

1960s Interstate Highways and Homeowner Wealth Distribution

Jeffrey P. Cohen, Nicholas Lownes, and Bo Zhang

This article studies house-level real estate wealth distribution changes nearby a major interstate highway, comparing values before the announcement of the highway's construction (1940) with those during and shortly after the construction period (1961-74). We also develop Lorenz curves to examine the distribution of housing wealth among various demographic groups of homeowners. First, we find that properties at least a half-mile away from I-84 experienced statistically significant appreciation (on average). Houses further away, in 0.25 mile increments up to 1.25 miles, appreciated less. Our Lorenz curves exhibit a small inequitable distribution of wealth gains among all homeowners experiencing appreciation. But there was a large inequitable distribution of wealth losses among homeowners whose houses depreciated in value during and after construction compared with 1940 (pre-announcement). The Lorenz curves imply that, for the 10th percentile of homes with wealth increases, the majority-White-population Census tracts experienced over 25 percent higher house price appreciation than the majority-Black-population Census tracts. Finally, we observe that approximately 0.5 percent of the houses in our 1940 Census sample of around 2,500 homes had a Black homeowner. (JEL R3, R4)

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INTRODUCTION

Many interstate highways in the United States were built at a time of dramatic changes in America's land-use patterns. Where they were built may be correlated with homeowner wealth differences across various demographic groups that lived near the planned highways. Housing is the largest expenditure item for many American households, and it is one of the major mechanisms for households to accumulate wealth. The introduction of new highways can be associated with land-use pattern changes and the values of real estate nearby. Geospatial analyses are crucial tools

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to examine highways and wealth distribution. Relatively little research has been published on the relationships between the introduction of the U.S. interstate highway system and household-level real estate values. The major focuses of this research are to leverage geospatial analysis to test the hypothesis that house values have risen near a highway and to explore the homeowner wealth distribution among various levels of house prices and across demographic groups (i.e., houses in neighborhoods with majority-Black populations and majority-White populations).

The objectives of this research are to consider the above-described issues for one particular interstate highway in Hartford, Connecticut. Specifically, we (i) use regression analysis to evaluate how the implementation of Interstate 84 (I-84) in Hartford, Connecticut (the state capital), is correlated with real estate values over the 20-to-30-year period spanning from the planning stages (circa 1940) through the years near the opening of the highway (1961-74) and (ii) construct Lorenz curves to demonstrate visually how this homeowner wealth creation varied across different groups of residents in Hartford, Connecticut.

To accomplish these objectives, several tasks have been undertaken. Data have been manually collected on nearly 2,500 home values near I-84 from the 1940 Census (before the development of the interstate highway plans) and matched with the corresponding home values from when the homes sold between 1961 and 1974 (after the opening of I-84 in Hartford). For each property address, we then have two observations on that property's estimated value: one from 1940, before the development of the interstate highway system, and one from between 1961 and 1974. These data were geocoded and maps developed that demonstrate how the appreciation/depreciation in property values (i.e., "wealth" changes) have varied across these homes. Included among these maps is one showing percentage changes for properties that appreciated or depreciated and one showing dollar ranges for house value appreciation/depreciation. While some patterns are evident from visual inspection of these maps, a more rigorous analysis using multiple regression analysis finds the following correlations.

First, we find insignificant statistical evidence of depreciation between 1940 and the 1961-74 period for houses that are very close to the highway (i.e., within 0.25 miles), after holding constant other factors.¹ Second, properties that are 0.5 miles or more away from I-84 experienced 55 percent appreciation, and as the distance to I-84 increases, the appreciation is less, falling to 27 percent appreciation for houses within 1.25 miles. But at a distance of within 1.5 miles from I-84, property values appreciate again, rising to 45 percent, as those houses are closer to another interstate highway (I-91). Next, we find that properties that were worth more in 1940 actually appreciated less between 1940 and the 1961-74 period, after controlling for highway proximity and drive time to I-84.

For properties that increased in value between 1940 and the 1961-74 period, there was an inequitable distribution of wealth gains. When comparing Census tracts with a majority- (more than 50 percent) Black population and tracts with a majority-White population (based on 1960 tract-level Census data), there are some differences. As one example, we consider the 10th percentile of homes with price appreciation in these two demographic groups. The house price appreciation inequality among tracts with majority-Black populations was over 25 percent higher than among tracts with majority-White populations. The racial disparity in housing wealth accumulation over this period may have precluded many Black residents from accruing housing wealth in the same manner as other residents. This finding is underscored by our observation that approximately 0.5 percent of the houses in our 1940 Census sample of nearly 2,500 homes had a Black homeowner (based on 1940 Census individual-level demographics).

We also develop Lorenz curves to examine the extent of housing wealth inequality among the homeowners near I-84 who experienced property value decreases. There was a relatively small number of properties that experienced declines in value, but there was a large inequitable distribution of wealth losses among homeowners whose houses decreased in value. For instance, more than 70 percent of the wealth losses that occurred with the construction of I-84 were experienced by roughly 20 percent of the homeowners.

From a policy perspective, our findings could support future planning and policy to reconfigure and revamp I-84 (i.e., elevated, at grade level, or underground) given its current state of age-related deterioration. This research is also intended to lay the foundation for future research using similar techniques to address these issues for other U.S. cities where interstate highways have been built. It is important as a potential methodology to place a value on the interstate highway system in the United States. It can additionally be used as a tool for comparing inequality in real estate wealth accumulation within and across cities due to interstate highway construction, enabling researchers to uncover new information about where the net benefits of highway construction have been equitable or inequitable. These regional disparities could also inform future highway construction decisions that may be helpful to policymakers choosing how to allocate future highway construction funds across different regions of the United States. Other transportation modes (e.g., transit or airports) could be amenable to these techniques as well.

The remainder of this article is organized as follows. The next section presents a review of the literature on highways, wealth distribution, and real estate values. A detailed description of the data gathered and some geographic information system (GIS) maps that provide visual evidence on real estate value changes are presented before the description of methodologies for achieving the objectives. The methodologies consist of regression analysis and Lorenz curves. Finally, we conclude with a summary and discussion of potential directions for future research.

LITERATURE REVIEW

There has been extensive research on the linkage between highway infrastructure and economic performance. Much less research has focused on analysis of how proximity to a highway correlates with real estate wealth, going back to the dates of the announcement of the original plans for interstate highways. The issue of real estate wealth accumulation—resulting from the announcement of an original highway in the interstate system—has not been explored.

The existing studies generally agree on the positive role investments in transport infrastructure play in producing strong economic benefits and fostering growth (Congressional Budget Office, 2015, and Council of Economic Advisers and National Economic Council, 2014). These findings have justified government funding for new and improved transportation infrastructure.

