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Highways and Wealth Distribution: A Geospatial Analysis

Final Report

by

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DISCLAIMER

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EXECUTIVE SUMMARY

Highways have changed America's land use patterns, affected travel behavior, shaped domestic and international trade, and influenced the development of the manufacturing sector, as well as other industries. The magnitude of highway investment economic impacts remains subject to significant debate because of a great deal of variance in the estimates of the impacts. But relatively little research has been published on the effects of the introduction of the U.S. interstate highway system on household-level real estate values. A major focus of this research is to leverage geospatial analysis to assess the net benefits households have received from living near highways (which may be positive or negative). 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 substantially change land use patterns and the values of real estate nearby. Geospatial analyses are crucial tools to examine highways, land use, and wealth distribution.

This study first develops an extensive dataset of assessed values of nearly 2,500 residential properties in the City of Hartford that sold in the 1960's (after the development of one of the major interstates, I-84) and matched the data for each of these properties to the corresponding property in the 1940 U.S. Census. So for each property address, there are 2 observations on that property's estimated value – one before the development of the interstate highway system (in 1940) and one after the opening of the major interstate highway that runs through Hartford (in the 1960's). After geocoding these properties, several geospatial maps are developed, demonstrating how the changes in values in these properties over time were different in various parts of the city. Included among these maps is one showing properties that appreciated versus depreciated, and one showing dollar ranges for the home 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 causal relationships. First, properties closest to I-84 have experienced insignificant appreciation between 1940 and the 1960's. Second, properties that are a half-mile away or more from I-84 experienced 47% appreciation, and as the distance to I-84 increases, the appreciation is less, falling to 19% appreciation for houses within 1.25 miles. But at a distance of within 1.5 miles away from I-84, property values appreciate again, rising to 37%, likely due to those houses being closer to another interstate highway (I-91). Next, properties that were worth more in 1940 actually appreciated less between the period of 1940 and the 1960's, after controlling for highway proximity and drive time to I-84. We also develop Lorenz Curves to examine the extent of housing wealth inequality among homeowners who experienced value increases, and separately, among those with value decreases. While there was only a slightly inequitable distribution of wealth gains among homeowners experiencing appreciation, there was a tremendously inequitable distribution of the wealth losses among homeowners whose houses decreased in value in the 1960s compared with 1940. For instance, more than 80% of the cumulative wealth losses, after vs. before construction of I-84, are experienced by roughly 20% of the homeowners.

Chapter 1. Introduction

1.1 Problem Statement

The interstate highway system impacted real estate development, homeowner wealth, and wealth distribution within cities, but quantitative estimates of these effects are elusive.

1.2 Objectives

The objectives of this report are to (1) evaluate how the implementation of Interstate 84 (I-84) in Hartford, Connecticut impacted real estate values over the 20-30 year period spanning from the planning stages through the opening of the highway; (2) demonstrate visually how this wealth creation for homeowners varied in the city of Hartford, Connecticut; and (3) explore how the distribution of housing wealth changes related to the highway construction may have been equitable or inequitable.

1.3 Expected Contributions

To accomplish these objectives, several tasks have been undertaken. Data have been collected on real estate values in 1940 (before the development of the interstate highway plans) and matched with assessed values for each property in the 1960's (after the opening of the I-84 in Hartford). These data have been geocoded, and maps developed that demonstrate how the appreciation in property values (i.e., "wealth") have varied across the city of Hartford. Also, regression analysis has been conducted, estimating how appreciation in real estate values have been affected by proximity to the highway. These analyses have addressed the objectives in section 1.2 above. From a policy perspective, these findings could be supportive in planning and policy for how (i.e., elevated, at grade-level, or underground) and where to reconfigure I-84 as a result of the need to revamp the highway due to age-related deterioration. It also is intended to lay the foundation for future research using similar techniques that can address these issues for other U.S. cities where interstate highways have been built. It is also important as a potential methodology to place a value on the interstate highway system in the U.S. It can also be a tool for comparing real estate wealth accumulation inequality within cities due to the interstate highway construction, as well as across different cities. It could enable researchers to uncover new information about where the net benefits of highway construction have been equitable and where it has been relatively inequitable. These regional disparities could also inform future highway construction decisions that may be helpful to policy makers who are choosing how to allocate future highway construction funds across different regions of the U.S.

1.4 Report Overview

The remainder of this report is organized as follows: Chapter 2 presents a comprehensive review of the state-of-the-art and state-of-the-practice literature on highways and real estate. Chapter 3 provides a detailed description of the data gathered and some GIS maps that provide visual evidence on wealth distribution due to real estate value changes. Chapter 4 describes the methodologies for achieving the objectives, which consist of regression analysis and Lorenz Curves. Finally, Chapter 5 concludes this report with a summary and some discussion of the directions for future research.

2. Literature Review

2.1 Introduction

This chapter provides a review and synthesis of the state-of-the-art literature on highways and real estate values, and the associated wealth inequality. This should give a clear picture of the current state of research in this area and the needs for additional research.

2.2 Previous Research

Highways have had dramatic impacts on the U.S. economy. They have changed America's geography, shaped domestic and international trade, and influenced the distribution of manufacturing sector firms, as well as other industries. There has been extensive research done on the linkage between highway infrastructure and economic performance, but little work performed on inequality in the real estate wealth distribution of the net benefits from highways.

The existing studies generally agree upon the positive role of investments in transport infrastructure by producing strong economic benefits and fostering growth (the Congressional Budget Office 2015, the White House 2014). These findings have justified government funding for new and improved transportation infrastructure.

However, the magnitude of economic impacts of highway investment remains subject to significant debate because of a great deal of variance in the estimates of the impacts. The vast majority of highway infrastructure studies have focused on a variety of economic impacts, such as Gross Domestic Product (GDP), employment, productivity, production costs, and other considerations. See for instance, Aschauer (1989); Munnell and Cook (1990); and Cohen and Morrison Paul (2004).

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 infrastructure 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 wealth distribution effects of highway investment at the household level.

