Expecting an Expressway

Jeffrey Brinkman Jeffrey Lin Kyle Mangum

Federal Reserve Bank of Philadelphia[a]

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[a]The views expressed in this presentation are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

Introduction

What determines urban spatial structure?

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Do **self-fulfilling expectations** play a role?

- If moving is costly → households care about current & future conditions.
- With externalities or spillovers, future conditions depend on others' choices.
- If everyone expects that a neighborhood will be attractive in the future because other households will be there,
  → it will attract households today, **proving such expectations correct**.

Challenges

Identifying this **expectations** channel is challenging.

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

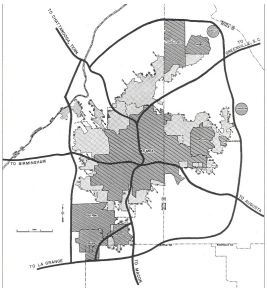
Our approach: Historical planned highway segments in US central cities

Certain construction, . . .

- Broad support and few constraints ca. **1956**.
- Initial construction revealed disamenities from noise, pollution, barrier effects. Brinkman & Lin, 2022

. . . then certain cancellation.

- 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.



What we do: Evidence and theory

Evidence from 40+ US central cities that **expected** highways caused neighborhood decline, and declines persisted even after plans were canceled.

- Simple contrast, regression, matching, IV (early distant connections), runner-up.

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Evidence from 40+ US central cities that **expected** highways caused neighborhood decline, and declines persisted even after plans were canceled.

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

- Two key ingredients: Forward-looking households & Agglomeration economies.

→ Potential multiplicity of steady states in neighborhood size.

→ Self-fulfilling expectations: Expected *future* decline in neighborhood QOL leads to neighborhood decline *today* by altering the number of steady states.

→ Path dependence: Nbhd decline persists, even when future shock is never realized.

Contributions & implications

The spatial organization of the economy may feature multiple steady states.

- If strong spillovers, then many outcomes are possible, including path dependence & self-fulfilling expectations. Allen & Donaldson (2022), Bleakley & Lin (2012), Krugman (1991)
- We add to understanding when nature & history may not fully determine future spatial structure — i.e., when "anything" can happen!

Contributions & implications

The spatial organization of the economy may feature multiple steady states.

- If strong spillovers, then many outcomes are possible, including path dependence & self-fulfilling expectations. Allen & Donaldson (2022), Bleakley & Lin (2012), Krugman (1991)
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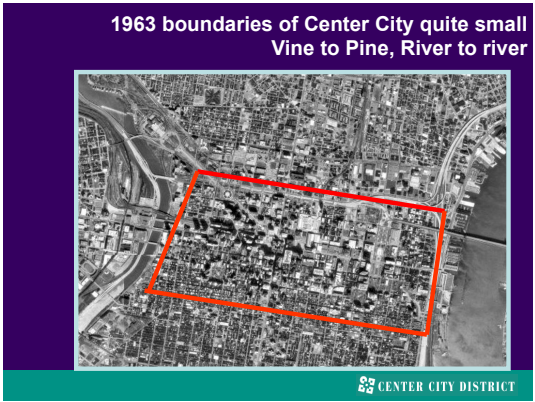
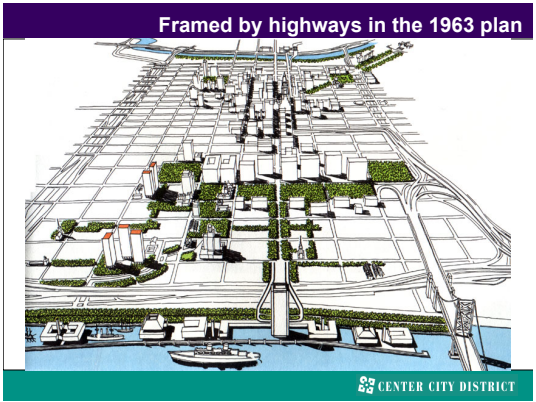
Local development policy may be sensitive to expectations.

- Policy makers might leverage expectations to solve coordination problems. Owens, Rossi-Hansberg, & Sarte (2020), Hornbeck & Keniston (2017)
- Highway planning may affect spatial structure through expectations. Brinkman & Lin (2022), Duranton & Turner (2012), Baum-Snow (2007)

Case Study:
The Crosstown Expressway

Center City Philadelphia was to be encircled by expressways

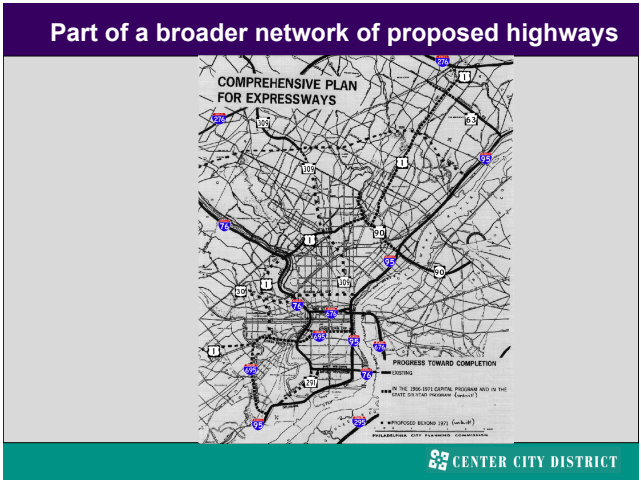




credit: Paul Levy, *Philadelphia Center City District* seminar, 2017

Built vs. planned but never built

- Some were built.
- Others, including the Crosstown or South Street Expressway, were not.



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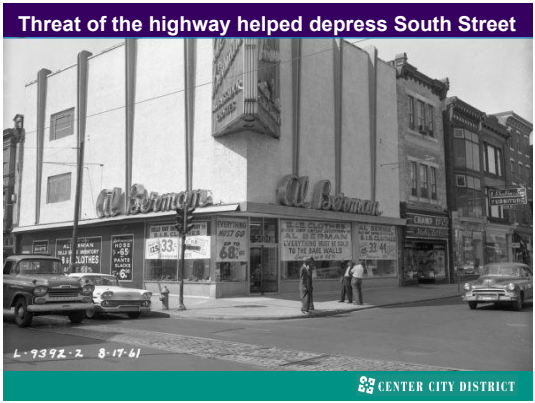
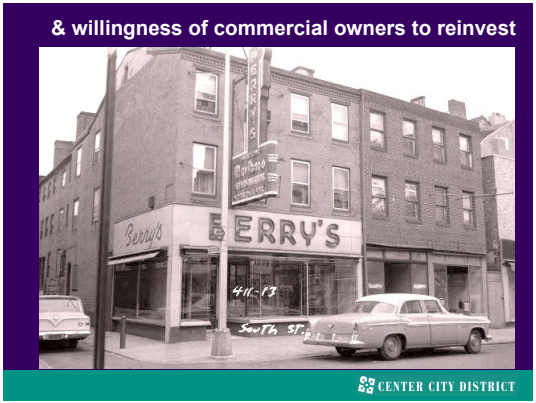
The threat of construction changed behavior





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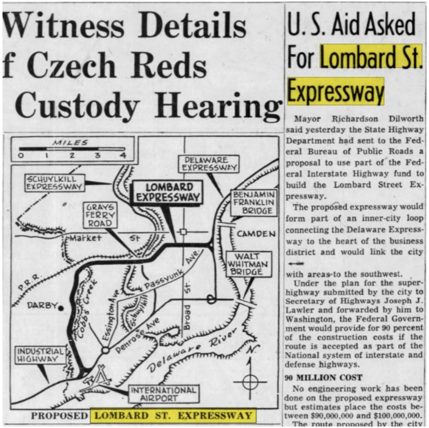
The controversy and the alternative



Witness Details
f Czech Reds
Custody Hearing

U. S. Aid Asked For Lombard St. Expressway

Mayor Richardson Dilworth said yesterday the State Highway Department had sent to the Federal Bureau of Public Roads a proposal to use part of the Federal Interstate Highway fund to build the Lombard Street Expressway.