However, there is no overarching consensus on the magnitudes of the economic impacts of highway investment, because estimates of the impacts vary greatly. A broad literature on highway infrastructure studies has focused on a variety of economic impacts, such as gross domestic product, employment, productivity, production costs, and other considerations.²

In fact, Boarnet (1998) has found that highway infrastructure improvement in some areas (in this case counties) can draw away the most productive resources from neighboring areas (counties), which implies a negative effect of nearby infrastructure investments. Also, externalities from infra-

structure investments in some locations, such as noise and air pollution, may have detrimental effects. It is also possible that the positive effects of highway infrastructure may dominate the negative effects in some locations, while at other locations the opposite may hold. Although many of the studies described above have become widely accepted benchmarks for measuring the macroeconomic impacts of public highway infrastructure on the economy as a whole or of a particular sector (such as manufacturing), relatively little research has been published on the household-level wealth distribution associated with highway investment.

The announcement of highway improvements such as new construction can substantially change the values of properties nearby (with a net effect being either positive or negative, as described below). This change in home equity for the average household due to the potential benefits from access to highways (e.g., enhanced access to the city center and/or to other cities) is called “capitalization.” The capitalization of highways into house values is similar to the case for other amenities. Similarly, it is possible that proximity to highways can lead to negative impacts, such as air pollution and noise, which can also be capitalized into house prices. In other words, since the impacts of highways are capitalized into house prices, examining the impacts of highways on household wealth by analyzing house values could generate useful insights on wealth accumulation.

These observations naturally lead to the research question of the net benefits—either positive or negative—that households receive and the distribution of those benefits across society. Housing is the largest expenditure item for average American households, and it is one major mechanism for households to accumulate wealth. But there are disparities across demographic groups—for instance, the homeownership rate among the Black population is significantly less than among the White population (Perry and Ratcliffe, 2021). This finding implies the possibility of less capitalization for Black residents over time, as the house price increases from benefits of highway accessibility may not be reaped by Black residents in the same magnitude as by White residents.

In the U.S. context, Allen, Austin, and Swaleheen (2015) study Interstate 1-10 in Orlando, Florida. They find an accessibility benefit of 2.5 percent higher house prices for homes with a shorter drive time from the highway but a nuisance discount (from noise and congestion) of 4 percent for properties next to the highway. Chernobai, Reibel, and Carney (2011) consider Interstate 210 in the Los Angeles area and underscore the importance of nonlinear effects on property values. They find relatively low benefits for properties closest to the highway but increasing benefits for properties up to an optimal distance from the highway, beyond which the benefits fall. These nonlinear effects motivate our analysis of multiple distance bands, or cutoffs, which also yield different proximity effects in our context for proximity to I-84. Chernobai, Reibel, and Carney (2011) also find that there are essentially no “announcement” effects; most beneficial impacts on home values occur immediately or very soon after the completion of construction and opening of a highway.³

This literature review underscores the need for the empirical analysis of how highways have been correlated with housing wealth accumulation. Also, analysis of the wealth distribution associated with house price changes near new interstate highways would be desirable. These are among the focal points of our methodologies below.

APPROACH

There are several prongs to our analysis of real estate wealth accumulation and wealth inequality associated with new interstate highways. Regression analysis—and more specifically, a variation of

a long-differences approach—is a useful analytical tool for this problem. Separately, changes in the values of real estate near the highways, between 1940 and the 1961-74 period, can be visually demonstrated using GIS mapping. Because examination of these changes over time can also be useful in determining whether there is a severe degree of inequality in the distribution of wealth changes, we plot these changes using Lorenz curves. Below we discuss these methodologies in detail as applied to the problem of determining how the announcement and construction of I-84 has been correlated with real estate wealth changes, the spatial distribution of the changes in property values over the period under consideration, and the extent of any potential inequality in the accumulation of real estate wealth during the period.

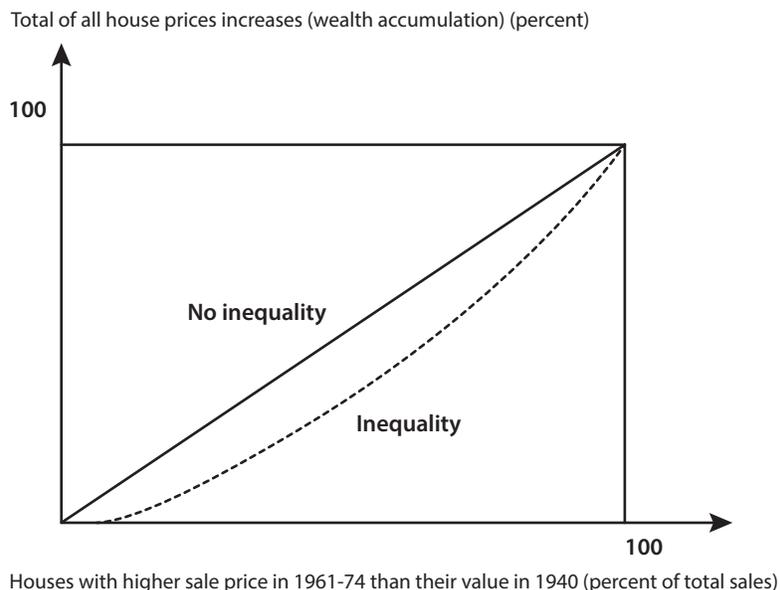
Specifically, we estimate a hedonic house price long-differences model, with the change in value of each individual property, i , in 1940 and the 1961-74 period (i.e., before versus after the announcement and construction) as a function of distance from property i to the highway. In this specification, the time-invariant property characteristics drop out of the long-differenced hedonic house price function.⁴ We use the Case-Shiller home price index to control for national-level increases in real estate values over the 1940 to the 1961-74 period (Shiller, 2015). Also, to control for general city-wide price differences across various years in the 1960s, we include a dummy (i.e., 1/0 indicator) variable for each year of the sample (in the years 1962-74), with 1961 as the base year. To control for variation across geographic space, we include a dummy variable for each Census tract. We also use the initial value of houses in 1940 as a control variable in the regression analysis. Starting with the basic relationship, more formally, this specification can be written as

$$(1) \quad \% \Delta V_{it} = f(H_{it}, X, D_C, D_t) + \varepsilon_{it},$$

where V_{it} is the property value of house i in year t ; H_{it} is the proximity to the highway for house i in year t ; D_t is a dummy variable that equals 1 if observation i sold in year t during the 1961-74 period and zero otherwise; D_C is a dummy variable that equals 1 if observation i was in Census tract C ; and $\% \Delta V_{it}$ is the percent difference between the assessed value of property i in the 1961-74 period and the value of the property in 1940, after adjusting the 1961-74 values for “inflation” in home prices since 1940 using the national-level Case-Shiller single-family home price index (Shiller, 2015). The variable H_{it} is a dummy variable that takes the value of 1 if a house is “close” to the highway and zero otherwise. Varying definitions of close are considered in the regressions, ranging in 0.25-mile increments from 0.25 miles to 1.50 miles. The variable X represents other control variables, which may include the value of the property in 1940 and possibly other control variables in more general settings when such data are available. With the assumption of long-differences using ordinary least squares with fixed effects, a simplified version of the model (1) is

$$(2) \quad \% \Delta V_{it} = \beta_1 + \beta_2 * H_{it} + \beta_3 X_i + \beta_C D_C + \beta_t D_t + \varepsilon_{it},$$

where $\beta_1, \beta_2, \beta_3, \beta_C$, and β_t are parameters to be estimated and D_C and D_t are fixed effects (or indicator variables). D_C is a fixed effect that controls for the Census tract where property i is located, and D_t is a fixed effect for the year in the 1961-74 period when property i was sold. X_i is the value of property i in 1940. Finally, ε_{it} is a random error term assumed to be a normal distribution with mean zero and constant variance. Including X as a regressor enables controlling for how more-valuable properties experienced price changes between 1940 and the 1961-74 period. Results from equation (2) are presented below, with varying proximity definitions.