These observations naturally lead to the research question of net benefits (which may be positive or negative) households receive, and the distribution across society. Housing is the largest expenditure item for average American households, and it is one major mechanism for households to accumulate wealth. The announcement of highway improvements such as new construction can substantially change the values of land and/or 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 real estate values is similar to the case for other "amenities" (such as has been found in other studies on the capitalization of parks, public safety, and public school quality into housing prices). 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 can be capitalized into housing prices, examining the impacts of highways on household wealth by an analysis of housing values could generate useful insights on wealth accumulation.

Several more recent papers 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 et al (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 papers 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 U.S. 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. There is a vast lack of rigorous empirical research in this literature.

2.3 Summary

A comprehensive review and synthesis of the current and historic research on highways and real estate wealth accumulation has been discussed in this chapter. This literature review underscores the need for the rigorous empirical analysis of how highways have affected wealth accumulation and wealth distribution due to real estate value changes near new interstate highways. This is the focus of the solution methodology below.

3. Solution Methodology

3.1 Introduction

There are several prongs to the methods of addressing the analysis of real estate wealth accumulation and wealth inequality resulting from new interstate highways. Regression analysis – and more specifically, a difference-in-differences approach - is a useful tool in estimating causal relationships of highway proximity on real estate value appreciation. Separately, changes in the values of real estate near the highways, between 1940 and the 1960s, can be visually shown using GIS mapping. These changes over time can also be useful in determining whether there is a severe degree of inequality in the distribution of wealth, by plotting these changes using Lorenz curves. Chapter 3 discusses the solution methodologies in detail, as applied to the problem statement of determining how the announcement and construction of I-84 has impacted real estate wealth changes, the spatial distribution of the changes in property values over the time period under consideration, as well as the extent of any potential inequality in the accumulation of real estate wealth during this timeframe.

The following sections are organized as follows. Section 3.2 provides a description of the general solution framework. Section 3.3 concludes this chapter with a summary.

3.2 Solution Approach

A promising econometric estimation approach would be to estimate a hedonic housing price difference-in-differences model, with the change in value of each individual property, i, in 1940 and the 1960s (i.e., before vs. after the announcement and construction) as a function of distance from property i to the highway. One can control for national-level increases in real estate values over the period of 1940 to the 1960s with the Case-Shiller home price index. Also, general city-wide price differences across various years in the 1960s can be controlled for with including a dummy (i.e., 1/0 indicator) variable for each year of the sample (in the years 1960-1969). Variation across geographic space can be controlled for by including a dummy variable for each census tract. The initial value of houses in 1940 can also be a control variable in the regression analysis. Starting with the basic relationship, more formally, this can be written as:

$$\%\Delta\text{Property Value}_{it} = f([\text{Proximity to Highway}]_{it}, X, D_C, D_t) + \varepsilon_{it} \qquad (1)$$

where D_t is a dummy variable that equals 1 if observation i sold in year t during the 1960s, and 0 otherwise; D_C is a dummy variable that equals 1 if observation i was in census tract C; and $\%\Delta\text{Property Value}_{it}$ is the percent difference between the assessed value of property i in the 1960s and the value of the property in 1940, after adjusting the 1960s value for "inflation" in home prices since 1940 using the national-level Case-Shiller single family home price index. The variable $[\text{Proximity to Highway}]_{it}$ is a dummy variable that takes the value of 1 if a house is "close" to the highway, and 0 otherwise. Varying definitions of

"close" are considered in the regressions, as small as 0.25 miles and in increments up to 1.50 miles. The variable X represents other "control" variables, which include the value of the property in 1940; and could possibly include other control variables in more general settings when such data are available. With the assumption of Ordinary Least Squares (OLS), a simplified version of the model (1), would be written as follows:

$$\%\Delta\text{Property Value}_{it} = \beta_1 + \beta_2 * [\text{Proximity to Highway}]_{it} + \beta_3 X_i + \beta_C D_C + \beta_t D_t + \varepsilon_{it} \quad (2)$$

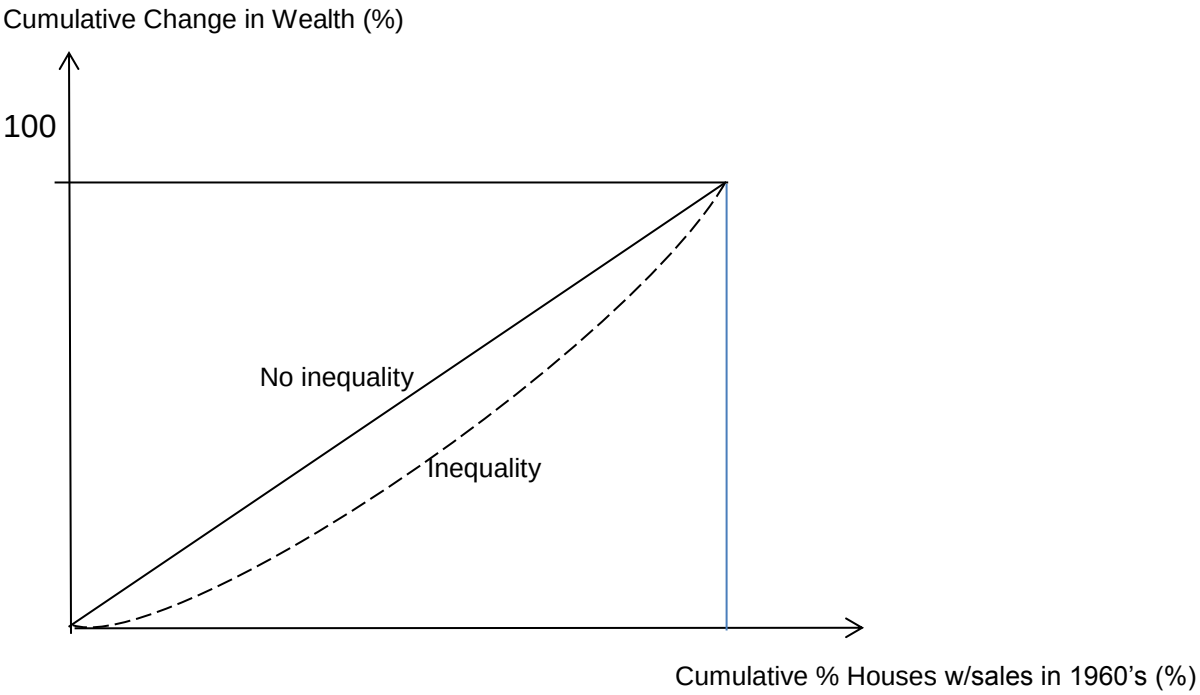
where β_1 , β_2 , β_3 , β_C and β_t are parameters to be estimated, and D_C and D_t represent "fixed effects" (or indicator variables). D_C is a "fixed effect" that controls for the census tract where property i is located, and D_t represents a "fixed effect" to control for the actual year in the 1960's 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 normal distribution with mean 0 and constant variance. Including X as a regressor enables the researchers to control for how more valuable properties experienced price changes between 1940 and the 1960s. In the results section below, regression parameter estimates are presented from (2), for varying definitions of "Proximity to Highway".

