# Expecting An Expressway

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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

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- If moving is costly → households care about current & future conditions.
- With 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

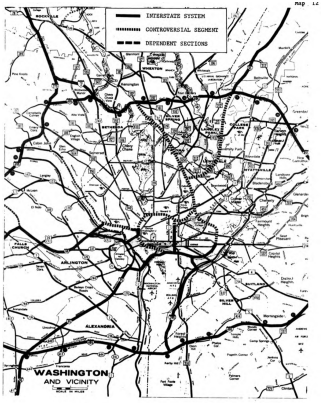
Identifying this expectations channel is challenging.

- 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, then certain cancellation.
- Broad support and few constraints in mid-1950s. Initial construction revealed disamenities from noise, pollution, barrier effects. Brinkman & Lin, 2022
- 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 planned highways caused neighborhood decline, and declines persisted after plans were canceled.

- Simple contrast, regression, matching, IV (dependent segments)

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Evidence from 40+ US central cities that planned highways caused neighborhood decline, and declines persisted 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 & spillovers.
- Expected *future* decline in neighborhood QOL leads to neighborhood decline *today* (self-fulfilling expectations).
- Decline persists, even when future shock is never realized (path dependence).

# 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 — 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)
- We add to understanding when nature & history may not fully determine future spatial structure — when anything can happen!

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)

# Evidence

# Data and sample selection

- Consistent-boundary census tracts, 1940–2010.
- 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 and 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

- Pre-highway growth rates are similar (and $> 0$).
- Highways planned in nbhds expected to decline most.
- Cancellations typically in high-SES nbhds.

Use 3 strategies: Regression, matching, IV.

# Historical evidence on planned route selection

Routes were favored that:

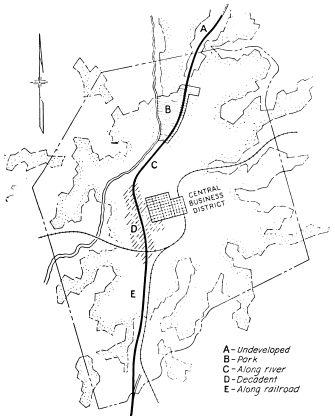
- Penetrated downtown or circumvented cities via beltway.
- Used undeveloped land.
- Linked to other modes such as rail stations and ports.
- Followed forecasted demand.
- Followed topography and physical features such as rivers.
- Were compatible with existing land use.
- National defense.

"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

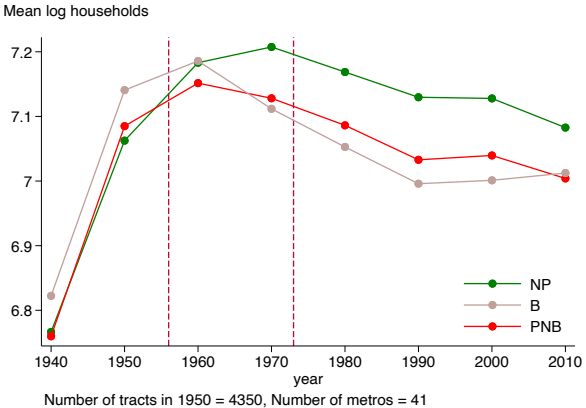
# Historical evidence on canceled route selection

- vs. 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.

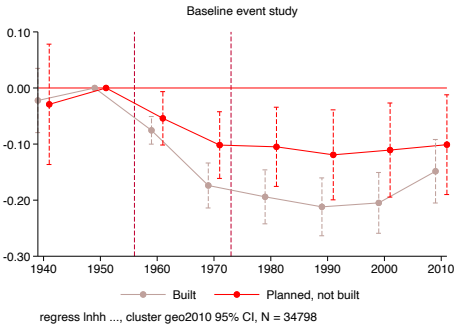
Brinkman & Lin, 2022

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

# Household population over time



# Event study estimates



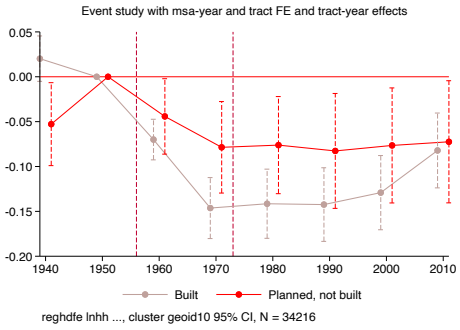

Differences in 1970:

- PNB vs. NP: -9.7%
- B vs. NP: -16.0%

N.b.:

