
- Region size depends on historical vs. contemporary spillovers.
- If historical $\longrightarrow$ multiple steady states, but *nature & history alone* uniquely determine future spatial structure.
- If contemporaneous $\longrightarrow$ multiple equilibria; future indeterminate.

Related literature 2

Expectations may play a decisive role in nbhd. development.

Why is Detroit empty? Owens, Rossi-Hansberg, & Sarte (2020)

- Spillovers$+$coordination failure$\rightarrow$vacant despite fundamentals.
- Our theory includes dynamics; Explicit role for expectations.

Related literature 2

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Why did Boston fire$\rightarrow$land value growth? Hornbeck & Keniston (2017)

Better coordination$\rightarrow$Gains from simultaneous reconstruction.

Our evidence more clearly identifies role of expectations.

Model

Overview

Dynamic model of residential location choice with forward-looking households and externalities.

Simplifying assumptions to deliver analytical expressions.

Goal (for now) is to develop testable implications and a framework for interpreting empirics.

Geography

Two neighborhoods, $j = 1, 2$.

Neighborhood amenity $A_{j,t} = a_{j,t} + \gamma N_{j,t}$.

$a_{j,t}$ is ***exogenous*** component of amenity.

$\gamma N_{j,t}$ is *endogenous* component of amenity.

Constant measure of $N = N_{1,t} + N_{2,t} = 1$ households.

Households and housing

Discounted lifetime utility for household in j at t:

$$V_{j,t} = \int_t^\infty e^{-(\beta+\eta)t}(A_{j,t} - R_{j,t})\,dt$$

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New households choose location, with perfect foresight.

Households cannot move after they choose location.

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Households cannot move after they choose location.

Housing is supplied elastically without adjustment costs.

Rent depends on population according to:

$$R_{j,t} = \nu N_{j,t}$$

Steady-state equilibrium

Discounted lifetime utility for household in j at t:

$$V_{j,t} = \int_t^\infty e^{-(\beta+\eta)t} (\underbrace{a_{j,t} + \gamma N_{j,t}}_{A_{j,t}} - \underbrace{\nu N_{j,t}}_{R_{j,t}})\, dt$$

Steady-state equilibrium

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New HHs choose neighborhood 1 if $V_{1,t} - V_{2,t} > 0$, i.e.:

$$\int_t^\infty e^{-(\beta+\eta)t} [(a_1 - a_2) + (\gamma - \nu)(2N_{1,t} - 1)]\, dt > 0$$

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$a_1 > a_2$, i.e., $j = 1$ has persistent natural amenity advantage.

- If $\gamma > \nu \rightarrow$ corner s/s eq exists (all HHs choose 1 for all t).

There may be multiple steady-state equilibria

For multiple steady states to exist, it must be that the endogenous amenity is strong enough to satisfy *both* $V_{1,t} > V_{2,t}$ & $V_{1,t} < V_{2,t}$.

$$\int_t^{\infty} e^{-(\beta+\eta)t}[(a_{1,t} - a_{2,t}) + (\gamma - \nu)(2N_{1,t} - 1)]\, dt \lessgtr 0$$

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$$\int_t^\infty e^{-(\beta+\eta)t}\left[(a_{1,t} - a_{2,t}) + (\gamma - \nu)(2N_{1,t} - 1)\right] dt \lesseqgtr 0$$

- If $\gamma - \nu$ large vs. $a_{1,0} - a_{2,0}$, i.e.,

$$(\gamma - \nu)\frac{\beta}{\beta + 2\eta} > (a_{1,0} - a_{2,0})$$

$\rightarrow$ (i) all HHs choose 1 for all t is a steady-state equilibrium.

and (ii) all HHs choose 2 for all t is a steady-state equilibrium.

Transition dynamics: Effect of future shock

What conditions for response to future shock, before it is realized?

Consider steady state with all HHs in 1 (ss_1) and $a_{1,0} > a_{2,0}$.

Negative shock announced for $t = T$, $a_{1,T} < a_{2,T}$.

Assume $ss_1 \rightarrow ss_2$ transition begins at $t = 0$, check consistency.