Another aspect of this "solution" is developing a set of GIS maps showing how property values changed between 1940 and the 1960's. Both GIS maps include the locations of the I-84 highway (as well as another major highway that was built in the 1960's – I-91 – although our focus is on properties near I-84). These maps also include a set of "buffer" zones, shown in grey, yellow and blue, denoting 0.10, 0.25, and 0.50 miles from I-84, respectively. The intent is to visually demonstrate how many properties in the sample are located very close, opposed to slightly further away from the I-84.

Finally, inequality in the accumulation of wealth from housing is demonstrated with Lorenz curves. A separate set of Lorenz curves are developed – one for properties that appreciated after the development of I-84, and another for properties that fell in value after the highway opened – compared with the same property's value in 1940 (i.e., before the announcement and construction of the highway). A Lorenz curve is a tool that can demonstrate whether a small number of homeowners realized a disproportionate gain in wealth. For instance, in Figure 3.2.1, the percentage of homeowners is on the horizontal axis, and the cumulative wealth corresponding to that percentage of homeowners is on the vertical axis. If the dashed line is the set of points that the researcher observes in the house value appreciation data, and if this dashed line is below the 45 degree line, this implies a disproportionately small amount of wealth is realized by a relatively large proportion of the homeowners. On the other hand, if the dashed line is very close to the 45-degree line, this represents a relatively equitable distribution of house price appreciation wealth. If the dashed line is above the 45-degree line, which may occur when there is 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 an equitable distribution or relative inequality in the distribution of wealth accumulation – either positive or negative wealth accumulation - due to the announcement and opening of I-84. Separate analyses will be considered for those properties that experienced a decrease in value after the opening of I-84,

and then a separate Lorenz curve analysis will be done to determine whether this depreciation in wealth is disproportionately borne over a small percent of the homeowners.

Figure 3.2.1: Lorenz Curve - How do wealth changes track number of property owners?
Example of relative inequality



Source: Authors' calculations and Nijssen et al. (1998)

3.3 Summary

The objective of this chapter is to present the basic framework of the solution methodology to addressing the problem statement of (1) how has the development of I-84 in Hartford, CT impacted property values nearby; and (2) how has this wealth change been distributed among various homeowners. Description of the data and the results of the empirical analyses will be presented in the subsequent chapters.

4.0 Data

4.1 Introduction

Data on property-level 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 dates in the 1960s – sometimes exist and other times do not, depending on the city. When they do exist, usually they are in hard-copy format and involve intensive digitization. Similarly, the house value data from the 1940 Census is available on microfiche in most public libraries, but often there is the need to digitize the data as well. The analysis in the later chapters of this report relies on house value data from the 1940 Census and data for the corresponding properties from the 1960s obtained from digitization efforts undertaken as a part of this project based on hard copy records at the office of the City of Hartford Assessor.

The rest of this chapter is organized as follows. Section 4.2 provides an overview of the challenges of data gathering for this type of project, and a detailed summary of the data sources. In addition, descriptive statistics and several maps help visualize the details of the spatial locations of houses with different values over time. Finally, Section 4.3 summarizes this chapter.