Figure 1**Lorenz Curve: How Do Wealth Changes Track Number of Property Owners? Example of Relative Inequality**

NOTE: The x-axis denotes the percent of total houses that sold during the 1961-74 period (between 0 and 100). The y-axis denotes the total (or sum) of all house prices increases (between 1940 and the 1961-74 period), expressed as a percent between 0 and 100.

SOURCE: Authors' adaptation of Nijssen, Rousseau, and Van Hecke's (1998) general exposition of Lorenz curves for inequality.

An alternative way to view the changes in homeownership wealth over time is to develop a set of GIS maps showing how individual property values changed between 1940 and the 1961-74 period. The GIS maps for the area include the location of the I-84 highway (as well as another major highway built in the 1960s—I-91—although our focus is on properties near I-84). The I-84 maps also include a set of “buffer” zones, shown in various shades of grey, denoting 0.10, 0.25, and 0.50 miles, etc., from I-84. The intent is to visually demonstrate how many properties in the sample are located close to or slightly farther away from I-84.

Finally, inequality in the accumulation of wealth from housing is demonstrated visually with Lorenz curves. Separate sets of Lorenz curves are developed—one for properties that appreciated after the development of I-84, and another for properties that depreciated after the highway development—compared with the values of the same properties in 1940 (i.e., before the announcement and construction of the highway). Lorenz curves demonstrate whether a small number of homeowners realized a disproportionate gain in wealth. For instance, in Figure 1, percentiles of homeowners with wealth increases are on the horizontal axis and the wealth change corresponding to each percentile of homeowners is on the vertical axis. The dashed line is the set of points observed in the house value appreciation data: If the line is below the 45-degree line, it implies a disproportionately small amount of wealth is realized by a large proportion of homeowners. But if the dashed line is very close to the 45-degree line, it represents a relatively equitable distribution of wealth from

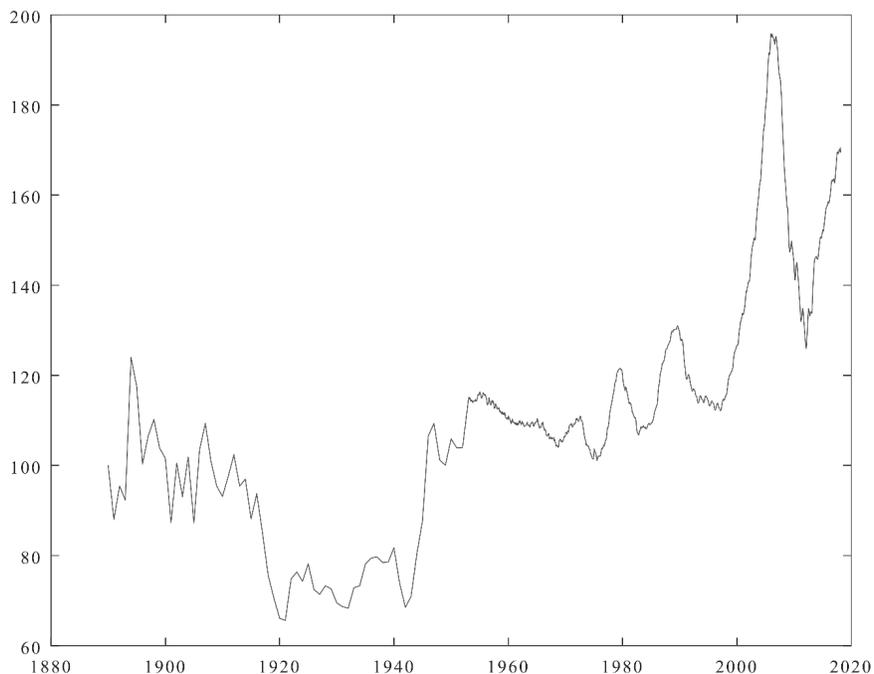
house price appreciation. If the dashed line is above the 45-degree line, which may occur due to a disamenity such as noise or pollution, for instance, then a large portion of this disamenity is distributed to a small proportion of the population. One objective of this study is to examine whether there is equity or relative inequality in the distribution of housing wealth accumulation. Separately, we consider those properties that experienced a decrease in value after the opening of I-84 and then whether the depreciation in wealth was disproportionately borne by a small percent of homeowners. We also consider how the Lorenz curves differ in majority-Black- and majority-White-population Census tracts.

DATA

One approach to comparing housing wealth accumulation before versus after the highway announcement and opening is to examine individual house prices from before (1940) and after (the 1961-74 period) the announcement. Data on property-level residential real estate values from recent decades (going back to the early 2000s) are typically well-documented and generally available from a variety of sources. But earlier data—such as from the 1960s—sometimes exist and sometimes not, depending on the city. When they do exist, usually they are in hard-copy format and involve intensive digitization efforts. Similarly, the house value data from the 1940 Census is available on microfiche in most public libraries but also often need to be digitized (unless the researcher has access to the 1940 Census data that is available through IPUMS, which we did not have at the time of this research). The analysis here relies on house value data from the 1940 Census and the corresponding data from the 1961-74 period. The research team obtained these data by compiling and then digitizing hard copies of land records from the City of Hartford Assessor's Office.

While the entire U.S. interstate highway system, for example, constitutes a complex interconnected network, which was planned and built over decades, it is possible (and relatively tractable) to analyze the local impacts in one city by using a counterfactual approach. This approach is based on repeated observations for the same properties. For instance, in Hartford, Connecticut, the property-level sales data available through the assessor's hard-copy land records were traced back to the early 1960s. The timeframe under consideration is crucial because it enables examination of how property values changed over an extended period of time where property value information is available for specific properties—both before and after the announcement of the interstate highways in a major city. See Figure 2 for a map of Connecticut and the major interstate highways. It is noteworthy that several of the largest cities in the state—including the state capital of Hartford—have major highways passing directly through these cities.

This study centers on the assessed values of single-family residences near I-84 in Hartford that sold in the 1961-74 period. For each of those residential addresses near I-84 in Hartford, the publicly available 1940 U.S. Census files were used to obtain information on the exact property addresses, whether each property was owned or rented, and the associated residential property values (if owned).⁵ By comparing the property appreciation—that is, the difference between the assessed values of the properties in the 1961-74 sample and the estimated values of the same properties in the 1940 Census—we obtain estimates of wealth accumulation (through home value appreciation or depreciation). The 1961-74 period sample was collected based on the properties in and around the highway in multiple Census tracts (with 1960 Census tract boundaries indicated on the maps).