The proposed expressway would form part of an inner-city loop connecting the Delaware Expressway to the heart of the business district and would link the city with areas to the southwest.

Under the plan for the superhighway submitted by the city to Secretary of Highways Joseph J. Lawler and forwarded by him to Washington, the Federal Government would provide for 90 percent of the construction costs if the route is accepted as part of the National system of interstate and defense highways.

90 MILLION COST

No engineering work has been done on the proposed expressway but estimates place the costs between $90,000,000 and $100,000,000.

The route proposed by the city

PROPOSED LOMBARD ST. EXPRESSWAY

credit: *Philadelphia Inquirer*, Feb. 1957

Alternative Washington Avenue alignment (dating to the 1910s)

THE PHILADELPHIA INQUIRER, THURSDAY MORNING, SEPTEMBER 19, 1957

Expert Proposes New Crosstown Expressway Plan

By SAUL KOHLER

Quill Charges 'Irregularities' In Local Funds

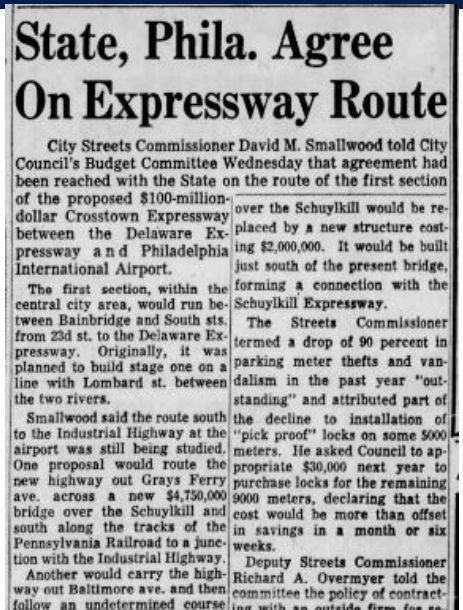
Talks Renewed to End 3-Day Phone Strike; Some Delays Admitted

PROPOSED EXPRESSWAYS: WASHINGTON AND LOMBARD ST. (INSET)

AFL-CIO Denounces Hoffa

credit: *Philadelphia Inquirer*, Sep. 1957

A route was selected



State, Phila. Agree On Expressway Route

City Streets Commissioner David M. Smallwood told City Council's Budget Committee Wednesday that agreement had been reached with the State on the route of the first section of the proposed $100-million-dollar Crosstown Expressway between the Delaware Expressway and Philadelphia International Airport.

The first section, within the central city area, would run between Bainbridge and South sts. from 23d st. to the Delaware Expressway. Originally, it was planned to build stage one on a line with Lombard st. between the two rivers.

Smallwood said the route south to the Industrial Highway at the airport was still being studied. One proposal would route the new highway out Grays Ferry ave. across a new $4,750,000 bridge over the Schuylkill and south along the tracks of the Pennsylvania Railroad to a junction with the Industrial Highway.

Another would carry the highway out Baltimore ave. and then follow an undetermined course over the Schuylkill would be replaced by a new structure costing $2,000,000. It would be built just south of the present bridge, forming a connection with the Schuylkill Expressway.

The Streets Commissioner termed a drop of 90 percent in parking meter thefts and vandalism in the past year "outstanding" and attributed part of the decline to installation of "pick proof" locks on some 5000 meters. He asked Council to appropriate $30,000 next year to purchase locks for the remaining 9000 meters, declaring that the cost would be more than offset in savings in a month or six weeks.

Deputy Streets Commissioner Richard A. Overmyer told the committee the policy of contract-

[credit: *Philadelphia Inquirer*, Oct. 1959]

"...Between Bainbridge and South St, from 23rd Street to the Delaware Expressway..."

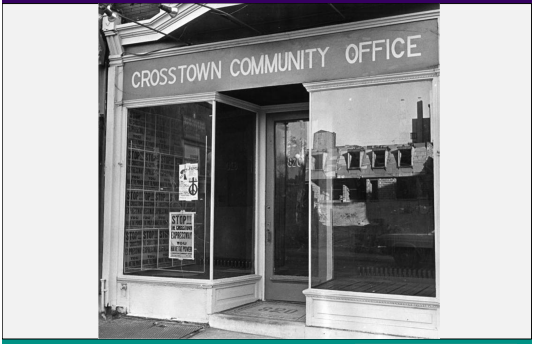
i.e., The northern route, from river to river

But this was opposed by communities in the path

Organized protests, a sense of empowerment:
Preserving neighborhoods more important than building highways

CENTER CITY DISTRICT

Brought very diverse groups together

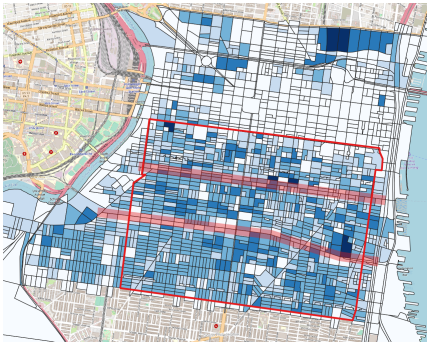


CENTER CITY DISTRICT

credit: Paul Levy, *Philadelphia Center City District* seminar, 2017

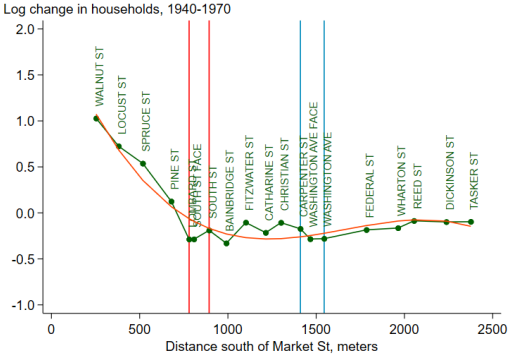
Timeline and matched runner-up estimator

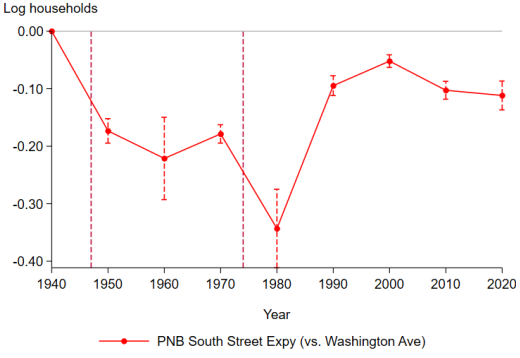
- 1910s: Early proposals for South Street alignment, Washington Ave runner-up alternative.
- 1947–1949: City approves and publicizes South Street alignment.
- 1964: First public hearing.
- 1973–1974: City, State abandon plans.



Sample area: Red box within Center City and South Philadelphia (Walnut to Tasker, 2nd to 24th)
Map shows 1940 household population (blue) and South St, Washington Ave (red)

Matched runner-up estimates





Estimated effect of PNB:

- In 1970: -16.4%
- In 2020: -10.6%

Evidence

Data and sample selection

- Balanced panel of consistent-boundary census tracts, 1940–2017. Lee & Lin, 2018
- Metro areas with digitized 1955 Yellow Book (YB) plans.
  - Neighborhoods that expected expressways.
- National Highway Planning Network
  - Neighborhoods that built expressways.
- Tracts with 5 miles of established city centers.
  - Consistent with net negative effects of highways. Brinkman & Lin, 2022

→ 4,000+ tracts in 40+ metros that have YB *and* 1940 tract data.