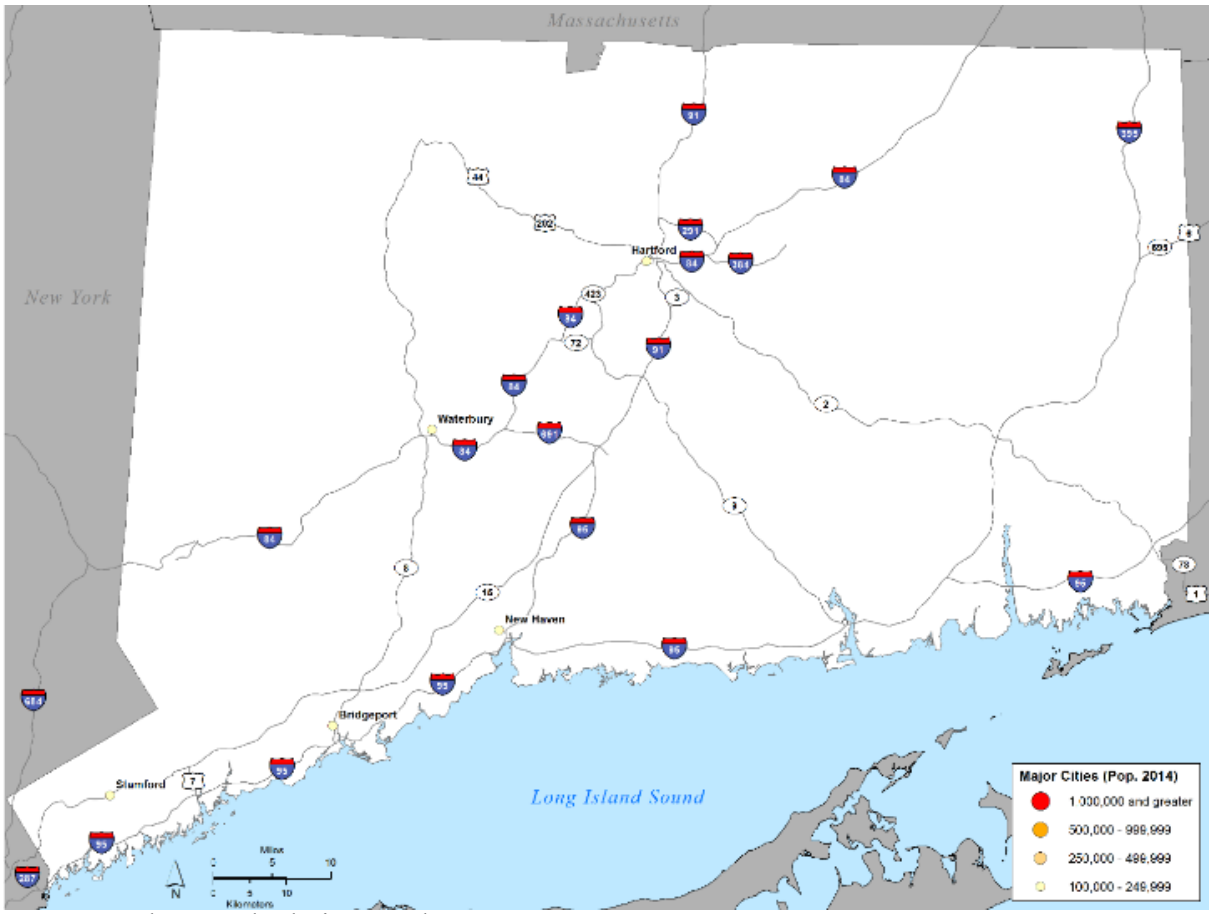
4.2 Summary of Data Sources

While the entire U.S. interstate highway system, for example, constitutes a complex inter-connected network, which was planned and built over decades, it is possible (and relatively tractable) to begin an analysis of exploring local impacts in one city using a counterfactual approach based on repeated observations of the same properties. For instance, in Hartford, Connecticut, there is property-level sales data available through the assessor's land records that were traced back to the early 1960's. This data involved the research team compiling the data from hard copies of land records at the city of Hartford assessor's office, and then putting the data into electronic form. This timeframe under consideration would be crucial because it enabled examination of how property values changed over an extended period of time where property value information was available for specific properties, both before and after the "announcement" of the interstate highways in the capital city of Connecticut. See Figure 4.2.1 below for a map of Connecticut and the major interstate highways. It is noteworthy that many of the largest cities in the state – including the state capital of Hartford - have major highways passing directly through these cities.

The focus properties of this study centered around the single family residences near I-84 in Hartford that sold in the 1960's. For each of those residential addresses near I-84 in the City of Hartford, Connecticut, the publicly available 1940 U.S. Census files were utilized to obtain information on the exact property addresses, whether each property was owned or rented, the associated residential property values (if owned) or the rent (if rented). By comparing the property appreciation – i.e., the difference between the assessed value for properties in the sample from the 1960's and the estimated value in the 1940 census, estimates of wealth accumulation (through home value appreciation) are obtained. To purge the effects of general home price appreciation throughout the U.S., the 1960s prices are "deflated" using the Case-

Shiller home price index, which covered this period. Figure 4.2.2 shows the overall U.S. price fluctuations of residential real estate from 1890-2018.

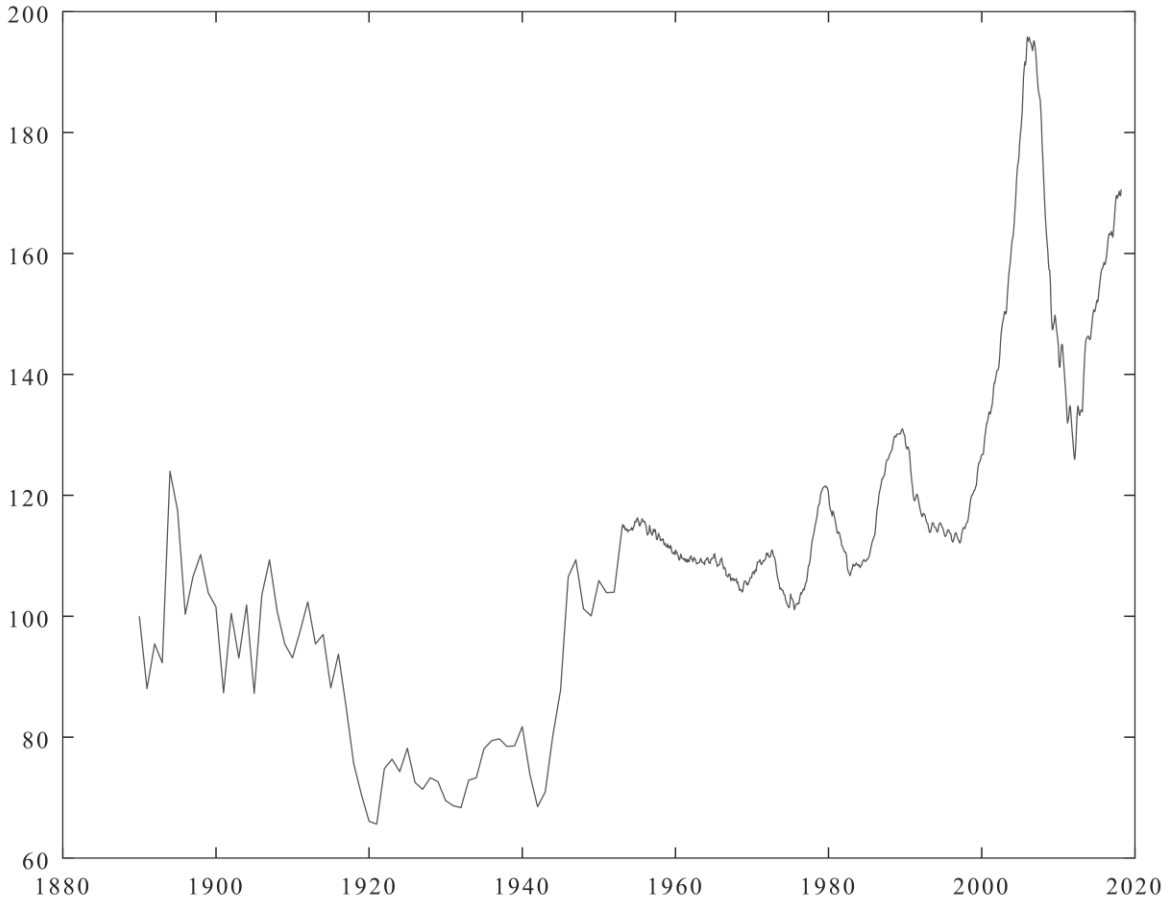
Figure 4.2.1 – Current Interstate Highways in the State of Connecticut



Source: authors' calculations and ArcGIS

Hartford, the state capital, is located near the center of Connecticut, where I-84 and I-91 intersect. I-84 stretches from the west at the New York State border, to the northeast at the Massachusetts border.

