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New England's Manufacturing Legacy and Neighborhood Change: Does History Matter?

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Abstract

Why urban neighborhoods change and which policy interventions can be effective in halting the decline of incomes and housing quality in urban neighborhoods are questions that have interested urbanists for many decades since the historic changes that started sweeping through the American urban system after World War II. The diverse answers to the question of why change takes place have informed many decades of policy toward cities. The consensus view of the dynamics of neighborhood change focuses on long-run processes of decline and then renewal in the housing stock. This paper offers an initial look at the macroeconomic and spatial impact of the decline of manufacturing on neighborhood change in the context of 27 midsize cities in New England that had populations ranging from 47,000 to 207,000 in 1960. Some cities, such as New Bedford, Fall River, and Holyoke, Massachusetts, have lost population continuously since World War II. Others, such as Lawrence and Worcester, Massachusetts, and Waterbury, Connecticut, have experienced varying degrees of economic and population recovery after a few decades of population loss. Almost all of the cities have a legacy of spatially concentrated abandoned factory space that once provided employment to thousands of workers who were living in nearby neighborhoods. Using a new georeferenced data set of manufacturing employment in the early 1960s, a new block-level data set on housing for 1960 and 1990 within constant geographies, and census-tract data on median rents and housing values for 1960 through 2010, the study finds that macro shocks of declines in manufacturing employment prompted at the most a modest decline in rents and exerted no appreciable impact on averages of housing values citywide. The impact of the loss of manufacturing employment on neighborhoods was spatially concentrated. Housing values (but not rents) in the areas of cities that once had access to thousands of jobs in manufacturing fell substantially through 2000. The relative decline in housing values in the neighborhoods most affected by the manufacturing legacy meant that for a given level of housing quality (and value), the market demanded a higher stream of rental income.

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Introduction

As observers of American urbanization have noted, cities as they existed in the America of the 1950s primarily reflected the source of their relative affluence: the benefits of agglomeration economies associated with manufacturing and proximity to natural resources (see Glaeser 2005; Glaeser 2011; and Kim and Margo 2004). Over the subsequent 50 years, the economic raison d'être and the spatial structures of American cities underwent dramatic changes. This paper focuses on two key developments in the second half of the 20th century that prompted changes in the spatial and economic structure of cities: shifts away from a comparative advantage in manufacturing and the creation of an integrated system of multi-lane limited-access expressways, many of which cut through city centers.[1]

Although studies such as Glaeser (2005) and Baum-Snow (2007) examine the impacts of some of these changes on large metropolitan areas of the United States, they overlook the developments in America's midsize cities, or those cities with populations in the 25,000 to 250,000 range.[2] In 1960, one-third of the urban population lived in midsize cities. By 2010, they were home to 40 percent of the urban population, which includes the 22 percent living in cities classified as midsize cities in 1960.[3]

Aside from their importance for the urban system of the United States, midsize cities warrant attention because of their potential vulnerability to structural change. Overall, the 622 midsize cities accounted for about one-quarter of manufacturing employment in the United States in 1960. Large cities accounted for another quarter. Henderson (1988), Henderson (1997), and Black and Henderson (2003) emphasize that midsize cities are more specialized in manufacturing—and specialized within manufacturing in a narrower range of industries—than large metropolitan areas. Metropolitan areas such as Miami, Chicago, and Atlanta are home to more diversified manufacturing sectors and in general have a more diverse economic structure

[1] The other potential influences would have been the decisions of the courts and local governments to desegregate schools and the enactment of fair housing legislation. Reactions to these decisions could have prompted white flight from the affected cities.

[2] See Henderson (1997) for an extended discussion of the characteristics of what he terms medium-size cities. His definition includes cities in the range of 30,000 to 300,000, but it uses counties instead of cities as the unit of analysis.