Figure 3**Case-Shiller House Price Index, 1890-2018 (1890 = 100)**

NOTE: This Case-Shiller house price index is used to deflate the house values in Figures 4 and 5 when calculating the change in house values between 1940 and the 1961-74 period.

SOURCE: <http://www.econ.yale.edu/~shiller/data/fig3-1.xls>.

Table 1**Descriptive Statistics: Houses That Sold in the 1961-74 Period Near I-84 in Hartford**

	Real home value change (percent), 1940 to the 1961-74 period	Percent within 0.25 miles	Percent within 0.50 miles	Percent within 0.75 miles	Percent within 1.00 miles	Percent within 1.25 miles	Percent within 1.50 miles	Home value (1940)
Mean	250.59	3	11	24	37	54	72	\$6,063
Median	149.49	0	0	0	0	100	100	\$5,000
Maximum	5,206.66	100	100	100	100	100	100	\$82,600
Minimum	-78.82	0	0	0	0	0	0	\$250
SD	331.33	16	32	42	48	50	45	\$4,953
N	2,494	2,494	2,494	2,494	2,494	2,494	2,494	\$2,494

NOTE: SD, standard deviation.

SOURCE: 1940 Census data, City of Hartford assessor, and authors' calculations.

an Excel spreadsheet. The 1961-74 data include the property address, the sale price, and the assessed value of the property at the time of the sale. The addresses of the 1940 Census data properties were then matched with the properties that sold in the 1961-74 period, leading to two observations for each of the approximately 2,500 properties in the dataset: one before the announcement and construction of I-84 (in 1940) and another from the construction period.⁷

Finally, a 1940 GIS layer⁸ street map of the City of Hartford was used together with the properties in the dataset described above to geocode and overlay the property information and the location of I-84. Distance between each property and I-84 was calculated. A set of descriptive statistics of the data is in Table 1. The sample size in Table 1 is 2,494 and includes all observations with matched 1961-74 property sales data and 1940 Census data. In the regression analysis presented in Table 2 in the results section, properties with a 1940 home value less than \$1,000 were dropped from the sample, yielding 2,477 observations.

In the neighborhoods near I-84 in Hartford, the mean home value change was approximately 250 percent between these time periods, with a median home value change of 150 percent. Relatively few properties were located within 0.25 miles of I-84 (3 percent of the sample),⁹ while 72 percent of the sample was within 1.50 miles of I-84.¹⁰ The mean (median) home value in 1940 was \$6,063 (\$5,000).

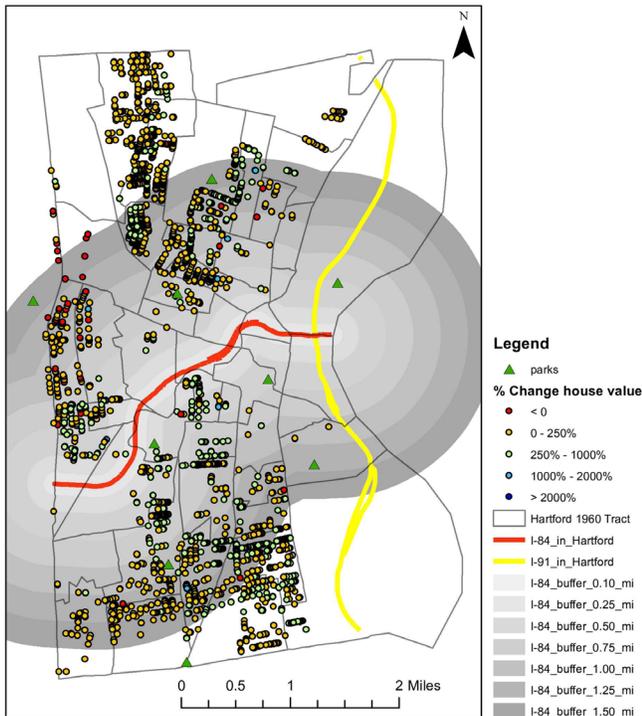
The inequality analysis includes two separate calculations: one for properties that appreciated in value and one for properties that depreciated in value between 1940 and the 1961-74 period. We also stratify the samples by 1960 Census tracts with at least a 50 percent Black population and those with at least a 50 percent White population. Then, a separate set of Lorenz curves are calculated and plotted for each. Specifically, the percent change in real estate wealth is plotted on the *y*-axis and the percentile of homeowners with wealth gains is plotted on the *x*-axis. In theory, there would be equality in the distribution of wealth if the Lorenz curve coincided with the 45-degree line. Thus, one objective of the Lorenz curve analysis is to gather visual evidence regarding the distribution of housing wealth accumulation after the construction of I-84 that may have been correlated with the proximity of those houses to I-84.

The locations of the 2,494 properties are shown in Figures 4 and 5. Figure 4 shows the percent changes in value between 1940 and the 1961-74 period. Figure 5 shows the dollar ranges of the changes in property values between these two periods, in constant (1940) dollars. These figures also show buffer zones of 0.10 miles, 0.25 miles, and 0.50 miles. Properties located in the western edge of Hartford, due west of I-84, are concentrated in an area with decreased values after the construction of I-84. Many properties throughout the neighborhoods near I-84 experienced property value increases of more than \$15,000. As can be seen in Figure 4, some properties near the center of the map and just south of I-84 experienced gains of 250 percent to 1,000 percent between 1940 and the 1961-74 period. Both directly south and directly north of I-84 at the center of the map, there are clusters of properties with appreciation of up to 1,000 percent.

Very few houses depreciated in these neighborhoods. Overall, in this sample, approximately 60 houses fell in value between 1940 and the 1961-1974 period, while slightly more than 2,400 houses rose in value. Perhaps the houses that would have seen substantial depreciation were so close to the proposed highway that they ended up being demolished prior to the highway construction; however, we do not have data on those teardown properties, since we only include in our sample those houses with at least one sale in the 1961-74 period (after I-84 construction).

Figure 4

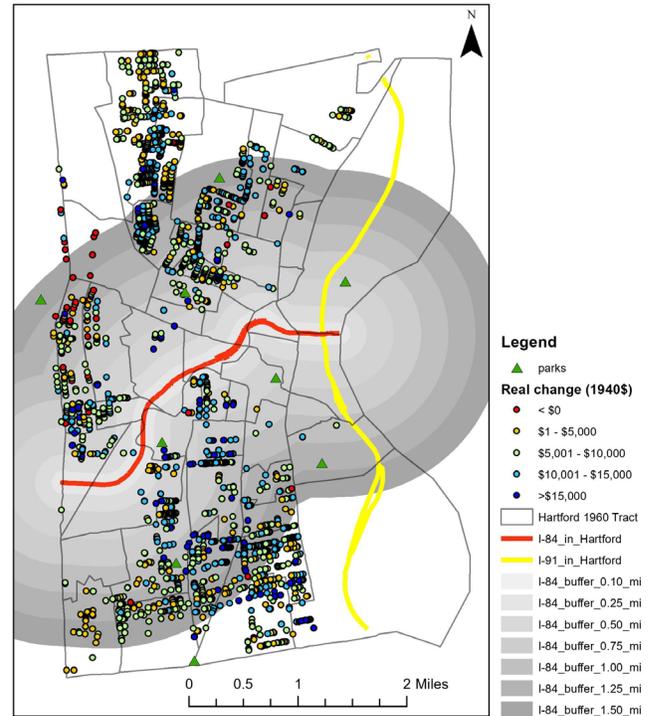
**Percent Change, Property Values (1940 dollars)
Near I-84, 1940 vs. the 1961-74 Period**



SOURCE: 1940 and 1960 Census, City of Hartford assessor, authors' calculations, and ArcGIS.