For all $t > 0$, new HHs choose 2 and population of 1 declines:

$$N_{1,t} = e^{-\eta t}$$

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Utility gap can be written as piecewise function for $t = 0$ to T:

$$U_{1,t} - U_{2,t} = (a_{1,0} - a_{2,0}) + (\gamma - \nu)(2e^{-\eta t} - 1)$$

and from $t = T$ to ∞:

$$U_{1,t} - U_{2,t} = (a_{1,T} - a_{2,T}) + (\gamma - \nu)(2e^{-\eta t} - 1)$$

Difference in value functions $(1-2)$ at the start of the transition:

$$DV_0 \equiv \frac{1}{\beta+\eta}[\underbrace{(a_{1,0}-a_{2,0})(1-e^{-(\beta+\eta)T})}_{\textit{Exogenous amenities before the shock}} + \underbrace{(a_{1,T}-a_{2,T})e^{-(\beta+\eta)T}}_{\textit{Exogenous amenities after the shock},<0} + \underbrace{(\gamma-\nu)\frac{\beta}{\beta+2\eta}}_{\textit{Endogenous amenity from changing populations}}]$$

This expression assumes $ss_1 \rightarrow ss_2$ transition begins at $t=0$. Need to check consistency w/ HH utility maximization, i.e. $DV_0 < 0$.

- If T such that:

$$(a_{2,T} - a_{1,T}) > (\gamma - \nu)\frac{\beta}{\beta + 2\eta}$$

$\rightarrow$ $DV_0 < 0$ and new HHs would begin choosing 2 at $t = 0 < T$.

i.e., If value of *negative future shock* exceeds *positive current externality*, then expectations about future amenities cause neighborhood change before the future shock.

Transition happens earlier (T larger) if:

- Announced exogenous amenity shock larger.
- HHs care more about future through lower β or η.
- Positive net externality $\gamma - \nu$ weaker.

History dependence after a cancelled shock

Suppose:

$(\gamma - \nu)\frac{\beta}{\beta+2\eta} > (a_{1,0} - a_{2,0})$, i.e., multiple s/s eq exist.

Negative shock *announced*, *transition begins*, shock *cancelled*.

Population of $j = 1$ at time of cancellation is:

$$N_{1,S} = e^{\eta S}$$

$S =$ time between start of transition, cancellation.

Derive DV at time of cancellation for two limiting cases.

If transition continues, new HHs choose 2, and:

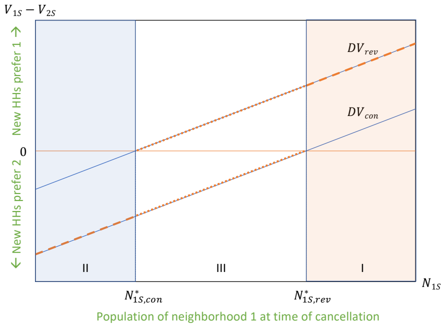
$$DV_{con} = \frac{1}{\beta+\eta}\left[(a_{1,0} - a_{2,0}) + (\gamma - \nu)\left(\frac{2(\beta+\eta)}{\beta+2\eta}N_{1,S} - 1\right)\right]$$

If transition reverses, new HHs choose 1, and:

$$DV_{rev} = \frac{1}{\beta+\eta}\left[(a_{1,0} - a_{2,0}) + (\gamma - \nu)\left(\frac{2(\beta+\eta)}{\beta+2\eta}N_{1,S} + \frac{\beta}{\beta+2\eta}\right)\right]$$

- Both expressions are linear in $N_{1,S}$ and differ by only a constant; we can analyze dynamics graphically.

When does transition continue despite cancellation?



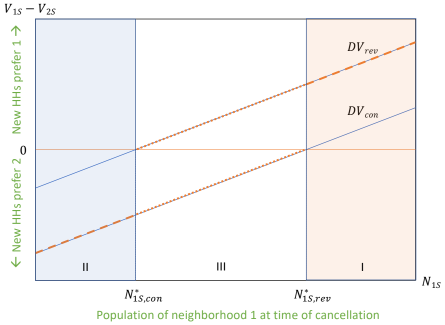
Case I.

DV_{rev} and $DV_{con} > 0$.

All households prefer 1.

$\rightarrow$ Only possible path is reversal back to ss_1.

If negative shock canceled quickly, or 1's population still large, then reversal to initial ss_1.



