Expecting an Expressway

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Abstract

We provide theory and evidence on the role of self-fulfilling expectations in determining urban spatial structure. In U.S. central cities, there was near certainty in the mid-1950s that planned urban highway segments would reduce neighborhood quality of life, as Interstate builders enjoyed widespread support and faced few constraints. But unanticipated federal and state reforms led to the permanent cancellation of some highway projects after 1973. Planned—but never constructed—urban Interstate segments caused neighborhood declines through 1970, and these declines persisted for decades afterwards, despite plan cancellation. These results are consistent with forward-looking behavior and strong economies of density in residential location choice.

Keywords: self-fulfilling expectations, history dependence, multiple equilibria
JEL classification: D84, N92, O18, R14

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1 Introduction

What determines urban spatial structure? An intriguing hypothesis is that self-fulfilling expectations can play a decisive role. In models with positive externalities or agglomeration economies, there may be multiple equilibria or steady states. If so, then *historical* accidents might get "locked in" through the self-reinforcing logic of virtuous circles (Bleakley and Lin 2012). Alternatively, the key determinant of equilibrium selection might be coordinated *expectations* (Krugman 1991; Matsuyama 1991).

To see this, consider the setting of residential location choice. If moving is costly, then households will be interested not only in current neighborhood conditions but also neighborhood conditions in the future. And if households care about the size or composition of a neighborhood because of externalities, then future neighborhood conditions depend on the choices of others. Thus, there is the potential of self-fulfilling prophecy: if, for example, everyone thinks that quality of life in a particular neighborhood will improve, they may act accordingly by investing in properties, opening new businesses, or moving in. These actions may then improve the attractiveness of the neighborhood, proving expectations correct.

Identifying this expectations channel can be challenging, in part because expectations are hard to measure and in part because expectations may be correlated with neighborhood factors, including the realizations of expected future shocks. In this study, we consider large, long-planned, and salient and well-publicized local investments that were widely expected to affect neighborhood quality of life, thus addressing the challenge of measuring expectations. Further, decades later, many of these planned local investments were cancelled permanently, thus breaking the link between expected versus realized shocks.

We study historical planned highway segments within U.S. cities that were expected to reduce future neighborhood quality of life. In the mid-1950s, there was widespread consensus that urban highways would be built; highway builders enjoyed broad support and few constraints. It was also widely understood that urban highways would have significant negative local quality of life effects on central neighborhoods through noise, pollution, and barrier effects (Brinkman and Lin 2022). The grassroots protests known as the freeway revolts are *prima facie* evidence of these expected disamenities. While the freeway revolts had little initial success in altering or blocking urban highway construction, federal and state reforms eventually led to the permanent cancellation of some highway projects and their dependent segments, especially after 1973. These cancellations meant that expected future neighborhood disamenities from *completed* highways never materialized. In many cases, which highway segments were planned and which were cancelled depended on idiosyncratic factors that were unrelated to neighborhood confounders. Therefore, this setting addresses both the challenges of measuring expectations and identifying their effects.

We provide evidence that planned highways in the mid-1950s caused neighborhood decline, and that these declines persisted even after planned highways were cancelled in the mid-1970s. We use spatial data on completed highways and highway plans from the 1955 "Yellow Book," the first national publication describing the planned routes of highways *within* cities (U.S. Department of Commerce 1955). We combine these with neighborhood population, demographics, and fixed characteristics 1940–2010 from a new consistent-boundary census tract panel extending Lee and Lin (2017).

We find that central neighborhoods near completed highways experienced population declines of 16% between 1950 and 1970, and this decline persisted through 2010, consistent with Brinkman and Lin (2022). Surprisingly, neighborhoods near planned, *but never constructed*, highways experienced declines of 10% between 1950 and 1970, despite having avoided the direct negative effects of new highways. These declines also persisted through 2010. Since the planned highway was never built, these results suggest that self-fulfilling expectations played a decisive role in neighborhood development.

We address several potential confounding factors in our analysis. Highway were unlikely to have been randomly allocated to neighborhoods. There are two relevant selection margins of concern. One, planned highways may have been routed through neighborhoods expected to decline. Two, planned highways may have been more likely to have been cancelled in neighborhoods expected to decline. Either could provide an alternative explanation for our results. However, there is little support for either explanation in historical narrative evidence. Planned highways targeted neighborhoods that were then-underdeveloped (conditioned on observables) and thus had higher growth potential, which would cause us to underestimate the negative effects of planned and built highways. Highway construction was cancelled in some neighborhoods not because of they were themselves controversial, but because of connections to other distant segments.

We use several different designs to estimate the effects of planned highways. First, we use regression adjustment to control for city–year effects and time-varying effects of natural and historical neighborhood factors such as rivers, slope, proximity to the city center, and 1940 and 1950 demographics. Second, we use an inverse probability weighted regression adjustment (IPWRA) estimator that combines matching and regression. Third, we use an instrumental variables (IV) estimator. We follow the literature and use planned and historical intercity route instruments (Baum-Snow 2007; Duranton and Turner 2012; Redding and Turner 2015). We also develop a new *distant delayed completion* instrument to address potential endogenous freeway cancellation. This instrument relies on within-city variation from the pre-1956 completion of connecting, but distant, rural segments of the Interstate highway program. Fourth, we use a matched runner-up estimator that compares outcomes for blocks along the proposed Crosstown Expressway in Philadelphia with an early alternative route considered by planners in the 1910s. Taken together, our results suggest that negative selection of neighborhoods into the highway plan or cancellation treatments is not a concern. Planned highway segments appear to have caused neighborhood decline in advance of construction, and these declines persist to this day, decades after cancellation.

We develop a dynamic model of household neighborhood choice to rationalize these results and quantify local economies of density. The two key features are forward-looking behavior and economies of density in residential location choice. Together, these features can lead to multiple steady-state spatial configurations, and they can rationalize both self-fulfilling expectations (expected future decline in neighborhood quality of life leads to neighborhood decline today) and path dependence (neighborhood decline persists, even when the future shock is never realized.)

In the model, neighborhood quality of life depends on both exogenous factors and an endogenous agglomeration factor that increases with neighborhood population. Households face migration frictions and are forward-looking. There is a steady-state equilibrium path where the larger neighborhood features superior quality of life. However, multiple steady-state equilibria are possible if agglomeration economies are strong relative to the exogenous amenity differences across neighborhoods. Intuitively, strong agglomeration benefits can compensate for inferior exogenous amenities.

We use the model to illustrate the role of self-fulfilling expectations. Initially, the economy is in a steady state where the neighborhood with superior *exogenous* amenities is larger. A shock is announced that will reduce future neighborhood quality of life in this neighborhood only. If the size of the announced negative shock is large enough relative to the agglomeration externality, the neighborhood will begin to shrink, before the shock is realized, as it transitions to a new steady-state equilibrium size. Later, the announced negative shock is cancelled. If the transition has advanced far enough, and the externality is strong enough, then the economy will continue to transition to the new steady-state equilibrium outcome. We characterize these conditions where temporary shocks to expectations can lead to permanent or persistent neighborhood change.

In the dynamic spatial model of Allen and Donaldson (2020), the sizes of regions depend on natural, historical, and contemporaneous factors. Strong *historical* spillovers from fixed legacy investments admit the possibility of multiple steady states and persistent effects of temporary historical shocks, or history dependence. They characterize conditions under which, conditioned on nature and history, the future path of the spatial economy is uniquely determined. In contrast, our results suggest that urban spatial structure is not fully determined, even conditioned on natural and historical factors (Lin and Rauch 2022). Instead, in the context of forward-looking households and strong contemporaneous agglomeration externalities, expectations may play a decisive role.

Our paper also improves our understanding of externalities and coordination in neighborhood development. In Owens III, Rossi-Hansberg, and Sarte (2020), residential externalities and the absence of coordination among developers and residents explains vacant land in central Detroit, even with sound fundamentals. In comparison, our theory incorporates dynamics to highlight an explicit role for expectations and we provide evidence for this channel. In Hornbeck and Keniston (2017), widespread simultaneous reconstruction following the Boston Fire appears to have generated substantial economic gains, perhaps by better coordination of building investments that generate positive externalities. In comparison, our setting more clearly highlights the role of expectations in determining urban spatial structure.

2 Data

We compile and construct data from several sources for our analysis. Data on highway plans come from the "Yellow Book" plans from 1955 (U.S. Department of Commerce 1955) digitized by Brinkman and Lin (2022). These were the first published plans with national scope describing the planned routing of highways within cities. Data on highway construction comes from ESRI (2010), a database of line features for all limited-access highways in the U.S in 2010. These data describe built highway segments. (We hand-corrected these data to account for a small number of highway segments that were built but demolished in the 1980s and later, such as the Embarcadero Freeway in San Francisco.)