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

# Event study estimates with FE, natural & historical controls




Controls:

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

Differences in 1970:

- PNB vs. NP: -7.6% -9.7%
- B vs. NP: -13.6% -16.0%

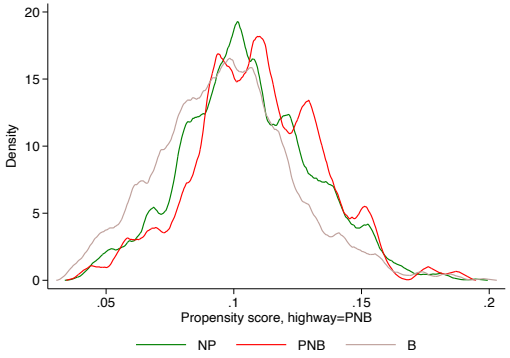
# Matching estimator

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

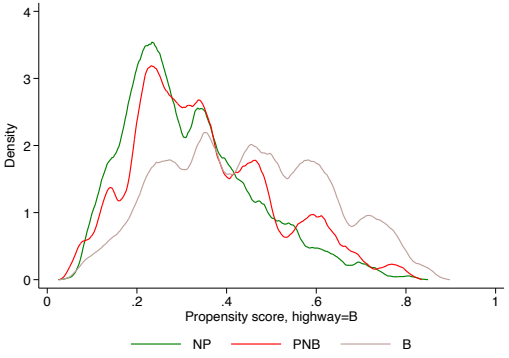
- Estimator of multi-level treatment effects that combines matching and regression.
  (1) Estimate probability of treatment $h$ conditioned on $W$.
  (2) Estimate treatment-level mean outcomes (conditioned on $X$) with inverse probability weights.
    - $\widehat{ATE}$ is contrast between predicted treatment-level 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.

# Overlap

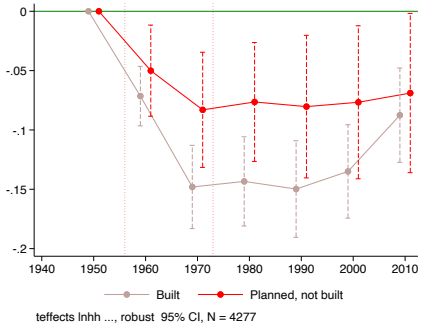
$\widehat{Pr(PNB)}$




$\widehat{Pr(B)}$



# Matching estimates




Differences in 1970:

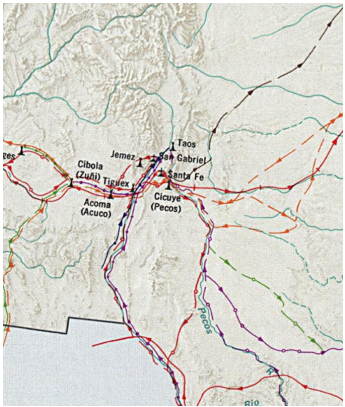
- PNB vs. NP: -8.0%, -7.6%, -9.7%
- B vs. NP: -13.8%, -13.6%, -16.0%

# 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 (up to 4 instruments).
  - Dependent segments (1) — This is new.

# Historical routes




Pre-1675 explorer routes near Santa Fe, NM

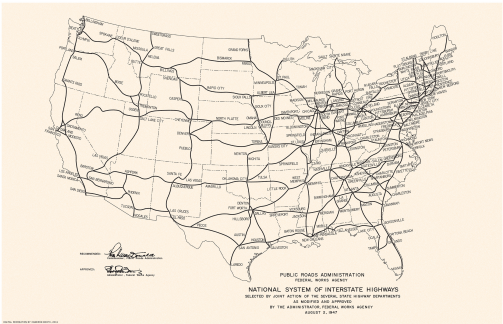
Least-cost routes based on obsolete topography + history dependence. Duranton & Turner, 2012

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

# Planned 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

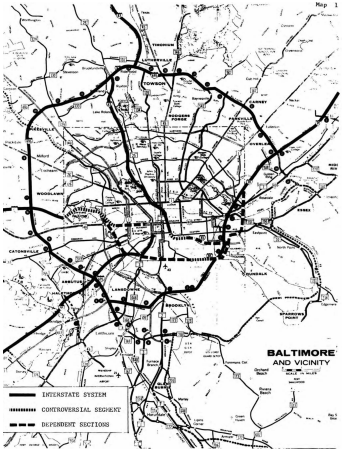
# Dependent segments

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

Report distinguished controversial vs *dependent* segments.