[3] For comparison purposes, the share of large cities in the United States urban population in 1960 was 34.8 percent. Urban areas were defined then as towns, villages, and cities with a population of 2,500 or above.

as “market centers,” or centers of specialization in services. Midsize cities exhibit a higher degree of specialization in manufacturing than large metropolitan areas. The manufacturing sectors of midsize cities tend to employ fewer skilled workers than manufacturing in large metropolitan areas.[4]

As employment in manufacturing has declined since World War II, a key question has been the impact of the decline on American cities. Table 1 provides information on the evolution of manufacturing employment at ten-year intervals from 1950 through 2010 for the midsize cities of the Rust Belt by census division: New England; the Mid-Atlantic division, the East North Central division, and the West North Central division. For comparison, the table includes similar information on midsize cities of the South Atlantic division and the East South Central division. Manufacturing employment was always more important for midsize cities of the Rust Belt than for other midsize American cities over the entire period. The decline in employment was most dramatic in the rust belt states east of the Mississippi.

To what extent did the concentration in manufacturing influence subsequent population growth during an era of manufacturing decline? Figure 1 illustrates the pattern of population change for 1960 through 2010 by census division for midsize cities as a function of the share of employment in manufacturing in 1960. The scatter diagrams include the line from a regression of the same data for each division. The final column of Table 1 includes the slope coefficient of the regression line and its standard error. In all of the divisions except the Mid-Atlantic and New England, the more important manufacturing employment was for a midsize city in 1960, the lower its population growth over the next 50 years. As the coefficients in the final column of Table 1 suggest, specialization in manufacturing could have a profound impact on population growth, particularly in the East North Central, West North Central, and South Atlantic divisions. For the country as a whole, a 10 percent increase in the city’s labor force that was employed in manufacturing implied a reduction in the growth rate of 0.19 percent per year, or about one-half of the average annual population growth of all 454 cities classified as midsize cities in 1960.[5]

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[4] See Henderson 1997 and Black and Henderson 2003 (Appendix Table A1).

[5] This core result extends the correlations between population change and specialization for 1980–1990 noted in Black and Henderson 2003 (page 366).

The New England division offers a good opportunity for two reasons to examine the impact of this process of economic and spatial restructuring on neighborhood development. First, New England's pioneer role as the first heavily industrialized division of the United States means that its transition out of manufacturing has extended over a longer period of time than other divisions. As Table 1 illustrates, New England's midsize cities were very concentrated in manufacturing in 1960, and the steep decline in manufacturing employment through 2010 hit them particularly hard. The absence of a strong negative relationship between concentrated manufacturing employment in 1960 and population growth through 2010 masks two important aspects of the New England experience that make this division especially interesting for understanding how economic change in the macro economy of a city can influence neighborhood development. Several New England cities had the dubious distinction of being among the first in the United States to experience widespread dislocation because of shifts in the comparative advantage of manufacturing during the 1920s and 1930s, as much of the cotton textile industry of the division moved to lower-cost towns and villages in the South. In addition, the diversity of New England's manufacturing economy meant that the decline in manufacturing employment after World War II hit different parts of the division at different times. Many of the textile cities had begun to recover population and some employment by 1990, even as other cities that concentrated on metalworking, such as New Haven and Bridgeport, Connecticut, continue to experience population decline to this day.

The second reason for focusing on New England's cities is that their spatial structure in 1960 was similar to midsize cities elsewhere in the United States. In 1960, the median population density of New England's midsize cities was 4.6 thousand per square mile, or a bit less than the median density of 4.96 for the other midsize cities in the United States. The results of the 1958 Census of Business reported in United States Department of Commerce (1961a) show that for most American cities, the central business district (CBD) remained an important shopping destination. For all midsize cities, the interquartile range for the CBD's share of all retail sales within a city's SMSA was 0.20 to 0.28, with a median of about one-quarter. For the eight midsize New England cities for which CBD data are available, six fell within the interquartile range, one fell below, and one was above. Finally, about 65 percent of workers both in New England's cities and in cities elsewhere in the United States relied upon some form of private automobile, van, or truck transportation to get to work in 1960. About 13 percent walked to work in New England, compared with 8 percent elsewhere. Commuters relied more heavily on public transportation in other urban areas than in New England. Notably, the share of households with automobiles in New England cities was about 78 percent, a bit higher than in other urban areas in the United States.[6]