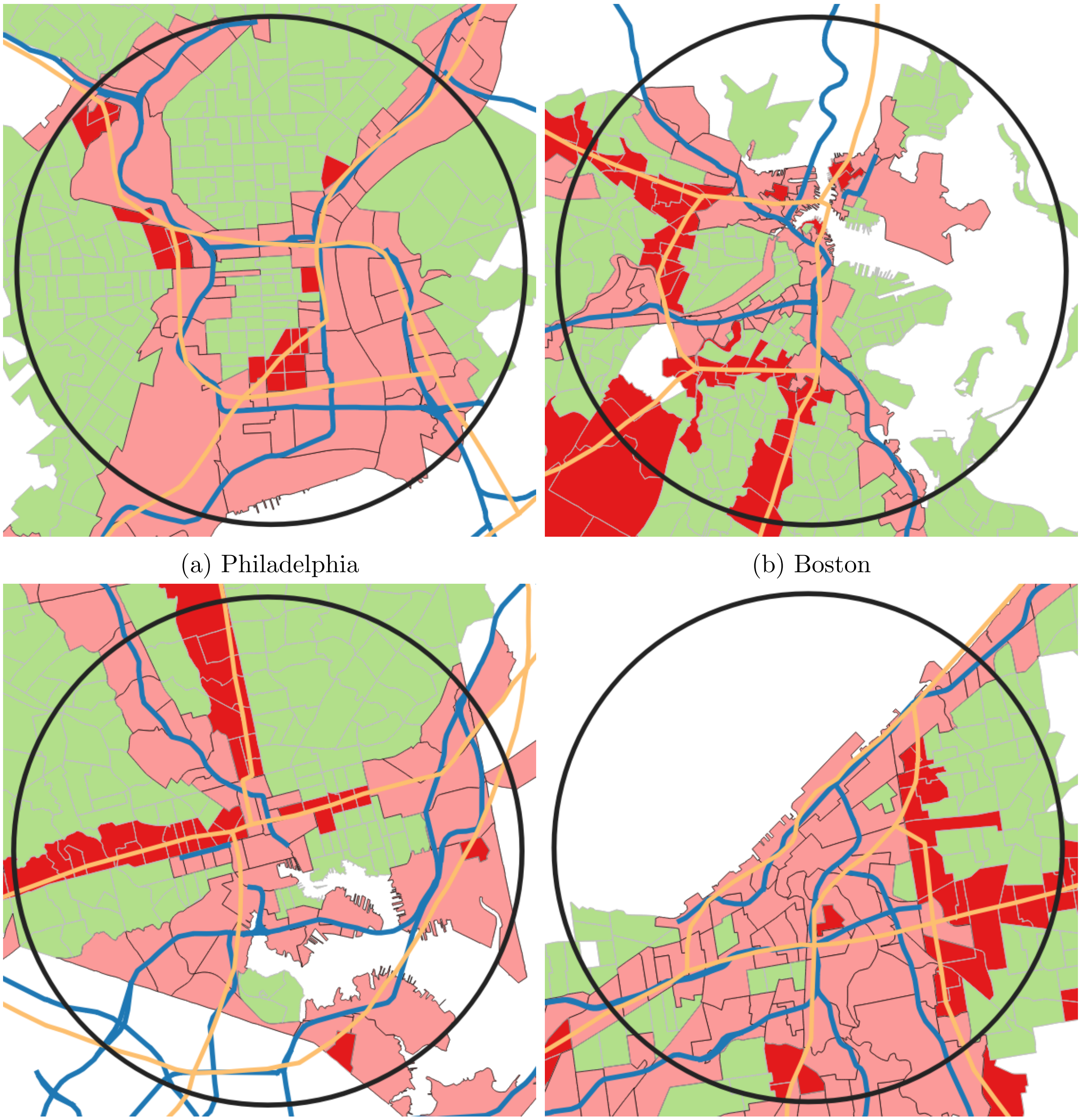
The Yellow Book plans were developed by state highway departments and coordinated by the Bureau of Public Roads (BPR), the federal agency that preceded the Federal Highway Administration. Thus, the Yellow Book plans represent one version—from 1955—of the many iterations of highways plans over the decades. The earliest attempts to develop a national highway network began in the 1910s, with a patchwork of federal, state and local planning. Following the 1956 highway act that authorized and financed the Interstate system, state highway departments were given wide latitude in implementing the plans. Despite the many highway plan iterations, the Yellow Book closely predicts the routing of current built highway segments. Figure 1 shows the Yellow Book plan and built highways in four U.S. cities. There is a high spatial correlation between the Yellow Book plan and highways that were actually built. Across 50 U.S. metropolitan areas, Brinkman and Lin (2022) find a high tract-level correlation between Yellow Book plans and built highways, exceeding 0.8.

One implication of the existence of a patchwork of highway plans over the decades is that we may under-estimate the negative effects of built highway and planned highway segments. Other plans may have shown different routings. Thus, in using the Yellow Book plans, there is likely some misclassification of neighborhoods—some Yellow Book neighborhoods were likely to never have been seriously considered for highways, while non-Yellow Book neighborhoods may have been more certain to have been slated for highways. Because of this misclassification, our analysis likely understates the effect of planned highway segments on neighborhoods.

We use a consistent-boundary census tract panel between 1940 and 2010. This is an updated version of the database developed by Lee and Lin (2017). Since tract boundaries change over time, these data are normalized to 2010 boundaries using area weights, or, in later years, block population weights. Census tables provide information about population and housing in each tract and census year.

We compute each tract's distance to the city's center, a point in space defined using the 1982 Census of Retail Trade (Fee and Hartley 2013). Holian (2019) compares alternative measures of city centers and concludes that the 1982 Census of Retail Trade is "probably the best measure of the [central business district] concept."

We limit our analysis to tracts within 5 miles of city centers. This is because we want to focus on neighborhoods where highways had net negative local effects. In the model of Brinkman and Lin (2022), highways reduce local quality of life. This is effect is localized in



(a) Philadelphia (b) Boston

(c) Baltimore (d) Cleveland

Figure 1: Yellow Book plans and built highways in four cities

This figure shows Yellow Book plan routes (yellow lines), built highways (blue lines) and areas within 5 miles of city centers (black circles). Background geographic units are 2010 Census tracts with valid 1940 data. Tracts are classified into one of three mutually exclusive and exhaustive groups: (i) Plan Not Built (red), (ii) Built (pink), and (iii) Not Built (green).

the sense that disamenities reduce quality of life in neighborhoods close to highways more compared with neighborhoods far from highways. However, the benefits of highways—from access to regional destinations like employment centers—vary with centrality. These benefits are modest in the center of the city, which already had superior *ex ante* access, but larger in the suburbs, which benefit significantly from faster travel speeds. Thus, the net local effect of highways is more negative near downtown.

These choices yield a balanced panel database with more than 4,000 census tracts in 41 metropolitan areas that (i) are within 5 miles of city centers, (ii) have available Yellow Book plans, and (iii) have available 1940 tract data. We also explore robustness to alternative sample selection below.

Next, we define treatment and comparison groups. Each tract is allocated to one of three mutually exclusive and exhaustive groups. One, "built" tracts (B) contain a built highway. Two, "planned, not built" (PNB) tracts contain a 1955 Yellow Book planned route and do not contain a built highway. Three, "not planned" (NP) tracts do not contain a built highway nor a 1955 Yellow Book planned route. Later, we also explore robustness to an alternative *spatial* definition, where treatment intensity varies with (log) distance to the nearest planned or built highway segment.

Figure 1 illustrates these classifications for four U.S. cities. B tracts are pink, PNB tracts are red, and NP tracts are green. Note again that because we are interested in the effects of planned highways through anticipated declines in quality of life, we focus only on tracts within 5 miles of the city center, circumscribed by black circles.

In our sample of 41 cities, 53% of tracts are in the NP comparison group. 10% of tracts are in the PNB treatment group. 37% of tracts are in the B treatment group.

3 Evidence

We estimate the effect of planned, but not built (PNB) highway segments on neighborhoods. We also estimate the effects of built (B) highway segments. B neighborhoods declined in size compared with neighborhoods never planned (NP) for highways. Surprisingly, PNB neighborhoods also suffered declines, despite having avoided the direct negative effects of new highways.

3.1 Simple contrast

The first estimator assumes that the allocation of planned and built highways to neighborhoods was at random. If highway plan assignment is mean independent, then a simple contrast between the PNB and NP groups identifies the causal effect of planned but never constructed highway segments. Similarly, a simple contrast between the B and NP groups identifies the causal effect of built highway segments.

Figure 2 shows sample means of log neighborhood household population by census year for the three groups. Vertical lines show 1956, the year of the passage of the Federal-Aid Highway Act, and 1973, the year of the passage of a revised Federal-Aid Highway Act that first allowed for the permanent cancellation of some planned Interstate segments.

A few qualitative features stand out. First, population increased for all three groups between 1940 and 1960.

Second, in the 1940–1950 decade before the Interstate highway act, B and PNB neighborhoods grew at similar or slightly faster rates compared with NP neighborhoods. Thus, pre-trends suggest that NP neighborhoods may provide appropriate counterfactual outcomes (or even slightly negatively selected outcomes) for B and PNB neighborhoods.

Third, in 1950, B and PNB neighborhoods were slightly larger on average compared with NP neighborhoods. This is due to the tendency for B and PNB neighborhoods to be closer to the city center compared with NP neighborhoods; we control for this factor later. Still,

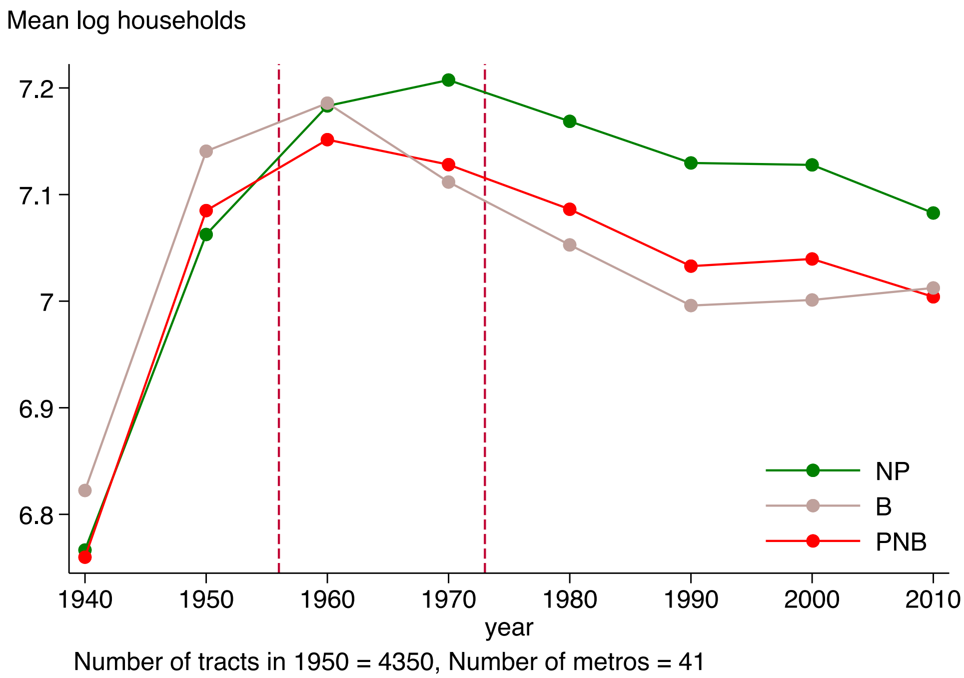


Figure 2: Average household population by year by treatment or comparison group

This figure shows mean log household population by census year for three groups of tracts. NP is not planned; PNB is planned, not built; and B is built. Vertical lines show 1956, the year of the passage of the Federal-Aid Highway Act, and 1973, the year of the passage of a revised Federal-Aid Highway Act that first allowed for the permanent cancellation of some planned Interstate segments.