Figure 5

**Change in Property Values Near I-84, 1940 vs.
the 1961-74 Period**



SOURCE: 1940 and 1960 Census, City of Hartford assessor, authors' calculations, and ArcGIS.

More specifically, the data collected for this article are unique in the sense that they consist of matches between property data in the 1961-74 Hartford assessor's rolls (that had arms-length property sales during that time period) and the corresponding property data from the 1940 U.S. Census. The spatial locations of different houses and how their values have changed between 1940 and the later period are mapped, making the changes in values visually observable. Additionally, these relationships are explored with regression analysis in the results section.

RESULTS

Two major sets of results are discussed below. First, the regression results (using a variation of long-differences) are presented and discussed as a technique to demonstrate the correlations (although not causality) between I-84 proximity and house value changes. Second, the Lorenz curve results are presented and analyzed, in order to study the wealth distribution related to the house value changes near I-84.

Table 2 presents the regression results described in equation (2). Each column in this table represents a regression using a different proximity to the highway, that is, the cutoffs for the near I-84 variable: 0.25 miles, 0.50 miles, 0.75 miles, 1.00 mile, 1.25 miles, and 1.50 miles.

Table 2**Regression Results—Dependent Variable: Percent Change in House Value, 1940 to the 1961-74 Period**

Regressor	0.25 miles	0.50 miles	0.75 miles	1.00 mile	1.25 miles	1.50 miles
Constant	564.76	787.82	804.81	798.82	825.79	853.92
t-Statistic	2.24	3.08	3.12	3.08	3.14	3.33
Near I-84 dummy	-0.07	0.55	0.39	0.30	0.27	0.45
t-Statistic	-0.31	4.37	4.03	3.52	3.24	4.96
House value in 1940	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
t-Statistic	-27.87	-27.26	-27.12	-27.55	-27.83	-27.69
R^2	0.30	0.30	0.30	0.30	0.30	0.30
F-statistic	18.49	18.98	18.90	18.80	18.75	19.12
P-value (F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00
N	2,477	2,477	2,477	2,477	2,477	2,477
Year FE	Y	Y	Y	Y	Y	Y
Tract FE	Y	Y	Y	Y	Y	Y

NOTE: Sample includes properties with value of at least \$1,000 in 1940 (which is the reason for the discrepancy between the sample size here and that of Table 1). Distance calculated “as the crow flies.” Latitude and longitude coordinates are included as regressors (estimates not shown here), following the suggested approach of Ross, Farmer, and Lipscomb (2011). FE, fixed effect. SOURCE: 1940 and 1960 Census data, City of Hartford assessor, and authors’ calculations.

Before presenting the regression results, note that it might be possible to include both a range-of-distance (“as the crow flies”) indicator variable and a driving-distance indicator variable, to try and disentangle the benefits from access to I-84 from the drawbacks of proximity due to noise and pollution. But this would raise other undesirable complications. Ross, Farmer, and Lipscomb (2011) highlight an inherent concern with such an approach of including multiple distance indicator variables (or multiple continuous distance variables) in the same regression model. Specifically, Ross, Farmer, and Lipscomb (2011) note that interpreting the marginal effect of a primary distance variable is problematic when there are other distance variables in the same regression, since the marginal effect on the primary distance variable assumes all other variables are held constant. But when the primary distance variable changes, this likely also changes other distance variables in the same regression, which negates the *ceteris paribus* interpretation on the primary distance variable. Therefore, the focus here is on including only one distance indicator variable and varying that indicator across different regressions to examine whether the signs and significance change across different cutoff distances. The distance variable used here is a range-of-distance indicator variable. Using a driving-distance indicator variable does not substantively impact the results. Using the range-of-distance indicator variable in separate regressions is our approach to capturing the heterogeneous correlations with distance to the highway. We also control for the latitude and longitude coordinates of each property, which Ross, Farmer, and Lipscomb (2011) suggest as a more viable alternative to including multiple distance regressors.

There are 2,477 observations in each of the regressions in Table 2. The regressors include a constant, a dummy for near I-84 (which is the variable of interest), and the house value in 1940.

The dependent variable is the percent change in house value between 1940 and the 1961-74 period (in 1940 dollars). We do not include the property characteristics since, based on Bailey, Muth, and Nourse (1963), the assumption that they are time-invariant implies they drop out when taking their long-difference (and also, we do not have data on these property-level characteristics). For all regressions, the *R*-squared is approximately 0.30, which is in the general range of many hedonic studies. The proximity indicator for the cutoff closest to I-84 (i.e., 0.25 miles) is statistically insignificant.¹¹ The proximity indicator for 0.50 miles is positive and statistically significant and equal to 0.55. This finding implies that properties within 0.5 miles of I-84 appreciated approximately 55 percent more than properties farther away. The proximity indicators gradually diminish (but are still statistically significant) as the distance cutoffs increase to 0.75 miles, 1.00 mile, and 1.25 miles, which is intuitive, as the benefits from proximity are reduced with fewer accessibility benefits. Finally, the proximity indicator for the 1.50 miles cutoff is positive and equal to 0.37, which is larger than the corresponding effects for 0.75 miles, 1.00 mile, and 1.25 miles.¹² While one might conjecture that further distance from I-84 is correlated with fewer accessibility benefits, there are some houses within 1.5 miles of I-84 that are relatively close to I-91.¹³ The benefits of proximity to I-91 for these houses could be the source of the relatively higher proximity indicator estimate for the 1.50 miles from the I-84 cutoff.¹⁴

Regarding the coefficients on the house value in 1940 variable, they are generally negative and very small but statistically significant. These parameter estimates are approximately -0.00023 in all model specifications. This finding implies that for every \$1,000 lower a house was valued in 1940, that house tended to be worth approximately 23 percent more in the 1961-74 period. In other words, lower-valued houses appreciated more than higher-valued houses in these Hartford neighborhoods from 1940 to the 1961-74 period.