New England led the way in the transformation from manufacturing to other industries. Unlike in the Rust Belt cities farther west and south, by 2010, the direct impacts of economic restructuring on population had worked their way through a process of change and adaptation in New England's midsize cities.[7]. Nonetheless, as the existence of the gateway city designation in Massachusetts attests to, many of New England's midsize cities that have both experienced transitions in their economies and also perhaps recovered population continue to face persistent problems of neighborhood decay.[8] Despite millions of dollars in investments in housing rehabilitation, new construction, and other initiatives, the problems of low-quality housing, crime, and poverty that first emerged after World War II and became acute as the transition away from manufacturing got under way after 1980 still remain.

This paper examines the impact of the structural changes of the 1960s and later—the decline of manufacturing and the introduction of freeways into cities—on the long-term development of neighborhoods within New England's midsize cities. The analysis addresses the question of whether the legacy of the manufacturing past continues to exert an influence years after most factories were closed. The study draws on insights from the urban economics literature about the causes of neighborhood dynamics, including the aging of the housing stock and the impact of declines in property values on maintenance. In addition, the study recognizes the potential for ubiquitous spillover effects from abandoned or underutilized factory space that can continue to cast a shadow over the prospects for redeveloping adjacent

[6] See Ruggles, Genadek, et al. 2015 for the 1 percent sample from the 1960 United States Census of Population and Housing.

[7] See Glaeser 2011 for the regional economy around Boston, and by Browne and Sass 2000 for New England as a whole

[8] The term *gateway cities* refers to midsize Massachusetts cities with below-average median income and below-average educational attainment. Most mid- to large-size former centers of manufacturing in the state are now gateway cities.

neighborhoods. The analysis assumes that the valuation of housing in neighborhoods captures the complex interplay of supply-and-demand forces. The empirical strategy examines whether the changes that freeway construction brought about and the legacy of manufacturing employment in a neighborhood exert a persistent impact on the price of housing, even after controlling for housing characteristics, other relevant locational characteristics, the location itself, and changes in the macroeconomic circumstances of the city.

The paper draws on two newly developed data sets and other digitized census data to address these questions. The first data set is a GIS that replicates the blocks used in the 1960 housing census for the midsize cities of New England. The GIS for 1960 is matched with the GIS for blocks that first became available from the TIGER/Line Files in 1990 so that analysis within consistent geographies over time is possible. The other data set developed for this paper includes georeferenced data on employment in manufacturing at the plant level by town and address. The employment data set offers a unique opportunity to map the spatial distribution of manufacturing employment with maximum precision. The newly created data sets are incorporated into a two-year panel of block-level census data on housing rents, values, characteristics, and other location-specific attributes for 1960 and 1990. A more comprehensive tract-level panel covers the six census years from 1960 through 2010. The data sets are also used to establish the main characteristics of the spatial equilibrium that prevailed in New England's midsize cities in 1960.

The mapping of employment in manufacturing revealed a pattern of high spatial concentration in New England's midsize cities. The analysis of census tract data revealed that in 1960, New England cities had several neighborhoods that were home to a large number of employees who walked to work. Rents on housing and housing values were closely linked. Housing in a walking neighborhood did not necessarily command a premium over housing located elsewhere in the city. Rents conformed to the assumption of the standard urban model: they declined with distance from the central business district. The introduction of freeways and the subsequent decline of manufacturing upset this equilibrium. Analysis of block-level data from 1960 and 1990 suggests that the relative value of homes in closest proximity to centers of manufacturing employment fell by about 1 percent. The value of access to the CBD for renters vanished. Access to a freeway raised rents, even as it was viewed as a disamenity by homeowners.