Figure 4.2.2 – Case-Shiller House Price Index, 1890-2018 (1890=100)



Source: Shiller (2015), http://www.econ.yale.edu/~shiller/data/Fig3-1.xls

The 1940 census data collection was a very labor intensive process, as the data were located on microfiche in the West Hartford Public Library (through Ancestry.com) and had to be manually entered into an Excel spreadsheet for the approximately 2,500 properties in this analysis. Before the 1940 census data were collected, the property information for those single-family homes in Hartford near I-84 that sold in the 1960s had to be manually entered into an Excel spreadsheet. The data from the 1960s included the property address, the sale price, and the assessed value of the property at the time of the sale. The corresponding addresses for the 1940 census data properties were then matched with the properties that sold in the 1960s, 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 after the completion of construction (in the 1960s).

Finally, a 1940 street map GIS layer of the City of Hartford was used together with the properties in the dataset described above, to geocode and overlay the property information with a map of 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 4.2.1. The sample size in Table 4.2.1 is 2,494 and this includes all observations that were able to be matched from the 1960s property sales files with the 1940 census data file. In the regression analysis presented in the results section, properties with 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% between these time periods, with the median home value change of 150%. Relatively few properties were located within 0.25 miles of I-84 (3%), while 72% of the sample was within 1.50 miles of I-84. The mean (median) home value in 1940 was $6,063 ($5,000).

Table 4.2.1 – Descriptive Statistics – Houses That Sold in the 1960s Near I-84 in Hartford

	Real Home Value Change (%), between 1940-1960s	% Near (0.25 mi)	% Near (0.50 mi)	% Near (0.75 mi)	%Near (1 mi)	% Near (1.25 mi)	% Near (1.50 mi)	Home Value (1940)
Mean	250.59	0.03	0.11	0.24	0.37	0.54	0.72	6063.14
Median	149.49	0	0	0	0	1	1	5000
Max	5206.66	1	1	1	1	1	1	82600
Min	-78.82	0	0	0	0	0	0	250
StDev	331.33	0.16	0.32	0.42	0.48	0.50	0.45	4953.40
N	2494	2494	2494	2494	2494	2494	2494	2494

For the inequality analysis, there are two separate sets of calculations that are done with the data – one for properties that appreciated in value between 1940 and the 1960s, and a separate calculation for those properties that depreciated in value between those two time periods. Then, a separate set of Lorenz curves are calculated and plotted for each. Specifically, the cumulative % change in real estate wealth is plotted on the Y-axis, and the cumulative % of houses 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 wealth accruing after the construction of I-84 that may have been correlated with proximity of those houses to I-84.

The locations of the 2,494 properties are shown in Figures 4.2.3 and 4.2.4 below. Figure 4.2.3 shows the percent change in value between 1940 and the 1960s. Figure 4.2.4 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 where there is decreased values after vs. before the construction of I-84 (i.e., between 1940 and the 1960s). Many properties throughout the neighborhoods near I-84 experienced property value increases of more than $15,000. As can be seen in Figure 4.2.3, there are some properties near the center of the map and just south of I-84, which experienced gains of 250%-1000% between 1940 and the 1960s. 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 1000%. But there are very few houses that experienced negative appreciation in these neighborhoods. Overall in this sample of houses, approximately 60 houses experienced a fall in value between 1940 (pre-announcement of I-84) and the 1960s

(post-completion of I-84 construction), while slightly more than 2,400 houses rose in value during this same time-period.