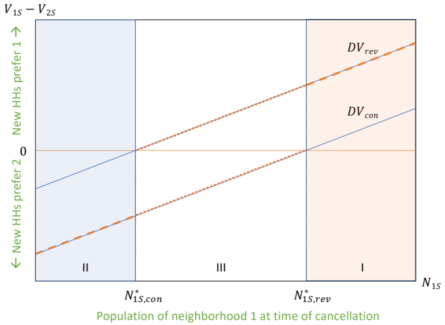
Case II.

DV_{rev} and $DV_{con} < 0$.

All households prefer 2.

$\rightarrow$ Only possible path is continue to new ss_2.

When externality large, and negative shock canceled late or 1's population small, then transition to ss_2 continues.



Case III.

$DV_{rev} > 0$ & $DV_{con} < 0$.

Reversal & continuation consistent w/ utility max.

If transition reverses, new HHs would choose 1.

If transition continues, new HHs would choose 2.

Uniqueness not a general feature of this type of model.

Model predictions

If time elapsed is large between initial announcement of negative shock and cancellation, and externality is large relative to initial amenity difference,

then temporary negative shock to expectations $\rightarrow$ persistent neighborhood decline.

Data

Overview

Highway plans

Digitized “Yellow Book,” 1955 — Brinkman & Lin, 2020

First nat’l publication describing planned *intracity* routes.

Built highways

National Highway Planning Network v14.05

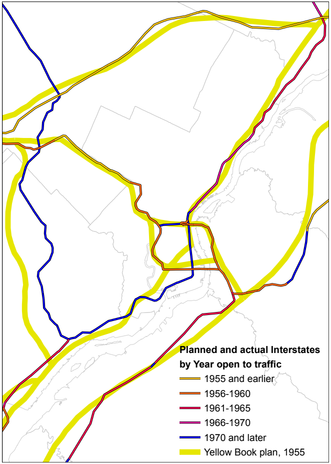
Consistent-boundary census tract panel database, 1940–2010

Demographic and fixed characteristics. — Lee & Lin, 2018

Brief history of Interstate planning and construction

1910s	Earliest attempts to develop nat'l highway network. Patchwork of federal, state, and local planning.
1944	Congress authorizes Interstate system (but no $).
1955	BPR w/ state DOTs publish Yellow Book plans.
1956	Congress authorizes and funds Interstate system. State DOTs given wide latitude in implementation.
1965	$\approx 1/2$ of Interstate system completed.
1970	$\approx 3/4$ of Interstate system completed.
c.1970+	Policy reforms lead to cancellation of some segments.
c.1980	Near-completion of Interstate system.

Yellow Book plans predict built highways



n.b. Other state & local plans
$\rightarrow$ YB is “fuzzy” treatment; likely
some misclassification.

Empirics

Sample selection

Consistent-boundary census tracts, 1940–2010.

Tracts with 5 miles of city centers.

Consistent with net negative effects of highways. Brinkman and Lin, 2019

Metropolitan areas with digitized Yellow Book plans.

Neighborhoods that expected highways.

$\rightarrow$ $\approx$5,000 tracts in 42 metros that have YB *and* 1940 tract data.

Treatment and comparison groups

Each tract in one of three mutually exclusive groups:

NP — "Not Planned"

$\geq$ 0.1 miles from built highway

& $\geq$ 0.1 miles from 1955 YB planned route.

PNB — "Planned, Not Built"

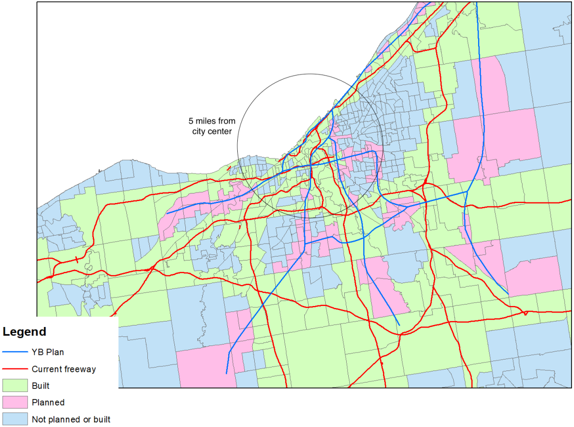
$<$ 0.1 miles from 1955 YB planned route.