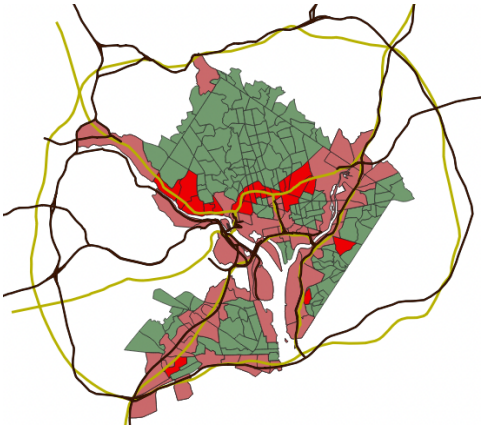
Treatment and comparison groups

B "Built" – Highway intersects tract.

PNB "Planned, Not Built" – Highway *plan* intersects tract, but not built.

NP "Not Planned" – Neither B nor PNB.

Washington DC



Note: Only tracts within 5 miles of downtown are in analysis sample.

Causal inference

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

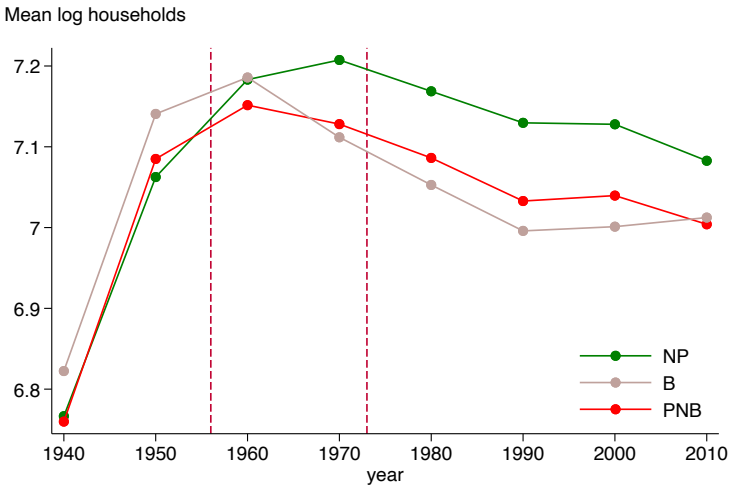
- *Negative* selection on growth factors into plan.
- *Negative* selection on growth factors into cancellation, conditioned on plan.

Narrative evidence suggests *positive selection*. Brinkman & Lin, 2022

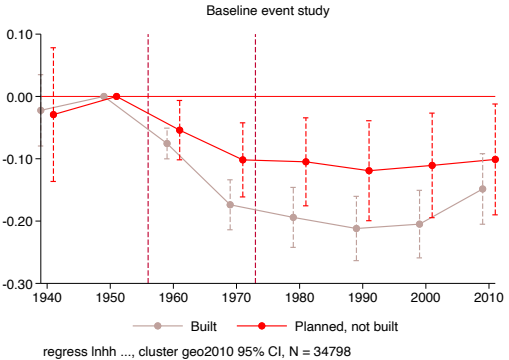
- Highways planned in nbhds expected to grow most.
- Cancellations typically in high-SES neighborhoods.
- Pre-highway growth rates are similar (and > 0); Reversal of fortune.

Designs: Simple contrast, regression, matching on observables, IV, matched runner-up.

Household population over time



Event study estimates

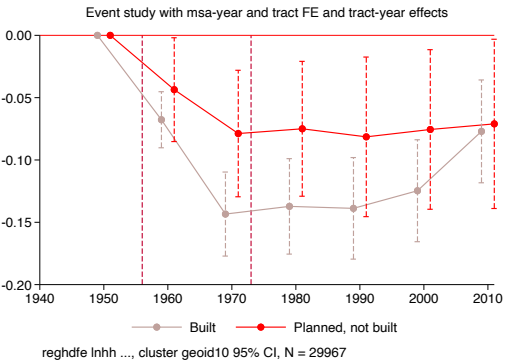


Differences in 1980:

	PNB vs NP	B vs NP
Simple contrast	-10.0%	-17.6%

- Pre-trends similar; reversal of fortune.
- Decline persists after 1973, despite cancellations.

Event study estimates with FE, natural & historical controls



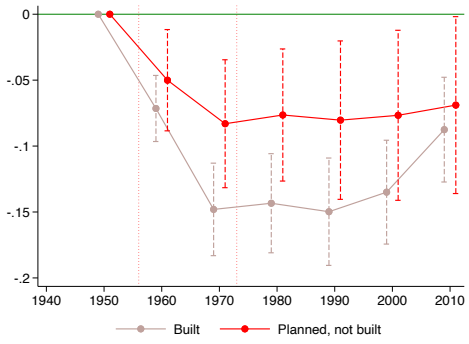
Differences in 1980:

	PNB vs NP	B vs NP
Simple contrast	-10.0%	-17.6%
Regression adjustment	-7.2%	-12.8%

Controls:

- Metro×Year FE
- Tract FE
- Tract natural & historical factors×Year effects (e.g., Year×flexible dummies for quantiles of proximity to river, to city center, slope, land area, 1940/1950 demographics)

Matching estimates



Differences in 1980:

	PNB vs NP	B vs NP
Simple contrast	-10.0%	-17.6%
Regression adjustment	-7.2%	-12.8%
Matching	-7.4%	-13.3%

Treatment factors: ⏩ IPWRA ⏩ overlap

- Tract natural factors (e.g., proximity to river, to city center, slope, land area) & pre-determined historical factors (1940/1950 demographics).

IV estimator

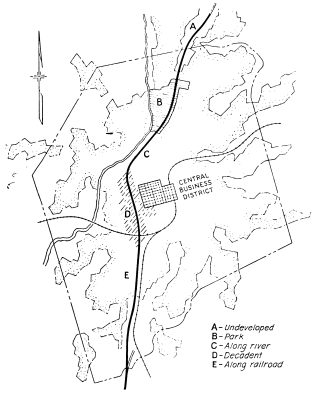
Remaining concern is that conditional ignorability of planning & cancellation is too strong an assumption.

- We need 2 instruments for 2 endogenous vars (B, PNB) or 2 endogenous margins:
  1. Selection into plan, and
  2. Selection into cancellation (conditioned on plan).
- We propose and use 2 types of IVs:
  - Historical rail and explorer routes [1]. ⏩ Duranton & Turner, 2012
  - 1947 **Inter**-city plan routes [1]. ⏩ Baum-Snow, 2007
  - Early and delayed distant connections [2] — These are new.

Early distant completions

Early, rural highway construction affected cancellation.

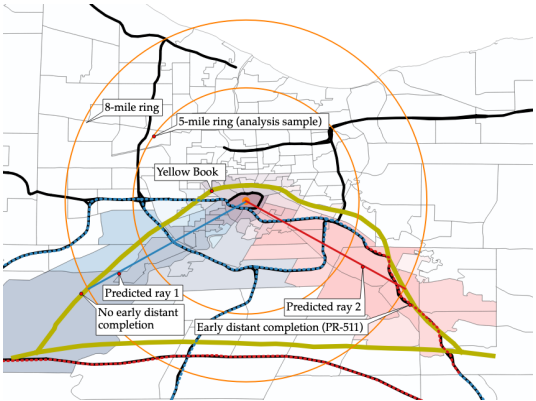
- Pre-1956 State routes were rural; no opposition.
- Which projects were started first often idiosyncratic; unrelated to central neighborhood factors. Johnson, 1965
- Design standards called for **rays** converging to CBD. →
- **Early distant completion** of rural rays (A) reduced likelihood that central rays (C) would be cancelled.
- On the other hand, **delayed distant completion** of rural rays increased likelihood of central-ray cancellation.