Figure 4.2.3-Percent Change, Property Values (1940$) Near I-84, 1940-1960s

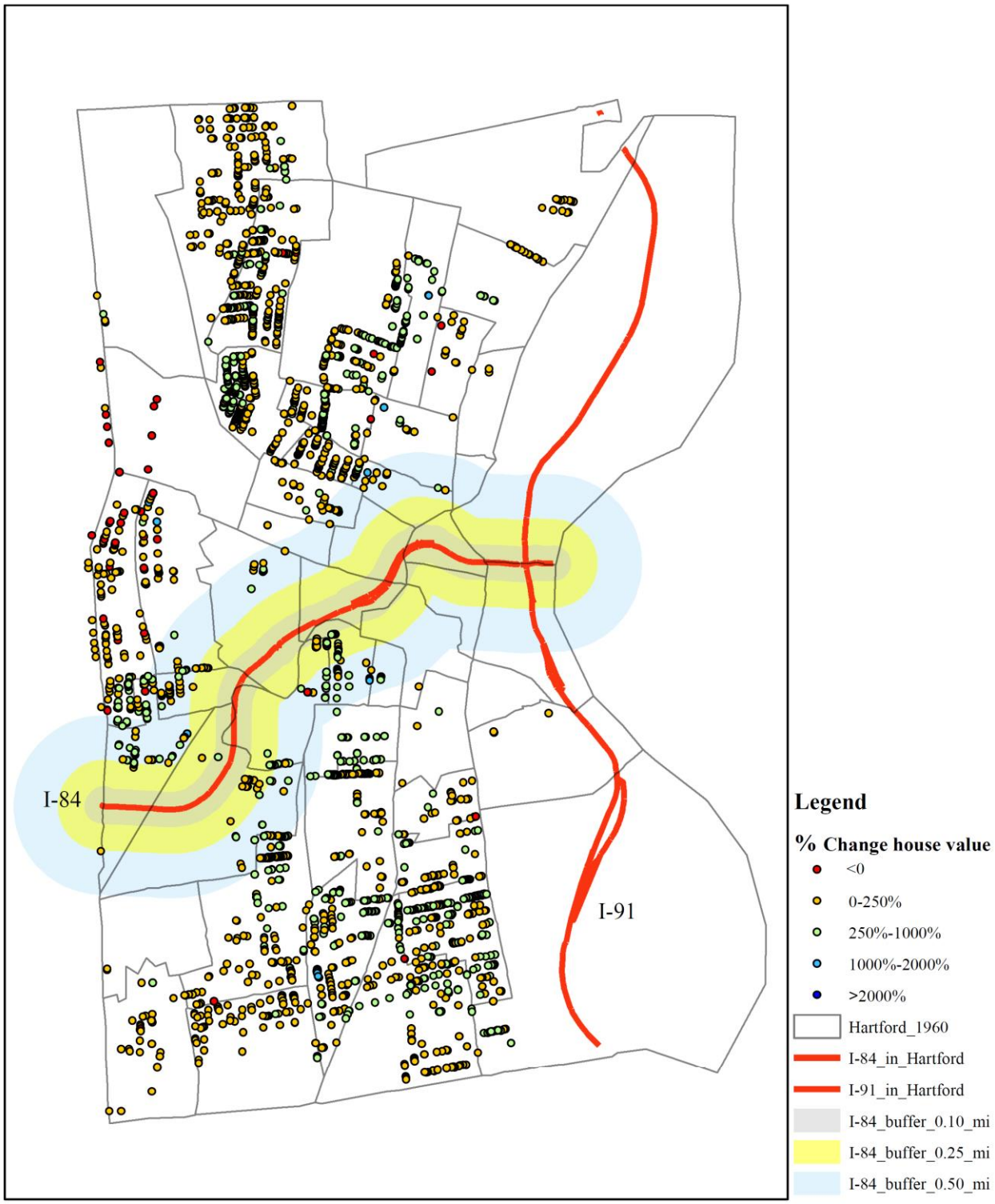
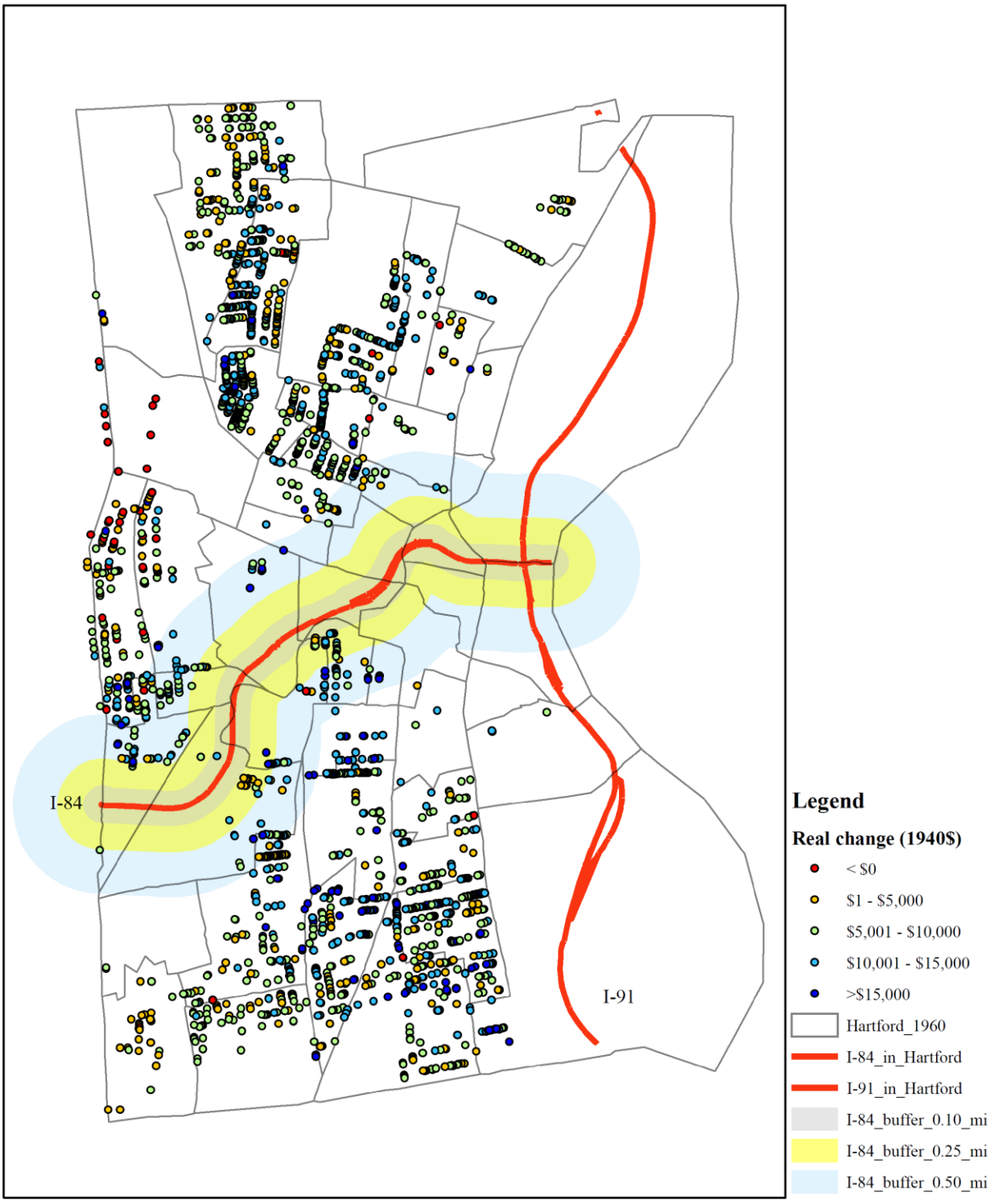


Figure 4.2.4 – Change in Property Values (1940$) Near I-84, 1940-1960s



4.3 Summary

The data collected in this project are unique in the sense that they consist of matches between properties in the 1960s Hartford Assessor's roll and data for corresponding properties from the 1940 U.S. Census. The spatial locations of different houses, and how their values have changed between 1940 (before the announcement of I-84) and the 1960s (after the completion of I-84 construction) are mapped, so that visual representations of the changes in values are observable. Some properties to the north and west of I-84 experienced declines in value, while properties due north and due south of I-84 generally experienced substantial value increases in the range of several hundred percent. While one might conjecture these changes are attributable to I-84, these are merely correlations and there is no information here on causality. The causality question is one focus of the next chapter of this report.

5 Results

5.1 Introduction

There are two major sets of results that are discussed in this chapter. First, the difference-in-differences regression results are presented and discussed in section 5.2, as a technique to demonstrate the causal impacts of I-84 on house value changes. Second, the Lorenz Curve results are presented and analyzed in section 5.3, in order to study the wealth distribution effects of house value changes near I-84. Finally, a summary of this results chapter is presented in section 5.4.