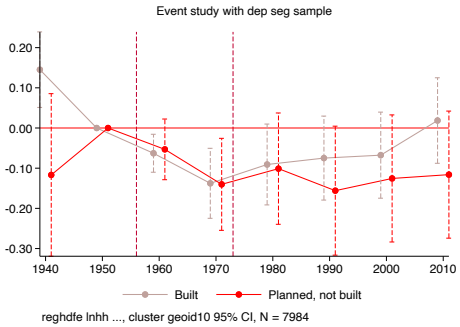
Dependent segments were not themselves controversial, but were likely to be cancelled if controversies were not resolved.

! Only 8 cities; mainly Baltimore, Boston, Cleveland, New York.




Baltimore controversies & dependent segments

# Event study estimates with IV sample

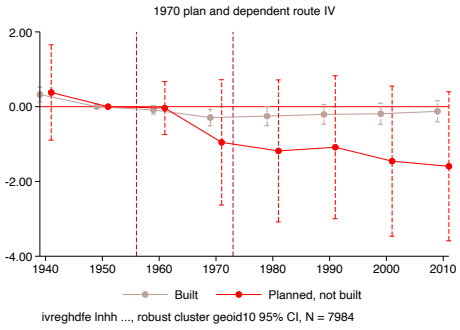



Metro–year FE, tract FE, & tract factor× year effects.

Differences in 1970:

- PNB vs. NP: -13.1%, -8.0%, -7.6%, -9.7%
- B vs. NP: -12.9%, -13.8%, -13.6%, -16.0%

# IV estimates




Differences in 1970:

- PNB vs. NP: -62%, -13.1%
- B vs. NP: -25%, -12.9%

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

- PNB is weakly instrumented.
- LATE?

# Other outcomes and robustness

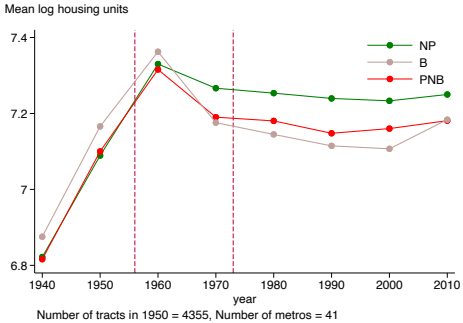
Other outcomes:

- Population: Quantitatively similar results.
- Housing units: Evidence of substantial disinvestment in B & PNB n'hoods.
- Income and race: Large net changes in total white and nonwhite populations; modest net effects on sorting.

Robustness:

- Sample selection: 25% densest tracts in each city in 1950; >14k persons per sq mi in 1950; >4k housing units per sq mi in 1950.
- Spatial treatment: Log distance to B & PNB vs. $1(\cdot)$.

# Housing units

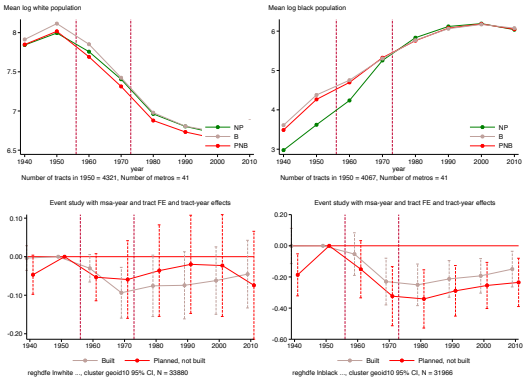



Evidence of substantial housing disinvestment.

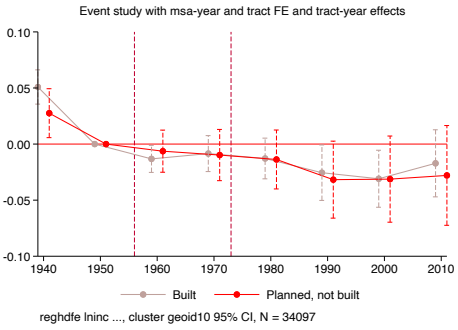
- Housing units = occupied + vacant; i.e., "habitable."

# 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.



# Income




Modest and insignificant decline in income.

- Theory is ambiguous w/ multiple dimensions of heterogeneity.