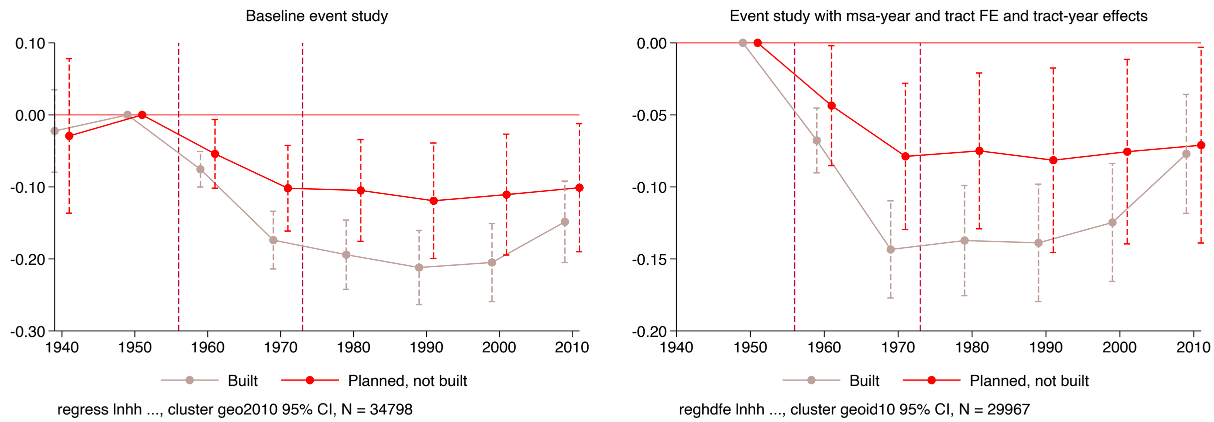
the initial size advantage of B and PNB neighborhoods sets up a reversal-of-fortune result.

Fourth, between 1950 and 1960, household population growth slows markedly, especially in B and PNB tracts. Between 1960 and 1970, household population declines in B and PNB tracts; in contrast, household population continued to increase in NP tracts. These two decades (1950–1970) correspond to the period of most active highway planning and construction. (Almost three-quarters of planned Interstate mileage was completed by 1970.) Notably, by 1970, the reversal of fortune is complete.

At first, the freeway revolts had little success in blocking or changing planned freeway segments. But policy began to respond to the concerns of neighborhood groups in the middle to late 1960s. For example, highway legislation in 1966 and 1968 created new environmental and historic-preservation hurdles for new highway construction. By 1967, "the freeway debates and protests[...] began to erode formerly uncritical acceptance of urban freeways," and federal and state policy had swung decisively in favor of the revolts (DiMento and Ellis 2013, p. 140). A key new measure in the 1973 highway act allowed state and local governments to cancel planned Interstate segments, and even substitute funds for mass transit projects. Moreover, some planned segments were cancelled not because they were themselves controversial, but because they connected to other distant segments that were controversial. A special report from the Federal Highway Administration (1970) details many of these so-called "dependent segments."

Figure 2 also shows that, after 1970, there is little evidence of relative recovery of neighborhoods near PNB and B highways compared with NP neighborhoods. The declines of neighborhoods near planned but never constructed highways and neighborhoods near built highways appear persistent. In the case of PNB neighborhoods, these declines persisted despite the cancellation of the planned highways.

We can more formally estimate these differences in regression. For each census year t, we regress the log change in household population of tract g since 1950 $\Delta \log N_g$ on the binary highway treatments B and PNB. This yields estimates of the mean differences across groups



(a) Event study (b) With regression adjustment

Figure 3: Simple contrast and regression adjustment estimates

Panel A: Coefficient estimates from an event study regression of tract log population on full set of highway treatment indicators and census year interactions. Whiskers show 95% confidence intervals based on standard errors clustered on census tract. Panel B: Coefficient estimates from a specification including metro–year fixed effects, tract fixed effects, and time-varying effects of natural and pre-determined tract characteristics.

by year, β_t and ϕ_t, corresponding to the gaps shown in Figure 2.

$$\Delta \log N_{g(t)} = \alpha + \beta_t 1(B)_g + \phi_t 1(PNB)_g + \varepsilon_g \tag{1}$$

Figure 3a shows the results. 1950 is the base year. NP neighborhoods are the base (omitted) category, so the estimates of β_s and ϕ_s compare B and PNB neighborhoods, respectively, versus NP neighborhoods in each year. Whiskers show 95% confidence intervals based on robust standard errors.

We find that by 1970, PNB tracts declined 9.7% compared with NP tracts. In addition, these declines persisted through 2010, more than 30 years after the cancellation of many of these highway projects. These effects are smaller than the effects of completed highways. B tracts declined 16% compared with NP tracts by 1970, and these declines also persisted through 2010.

3.2 Causal inference: Narrative evidence on selection

We address factors that could confound causal inference. Highway were unlikely to have been randomly allocated to neighborhoods. There are two relevant selection margins of concern. One, planned highways may have been routed through neighborhoods expected to decline. Two, planned highways may have been more likely to have been cancelled in neighborhoods expected to decline. Either could provide an alternative explanation for the decline of neighborhoods near planned or built highway segments.

However, there is little support for either explanation in historical narrative evidence. Both planned and constructed highways targeted neighborhoods that were then-underdeveloped (conditioned on observables) and thus had higher growth potential, which would cause us to underestimate the negative effects of planned and built highways. In a statement submitted to Congress in 1955, Commissioner of Public Roads C.D. Curtiss cited several criteria the BPR considered in designating urban Interstate routes; most relevantly, the BPR recommended routes on undeveloped land and routes that followed forecasted demand growth (Weingroff n.d.). Both criteria suggest positive selection of planned Interstate routes on neighborhood growth factors. These patterns were codified by the American Association of State Highway and Transportation Officials (AASHTO, 1957) in the "Red Book," which recommended routes on undeveloped land.

With respect to the second margin (endogenous cancellation), Brinkman and Lin (2022) find that neighborhoods that were highly educated and white in 1950 were more likely to succeed in blocking proposed highways in the 1970s. Compared with the positive selection into planned routes on neighborhood growth factors, it is less clear whether or not these patterns suggest positive selection into cancellation. However, the narrative evidence does not clearly suggest that our findings are driven by negative selection into cancellation on neighborhood growth factors.

3.3 Regression adjustment

We use several estimators that rely on weaker assumptions than mean independence on the allocation of planned and built highways to neighborhoods.

First, the simple contrast results are robust to including regression controls. Figure 3b shows the results from a specification that includes metro–year fixed effects, census tract fixed effects, and time-varying effects of natural and historical neighborhood characteristics. Metro–year fixed effects control for metropolitan factors affecting neighborhood growth. In other words, including metro–year fixed effects means that we are comparing tract growth *within* metropolitan areas. Tract fixed effects absorb any time-invariant tract-level growth factors. For example, highways tended to be routed near rivers and coastlines. Tract fixed effects account for constant growth effects of rivers and coastlines. Finally, we control for time-varying effects of natural and historical neighborhood characteristics. We create indicator variables for proximity (within 1 kilometer) to a river, a lake, a shoreline, or a seaport. We also create indicators for quintiles of distance to the city center, minimum January temperature, maximum July temperature, annual precipitation, average slope, the non-white shares in 1940 and 1950, log household population in 1940 and 1950, log housing units in 1940 and 1950, and log land area. In addition to quintiles of distance to the city center, we control for log distance to the city center. All of these tract characteristics are interacted with census year dummies. (As a result of controlling for household population in 1940, the 1940 coefficients can no longer be reliably estimated.)

The results are quantitatively similar to the simple contrast estimates. By 1970, PNB tracts declined 7.6% compared with NP tracts (versus -9.7% from simple contrast), and these declines persisted. B tracts declined 13.6% compared with NP tracts (versus -16.0% from simple contrast), and these declines persisted after 1970.

3.3.1 Robustness and other outcomes

Our results are robust to sample selection. We experiment with alternative classifications of 1940 census tracts, holding constant the goal of identifying neighborhoods with central locations near commuting destinations where the net effect of highways was likely negative. Our results are robust to using samples of (i) the top 25% of tracts in each city by 1940 household popualtion density; (ii) tracts with greater than 14,000 population per square mile in 1940; (iii) tracts with greater than 4,000 housing units per square mile in 1940.

Our results are also robust to defining a spatial treatment versus a binary treatment. We repeat our analysis, substituting log distance to B and PNB highway segments for tract indicators. These spatial treatment definitions address the concern that small re-routings of planned highway segments could account for our results. For example, if a planned segment was re-routed to a parallel route 1 mile away, then the decline of PNB neighborhoods might be attributed to the effects of a somewhat more distant built highway. The specification using a spatial treatment controls for this confounding factor. The results are shown in Figure A.1. The figure shows opposite (positive) signed coefficient estimates, which is expected given that closer proximity to a highway segment is associated with smaller values of the variable. These results show qualitatively similar patterns compared with our main results.

We also consider other outcomes. Results using total population are quantitatively nearly identical.

Figure A.2 shows substantial declines after 1960 in the number of habitable housing units in B and PNB neighborhoods. This suggests substantial disinvestment in the housing stock.