5.2 Regression Results

Table 5.2.1 presents the regression results that are described in equation (2) above. Each separate column in this table represents a different "treatment", for instance, cutoffs for the "near I-84" variable ranging from 0.25 miles, 0.50 miles, 0.75 miles, 1.0 mile, 1.25 miles, and 1.50 miles.

Before presenting the regression results, note that it might be possible to include both an "as-the-crow-flies" distance 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 et al. (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 et al. (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 sign and significance changes across different cutoff distances. The distance variable used her is an "as the crow flies" indicator variable. Using a drive distance indicator variable does not substantively impact the results. Using the range of distance indicator variables as separate treatments is an approach to capturing the heterogeneous effects of distance to the highway.

Table 5.2.1 – Difference-in-Differences Regression Results

Dependent Variable: Percent Change in House Value, 1940 to 1960s

	Cutoff for Near I-84 Dummy:					
Regressor:	Near I-84= 0.25 mi	Near I-84= 0.5 mi	Near I-84= 0.75 mi	Near I-84= 1.00 mi	Near I-84= 1.25 mi	Near I-84= 1.50 mi
Constant	4.04	3.97	3.93	3.92	3.93	3.79
t-stat	*8.76*	*8.63*	*8.52*	*8.50*	*8.49*	*8.20*
Near I-84 Dummy	-0.10	0.47	0.31	0.23	0.19	0.37
t-stat	*-0.43*	*3.84*	*3.40*	*2.84*	*2.43*	*4.25*
House Value in 1940	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
t-stat	*-29.00*	*-28.66*	*-28.59*	*-28.93*	*-29.10*	*-29.03*
R-Squared	0.29	0.30	0.30	0.30	0.30	0.30
F-Statistic	19.06	19.45	19.37	19.27	19.22	19.54
P-Value (F-Statistic)	0.00	0.00	0.00	0.00	0.00	0.00
N	2477	2477	2477	2477	2477	2477
Year FE	Y	Y	Y	Y	Y	Y
Tract FE	Y	Y	Y	Y	Y	Y

Notes: Distances are calculated "as the crow flies". Sample includes properties with value of at least $1,000 (which is the reason for the discrepancy between the sample size here and that of Table 4.2.1).

There are 2477 observations in each of the regressions in Table 5.2.1. The regressors include a constant, a dummy for Near I-84 (also referred to below as the "treatment effect"), and the house value in 1940. The dependent variable is the percent change in house value between 1940 and the 1960s (in 1940 dollars). For all regressions, the R-squared is approximately 0.30. The treatment effect with cutoff very close to I-84 (i.e., 0.25 miles) is statistically insignificant. The treatment effect for 0.50 miles is positive and statistically significant, and equal to 0.47. This implies that properties within 0.5 miles of I-84 appreciated approximately 47% more than properties outside of 0.5 miles from I-84. The treatment effects 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 due to less accessibility benefits. Finally, the treatment effect with 1.50 miles cutoff is positive and equal to 0.37, which is larger than the treatment effects for 0.75 miles, 1.00 mile, and 1.25 mile. While one might conjecture that further distance from I-84 yields lower accessibility benefits, there are some houses within 1.5 miles of I-84 that are relatively close to I-91. The benefits of proximity to I-91 for these houses could be the source of the relatively higher treatment effect for the 1.50 mile from I-84 cutoff.

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 implies that for every $1,000 lower a house was valued in 1940, that house was worth approximately 23% more in the 1960s. In other words, lower-valued houses appreciated more than higher-valued houses in these Hartford neighborhoods over the time-period of 1940 to the 1960s.

5.3 Lorenz Curve Results

The Lorenz Curves are presented in Figures 5.3.1 and 5.3.2. Figure 5.3.1 presents the Lorenz curve for the houses with positive appreciation between 1940 and the 1960s, while the Lorenz Curve in Figure 5.3.2 is the Lorenz Curve for the houses that experienced a depreciation in value between 1940 and the 1960s. As also noted in section 3.2 above, when the blue curve in Figures 5.3.1 and 5.3.2 is close to the 45-degree line, there is relatively equal distribution of cumulative wealth appreciation (or depreciation) across homeowners. But when the blue curve is very bowed and far from the 45-degree line, there is relatively unequal distribution of cumulative wealth appreciation (or depreciation) across homeowners.

In Figure 5.3.1, for instance, the lowest 20% of homeowners experience less than 20% of the cumulative wealth. Similarly, the lowest 60% of homeowners experience slightly over 40% of the cumulative wealth. While there is some evidence of inequality here, the blue Lorenz Curve is not dramatically far from the equal distribution line (i.e., the 45-degree line).