& $\geq$ 0.1 miles from built highway.

B — "Built"

$<$ 0.1 miles from built highway.

Tract groups example



n.b. Analysis sample excludes tracts > 5 miles from city center.

Highway treatment summary

	Freq.	Percent
NP	2,689	50.4%
PNB	525	9.9%
B	2,117	39.7%
Total	5,331	100%

n.b. Analysis sample excludes tracts $>$ 5 miles from city center.

Estimating the effect of planned and built highways

Goal: Estimate $ATE \equiv E(y_1 - y_0)$ of PNB, B on log pop.

y_1 (y_0) is *log population* with (without) treatment h.

We observe $y = (1 - h)y_0 + hy_1$, h, X, W, Z.

If h is *mean independent* of y_0 and y_1, use simple contrast.

If h is *strongly ignorable* conditioned on X, W, use doubly-robust matching/regression estimator.

If Z is a valid IV for h, use IV estimator.

Comparison of means over time

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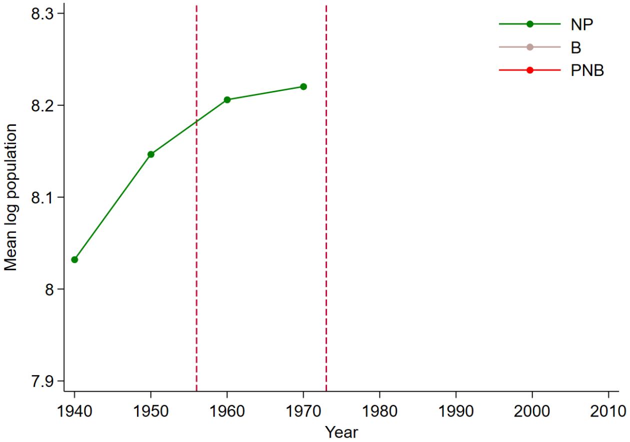

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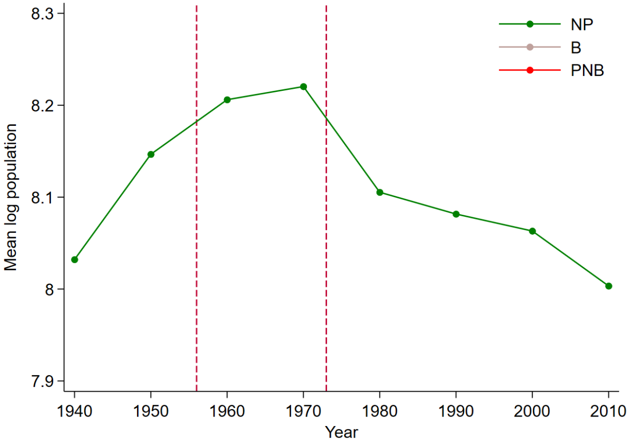

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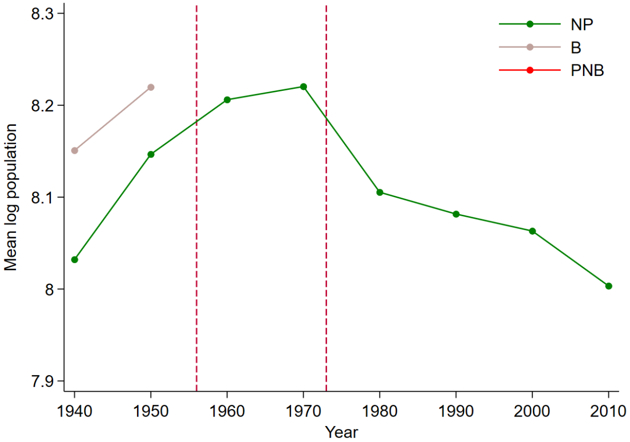