Figure A.3 shows large absolute declines in total white populations in B and PNB neighborhoods and large relative declines in total nonwhite populations in B and PNB neighborhoods. (This is in the context of white flight and Black migration into city centers.) Our interpretation is that both white and black households prefer to avoid the negative local effects of highways. On net, these leaves a modest and insigificant decline in the nonwhite share in B and PNB neighborhoods.

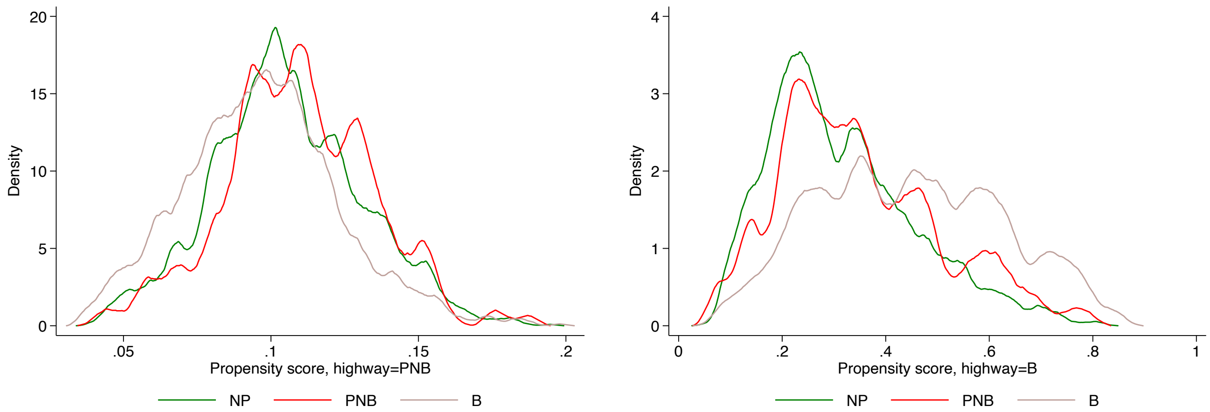
Finally, Figure A.4 shows a modest and insigificant decline in average household income in B and PNB neighborhoods. Households of different incomes may vary in their valuation of housing, their valuation of the freeway disamenities, or their valuation of the access benefits of freeways. As noted by Brinkman and Lin (2022), the presence of multiple sources of household heterogeneity make pure theoretical predictions of sorting responses to highways ambiguous.

3.4 IPWRA estimates

Next, we use the inverse probability weighted regression adjustment (IPWRA) estimator (Wooldridge 2007). This estimator combines matching and regression and accounts for selection by weighting observations in the control group based on similarities to the treatment group. This is a two-step estimator. In the first step, we estimate the probability of treatment conditioned on a set of observed factors W. In the second step, we estimate treatment-level mean outcomes with inverse probability weights (obtained from the first step), conditioned on a set of observed factors X. The estimate of the average treatment effect is the contrast between the predicted treatment-level means obtained from the second step.

This estimator assumes that highway treatment is strongly ignorable conditioned on observed factors affecting highway treatment in W and population in X. The estimator is doubly robust. If either the treatment model or the outcome model are correctly specified, then the IPWRA estimator is a consistent estimator of the average treatment effect. Intuitively, the inverse probability weights obtained in the first step magnify the comparison group units that look like the treated (on covariates in W), and vice versa. The regression adjustment in the second step accounts for differences in observed covariates in X across the treatment and comparison groups. Thus, the IPWRA estimator has two chances to "get it right."

We use the same vector of tract characteristics for both W and X. We include the same controls for natural and historical factors as in the previous section.



(a) $\widehat{Pr(PNB)}$ (b) $\widehat{Pr(B)}$

Figure 4: Overlap in propensity score distributions

Overall, there is good overlap in estimated propensity scores from the first step. PNB tracts look very similar compared with NP tracts on propensity scores. B tracts look somewhat less similar, but there is good overlap in the propensity score distributions. Figure 4 shows this overlap.

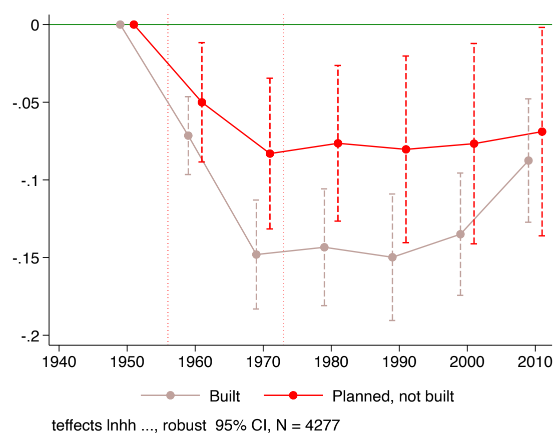


Figure 5: IPWRA estimates

This estimator yields quantitatively similar estimates for the effects of PNB and B. Figure 5 shows these results. By 1970, PNB tracts declined 8.0% compared with NP tracts, and B tracts declined 13.8% compared with NP tracts. These are quantitatively similar to our earlier estimates of -7.6% and -13.6% for PNB and B, respectively, obtained by regression adjustment alone. The persistent declines following cancellation similarly echo the simple contrast and regression adjustment estimates.

3.5 IV estimates

We use instrumental variables (IV) to estimate the effect of planned highway segments. Recall that we have two endogenous margins of selection: selection into the highway plan, and then, conditioned on selection into the highway plan, selection into cancellation. Alternatively, we also have two endogenous treatments: PNB and B. Thus, we need at least 2 instruments.

We start with a set of *inter*city historical and planned routes as instruments. These are good predictors of planned *intra*city highway segments. We follow the literature in the use of these instruments (Redding and Turner 2015). Following Baum-Snow (2007), we use the 1947 intercity highway plan. The goal of the 1947 plan was to improve travel between distant cities and national defense. Thus, the plan is unlikely to be correlated with neighborhood growth factors. In fact, the planned routes were drawn at national, not regional or metropolitan, scales, so the planned-highway instrument is determined by the number and orientation of nearby large metropolitan areas. For example, the north-south orientation of I-35 through Austin, Texas, is determined by the orientation of Austin compared with Dallas (north) and San Antonio (south), rather than neighborhood factors.

We also construct a variant of this instrument that instead connects via shortest-distance routes all city center pairs connected by the 1947 plan without going through an intermediate third city. This variant is correlated with the planned route instrument, except when a "curved" plan route is "straightened out." For example, the actual planned route between Las Vegas and Salt Lake City displays a notable curve; the variant instrument shifts this route westward and northward.

We also use neighborhood proximity to historical routes as instruments. Identification relies on the premise that historical transportation routes, such as explorers' paths or rail lines, are unlikely to be correlated with current neighborhood characteristics. These routes are likely low-cost locations either due to topography (first nature) or for land assembly reasons (second nature). Following Duranton and Turner (2012), we use exploration routes in the 16th–19th centuries, digitized from the National Atlas (U.S. Geological Survey 1970), and historical railroads in operation by 1898 by Atack (2015). These planned and historical routes were re-digitized by Brinkman and Lin (2022), as the original constructed instruments in Baum-Snow (2007) and Duranton and Turner (2012) contain only cross-metropolitan variation, with insufficient spatial detail for neighborhood-level analysis.

We also develop a new *delayed distant completion* instrument to address potential endogenous freeway cancellation. This instrument is new to the literature. The basic idea relies on two features of the Interstate highway program.

One, some rural sections of the national highway network, far away from city centers, were completed before 1956 under earlier state and federal highway programs. In this era and earlier, which (rural) highway segments were completed first often depended on idiosyncratic factors (Johnson 1965). Further, the early completion of rural highway segments likely had little to do with central neighborhood factors. Despite their eventual extent, the freeway revolts were largely unanticipated by planners, builders, and even later critics of the Interstate program—the early rural segments faced no local opposition.

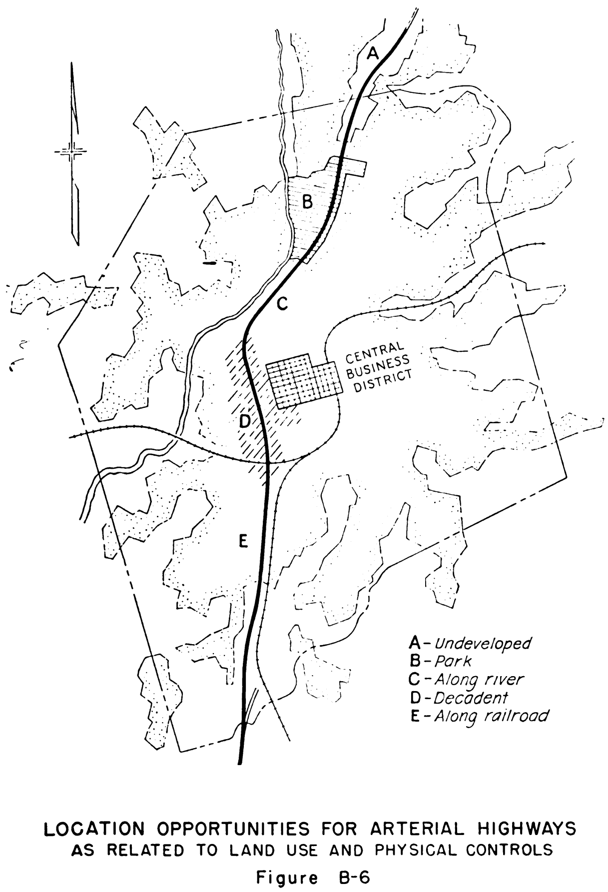
Two, uniform design standards under the Interstate program called for highway rays that converged to the central business district. Consider the schematic diagram of a hypothetical city from the AASHTO's "Red Book" (1957) in Figure 6a. Early design standards called for highway construction along "rays" that converged near the central business district. Here, two segments labeled (i) A–B–C and (ii) D–E represent two distinct rays approach the city center from the north and south, respectively.