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

Early distant completions — Example

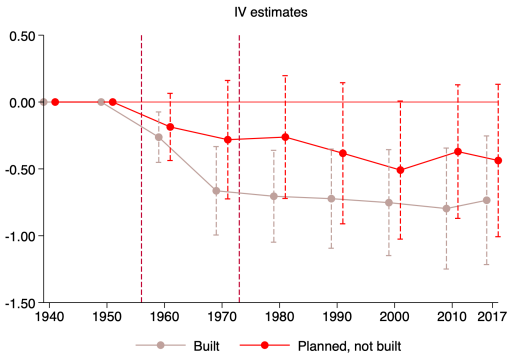
- 8-mi ring defines 2 predicted rays.
- Rural portion of ray 2 completed 1955, predicts B | Plan.
- Rural portion of ray 1 *not* completed by 1956, predicts PNB | Plan.
- 19 cities have both early & delayed distant completions.



Rochester example

Toledo and Houston

IV estimates



Differences in 1970:

	PNB vs NP	B vs NP
Simple contrast	-10.0%	-17.6%
Regression adjustment	-7.2%	-12.8%
Matching	-7.4%	-13.3%
IV	-23.0%	-50.6%

- 2-step IV estimator. Wooldridge, 2010
- Instrumentation is strong. ($F^B = 99$, $F^{PNB} = 46$)
- Larger IV estimates consistent with narrative, statistical evidence that highways planned & cancelled in neighborhoods expected to grow.

Other outcomes, robustness, and extensions

Other outcomes:

- Population: Quantitatively similar results.
- Housing units: Substantial disinvestment in B & PNB n'hoods. ⏩
- Income, prices, and race: Large gross changes in total white and nonwhite populations; modest net effects on sorting. ⏩ race ⏩ income

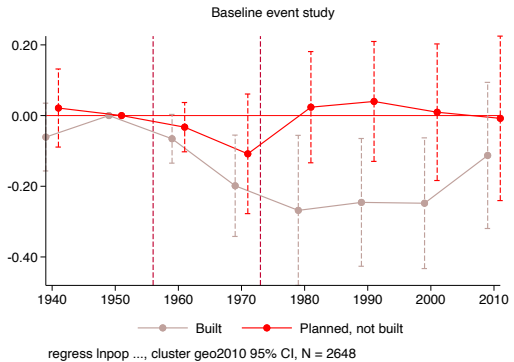
Robustness:

- Sample selection: 25% densest tracts in each city; >14k pop/mi^2; >4k HU/mi^2.
- Spatial treatment: Log distance to B & PNB vs. $1(\cdot)$. ⏩

Extensions:

- Early cancellation has temporary effects (San Francisco, Baltimore).
- Matched runner-up design (Philadelphia's South Street Expy; Block scale).

Early cancellation has temporary effects



San Francisco and Baltimore were exceptional in that they had local control powers to stop highway construction.

- SF had sole power to close roads; Board of Supervisors cancelled all highway construction in **1959**.
- Baltimore had sole authority to condemn properties.
- Differences in 1970 are similar, but PNB then returns to pre-highway levels.

Summary of evidence

- Expected expressways caused significant **neighborhood decline**.
- Neighborhood decline persisted, even when construction was cancelled.
  - Except in cases where planned highways were cancelled early.

Model

Model outline

Goal: Rationalize these results and quantify local agglomeration economies

Two key ingredients:

- Agglomeration economies
- Forward-looking households

Key results:

- Strong agglomeration economies → multiple steady states in neighborhood size.
- Expected *future* shock leads to nbhd decline *today* (self-fulfilling expectations).
- Decline persists, even when future shock is never realized (path dependence).

Environment

- Households choose among J neighborhoods in each period, subject to a move cost.
- Value of nbhd j depends on exogenous amenities a_j and endogenous pop. n_j.
- Timing:
  - Initial allocation of population across neighborhoods.
  - Exogenous amenities determined $a_t = f(a|a_{t-1}, \nu)$.
  - Households choose location based on expected population $\hat{n}_j$.
  - Their choices determine realized population & next period's initial allocation.

Value of a location depends on others' choices

Choice-specific values, conditioned on beginning in nbhd j:

$$\text{stay: } v_j(a_{j,t}, n_{j,t-1}) = \underbrace{u(a_{j,t}, n_{j,t})}_{\textit{flow util}} + \beta \underbrace{V(a_{j,t}, n_{j,t})}_{\textit{continuation value}}$$

$$\text{move: } v_0 = u_0 + \underbrace{c_0}_{\textit{move cost}} + \beta V_0$$

How a location depends on others' choices

Utility can contain terms for negative and positive effects of neighborhood population

$$u(a_{j,t}, n_{j,t}) = a_{j,t} + \underbrace{u^{-}(n_{j,t})}_{\textit{congestion}} + \underbrace{u^{+}(n_{j,t})}_{\textit{agglomeration}}$$

We want do inference on the shape of u.

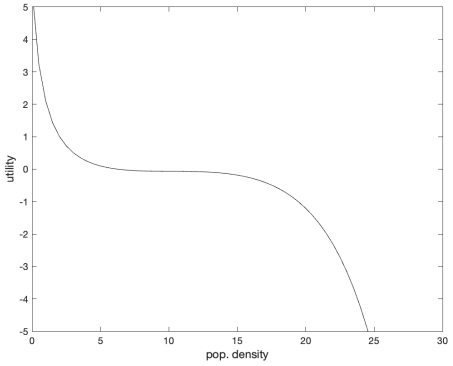
- Monotone congestion is when $u_n() < 0$ (for all n).
- Net agglomeration is when $u_n() > 0$ (over some n).

e.g.,

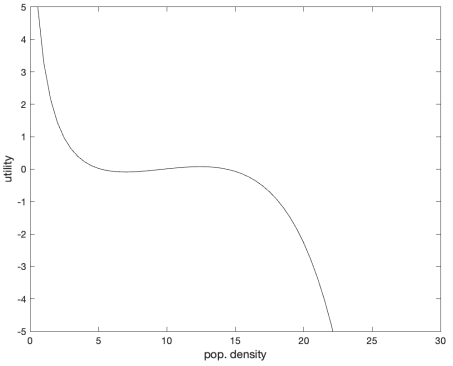
$$u(a_{j,t}, n_{j,t}) = a_{j,t} - \underbrace{\frac{A_1}{1+n_j}}_{\textit{shared resource}} + \underbrace{A_2 n_j}_{\textit{IRS consumption}} - \underbrace{A_3 exp(n_j)}_{\textit{rent}}$$

Shape of utility: 2 cases

Complete Congestion



Some Agglomeration



Definition of equilibrium population

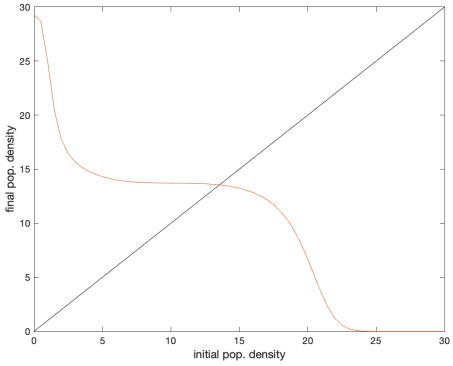
- Let choice probability from i to j be $\sigma_{j,i}(v_{j|i}(\hat{n}_j))$.
  - Standard extreme value shocks (logit demand).
- Equilibrium is fixed point in population, i.e., expected = realized population.

$$n_1^{*t} = \sigma_{1,0}(n_1^{*t})\, n_0^{t-1} + \sigma_{1,1}(n_1^{*t})\, n_1^{t-1}$$

  - History matters: Initial population allocations affect the equilibrium allocation.
  - There may be multiple equilibria and/or multiple steady states, depending on the shape of $v_{j|i}(\hat{p}_j)$.