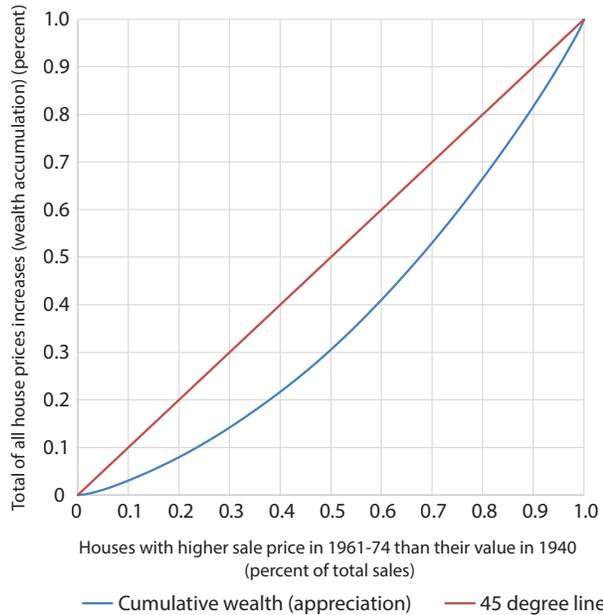
There may also be other factors related to the house price increases.¹⁵ For instance, we consider the Hartford assessor's database of all houses in the city, which contains some historical data on construction dates. We observe a differential rise around this time in the number of new houses built near versus farther away from the highway. Construction of I-84 in Hartford started in 1959 and was completed in 1969.¹⁶ Among all houses built in the Hartford between 1950 and 1970, 2,452 were built within 1 mile of I-84, while only 2,003 were built within 1 to 2 miles of I-84. These findings imply that more houses were built near the highway after the late-1940s announcement of the highway. From 1970 to 1975 (shortly after completion), there were 463 houses built within 1 mile of the highway, while 241 were built within 1 to 2 miles of the highway. Thus, the increase in the housing stock may be related to the overall rise in house prices, possibly due to an increased desire of residents to live close to the highway; that is, the greater housing stock may have accommodated the higher demand for houses near the highway.

Next, the Lorenz curves are presented in Figures 6, 7, 8, and 9. Figure 6 presents the Lorenz curve for the houses that appreciated in value between 1940 and the 1961-74 period; Figure 7 presents the Lorenz curve for the houses that depreciated in value between 1940 and the 1961-74 period. As also noted above, when the blue curve is close to the 45-degree line, there is equal distribution of wealth appreciation (or depreciation) across homeowners. But when the blue curve is very bowed from the 45-degree line, there is unequal distribution of wealth appreciation (or depreciation) across homeowners.

In Figure 6, for instance, 20 percent of the homeowners experienced approximately 8 percent of the house value wealth increase. Similarly, 60 percent of the homeowners experienced slightly over 40 percent of the house value wealth increase associated with the proximity benefits of the

Figure 6

Lorenz Curve: Houses Near I-84 with Higher Value from 1940 to the 1961-74 Period

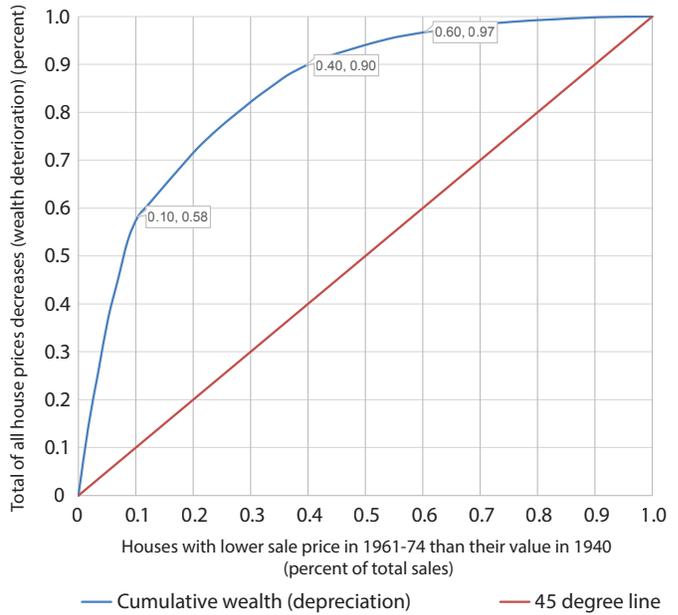


NOTE: $N = 2,404$.

SOURCE: 1940 and 1960 Census data, City of Hartford assessor, and authors' calculations.

Figure 7

Lorenz Curve: Houses Near I-84 with Lower Value from 1940 to the 1961-74 Period



NOTE: $N = 58$.

SOURCE: 1940 and 1960 Census, City of Hartford assessor, and authors' calculations.

highway. These findings imply some evidence of inequality here, given the blue Lorenz curve is below the equal distribution line (i.e., the 45-degree line).¹⁷

Figure 7 represents a Lorenz curve for the homeowners whose property values decreased between 1940 and the 1961-74 period.¹⁸ This Lorenz curve demonstrates extreme inequality in the distribution of the wealth losses from houses that decreased in value. For instance, 20 percent of the homeowners bore more than 70 percent of the losses in housing wealth associated with pollution and noise from the highway. This extreme inequality is visually indicated by the severely bowed-outward shape of the Lorenz curve in Figure 7.

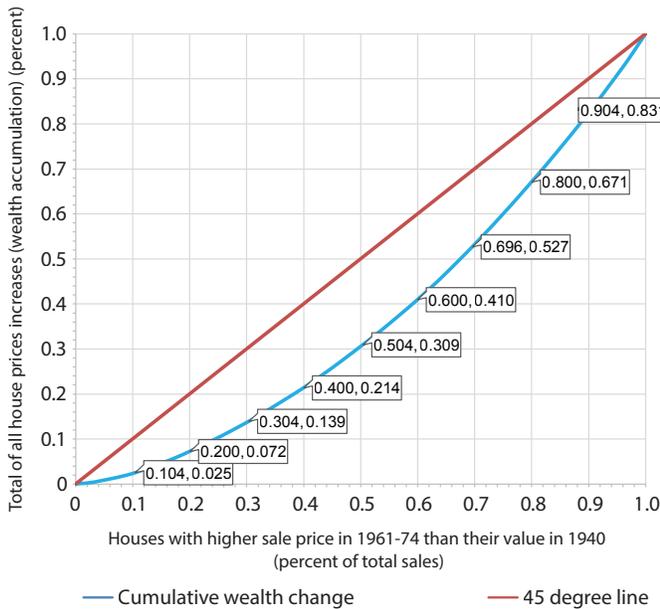
Differences Between Neighborhoods: Majority-Black versus Majority-White Populations

Here we consider two separate aspects of discerning inequality in housing wealth accumulation in Hartford: (i) the number of Black homeowners (in 1940) and (ii) Lorenz curves for houses that increased in value. These neighborhoods are categorized by 1960 Census tracts with at least a 50 percent Black population and, separately, tracts with at least a 50 percent White population. Note that very few houses in majority-Black-population tracts had decreases in value, which precludes us from showing them in a Lorenz curve.