Our delayed distant completion instrument relies on the idea that early completion (or not) of rural routes *beyond* segments A or E affect the later completion of intracity highway segments. To fix ideas, suppose that a rural segment to the north, just beyond A, was completed before 1956, but a rural segment to the south, just beyond E, was not. Because of the design standards that specified highways ray emanating out from the central business district, the early completion of rural rays beyond segment A increased the likelihood that planned uban segments A–B–C to the north of the city center would be completed to plan. Conversely, the delayed or lack of completion or rural rays beyond segment E decreased the likelihood that planned urban segments D–E would be completed to plan.

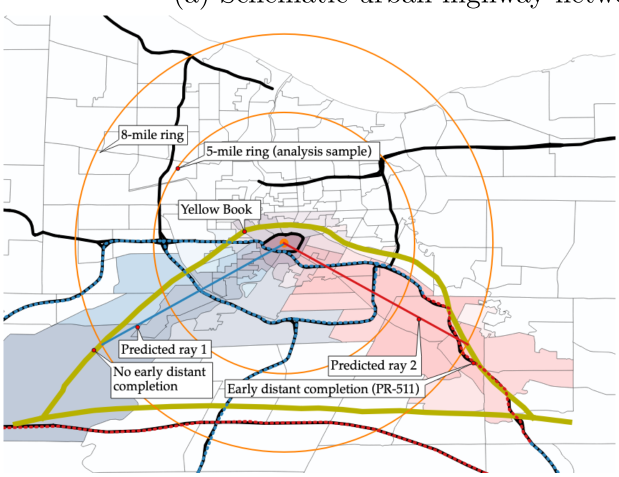
Figures 6b and 6c illustrate the construction of our early distant completion and delayed distant completion instruments for two cities, Rochester and Houston. In Figure 6b, the Yellow Book describes two planned rays emanating from downtown Rochester to the southwest and southeast. It also shows a peripheral route on the outskirts of the city, which we ignore.

We do not want to use the actual Yellow Book routes in central cities to construct our instrument, since the routing of the Yellow Book plan routes was likely endogenous for the reasons outlined earlier. Instead, we construct *predicted* routes based on the general orientation of the rays with respect to the city center. In practice, we use the intersection of the planned Yellow Book routes and a circle with 8-mile radius around the city center. Recall that our sample only includes tracts within 5 miles of city centers. For the construction of this instrument, we only use spatial information beyond 8 miles of city centers. Thus, the predicted rays have the same general routing of the actual planned rays, but deviate from the actual planned routing because they rely only on relative position of regional or intercity destinations. In this way, this instrument is a somewhat more local version of the intercity 1947 plan instrument by Baum-Snow (2007).

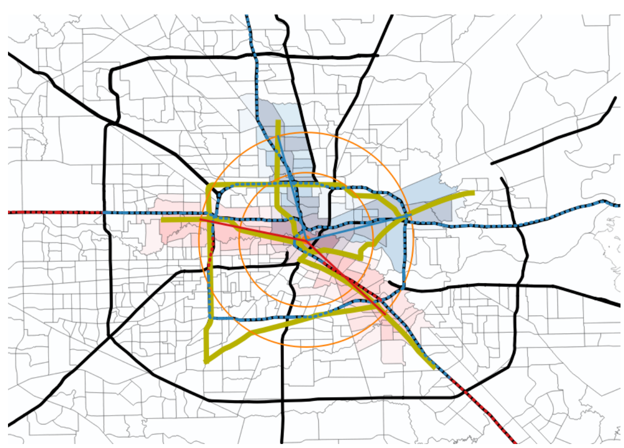
Predicted rays in hand, we then turn to classifying rays according to early (or not) distant completion. We rely on the PR-511 database compiled by the Federal Highway Administration, which includes information on date first open to traffic by Interstate highway segment. In the case of Rochester, there is a segment beyond predicted ray 2 that was completed before 1956 (as indicated by the red dotted lines). In contrast, the segment



(a) Schematic urban highway network design from the 1957 Red Book



(b) Rochester



(c) Houston

Figure 6: Constructing early and delayed distant completion instruments

beyond predicted ray 1 was not completed before 1956. As a result, we classify predicted ray 1 as a "delayed distant completion" and predicted ray 2 as an "early distant completion."

After classifying predicted rays, we then measure each tract's distance separately to the nearest early distant completion predicted ray and to the nearest delayed distant completion predicted ray. The shading of each tract in Figure 6 reflects these two calculations: tracts in shades of blue are closer to a delayed distant completion predicted ray, while tracts in shades of red are closer to an early distant completion predicted ray.

Figure 6c shows the construction of our instruments for Houston. We defined 4 predicted rays based on intersections with Yellow Book plan rays and the 8-mile circle. Two predicted rays connected to distant segments that were completed before 1956. These early completions were on I-10 (heading west to San Antonio) and along I-45 (heading southeast to Galveston). In contrast, two other predicted rays did not connect to segments that were completed before 1956. These are classified as delayed distant completions.

We use the two-step IV estimator of Wooldridge (2010) (Procedure 21.1) for estimating the effects of binary endogenous treatment. This is a two-step estimator. In the first step, we estimate a multinomial logit model of $Pr(w = j|\mathbf{X}, \mathbf{Z})$ by maximum likelihood, where j can take the values B, PNB, or NP. Then, we obtain the fitted probabilities, $\hat{G}_g$. In the second step, we estimate the following equation by 2SLS using instruments 1, $\hat{G}_g$, and $\mathbf{X_g}$. We separately estimate this equation by census year, to obtain IV estimates of the effect of B and PNB in each census year. The control variables in $\mathbf{X}$ are the same natural and historical factors used previously. The instruments $\mathbf{Z}$ include separate indicators for tracts containing intercity plan, historical, early or delayed distant completion routes, as well as log distance to the nearest IV route.

$$\Delta \log N_{g[m]} = \alpha_0 + \alpha_m + \mathbf{X_g}\gamma + \beta 1(B)_g + \phi 1(PNB)_g + \varepsilon_g \tag{2}$$

This estimator has several nice features. One, the usual 2SLS inference is asymptotically valid (Wooldridge 2010). Two, it is the optimal feasible instrument if step 1 is correctly spec-

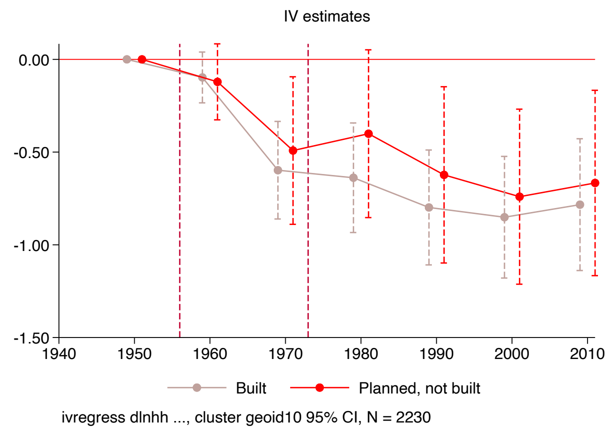


Figure 7: IV estimates

ified; it is a consistent estimator even if step 1 is incorrectly specified. Three, the nonlinear form improves efficiency and addresses potential weak instrument problems (Xu 2021). In practice, a linear 2SLS estimator delivers similar point estimates but larger standard errors.

Figure 7 shows IV estimates of the effect of planned but never built segments and built segments. Qualitatively, the estimated effects and their dynamics line up with previous results. Both PNB and B neighborhoods decline by 1970, and these declines persist until 2010, despite the cancellation of highway segments. Quantitatively, the effects are larger. By 1970, PNB tracts declined 39% versus NP tracts. B tracts declined 45% versus NP tracts. Thus, we obtain qualitatively similar results compared with the simple contrast estimates, but they are three to four times as large.

There may be several rationalizations for why the IV estimates are inflated versus the simple contrast: misclassification of treatment, positive selection into plan or cancellation, and/or the IV is identifying a local average treatment effect.

One potential explanation for the inflation of the IV estimates is that the Yellow Book plans have misclassified some neighborhoods. Over the decades of highway planning and construction, there were many iterations of highway plans. This would lead simple contrast to underestimate the effects of planned and built highways.

A second potential explanation is that there was positive selection into plan and cancellation on growth factors. This is consistent with the narrative evidence presented earlier than highway plans were allocated to neighborhoods expected to grow the most. Thus, the simple contrast may underestimate the causal effects of planned and built highways.

Finally, the IV estimator may be identifying a local average treatment effect. Intuitively, complier highway segments were more likely to plow through dense, already developed neighborhoods. These neighborhoods likely would have been more negatively affected by highway construction.

3.6 Extensions

3.6.1 Early cancellation has temporary effects

We find that early cancellation has temporary effects on PNB neighborhoods.

There is limited systematic information on the timeline of planning various highway segments. However, we do know that two cities, San Francisco and Baltimore, were exceptional in that they had (and used) local control powers to stop highway construction.

In San Francisco, the Board of Supervisors had the sole power to close roads, effectively giving a local veto over state highway construction within the city limits. The Board of Supervisors cancelled all further highway construction in 1959.

In Baltimore, there were two unique provisions in the city's home-rule charter. The city alone had the sole authority to condemn properties. In practice, this also meant the city had veto power over state highway plans that required the demolition of existing buildings.

We repeat our event-study analysis, focusing only on San Francisco and Baltimore. The results are reported in Figure 8. From 1950 to 1970, both PNB and B neighborhoods reflect similar dynamics compared with the 41-city sample. However, after 1970, PNB neighborhoods revert back to their pre-1950 size.