The panel of tract-level data for 27 study cities for the period 1960 through 2010 permits a more refined assessment of the impact of manufacturing decline, since a wider range of controls for housing characteristics is available. In most cities, manufacturing employment declined 75 to 80 percent after 1960. The citywide effects of this decline were modest. Instead, the impacts were felt most profoundly in those neighborhoods close to now-abandoned sites of manufacturing activity. Rents for housing in neighborhoods that were close to former sites of concentrated employment fell a small amount. Instead, in the most-affected neighborhoods, the value of owner-occupied housing bore the brunt of the shock. By 2000, the value per unit of owner-occupied housing had declined about 10 percent from 1960 in the one-quarter of neighborhoods that had the best access to manufacturing employment, even as rents fell only about 2 percent. Housing values began to recover only after 2000. Access to former sites of manufacturing employment actually raised rents in real terms by 2010.

This paper first presents a sketch of the main economic frameworks for thinking about neighborhood change, which focus on the gradual deterioration of housing as it ages and its eventual replacement with new construction. It then briefly reviews changes in the New England urban economy from the 1960s onward and identifies ways in which those changes could have influenced neighborhood development within the context of a straightforward bid-rent framework. A discussion of data sources follows. It introduces the manufacturing employment access measure used in the subsequent analysis. The study then examines the influences on housing prices and commuting patterns in1960, the determinants of block-level changes in housing prices between 1960 and 1990, and finally the determinants of changes in median housing prices at the tract-level over the period 1960 through 2010.

Frameworks for thinking about neighborhood dynamics

Two core concepts lie at the heart of how contemporary economic analysis assesses influences on neighborhood quality. Introduced in the Alonso-Muth-Mills models of urban economic structure developed during the 1960s, the concept of the bid-rent function is fundamental to this analysis.[9] Fujita (1989) provides a nice exposition of the model, which notes that any potential site in an urban area is fundamentally scarce. The model accounts for what makes a particular location—and the land that is at that location—valuable for a potential user and how differing bids for a location result in the allocation of potential bidders by income and other characteristics across different locations. In the simplest versions of the model, capital (factories, commercial buildings, houses) is excluded from consideration.

The bid-rent function framework asserts that any firm or household in an urban area is a potential bidder for every location. Bids for commercial or industrial use may reflect the advantages the site offers for access to transportation, workers, or customers. Households in the original framework value a site for its access to employment; subsequent extensions have added other location-specific amenities or disamenities of a site. Since land is a complement to housing consumption, and since income (the value of time foregone) is a critical component of commuting costs, the framework readily incorporates income as a potentially strong influence on household bids for a location. In the classic formulation of the framework, the household faces a trade-off between commuting costs (the greater the distance to employment, the higher the commuting costs) and housing consumption, which becomes relatively less expensive at more distant locations.

Within this model, changes in the relative demands for a location can prompt neighborhood change. For example, growth of the financial sector in downtown Boston and the amenities offered by the city center have prompted an influx of higher-income residents into the South End. What was once a crime-ridden neighborhood of dilapidated row houses is now one of the most expensive locations in the city. This paper focuses on the impact of freeway access on commuting costs and the adverse demand-side shock of the loss of manufacturing employment in close proximity to center-city neighborhoods.