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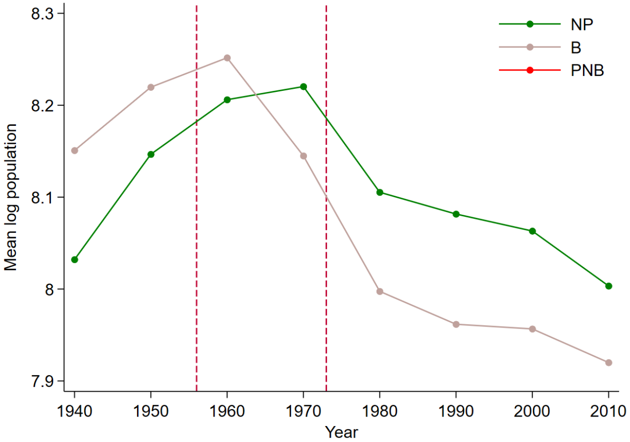

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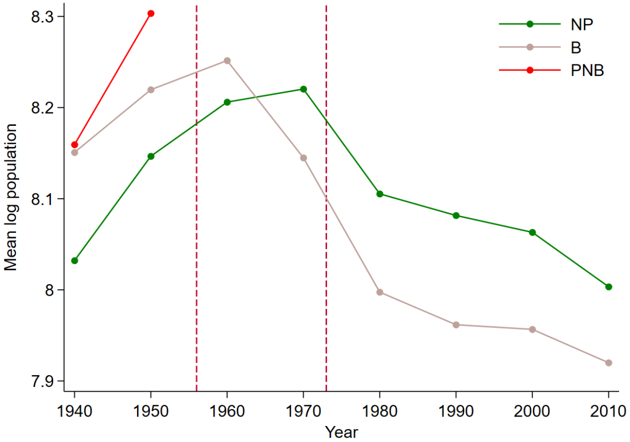

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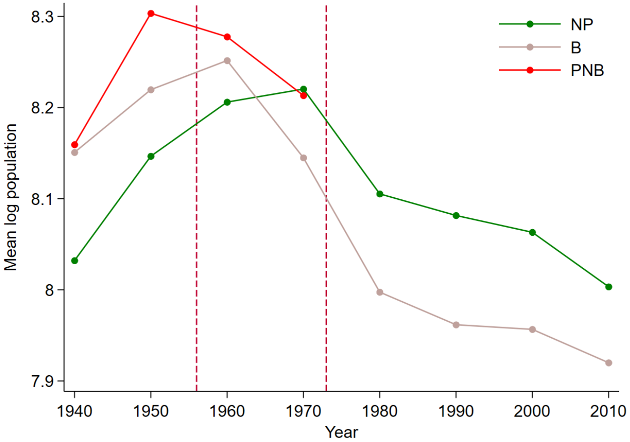

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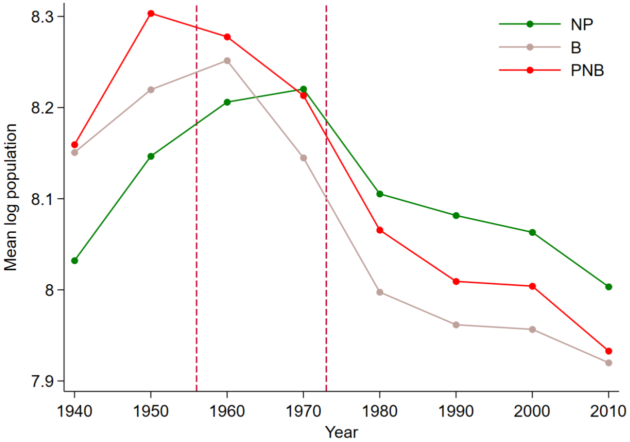


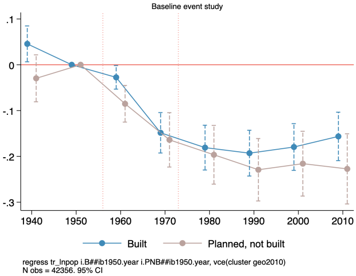
Comparison of means over time

Average log population in each group and census year.

Similar dynamics across groups, growth then decline.

PNB and B initially more populous and decline more.

Event study



Regress log population of tract–year on highway treatments $\times$ year interactions.

i.e., OLS estimate of mean differences.

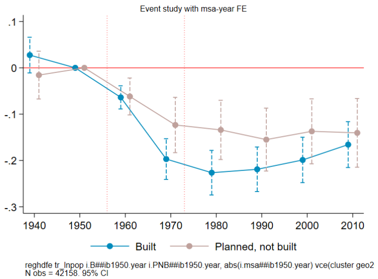
By 1970,

PNB -15% vs. NP.