Equilibrium

Complete Congestion



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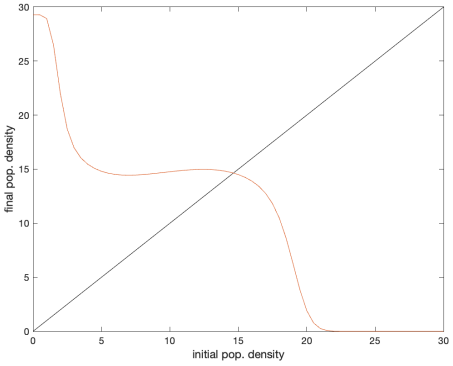
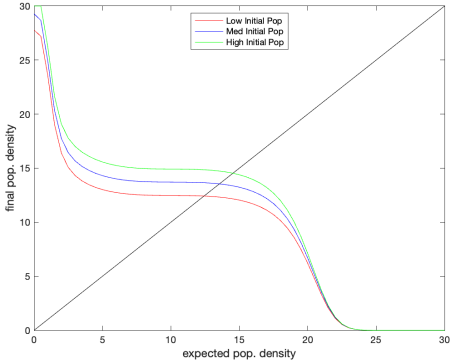


Equilibrium depends on history

Complete Congestion



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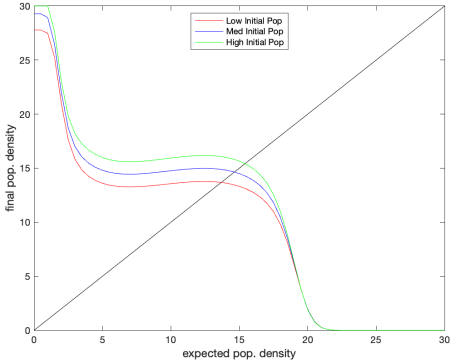
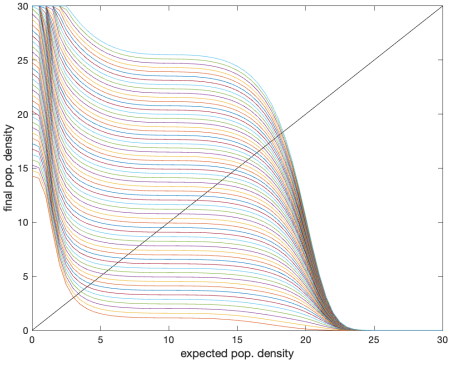
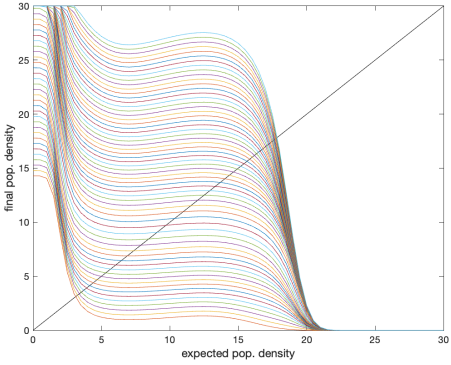


Equilibrium depends on history

Complete Congestion

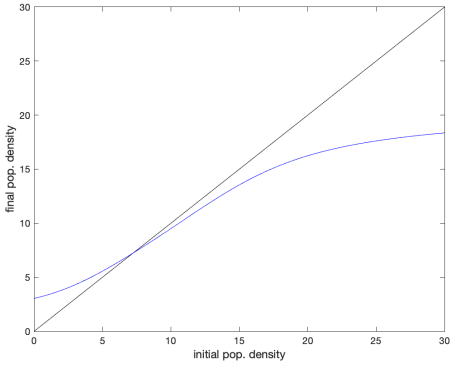


Some Agglomeration



History-dependent equilibrium determines population transitions

Complete Congestion



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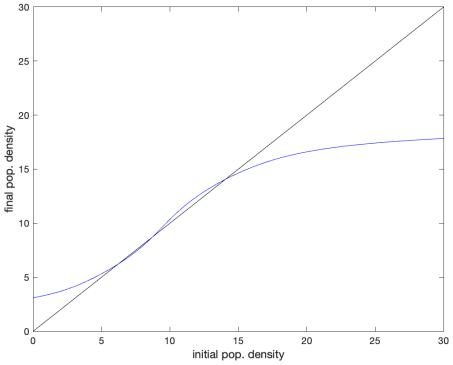
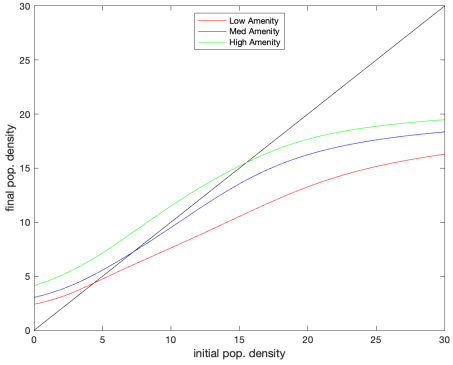


- Agglomeration can yield multiple equilibria or (in this case) multiple steady states.

Population transitions depend on amenity levels

Complete Congestion



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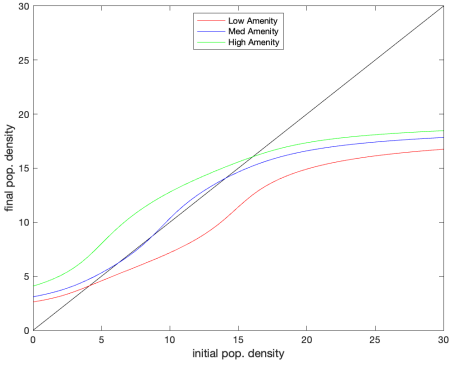
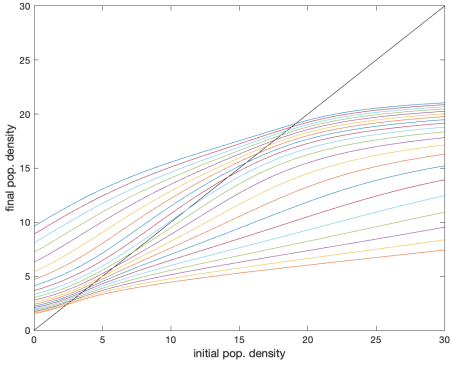


Population transitions depend on amenity levels

Complete Congestion



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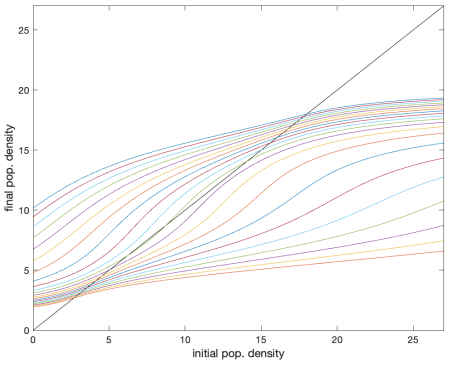
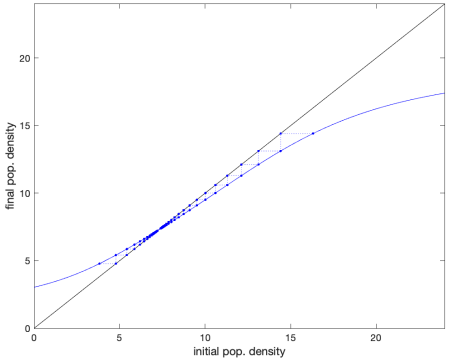


Population dynamics: Toward steady-state(s)

Complete Congestion



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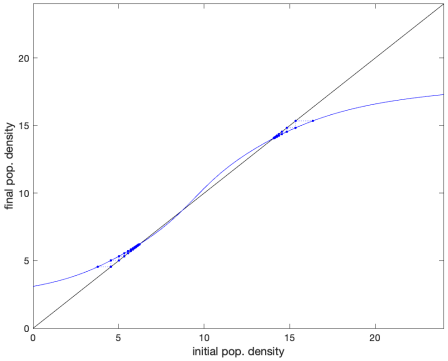
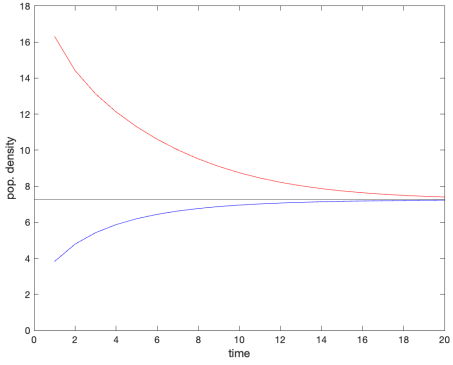