# 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

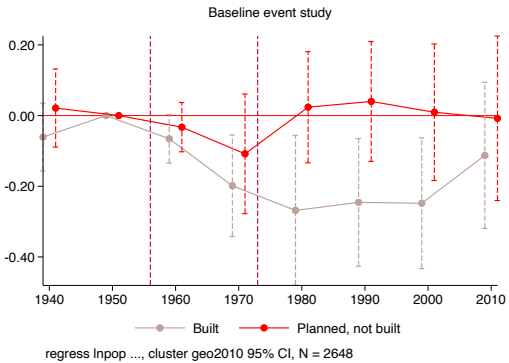
→ Board of Supervisors cancelled further highway construction in 1959

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 cancellation produces rebound




- Differences in 1970 are similar, but PNB then returns to trend.

# Summary of Empirical Results

- Expected expressway construction led to significant relative **neighborhood decline**.
- Populations did not recover, even when construction was cancelled.
  - Except in cases where the highway plan was cancelled early.

# Model

# Model outline

Goal: A model to rationalize these results (and later, quantify parameters. . . )

Essential ingredients:

- Externalities
- Forward-looking households

Key results:

- Expected *future* shock leads to n'hood 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 n'hood $j$ depends on exogenous amenities $A_j$ and endogenous pop. $p_j$.
- Timing:
  - Initial allocation of population across neighborhoods.
  - Households choose location based on expected population $\hat{p}_j$.
  - Their choices determine realized population & next period's initial allocation.
- Equilibrium is fixed point in population,
  - i.e., when expected population = realized population.

# Value of a location depends on others' choices

. . . now *and* in the future. Value of a location $j$ as viewed from $k$ (at time of choice):

$$v_{j,k}(A_j^t, \hat{p}_j^t) = \underbrace{u(A_j^t, \hat{p}_j^t)}_{\text{flow util}} + \underbrace{c_{j,k}}_{\text{move cost}} + \beta \cdot \underbrace{V_j(A_j^t, \hat{p}_j^t)}_{\text{continuation value}} \tag{1}$$

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

$$u(A_j^t, \hat{p}_j^t) = A_j^t + \underbrace{u^-(\hat{p}_j^t)}_{\text{congestion}} + \underbrace{u^+(\hat{p}_j^t)}_{\text{agglomeration}}$$

Let's focus on net agglomeration case: $u^- + u^+ > 0$.

# Two location model

Let's work with a simple example:

- 2 locations, 1 and 0.
- Closed economy with fixed population.
- Symmetric move costs.
- Symmetric exogenous amenities $A_1 = A_2$ (for now).
- We'll study location 1 (WOLOG).

# Definition of equilibrium population

- Let choice probability from $i$ to $j$ be $\sigma_{j,i}$.
- Standard extreme value shocks (logit demand).
- Equilibrium population is fixed point:

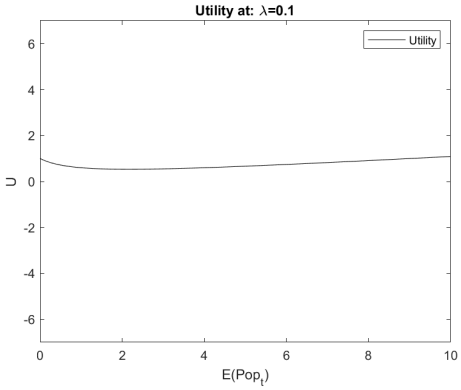
$$p_1^{*t} = \sigma_{1,0}(p_1^{*t})\, p_0^{t-1} + \sigma_{1,1}(p_1^{*t})\, p_1^{t-1}$$

- Initial population allocations affect the equilibrium allocation.

# Equilibrium under agglomeration

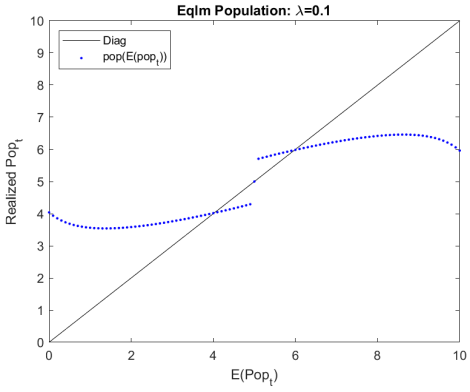
# Utility function slopes up

*Shape of utility under net agglomeration*



# Equilibrium population at given initial condition

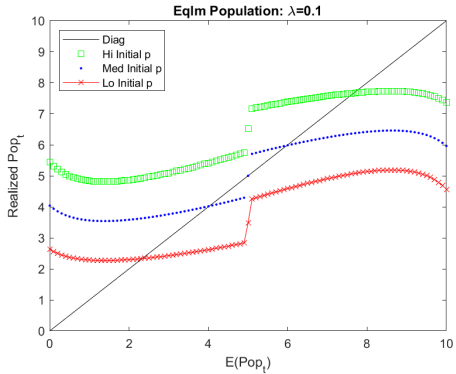
*Realized population as function of expected population*




Multiple intersections of diagonal → multiple equilibria.