B -14% vs. NP.

Declines persists through 2010.

Event study with metro–year fixed effects



Now include metro–year FE.

i.e., comparison is growth in PNB/B vs. NP, *within* metropolitan areas.

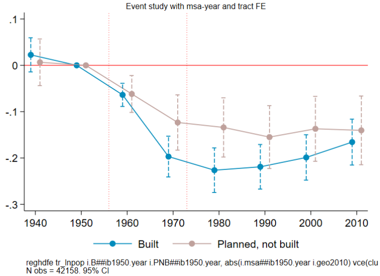
By 1970,

PNB -12% vs. NP.

B -18% vs. NP.

Declines persist through 2010.

Event study with metro–year and tract FE



Now include tract FE.

i.e., absorb any time-invariant, tract-level growth factors.

Quantitatively similar results.

No strong evidence of pre-trends.

Causal inference

Challenge: *Non-random* planning & construction of highways.

Main concern is *negative* selection on growth factors into plan.

i.e., Highways planned in nbhds expected to decline most.

n.b., Pre-highway growth rates are similar (and > 0).

Second concern is *negative* selection on growth factors into cancellation, conditioned on plan.

i.e., Planned highways canceled in nbhds expecting most decline.

n.b., Cancellations typically in high-SES nbhds.

Historical evidence on planned route selection

Routes were favored that:

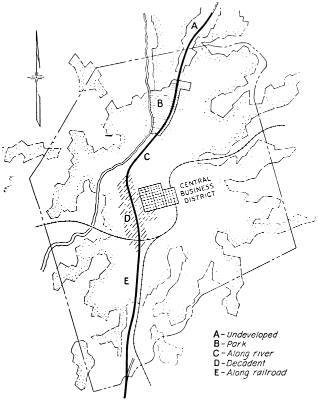
- Penetrated downtown or circumvented cities via beltway.
- Used undeveloped land.
- Linked to other modes such as rail stations and ports.
- Followed forecasted demand.
- Followed topography and physical features such as rivers.
- Were compatible with existing land use.
- National defense.

"Criteria for Selection of Interstate System Routes," testimony of CPR C.D. Curtiss, 4/15/1955.

1957 AAHSO Red Book

“The improvement of radial highways in the past stimulated land development along them and often left *wedges of relatively unused land* between these ribbons of development. These undeveloped land areas may offer locations for new radials.”

→ Planned routes likely to be *positively* selected on nbhd growth factors.



LOCATION OPPORTUNITIES FOR ARTERIAL HIGHWAYS
AS RELATED TO LAND USE AND PHYSICAL CONTROLS
Figure B-6

Historical evidence on canceled route selection

Vs. nbhds with built highways, nbhds with *unbuilt* YB plans:

- More educational attainment in 1950.
- Lower black share in 1950.
- Higher population density in 1950.
- Far from coastlines or rivers.

Brinkman & Lin, 2020

$\rightarrow$? Conditioned on plan, canceled routes might have been *negatively* selected on nbhd growth factors.

IPWRA estimator

Estimator of multi-level treatment effects that combines matching and regression. Wooldridge, 2007; Cattaneo, 2010

(1) Estimate probability of treatment h conditioned on W.

(2) Estimate treatment-level mean outcomes (conditioned on X) with inverse probability weights.

$\widehat{ATE}$ is contrast between predicted treatment-level means.

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Doubly-robust, if treatment model OR outcome model are correctly specified, then estimator is consistent.

IPWs magnify controls that look like treated (W) and vice versa.

RA accounts for differences in X across treated and control.

X and W

Land area

Distance to city center

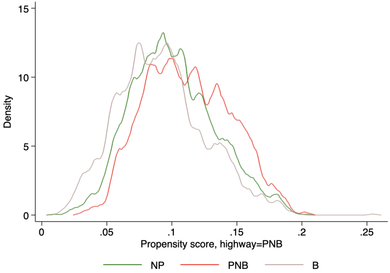
Natural amenities (coastline, rivers, slope, etc.)