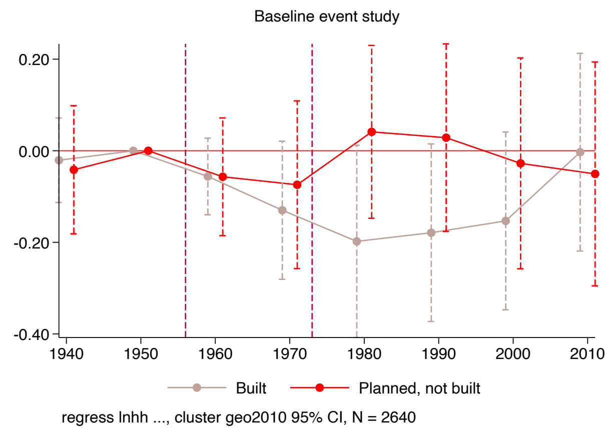


Figure 8: Early cancellation has temporary effects

3.6.2 Matched runner-up estimates

We compare outcomes for blocks along the proposed Crosstown Expressway in Philadelphia with an alternative route considered by planners. The case study of the Crosstown Expressway differs from the earlier analysis in three important ways: (i) it uses a distinct matched runner-up design, (ii) it uses block versus tract-level variation, and (iii) it allows us to control for confounders (such as urban renewal and other public interventions) that are observed in Philadelphia but not consistently measured across our larger panel of U.S. cities.

The proposed Crosstown Expressway was part of the earliest plans for a highway loop around Center City Philadelphia, dating to at least 1911 (T. A. Reiner, Sugarman, and J. S. Reiner 1970). The other three sides of the loop were eventually completed: the Schuylkill Expressway (I-76) on the western side, the Delaware Expressway (I-95) on the eastern side, and the Vine Street Expressway (I-676) on the northern edge of Center City. For the southern segment, early plans showed alternative alignments along either South Street or Washington Avenue. In 1947, the City Planning Commission proposed an alignment along South Street. This route was repeatedly approved and publicized between 1947 and 1964. The first opposition emerged around 1964, centered on the neighborhood of Queen Village. Eventually, the Crosstown Expressway was cancelled and deleted from long-run planning documents at

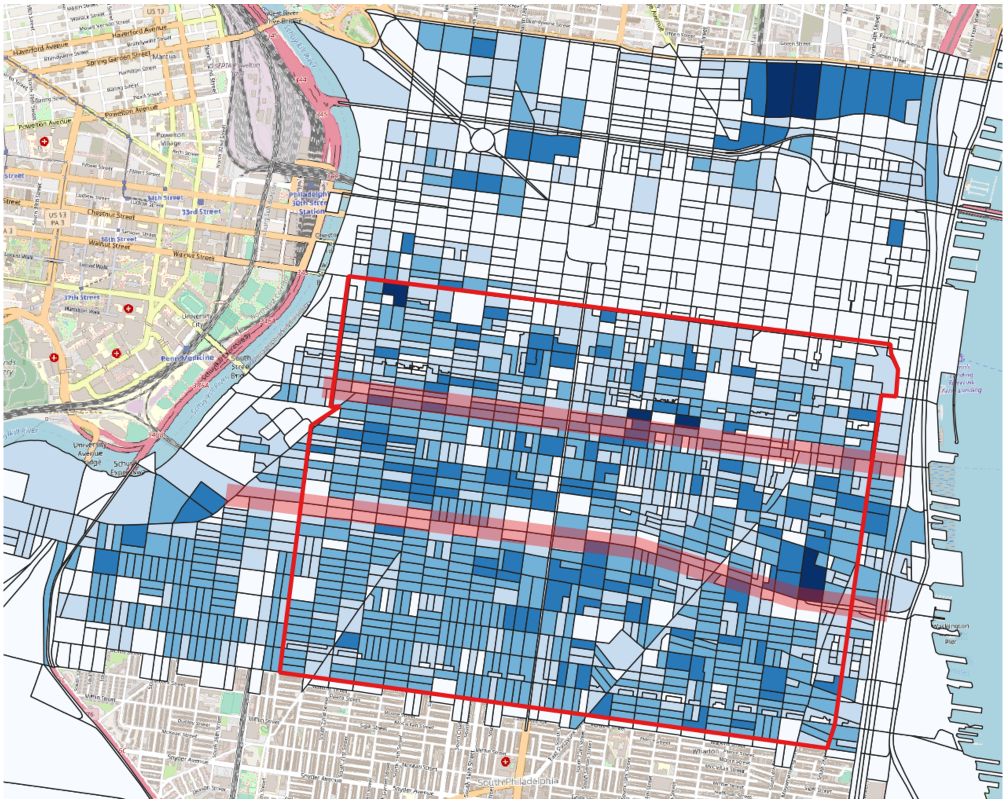
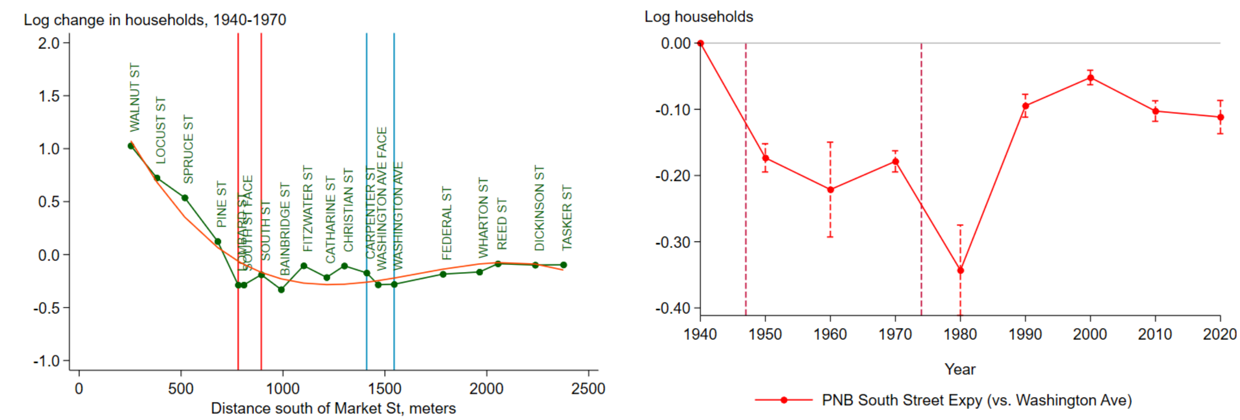


Figure 9: Matched runner up design sample area

the city and state levels between 1974 and 1977.

Our analysis compares South Street, the “winning” planned route, to Washington Avenue, the runner-up planned route. Figure 9 shows blocks in central and south Philadelphia. Our sample area, outlined in red, is bounded by Walnut Street on the north, 2nd Street on the east, Tasker Street on the south, and 24th Street on the west. We exclude blocks north of Walnut Street, which contains the central business district and was and is dominated by non-residential uses. Similarly, we exclude blocks east of 2nd Street due to the location of I-95 and the Delaware River waterfront.

The geographic units are consistent-boundary Census blocks. Blocks are shaded according to 1940 block household population: darker blues have greater 1940 populations. The two proposed alignments are shown as red bands: South Street is the northern band and Washington Avenue is the southern band, about 660 meters to the south. We digitized the



(a) Change in household population, 1940–1970 (b) Matched runner-up estimates

Figure 10: Matched runner-up estimates

block-level data from 1940–1970 for this analysis. We normalized the block data to consistent boundaries using areal weights.

For each census year, we compute the log change in household population from 1940, the only pre-treatment year that we observe. (The first plans advertising the South Street route were published in the late 1940s.)

Figure 10a summarizes 1940–1970 household population growth by block group. Block groups are defined as east-west corridors bounded by major cross streets; for example, the Walnut Street block includes all blocks bounded by Walnut Street on the north and Locust Street on the south. Red vertical lines denote the blocks that might have been affected by the proposed South Street route; Blue vertical lines denote the blocks that might have been affected by a Washington Avenue alignment. Our estimator compares blocks between the red lines versus blocks between the blue lines.

There are two identification issues. The first is that there is a strong spatial trend, evident from Figure 10a. Northern blocks experienced large growth in residential populations after 1940. The increasing residential demand for central locations complicates a direct comparison of South Street versus Washington Avenue, since South Street is proximate to the most central locations.

A second concern is that there may be spatial effects of the proposed highway, at unknown spatial scales. For example, the effect of the planned South Street Expressway may have extended to Pine Street and Bainbridge Street, one block north and south of the South Street corridor. It is possible that these spatial effects may have extended even farther.

We take a conservative approach to address both of these concerns. We fit a spatial trend using a third-degree polynomial to household population growth in each year. This is shown in the orange line in Figure 10a. The matched runner up estimate is then the difference between the orange fitted spatial trend and the green observed outcomes.

This approach is conservative. We are using relatively local variation to project the counterfactual outcomes for the South Street and Washington Avenue corridors. The South Street counterfactual outcome is heavily influenced by the outcomes for the surrounding blocks of Pine Street and Bainbridge Street. Further, any spatial effects spilling over to nearby blocks are effectively absorbed by the spatial trend. To see this, consider an alternative approach fitting a linear trend through the endpoints of Walnut Street and Tasker Street. This would yield larger estimates of the effect of the South Street plan.

The matched runner up estimates are shown in Figure 10b. We find that in 1970 the effect of PNB is -16.4%. These declines persisted after the highway was cancelled in 1974-1977; in 2020, South Street PNB blocks are still 10.6% smaller compared with Washington Avenue blocks. These are likely lower bounds given the identification issues discussed above.

4 Theory

We develop a dynamic model to better understand these results. The model illustrates the role of expectations in residential neighborhood choice and characterizes equilibrium spatial structure. In the model, there are multiple locations in the economy, characterized by different exogenous residential amenities. Household utility depends on exogenous neighborhood amenities as well as an amenity externality that increases with the population of a neighborhood. Upon entering the economy, households choose a location that maximizes lifetime utility with perfect foresight. There is a steady-state equilibrium where population is higher in the superior exogenous amenity neighborhood. However, multiple steady-state equilibria are possible if the externality is strong enough relative to the exogenous amenity differences of the neighborhoods.

To illustrate the role of expectations, we consider the case where a negative amenity shock is announced for one location that will be realized at some time in the future. Initially, the economy is in a steady-state where the location with the higher exogenous amenity has a larger population. A negative amenity shock is then announced that will affect the initially high-amenity neighborhood. Once the negative shock is announced, if the disamenity is large enough relative to the externality, and households care about the future, the neighborhood will begin to transition before the shock is realized. New households will choose to move away from the location receiving negative shock, and the neighborhood will transition to a new lower population steady-state.