# Equilibrium population, varying initial conditions

*Realized population as function of expected population*

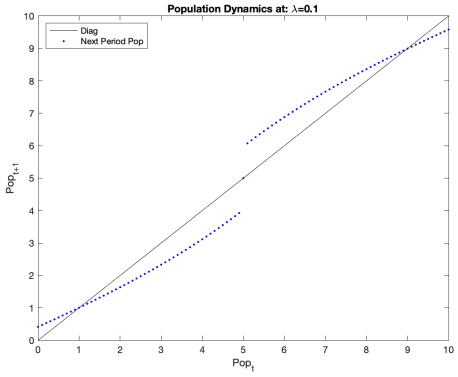



Equilibrium configurations depend on initial population allocations.

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

# Equilibrium locus determines population dynamics

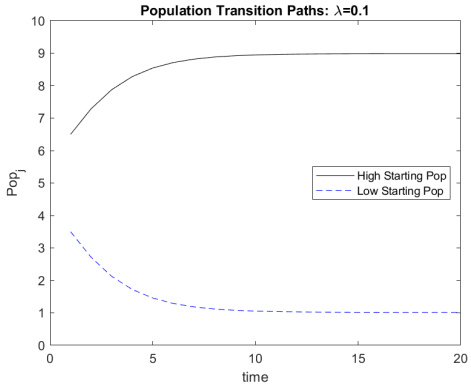
*Population transition function, $t-1$ to $t$*




There are multiple steady states in this scenario.

# Generates population time series from a given initial condition

*Population transition Time Series*




Population converges to nearest stable steady state.

# Shock to future amenities

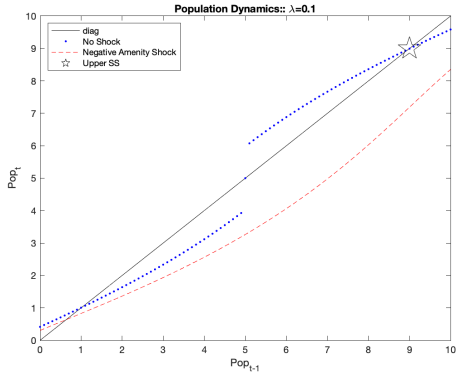
# Bad news shock

Starting from a high steady state population:

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

# Population dynamics are altered by expected amenity shock

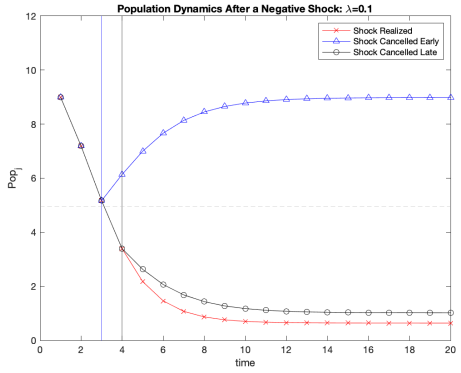
*Population Transition Function, $t-1$ to $t$, With and Without Amenity Shock*




The negative shock scenario has only one steady state, eliminating ★...

# Population time path after shock and cancellation

*Population Transition Time Series Under Cancellation Scenarios*




Reversal depends on extent of transition: **permanent effects** of expectations shock

# Summary of Model Results

- Positive externalities and moving frictions (forward-looking decisions) may result in multiple equilibria and multiple steady states in spatial structure.
- Shocks to future fundamentals can alter the number and location of steady states.
- Implications:
  - Even partial transitions can alter the economy's point of convergence
  - Consistent with the experience of expected expressways in U.S. cities

# Conclusion

# Summary and Next Steps

Planned but never-constructed expressways led to neighborhood decline that persisted even after cancellation.

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

- Shocks to expectations can cause transition to a new steady state.

On the agenda:

- "Case study" of Philadelphia's Crosstown Expressway.
  - Block-level resolution; better controls for potential confounders.
  - Alternative design; Runner-up × Near-far DD.
- Housing investment in the data and the model.
- Quantifying externalities.