First, there were 2,477 houses in our sample that sold in the 1961-74 period in these neighborhoods near I-84. Among these, 13 houses (i.e., approximately 0.5 percent of the sample) were owned

Figure 8

Lorenz Curve: Houses near I-84 with Higher Value from 1940 to the 1961-74 Period in Tracts with at Least a 50 Percent Black Population

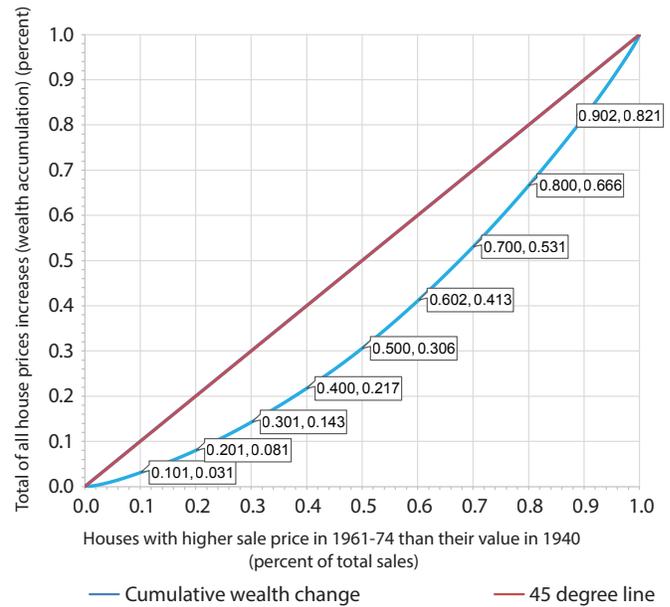


NOTE: $N = 125$.

SOURCE: 1940 and 1960 Census data, City of Hartford assessor, and authors' calculations.

Figure 9

Lorenz curve: Houses with Higher Value Between 1940 and the 1961-74 Period in Tracts With at Least a 50 Percent White Population



NOTE: $N = 2,278$.

SOURCE: 1940 and 1960 Census data, City of Hartford assessor, and authors' calculations.

by a Black head of household. Also, in the 1961-74 period there were approximately 125 houses sold in neighborhoods where the Black population exceeded 50 percent of total population.^{19,20} Apparently, there were serious barriers to homeownership for Black residents of Hartford. These barriers may have precluded most Black residents from accruing wealth effects associated with owning a home in proximity to I-84.

Second, we develop an additional set of Lorenz curves, one for properties in (1960) tracts with at least a 50 percent Black population and another for properties in (1960) tracts with at least a 50 percent White population. These are shown in Figures 8 and 9, respectively. As shown in Figure 8, in majority-Black-population tracts, the bottom 10 percent of the homeowners experienced 2.49 percent of the house price appreciation, while the bottom 20 percent of the homeowners experienced 7.2 percent of the increases in house price appreciation. In contrast, in majority-White-population tracts, the bottom 10 percent of the homeowners experienced 3.13 percent of the increases in house price appreciation, while the bottom 20 percent of the homeowners experienced 8.03 percent of the increases in house price appreciation.

As a way to interpret these Lorenz curves, we focus on the 10th percentile of the population that experienced wealth increases from house price appreciation, separately for the majority-Black- and majority-White-population tracts. These Lorenz curves imply the majority-White-population tracts experienced 25.7 percent higher house price appreciation than the majority-Black-population

tracts. Similarly, we consider the 20th percentiles of these populations that experienced wealth increases.²¹ Here the majority-White-population tracts experienced 11.5 percent higher house price appreciation than the majority-Black-population tracts. This finding implies the difference between the housing wealth accumulation in these two types of tracts is larger for homeowners whose houses appreciated less.²²

CONCLUSION

This study explores the housing wealth accumulation and its distributional effects related to the announcement and construction of a major interstate highway in Hartford, Connecticut (I-84). The approach here is unique in that it relies on data that have not been used together to develop regression estimates of how proximity to a highway is correlated with home values. Specifically, data from the 1940 U.S. Census on home values are combined and matched with 1961-74 period data from the City of Hartford Assessor's Office to develop a dataset of nearly 2,500 properties with two values for each home—one from 1940 (before the announcement of I-84) and another from 1961-74 (construction period).

Our approach to estimating the correlations between I-84 proximity and house values relies on the fact that the 1940 data are from before the announcement of the interstate highway system and the construction period. Therefore, using a proximity indicator variable for near versus far from I-84 produces an empirical estimate.

We have demonstrated that for properties located relatively close to I-84 (i.e., within 0.25 miles), there was an insignificant correlation between house values and highway proximity. But for properties within some wider critical point—within 0.50 miles from I-84—the benefits from being closer to I-84 were positive and significant. Compared with the 0.50 miles cutoff, the proximity indicator variables diminish as the distance of the proximity indicator rises: Houses that were close to the highway, as defined by various distance indicators, sold for 27 to 55 percent more. This finding implies that homeowners experienced an increase in home value the closer the home to I-84, but if their homes were too close (i.e., within 0.25 miles), there is no correlation between proximity and house values. Finally, there is strong evidence of unequal wealth distribution for properties that decreased in values. But there is moderate evidence of unequal wealth distribution for houses with a higher percent change in value from 1940 to the 1961-74 period. We discuss the implications of these findings for highway investment policy, and other policy implications, below. But first we drill deeper by looking at Lorenz curves in neighborhoods with majority-Black and majority-White populations. In the 10th percentile of the populations with wealth increases, the majority-Black-population tracts had 25 percent less wealth accumulation than the majority-White-population tracts.

We also considered the inequality of declining wealth related to I-84 proximity. Some properties in our sample (approximately 60) experienced price declines from 1940 to the 1961-74 period. A disproportionate amount of the wealth deterioration was borne by a very small percentage of the homeowners. Specifically, roughly 70 percent of the cumulative wealth decline was realized by only about 20 percent of the homeowners. This result represents a very strong degree of inequality. In contrast, for the approximately 2,400 houses with price increases over the same period, the additional housing wealth was relatively equitably distributed. For houses with price appreciation,

20 percent of the homeowners had approximately 8 percent of the wealth increase. While this is not representative of equality, these wealth gains are not as unequally distributed as the housing wealth losses for the homeowners discussed above.

There are a number of potential areas for future research. First, a more comprehensive set of data variables could enable a deeper dive into the regression analysis by enabling for additional control variables, although such data may be challenging to obtain. In the regressions approach used above, the (time-invariant) property characteristics cancel out when taking the long-differences. We include Census tract fixed effects, which can proxy for neighborhood demographics in our analysis. Second, it would be of interest to determine whether similar results hold for other cities with interstate highways, using comparable property value datasets. This research could happen if it were possible to identify some cities with rich historical property value records that date back to the 1960s (highway construction period).

These results can also have important policy implications for future highway construction, removal, and relocation decisions. If a comparison analysis of many cities can be done that leverages the approaches developed here, it would be possible to consider targeting new projects in locations where there is an expectation of relative equality in the house price appreciation/depreciation associated with the new highways. Similarly, it might be more desirable to target highway removal projects in cities where there is an unequal distribution of housing wealth accumulation, when the goal is to achieve a more equitable distribution of housing wealth. Such policy decisions would benefit from a more comprehensive analysis across many cities of the type performed in this study.

Finally, one might wonder whether the net housing wealth changes from interstate highways in the United States (or in one particular city) are positive or negative. This information would also provide important policy implications because if highways have a positive net correlation with housing wealth while rail and/or airports have a net negative change in housing wealth, these outcomes could imply that federal infrastructure resources should target highways and perhaps draw resources away from other transportation modes. A first step would be to conduct a similar set of inequality analyses for other modes, such as transit and/or airports.