Log population in 1940 and 1950

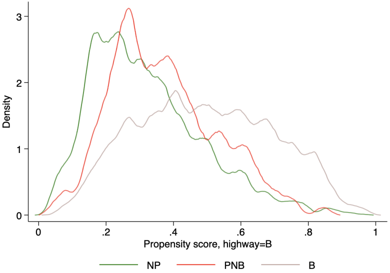
Demographics in 1940 and 1950

Good overlap: PNB, B similar to NP $|W$

$\widehat{Pr(PNB)}$



$\widehat{Pr(B)}$

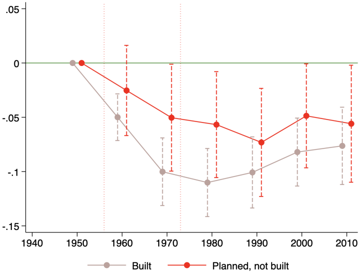


IPWRA estimates of PNB, B on log population

Qualitatively similar effects as simple contrast, but smaller by one-half.

By 1970,
PNB -5% vs. NP.
B -10% vs. NP.

Declines persist through 2010.



IV estimator

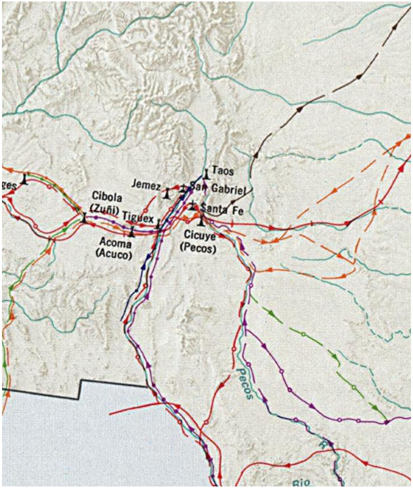
Remaining concern that ignorability of highway planning and construction conditioned on W, X is a strong assumption.

If we had valid IVs for PNB, B, we could estimate their (L)ATE under the (weaker) assumptions of IV.

We propose and use 2 types of IVs:

- Historical and planned *intercity* routes (4).
- Dependent segments (1) — This is new.

Historical routes



Pre-1675 explorer routes near Santa Fe, NM

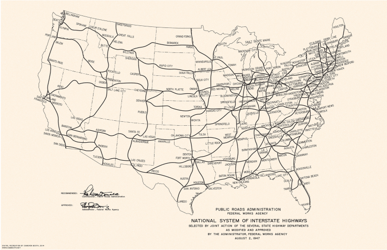
Pre-1898 rail and 16th-19th c. explorer routes. Duranton and Turner, 2012

Least-cost routes based on obsolete topography + history dependence.

Planned routes

1947 intercity plan. Baum-Snow, 2007

Planners connected distant cities for reasons of interregional trade and national defense.



1947 intercity plan

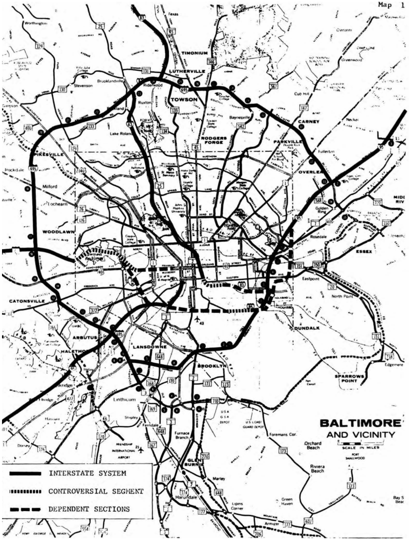
Dependent routes

In 1970 FHWA produced a report on controversial urban Interstate segments.

Report distinguished controversial vs *dependent* segments.

Dependent segments were not themselves controversial, but were likely to be cancelled if controversies were not resolved.

! Only 4 cities (916 tracts) with dependent segments: Baltimore, Boston, Hartford, New York.



Baltimore controversies and dependent segments

IV estimates of PNB, B on log population

By 1970,

PNB -49% vs. NP.

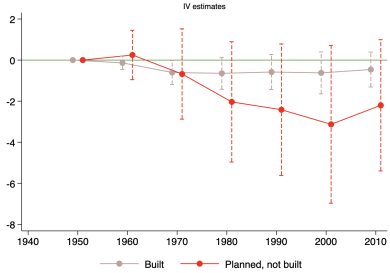
B -45% vs. NP.