The other mechanism that is crucial for understanding neighborhood change is the concept of *filtering*. Filtering refers to the likelihood that as a housing unit ages, it will be subject to a steady decline in the level of housing quality it can offer as it depreciates and as its features (floor space, configuration of rooms, etc.) depart further from the evolving

[9] Rosenthal and Ross 2015 offer a comprehensive summary of the literature.

preferences for housing. For example, the ubiquitous three-family units of New England's manufacturing cities—"triple-deckers"—were almost all built prior to 1930 for a particular pattern of ownership and tenancy that may not be consistent with the composition of contemporary households and preferences.[10] Given that the demand for housing quality is income-elastic, the reduced quality of the structure, irrespective of other shifts in the demand for housing, will lead to gradual downward filtering of that unit into market segments that are more appealing to lower-income residents. The original formulation by Sweeney (1974) was a response to the observed deterioration of central-city neighborhoods and the flight to newer housing in the suburbs. It posited a downward path for a housing unit until it was of such low quality that it would be demolished and replaced with newer housing. Arnott and Braid (1997) offer a richer model of filtering that allows for expenditures on maintenance and rehabilitation to raise the quality of a housing unit regardless of its age. The (downward- and "upward"-) filtering model can thus accommodate processes of neighborhood change that include both steady deterioration and gentrification through renovation.

The recent urban economics literature on neighborhood change, ably summarized by Rosenthal and Ross (2015), notes that changes in demand can lead to changes in patterns of sorting (primarily by income), which in turn can change the quality of housing demanded at a particular location. They argue that fundamentals associated with filtering—essentially the age of the housing stock—lead to longer-term cycles of neighborhood change. Demand-side influences include access to employment (commuting), access to public transit (which could push low-income residents toward neighborhoods with better access), the provision of public services (say, an improvement in school quality), and the emergence of location-specific amenities and disamenities.

Glaeser and Gyourko (2005) examine the dynamics of housing markets when macro shocks to the urban economy lead to sudden changes in employment and the demand for housing. Rapid increases in demand will lead, with a lag, to an adjustment in quantity, provided that there is an adequate supply of buildable land and/or that neighborhood resistance does

[10] These units were ideal for the multigenerational families inhabited the neighborhoods receiving the most immigrants prior to the cutoff of immigration in the 1920s. The classic pattern included owner-occupancy of one floor by an older generation and tenancy by relatives (for example, a daughter or nephew) on the others. See Kingston 2005.

not prevent changes in the density of housing. The expansion of Sunbelt cities, where housing continues to be relatively inexpensive despite an influx of population, illustrates how an elastic supply dampens increases in the price of housing even as market demand increases. The very durability of housing leads to an asymmetric market response when the shock to demand is negative. In this case, the quantity supplied remains nearly constant and the price must fall substantially to clear the market. The result is a large change in neighborhood composition as lower-income residents take advantage of the opportunity to occupy housing of relatively higher quality at a much lower price. In the extreme cases of cities such as Detroit, Michigan, or Youngstown, Ohio, a decline in the price in the wake of population loss may be insufficient to clear the market and may lead to further deterioration from externalities of widespread housing abandonment.

A one-time negative shock to demand can also prompt a form of hysteresis, as anticipated and actual declines in housing values undermine the incentive to maintain housing. Gyourko and Saiz (2004) conduct an analysis of data from the American Housing Survey and conclude that, aside from income, the expected sale price can have a substantial impact on expenditures for maintenance. They conclude that for homes underwater (that is, the replacement cost is well above the current market price), the expenditure on maintenance can be as little as one-half the amount spent by owners of homes with a market value at or above the replacement price. Their analysis raises important questions about what kind of policy response is appropriate in areas where adverse shocks to housing demand have prompted a decline in housing prices. A related consideration that does not receive much attention in Rosenthal and Ross (2015) is that a decline in maintenance can lead to substantial external effects. The case of foreclosed homes, which may have been subject to an extended period of limited maintenance prior to the actual completion of the foreclosure, offers an example of how significant these external effects may be. Using data from Worcester, Massachusetts, Biswas (2012) estimates that each foreclosure prompts a decline of about 3 percent in the sales price of nearby homes. The impact is strongest for foreclosures on multifamily homes: about three times the estimated impact for single-family homes found in Campbell, Giglio, et al. (2011).