However, if the announced shock is cancelled, then the long-run equilibrium outcome will depend on the current state of the economy. If the transition has advanced far enough, and the externality is strong enough, then the economy will continue to transition to the new steady-state equilibrium outcome. Thus under certain conditions, temporary shocks to expectations can lead to permanent or persistent neighborhood change.

Geography. Consider two neighborhoods indexed by $j = 1, 2$. Each neighborhood has an aggregate amenity value in each period t of $A_{j,t} = a_{j,t} + \gamma N_{j,t}$, where $a_{j,t}$ is an *exogenous* component of amenity and $\gamma N_{j,t}$ is an *endogenous* component of amenity that depends on the neighborhood population $N_{j,t}$ and a parameter γ. With the latter term we intend to capture endogenous amenities that tend to correlated with neighborhood size, such as consumption or socialization opportunities.

Households and housing. In each period, homogenous households enter and exit at an exogenous rate η. Thus, over time, there is a constant measure of total households, which we normalize to 1, $N = N_{1,t} + N_{2,t} = 1$.

Households face moving frictions. We choose a simple form for these moving frictions: entering households choose a neighborhood with perfect foresight, but they cannot move once they have made their choice. It is the death and replacement of households at rate η that allows for population dynamics across neighborhoods.

Each household consumes one unit of housing. Discounted lifetime utility for a household in neighborhood j in period t is:

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

where β is the discount rate and $R_{j,t}$ is housing rent. We choose a simple form to model housing supply. Housing is supplied elastically without adjustment costs, so that rent depends on population according to $R_{j,t} = \nu N_{j,t}$.

Steady-state equilibrium. Entering households choose neighborhood 1 if $V_{1,t} - V_{2,t} > 0$, i.e.:

$$\int_t^\infty e^{-(\beta+\eta)t}[(a_1 - a_2) + (\gamma - \nu)(2N_{1,t} - 1)]\,dt > 0 \tag{3}$$

Suppose that $a_1 > a_2$, i.e., neighborhood 1 has a persistent exogenous amenity advantage. Further, suppose that $\gamma > \nu$, i.e., the agglomeration externality is strong relative to the dispersion force of housing costs. It is easy to verify that equation (3) will always be satisfied if everyone lives in neighborhood 1. Thus, there is a corner steady state equilibrium where all households live in neighborhood 1 and entering households always choose neighborhood 1.

There can also be multiple steady states. For multiple steady states to exist, it must be the case that the endogenous amenity is strong enough to satisfy *either* $V_{1,t} - V_{2,t} > 0$ and $V_{1,t} - V_{2,t} < 0$. This will be the case if the net agglomeration externality $\gamma - \nu$ is strong relative to the exogenous amenity gap, i.e.,

$$(\gamma - \nu)\frac{\beta}{\beta + 2\eta} > (a_{1,0} - a_{2,0}). \tag{4}$$

One steady state equilibrium is the same as before: all households live in neighborhood 1 and entering households always choose neighborhood 1. Refer to this steady state equilibrium path as ss_1. But if equation (4) is satisfied, then another steady state equilibrium also exists: all households live in neighborhood 2 and entering households always choose neighborhood 2. In this case, $V_{1,t} - V_{2,t} < 0$ as the agglomeration externality compensates for the inferior exogenous amenities of neighborhood 2. Refer to this steady state equilibrium path as ss_2.

Proposition 1 *If* $a_1 > a_2$ *and* $(\gamma - \nu)\frac{\beta}{\beta+2\eta} > (a_{1,0} - a_{2,0})$, *(i) there exists a steady state equilibrium and (ii) there are multiple steady state equilibria.*

Transition dynamics. Consider an economy that begins in ss_1, the steady state where all households live in neighborhood 1 and entering households always choose neighborhood 1. Initially, neighborhood 1 also features superior exogenous amenities $a_1 > a_2$. Then, a future negative permanent shock to exogenous amenities is announced such that in all periods $t > T$, $a_{1,T} < a_{2,T}$. This corresponds to the situation of central neighborhoods in the middle 1950s. Central neighborhoods featured superior *ex ante* exogenous fundamentals (proximity to employment and consumption opportunities) but were faced with the prospects of reduced quality of life from proposed highways and their disamenities. Under what conditions will the economy respond to such an expected future shock, before the shock is realized?

To analyze transition dynamics, we first assume that a transition to ss_2 begins immediately at a time $t = 0$, T periods before the announced shock is realized. Then, we verify that this path is consistent with households' utility-maximizing behavior. If so, then there exists a positive $T > 0$ such that the transition to another steady state happens *before* the amenity shock is realized.

After the transition begins at time $t = 0$, the population of neighborhood 1 gradually declines: $N_{1,t} = e^{-\eta t}$. Then, the utility gap in each period between neighborhoods can be written as a piecewise function. From $t = 0$ to T,

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

From $t = T$ to ∞,

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

Combining these expressions yields a simple expression for the difference in value functions at the start of the transition, T periods before the shock is realized. This difference in value functions is $DV_0 \equiv V_{1,0} - V_{2,0}$:

$$\begin{aligned} DV_0 = \frac{1}{\beta + \eta}[& \underbrace{(a_{1,0} - a_{2,0})(1 - e^{-(\beta+\eta)T})}_{\text{Exogenous amenities before the shock}} \\ & + \underbrace{(a_{1,T} - a_{2,T})e^{-(\beta+\eta)T}}_{\text{Exogenous amenities after the shock}} \\ & + \underbrace{(\gamma - \nu)\frac{\beta}{\beta + 2\eta}]}_{\text{Endogenous amenity from changing populations}} \end{aligned} \tag{5}$$

The first term inside the brackets represents the stream of exogenous amenities before the shock. The second term represents the stream of exogenous amenities after the shock. The third term is the endogenous amenity derived from changing population in the two locations.

Recall that we derived this expression assuming that a transition from ss_1 to ss_2 began at time $t = 0$, in anticipation of the realized shock at time $t = T$. However, a transition will only begin if $DV_0 < 0$ and new households prefer neighborhood 2. In other words, we need to verify that the transition beginning at $t = 0$ is consistent with household utilitty maximization in each period. The time of the start of the transition can be calculated by solving for a value of T that ensures $DV_0 < 0$. This yields the following sufficient condition ensuring the existence of some positive $T > 0$ such that a transition ss_1 to ss_2 begins before the shock is realized:

$$(a_{2,T} - a_{1,T}) > (\gamma - \nu)\frac{\beta}{\beta + 2\eta} \tag{6}$$

To see that this is a sufficient condition for a transition to begin before the shock is realized, consider the limiting case where T is a small number, very close to zero. Then, the value of the stream of exogenous amenities after the shock will be more negative compared with the value of the stream of endogenous amenities, yielding $DV_0 < 0$. Thus, a transition is consistent with households' utility maximization. Intuitively, equation (6) says that if the negative shock to amenities is large enough to overcome the agglomeration externality, then the economy will transition to a new steady state at some strictly positive time T periods before the shock is realized. Thus, household expectations about future amenities can cause neighborhood change today.

Equations (5) and (6) also provide predictions about how fundamentals of the economy affect the timing of the transition. One, if the expected shock is large relative to the difference in initial amenities, then the transition will happen sooner. Two, if households care more about the future through a lower discount rate β or a lower exit rate η, then the transition will also happen sooner. Three, if net agglomeration externalities are weaker ($\gamma - \nu$ small), then the transition is more likely to happen and will happen sooner.

History dependence after a cancelled shock. Suppose the same conditions hold as before. Equation (4) is satisfied. The economy that begins in ss_1. Neighborhood 1 also features superior initial exogenous amenities $a_{1,0} > a_{2,0}$. Then, a future negative permanent shock to exogenous amenities is announced such that in all periods $t > T$, $a_{1,T} < a_{2,T}$. A transition to ss_2 begins at time $t = 0$. However, at time $t = S$ after the start of the transition, the announced decline in exogenous amenity is cancelled. In this section, we characterize conditions under which the transition continues. That is, when do temporary shocks to expectations cause persistent or even permanent neighborhood change?

The population of neighborhood 1 at the time of cancellation is $N_{1,S} = e^{-\eta S}$. Next, derive the difference in lifetime utility between the two neighborhoods for two limiting cases. In the first case, the transition continues such that new households choose neighborhood 2 and the economy continues to the new steady state ss_2. Then, the difference in value functions is:

$$DV_{\text{con}} = \frac{1}{\beta+\eta}\left[(a_{1,0} - a_{2,0}) + (\gamma - \nu)\left(\frac{2(\beta+\eta)}{\beta+2\eta}N_{1,S} - 1\right)\right] \tag{7}$$

In the second case, the transition reverses, so that new households choose neighborhood 1 and the economy converges back to the initial steady state ss_1. Then, the difference in value functions is:

$$DV_{\text{rev}} = \frac{1}{\beta+\eta}\left[(a_{1,0} - a_{2,0}) + (\gamma - \nu)\left(\frac{2(\beta+\eta)}{\beta+2\eta}N_{1,S} + \frac{\beta}{\beta+2\eta}\right)\right] \tag{8}$$

Both of these expressions are linear in neighborhood population $N_{1,S}$ and differ by only a constant. We can analyze dynamics graphically in Figure 11.

First, consider the conditions for the economy to revert back to the original steady state ss_1. This path is unique only if both equations (7) and (8) are both positive, so that no matter what, entering households prefer neighborhood 1. This corresponds to region I in Figure 11. In this region, when the population of neighborhood 1 is greater than $N^*_{1S,rev}$, the only possible outcome is a reversal back to ss_1. In other words, if the negative shock is cancelled quickly enough, and neighborhood 1 has not declined very much, then the economy unambiguously converges back to the initial steady state. Temporary shocks to expectations have temporary effects.