Qualitatively similar effects as simple contrast, but $3\times$ larger.

LATE? Compliers likely dense, developed neighborhoods.

Misclassification bias in OLS?

$\rightarrow$ Suggestive evidence that negative selection for cancellation is not a major concern.



Results summary

Estimates of (L)ATE of PNB, B on log population in 1970:

	PNB vs. NP	B vs. NP
Simple contrast	-12% to -15%	-14% to -18%
IPRWA	-5%	-10%
IV	-49%	-45%

Qualitatively similar dynamic effects: 1970 declines persist.

Conclusions

An expected large negative shock to neighborhood amenity can cause permanent decline, even if shock is never realized.

This result is consistent with forward-looking behavior and strong externalities in residential location choice.

→ Self-fulfilling expectations can shape city structure.

Next steps

More predictions — Planning timeline; Rents, race, income.
Quantifying the model; Estimating size of externality.
Improving IV inference.
Digitizing historical block statistics.

Case study of Crosstown Expressway, Philadelphia

1911	Earliest proposals selecting South St. alignment.
1953–1964	South St. alignment repeatedly approved. State completes engineering, surveying studies.
1964–1967	Opposition first emerges and organizes.
1967	Mayor announces opposition.
1968	City deletes South St. from plan. State continues work.
1973	MPO deletes South St. from plan.
1974	State DOT deletes South St. from plan.
1977	South St. cancellation leads to cancellation of dependent segments.

Timing of expectations:

1953 latest date when plan was widely known.

1967 earliest date when completion might have been in doubt.

Thus, South St Expwy was expected for 14–63 years.

Historical background

Overview

Broad consensus behind 1956 Federal-Aid Highway Act.

- In 1956, certainty that planned Interstates would be completed.

Urban highways caused big declines in local QOL. Brinkman & Lin 2019

By early 1970s, policy reforms allowed cancellation of *some* plans.

Consensus and certainty

Consensus and growing federal support up to 1956. DiMento & Ellis, 2013

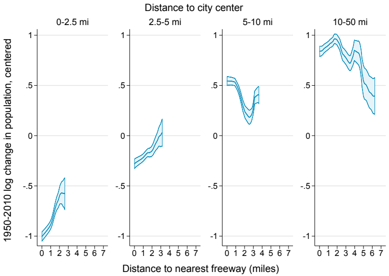
- “Parkway ambience” in concepts by Le Corbusier et al.
- State highway officials had only rural experience.
- Mumford on highways: “beneficent liberators of urban dwellers.”
- City planners, mayors thought freeways would revive downtowns.

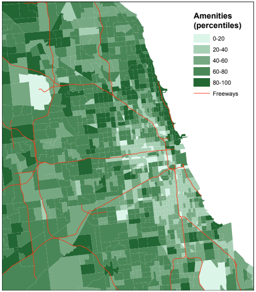
Aggressive timeline; Funding window was 41K miles by 1969.

- State DOTs faced few constraints, little opposition, and
- “believed they had to finish the entire mileage within the 13-year funding framework. No one anticipated the urban battles ahead”

DiMento & Ellis 2013, Weingroff, 2016

Negative quality of life effects





Brinkman & Lin (2019) find large negative effects of urban Interstates on population, income, prices. A highway reduces neighborhood amenity by $\approx \frac{3}{4}$ of one standard deviation.

Results consistent with large negative QOL effects exceeding modest accessibility benefits in central cities.

Households learned quickly (freeway revolts in 50+ cities).

By 1970s, reforms led to some cancellation of some plans

1958	At least 1 public hearing, economic impact study.
1962	"Local cooperation."
1966	Oversight by new DOT. Environmental protection. Historical preservation.
1967	First Transportation Sec'y Alan Boyd became "most effective national spokesman for the freeway revolt." Mohl, 2004
1968	More environmental and historical regulation. Relocation assistance & replacement housing.
1970	More environmental regulation. More relocation assistance.
1973	De-designation of 190 planned miles. Exchange federal funds for other transp. projects.

Source: DiMento & Ellis, 2013

Cancellations a surprise, from perspective of HHs, planners in 1956.

By 1970, three-quarters of system had already been completed.

Some potentially exogenous variation from *dependent segments*.

Plan deviations downtown, later construction