Population dynamics: From different initial populations

Complete Congestion



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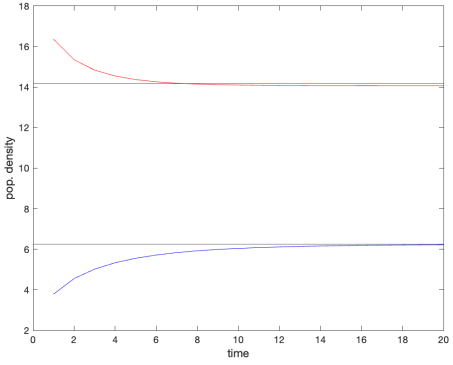
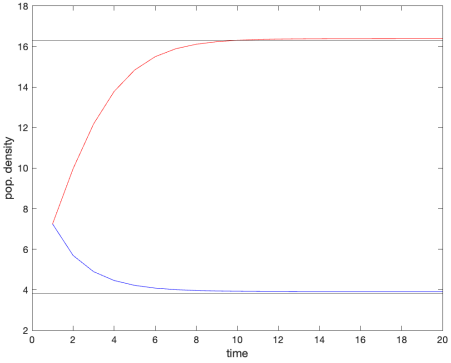


Population dynamics: Towards different amenity levels

Complete Congestion



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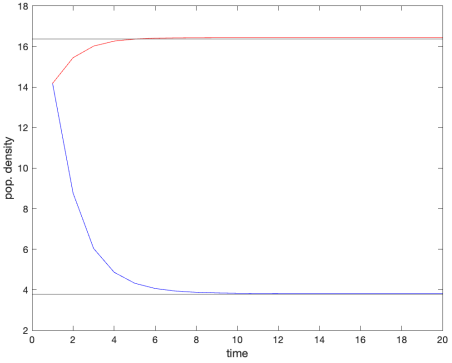
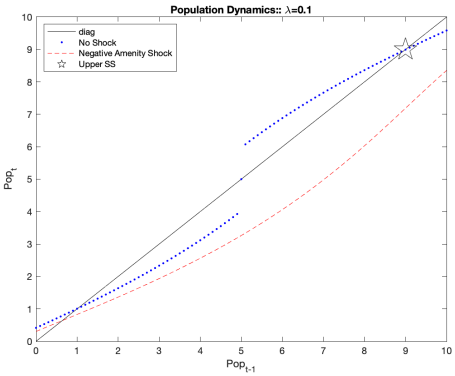


Bad news shock

Start from a high steady-state population.

- At date t, it is announced in s periods, nbhd 1 amenity will decline.
  - Changes expectations but negative amenity shock is not realized yet.
  - Forward-looking agents begin to act (via expectations of future population).
- In some cases, the shock is unexpectedly **cancelled** at $t + s' < t + s$.
  - But if $s' > 0$, households have already begun acting on the news.

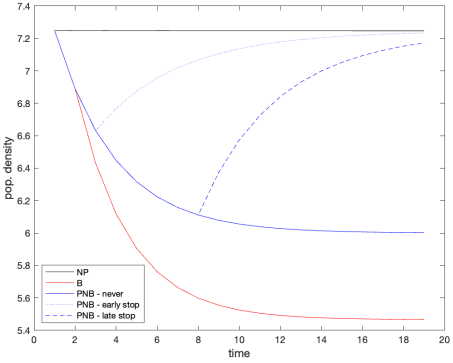
Future bad news leads to neighborhood decline today



- "Bad news shock," eliminates steady state ★, leaving only one steady state.
- Nbhd declines immediately, transitioning to remaining (low) s/s.
- Self-fulfilling expectations: Expected decline in (endogenous) QOL leads to decline today.

Population dynamics after PNB/B shock

Complete Congestion



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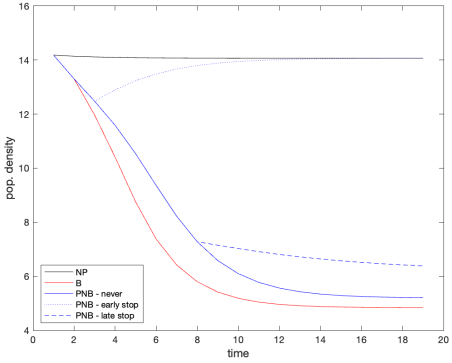
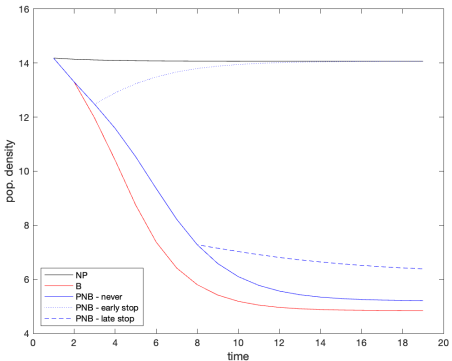


Declines can persist even when future bad news is cancelled

- Reversal depends on extent of transition: **Persistent effect** of expectations shock if cancelled late.
- Path dependence: Decline persists, even when future shock is never realized.

Some Agglomeration

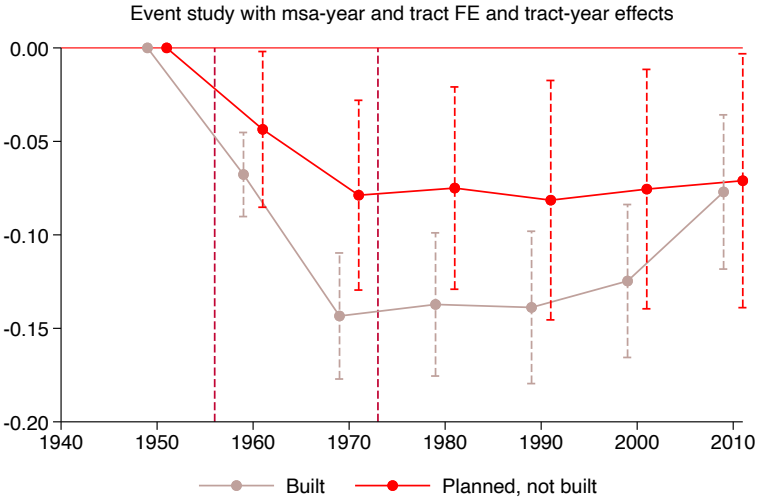


Nb. Effect size ordering: EC < PNB < B.

Estimation

Estimation: distinguishing utility functions

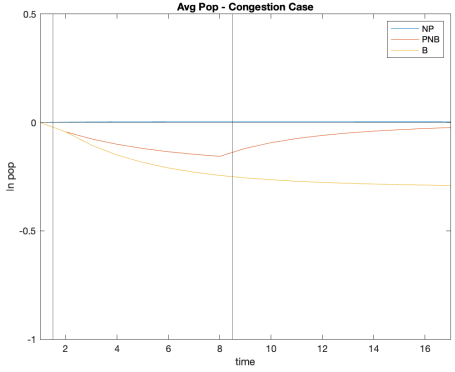
Recall the treatment-status patterns in the data:



Estimation: distinguishing utility functions

We can simulate data from different utility functions and run the same regression:

Complete Congestion



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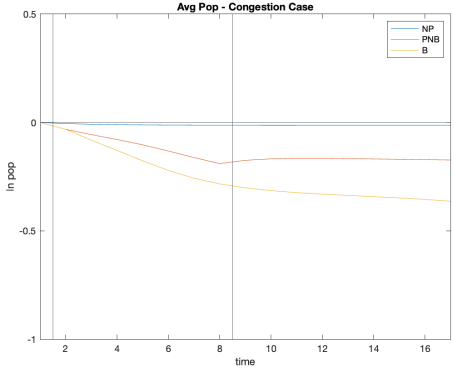


Divergence in treatment effect dynamics—PNB in particular—identifies utility function.