Such research could be particularly relevant in the times of a pandemic where residents may feel “safer” from a contagious disease when riding in their own cars than when flying or traveling by train. For these reasons, it could be instructive to trace forward the values of residential properties to more-recent time periods, such as from the 1970s to the present, to consider a longer-term trajectory of the relationships between house prices and highway proximity. Clearly, as interstate highways are modified over time (perhaps with new exits and/or with new connectivity to other parts of the country with new highways in distant states), the net benefits from highway proximity can change as well. Therefore, consideration of the full lifespan of the entire U.S. interstate highway system—from the planning stages in the early 1940s to the present—could glean substantial information to support policy decisions at a nationwide, system level. ■

NOTES

- ¹ This seems consistent with what we observe anecdotally in Figures 4 and 5.
- ² See for instance, Aschauer (1989), Munnell and Cook (1990), and Cohen and Morrison Paul (2004).
- ³ Several recent articles explore the issue of transportation and inequality through the spatial linkage between residence and employment opportunities. For instance, Wellman (2014) argues that transportation policy is correlated with inequality, given that many individuals in poor areas have limited access to transportation and in general exhibit lower car ownership rates. More generally, the notion of the “disconnect” in the relationship between housing location and the ability of residents to travel to job opportunities has been described as “spatial mismatch.” Gobillon, Selod, and Zenou (2007) describe the theory of the spatial mismatch hypothesis and summarize the literature in this area. However, little research has been done to directly examine the relationship between transportation access and wealth inequality. In fact, Chatterjee and Turnovsky (2012), who develop a theoretical model to address this issue, note that the empirical literature on public infrastructure investment and inequality more generally is “sparse, inconclusive, and largely anecdotal.” They cite several articles that address the empirical issue of public infrastructure investment and inequality, but the vast majority of this research is focused on developing countries in Asia and Africa, with extremely little applied research on the United States. Also, subsequent recent research, including that by Getachew and Turnovsky (2015), Turnovsky (2015), Mattauch et al. (2014), and Gibson and Rioja (2016), tends to focus on theoretical models and/or numerical simulations.
- ⁴ The time-invariant characteristics assumption underlies the Bailey, Muth, and Nourse (1963) repeat sales model.
- ⁵ John Logan provided data on the race of the head of household for individuals who owned each property according to the 1940 Census.
- ⁶ The repeat-sales approach was developed by Bailey, Muth, and Nourse (1963) and more recently popularized in the price indexes that became widespread in acceptance via Case and Shiller (e.g., Shiller, 2015). When used together with a hedonic house price model, as first developed in Rosen (1974), the repeat-sales approach assumes all of the property characteristics (number of bedrooms, bathrooms, living-area square footage, etc.) drop out of the regression, as they are time-invariant between the dates of the two house value observations. There would be some potential limitations to our findings if in fact there were quality changes in a substantial number of the regressors (i.e., characteristics of individual houses) in 1940 versus in the 1961-74 period, although it is unclear the extent of this happening in our dataset and likely impossible to determine how many houses experienced such quality changes.
- ⁷ Regarding potential concern with the possible changes in the composition of houses in the two time periods, our including time (i.e., year) fixed effects may be one way to address this potential issue.
- ⁸ The 1940 Hartford street layer was obtained from John Logan.
- ⁹ The values for the individual observations for the percent-near categories (which are indicator variables) were either 1 or zero. The “mean” and “median” represent the mean and median values for the percentages of houses that were within the given distance cutoff from the highway. The “maximum” and “minimum” are the maximum and minimum values for these distance indicator variables, which were 1 and zero, respectively.
- ¹⁰ Although not shown in Table 1, more than 90 percent of the houses in our sample were within 2 miles of I-84.
- ¹¹ Given that the sample of properties within 0.25 miles of I-84 includes only 3 percent of the entire sample, perhaps there are too few properties within 0.25 miles to be able to offer strong statistical power for that radius.
- ¹² To test whether the various distance coefficients in each model from Table 2 are statistically different from each other, we performed robustness tests for various coefficient pairs, using an approach similar to Paternoster et al.’s (1998). The coefficient on the 0.25-mile indicator is statistically different from each of the other distance cutoffs (i.e., 0.50 miles, 0.75 miles, 1.00 mile, 1.25 miles, and 1.50 miles). The coefficients for 0.50 miles and 1.25 miles are significantly different from each other at slightly less than the 10 percent level of significance (using a two-tailed z-test; z-value = 1.84). The coefficients for 0.50 miles and 1.00 mile are marginally significantly different from each other at the 10 percent level (z-value = 1.64). All of the other combinations of distant coefficient pairs not mentioned above are insignificantly different from each other.
- ¹³ We performed a robustness test where we kept the latitude and longitude in the regressions, as suggested by Ross, Farmer, and Lipscomb (2011), but we added an additional regressor for distance from I-91. This I-91 distance regressor was very small in all models but statistically significant, and including the regressor did not notably affect the sign and significance of the distance to I-84 indicators. Given the concerns of Ross, Farmer, and Lipscomb (2011) with including multiple distance regressors, we decided that the results without the I-91 distance regressor were superior to the results that include it.
- ¹⁴ We also tried running an alternative model that was suggested by a reviewer, with the 0.25-mile indicator variable as the “base” and including all other distance cutoffs as indicators in the same regression. The coefficients on the 0.50-mile and

1.50-mile indicators were positive and significant, while those in-between these (i.e., the 0.75-mile, 1.00-mile, and 1.25-mile indicators) were statistically insignificant.

- ¹⁵ In addition to including latitude and longitude coordinates as regressors, our use of cross-sectional fixed effects (for Census tracts) is another way we control for spatial heterogeneity such as proximity to parks. Follow-up work, which can incorporate other detailed econometric analyses, might consider tests for spatial autocorrelation.
- ¹⁶ One reason for the location of I-84 was its proximity to downtown Hartford; in fact, one of the highway exit ramps connected directly to the entrance of the parking garage of a major department store called G. Fox (McWilliams, 2014).
- ¹⁷ Note that this does not imply causality but rather a correlation between wealth distribution across various homeowners that is related to house value appreciation in the two periods.
- ¹⁸ One might attribute these decreases to the impacts of being close to the air pollution and noise pollution associated with very close proximity to I-84. However, the Lorenz curves do not intend to represent this type of causality.
- ¹⁹ This information was obtained when we compared John Logan's 1940 Census data with the 1940 Census data that we obtained from the Ancestry.com microfilms (and overlaid it with 1960 Census data at the tract level).
- ²⁰ John Logan's 1940 Census data recognizes a third category for race titled "Other," and there are no houses in our sample of 2,477 houses owned by individuals classified in that category.
- ²¹ If we had data for the full universe of houses in these neighborhoods near the highway, it might be possible to calculate how much (in total dollars) these percentages imply.
- ²² That is, the difference in wealth accumulation is greater in the lower end of the distribution of the population with wealth increases.

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