Second, consider the conditions for the opposite case, where the unique path of the economy is to continue the transition to ss_2. This outcome is unambiguous only when both equations (7) and (8) are negative, meaning that entering households always prefer neighborhood 2. This corresponds to region II in Figure 11. In this region, when the population of neighborhood 1 is less than $N^*_{1S,con}$, the only possible path is a continuation of the transition to ss_2. In other words, if the agglomeration externality is large, or the

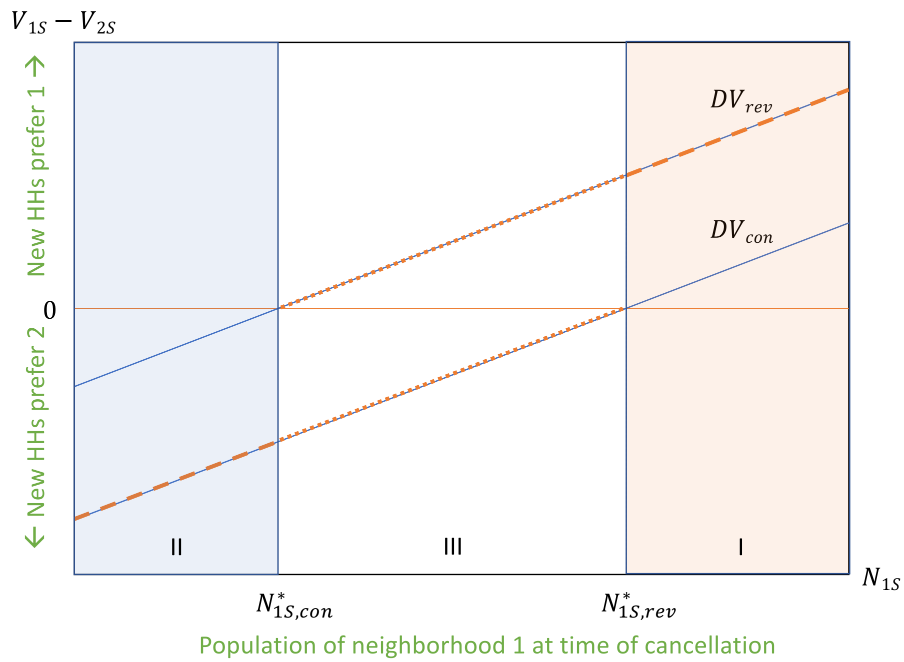


Figure 11: Transition dynamics after announced shock is cancelled

negative shock is cancelled late and neighborhood 1's population has declined significantly, then the transition continues. Temporary shocks to expectations have permanent effects.

For intermediate values of neighborhood 1's population there are multiple possible transition paths. This corresponds to region III in Figure 11. For these values of N_{1S}, if the transition continues, then entering households would prefer neighborhood 2, validating the continuation to ss_2. But if the transition reverses, then entering households would prefer neighborhood 1, validating a reversal back to ss_1. While additional structure or other functional form assumptions may not result in multiplicity, this result shows that uniqueness is not a general feature of this type of model.

Despite the presence of multiplicity, these results have clear predictions about the long run outcomes of neighborhood size due to temporary shocks to expectations. Neighborhood change is more likely to persist after an announced shock is cancelled, if (i) the time between the initial announcement and the cancellation increases and (ii) the net agglomeration externality is large relative to the initial difference in exogenous amenity. Overall, these results show that temporary shocks to expectations can cause permanent neighborhood chagne.

5 Conclusions

We analyzed the role of self-fulfilling expectations in determining urban spatial structure. An expected large negative shock to neighborhood amenity can cause permanent decline, even if the shock is never realized. This result is consistent with forward-looking behavior and strong economies of density in residential location choice. Our results open the possibility that spatial structure may not be uniquely determined, even conditioned on nature and history. Instead, self-fulfilling expectations can shape city structure.

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A Appendix

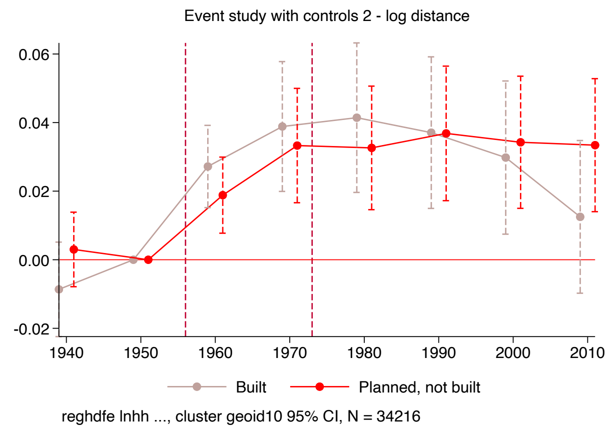


Figure A.1: Spatial treatment

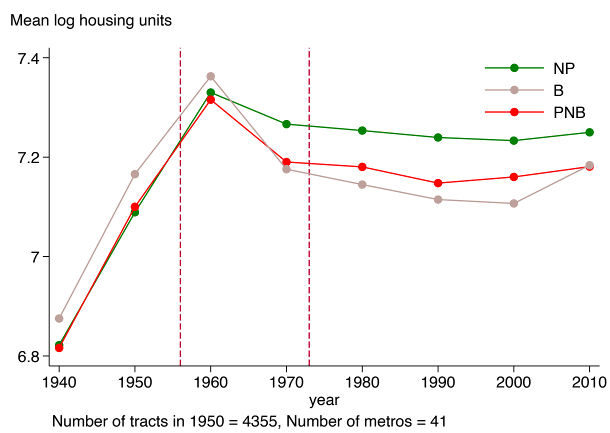
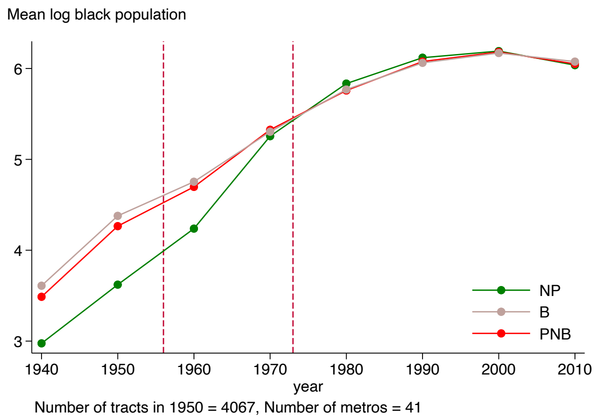
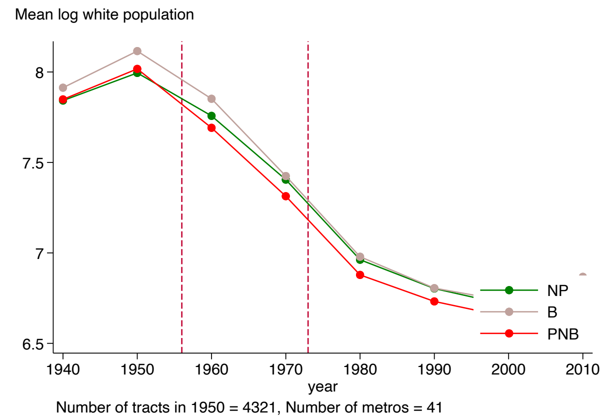


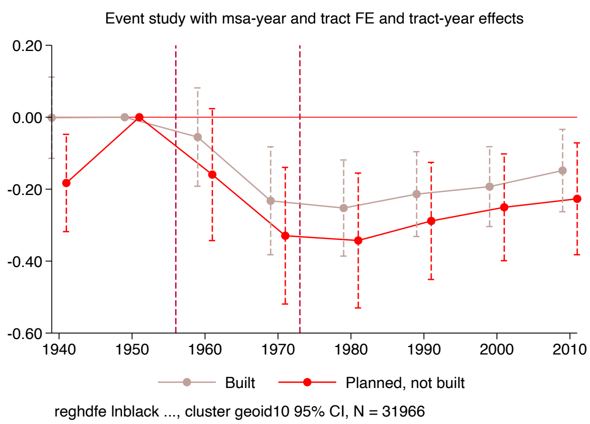
Figure A.2: Housing units



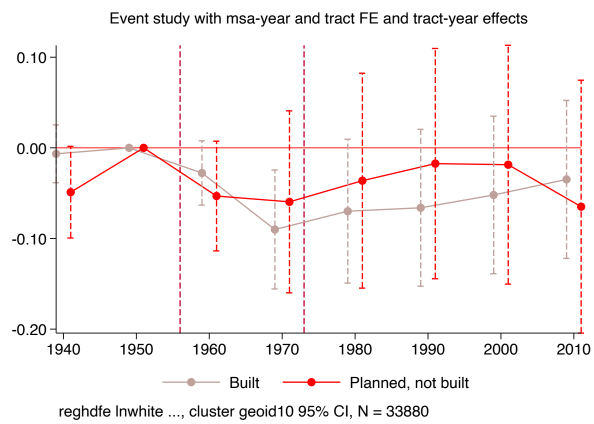
(a) Log Black population



(b) Log white population



(c) Event study, log Black population



(d) Event study, log white population

Figure A.3: Race

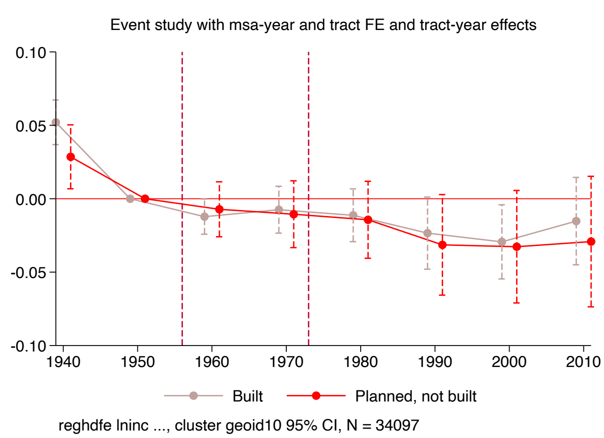


Figure A.4: Average household income