Complicating factors

Other factors affect population dynamics

- Neighborhoods receive other shocks (of unknown distribution).
- Observed population is a mixture of movements along a path toward steady state and shocks across paths.

Estimation procedure

1. Calibrate outside the model
   - Move costs, discount rates, and distribution of idiosyncratic draws.
   - Size of outside option relative to neighborhood.
2. Estimate via nested method of moments (or MLE)
   - Distribution of shocks to neighborhoods.
   - Cross-sectional variance in neighborhood long-run average amenity.
3. Estimate via indirect inference
   - Utility function $u(n_j, \lambda)$.

⏩ Non-parameteric ID argument

Conclusion

Summary and next steps

Expected expressways led to neighborhood decline that persisted even after cancellation.

- Special features about this setting: A big shock over nearly two decades; Little uncertainty; Surprise cancellation.

A model with externalities and forward-looking households can rationalize this result.

- Shocks to expectations can change equilibrium configurations and cause transition to a new steady state.

On the agenda:

- Quantifying externalities in the structural model.

Appendix

Historical evidence on planned route selection

Routes were favored that:

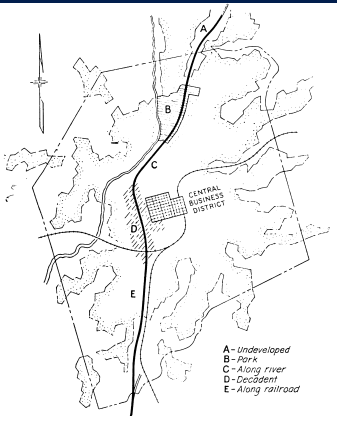
- Penetrated downtown or circumvented cities via beltway.
- Used undeveloped land.
- Linked to other modes such as rail stations and ports.
- Followed forecasted demand.
- Followed topography and physical features such as rivers.
- Were compatible with existing land use.
- National defense.

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

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

Return

Historical evidence on canceled route selection

- vs. neighborhoods 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, 2022

→? Conditioned on plan, canceled routes might have been *negatively* selected on neighborhood growth factors.

» Return

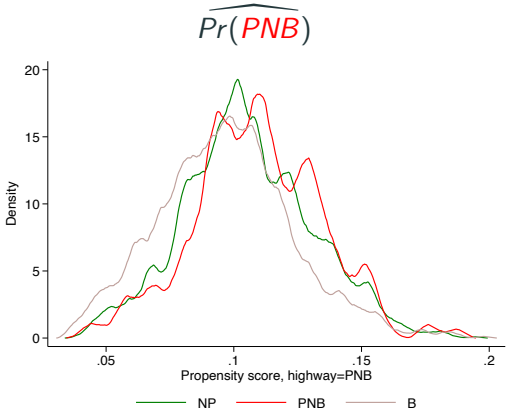
Matching estimator

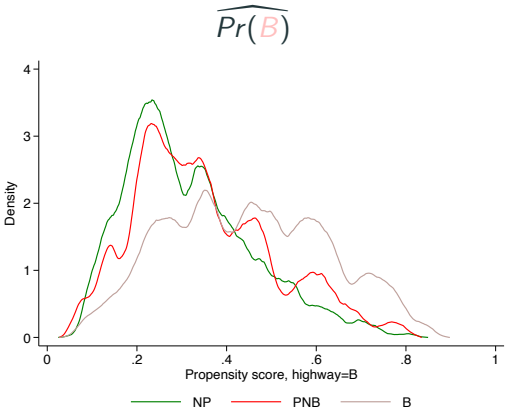
Inverse probability weighted regression adjustment Wooldridge, 2007; Cattaneo, 2010

- Estimator of multi-level treatment effects that combines matching and regression.
  (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.
- 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.

Return

Overlap





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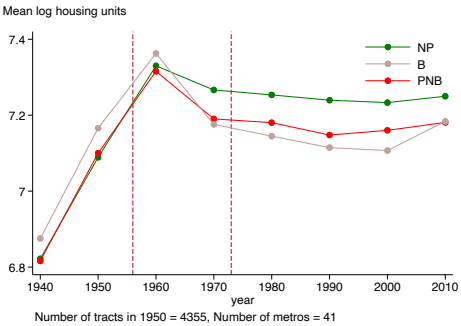
Housing units



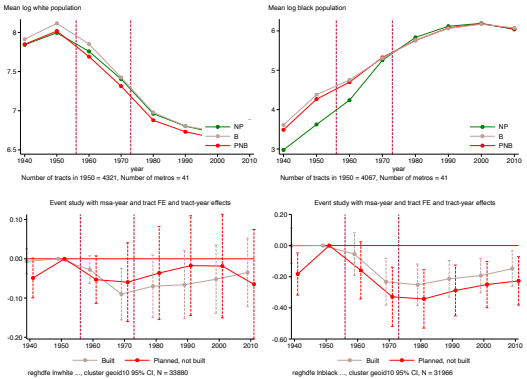
Evidence of substantial housing disinvestment.

- Housing units = occupied + vacant; i.e., "habitable."

Return

Race

- Large net population changes.
- Relative decline in both white and black pop in both B & PNB n'hoods.
- Net effect is modest and insignificant decline in nonwhite share.



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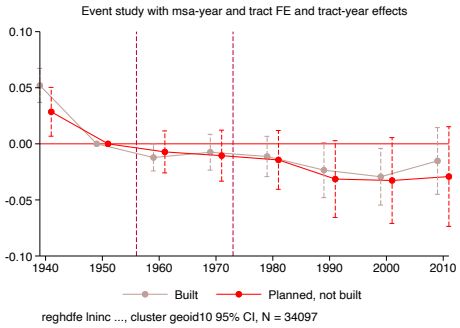
Income

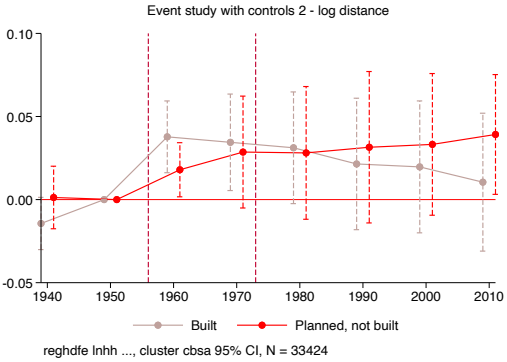


Modest and insignificant decline in income.

- Theory is ambiguous w/ multiple dimensions of heterogeneity.

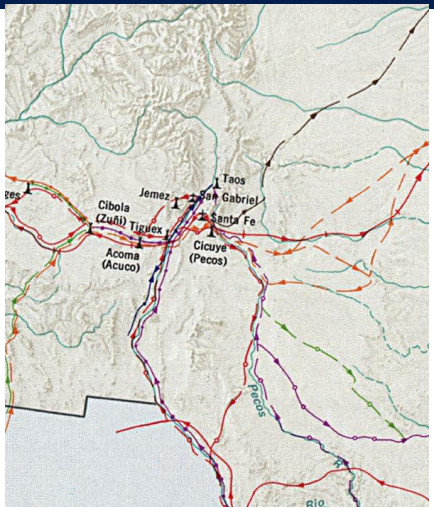
Return

Log distance treatment



Return

Historical routes



Pre-1675 explorer routes near Santa Fe, NM

Least-cost routes based on obsolete topography + history dependence. Duranton & Turner, 2012

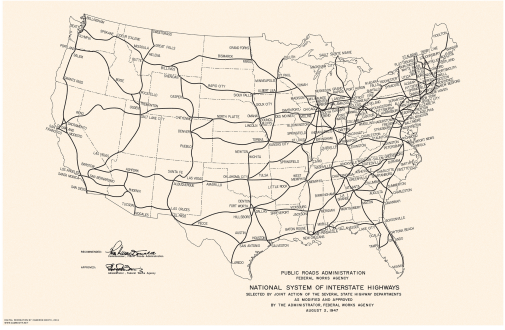
- Pre-1898 rail routes.
- 16th-19th c. explorer routes.