Figure 5.3.1 – Lorenz Curve – Houses with Higher Value between 1940-1960s

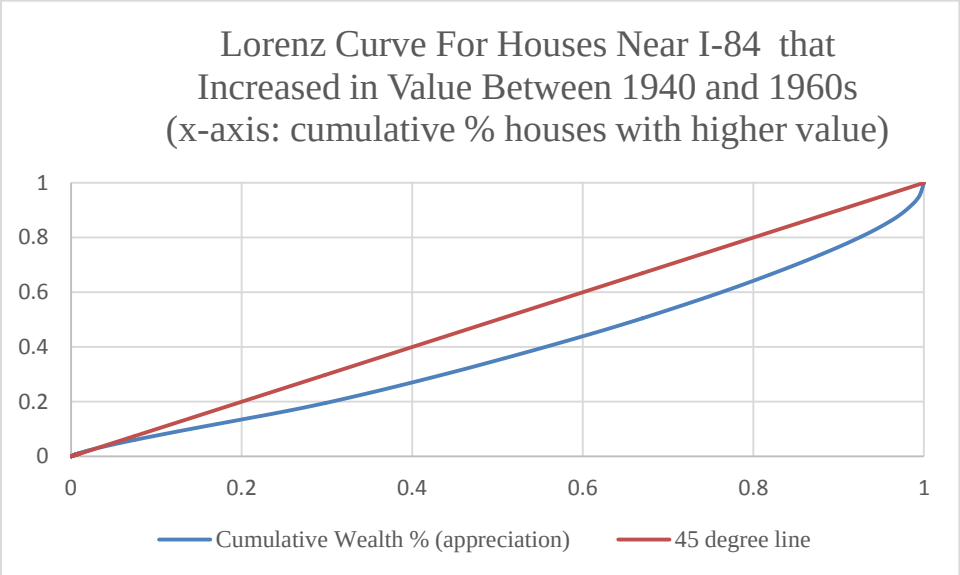
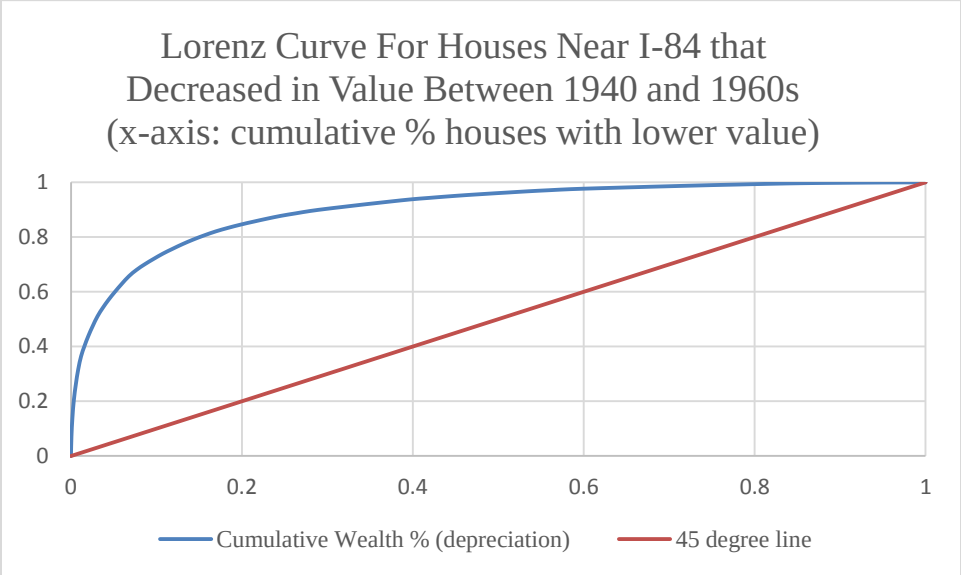


Figure 5.3.2 represents a Lorenz Curve for the homeowners whose property values decreased between 1940 and the 1960s. One might attribute these decreases to the impacts of being close to the air pollution and noise pollution associated with very close proximity to I-84. This Lorenz Curve demonstrates extreme inequality in the distribution of the wealth losses from I-84. For instance, 20% of the homeowners bear more than 80% of the losses in housing wealth due to proximity to I-84. This severe inequality is apparent visually with the severe bowed-upward shape of the Lorenz Curve in Figure 5.3.2.

Figure 5.3.2 – Lorenz Curve – Houses with Lower Value between 1940-1960s



5.4 Summary

This chapter has demonstrated that for properties located relatively "close" to I-84 (i.e., within 0.25 miles of I-84), there was an insignificant negative effect on house values from proximity. But for properties that were within some wider critical point – within 0.50 miles from I-84 – the benefits from being closer to I-84 were positive and significant. These benefits were smaller for larger cutoffs than 0.5 miles, up until the 1.5 miles cutoff, at which point the benefits from being within this cutoff was higher (due to proximity of some properties to I-91) than many of the smaller cutoffs. This implies that homeowners experience an increase in their value as they come closer to I-84, but if their homes are too close, their home value is diminished. Finally, there is strong evidence of unequal wealth distribution for properties that saw decreases in their

values, but moderate evidence of unequal wealth distribution for houses with higher percent changes in values in the 1960s compared with 1940.

6 Conclusion

This report 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 causal estimates of how proximity to a highway impacts home values. Specifically, data from the 1940 U.S. Census on home values are combined and matched with 1960s data from the Hartford assessor's office, to develop a dataset of nearly 2,500 properties with two values for each home – one in 1940 (before the announcement of I-84) and another in the 1960s (after construction completion).

The identification strategy for determining the causal impact of proximity to I-84 on house values relies on the fact that the 1940 data are from a time period before the "announcement" of the interstate highway system, and the data from the 1960s are from post-construction. Therefore, by using a "treatment effect" variable for near versus far from I-84, this has led to a causal estimate. These estimates, which are statistically significant, range from 19% to up to 47%, depending on the distance to I-84 cutoff used as the treatment effect variable.

In addition, this study also considers the inequality of wealth distribution aspects related to I-84 proximity. Some properties (approximately 60) experienced price declines over the period of 1940 to the 1960s. These homes saw a very disproportionate amount of this cumulative wealth deterioration being borne by a very small percentage of the houses. Specifically, roughly 80% of the cumulate wealth decline was realized by only about 20% of the cumulative houses among the roughly 60 houses with price declines. This result represents a very strong degree of inequality. For the approximately 2,400 houses with price increases over the same time period, the additional housing wealth was relatively equitably distributed, with 20% of the cumulative homeowners seeing approximately 15% of the cumulative wealth increases. While this is not quite a situation of equality, these wealth gains are not as unequally distributed as the wealth losses for the houses discussed above.

There are a number of potential areas for future research. First, given that the 1940 Census data collection was labor intensive, a more comprehensive data gathering process would enable a deeper dive into the regression analysis by enabling for additional control variables, such as demographics of the homeowners. In the regressions approach used above, the property characteristics cancel out when taking the first differences, but the neighborhood and/or property owner demographics could enrichen the 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 could happen if it were possible to identify some cities with rich historical property value records that date back to the 1960s (post-highway completion).

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 uses the approaches developed in this report, 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 that is associated with the new highways. Similarly, it might be more desirable to target highway removal projects in cities where there is a substantial degree of inequality in housing wealth accumulation if the goal is to achieve a more equitable distribution of 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 U.S. (or in one particular city) are positive or negative. This also provides important policy implications because if highways have a positive net correlation with housing wealth while rail and/or airports are associated with a net negative change in housing wealth, this could imply that federal infrastructure resources should target highways and perhaps resources drawn away from other modes.

This 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 opposed to 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 1940 to the present – could glean substantial information to support policy decisions at a nationwide, system level.

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