Return

Planned intercity routes

Planners connected distant cities for reasons of interregional trade and national defense unrelated to contemporary neighborhood factors. Baum-Snow, 2007

- 1947 intercity plan.
- Variant of 1947 intercity plan.



1947 intercity plan

Return

IV estimator

2-step IV estimator for binary endogenous treatments. Wooldridge, 2010; Xu, 2021

- Step 1. Estimate a binary response model (MNL) by maximum likelihood.
- Step 2. Use predicted values $\hat{B}, \hat{PNB}$ as excluded instruments in 2SLS.

Virtues:

- Usual 2SLS inference is asymptotically valid. Wooldridge, 2010
- Optimal feasible instrument if Step 1 correctly specified; Consistent even if incorrect. Wooldridge, 2010
- Nonlinear form improves efficiency and addresses weak instruments. Xu, 2021

Return

Early cancellation

San Francisco and Baltimore were exceptional in that they had (and used) local control powers to stop highway construction early on.

San Francisco

- CA State law gave power to close roads to local government
- SF Board of Supervisors had veto power over freeway system

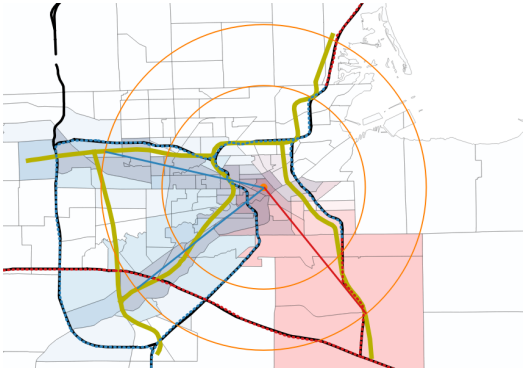
→ Board of Supervisors cancelled further highway construction in 1959

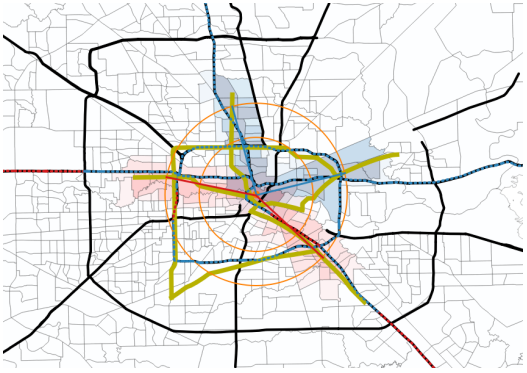
Baltimore

- Two unique provisions in city's home-rule charter
- City council had sole authority to condemn properties

→ City's planning commission could reject state highway plans

Early distant completions - Toledo and Houston examples





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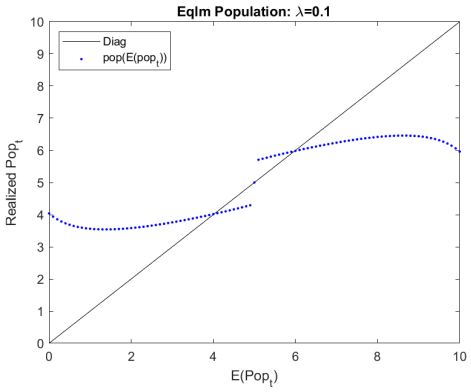
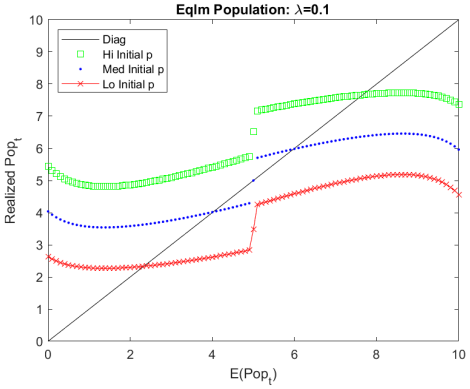
Equilibrium population



- Net agglomeration case: Upward-sloping utility (over some range).
- Equilibrium: realized = expected pop.
- There may be multiple equilibria.

Return

Equilibrium configurations depend on initial population allocations

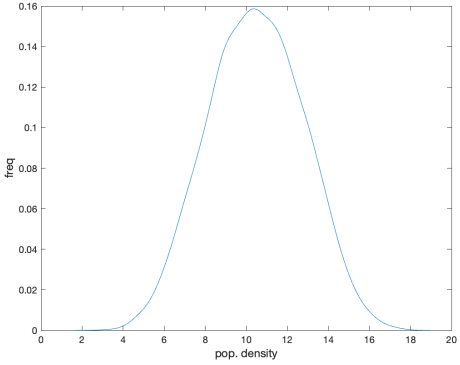


- Some initial conditions reach multiple equilibria; some have only one.

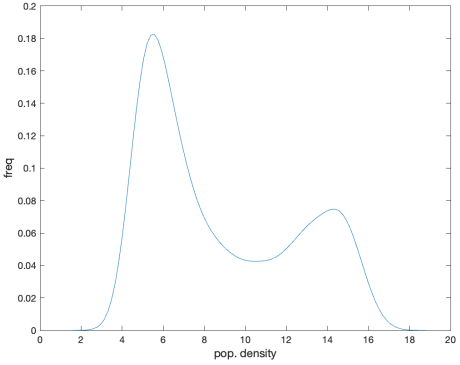
Return

Ergodic distribution of neighborhood size

Complete Congestion



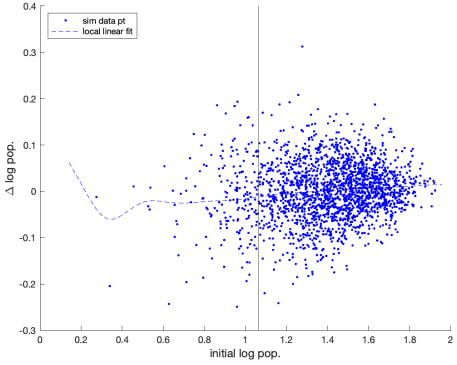
Some Agglomeration



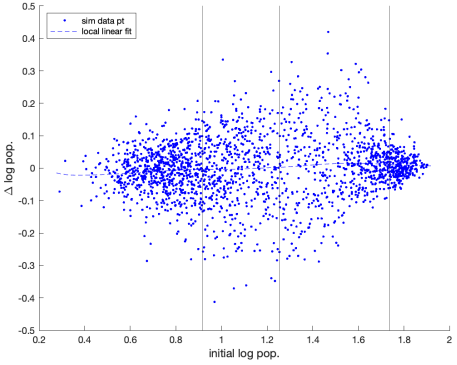
Return

Ergodic distribution of neighborhood population change (mean)

Complete Congestion

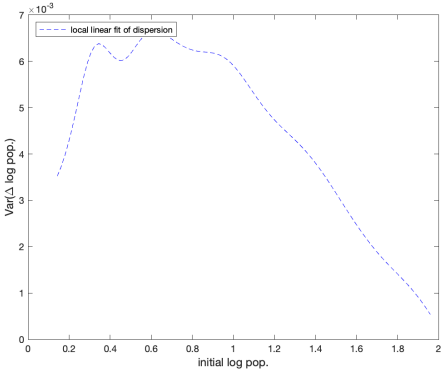


Some Agglomeration



Ergodic distribution of neighborhood population change (variance)

Complete Congestion



Some Agglomeration