Rosenthal (2008) offers a longer-term dynamic view of neighborhood change that draws on the concept of filtering and abstracts from the location of a neighborhood (and its housing). He argues that, consistent with a filtering model, the age of the housing stock substantially drives neighborhood quality, which he measures by income. Development patterns of American cities imply that most of the housing in a neighborhood is of a similar vintage, so that the filtering of housing units will be strongly correlated across nearby locations. Neighborhood upgrading in this perspective is inevitable, as renewal will eventually take place when the older housing stock wears out and is replaced. He argues that the process can be statistically separated from the impact of externalities associated with lower-income and lower-quality neighborhoods. Based upon evidence from Philadelphia, he argues that a complete cycle of decline and renewal takes about one hundred years.

Finally, Brueckner and Rosenthal (2009) link this long-term perspective to a model that characterizes the nature of the transition from low-quality (and old) housing stock to new and high-quality housing stock in a neighborhood. They argue that there is a tension between the value that higher-income households place on access to employment (consider Boston's South End as a prime example) and the age and quality of the housing stock. Usually depreciation of the housing stock implies a process of downward filtering with a gradual change in the character of a neighborhood. At the point of demolition, the process becomes discontinuous. A housing unit must have deteriorated so much that the value of the structure is negligible, and only the value of the site matters for a potential developer. In that case, the replacement housing must be of such high quality that it is attractive to higher-income residents who will be willing to pay enough to cover both the site rent and construction costs. The result is that gentrification will take place and disparities will emerge between incumbent, low-income residents and purchasers or occupants of new and high-quality housing.

A final dimension of neighborhood change that is most relevant for New England's older cities is that maintenance of housing—and hence the deterioration of the housing stock—can vary widely across homeowners. Rosenthal and Ross (2015) report that most studies estimate an annual rate of housing depreciation of about 3 percent. Investments in maintenance can slow the rate of depreciation, but how much the homeowner will undertake in terms of maintenance depends upon income *and* the costs of maintenance.

The literature points our attention to a crucial issue about how housing markets—and neighborhoods—in New England's midsize cities may have responded to the transition away from the past reliance on manufacturing employment. Neighborhoods in a city such as Lowell have had upward of 60 or 70 years to adjust to the negative demand-side shock brought about by the precipitous decline of New England's cotton textile industry. The population in this city is recovering, but it is not clear that its neighborhoods most affected by the loss of manufacturing employment have recovered along with its population. A key question is whether the long-term dynamic processes posited by Rosenthal and Ross are strong enough to offset the impact of shocks to demand that occurred well in the past century. It is possible that permanent shocks to the location of employment and the legacy of former manufacturing success, which include abandoned factories and brownfields, overwhelm the impact of the gradual depreciation and replacement of the housing stock.

New England after 1960: Influences on changes in spatial structure

This study focuses on changes in the neighborhoods of New England's midsize cities from 1960 through 2010. Except for older textile cities such as Lawrence, Lowell, Fall River, and New Bedford, New England was a generally prosperous division at the beginning of the 1960s.[11] Figure 2 plots the development of manufacturing employment from 1947 through 2012 for New England's midsize cities. The decline in manufacturing employment evident after World War II appeared to slow by the early 1960s as median employment rose. As late as 1963, manufacturing employment in three cities—Providence, Worcester, and Bridgeport—exceeded 35,000. The period of the Vietnam War buildup saw further recovery. Manufacturing employment in 1963 had yet to relocate to suburban locations outside New England's center cities. Figure 3 shows the share of midsize cities in a county's manufacturing employment between 1947 and 2012. With the exception of Worcester and Middlesex counties in

[11] See the1964 *Boston Globe* series Jobless Cities Fight Back, which focused on these four cities. The first piece was on Fall River (see Greenough 1964).

Massachusetts, 60 to 70 percent of manufacturing employment in New England's counties remained within the division's midsize center cities as late as 1963.[12]

Surprisingly, manufacturing employment in 1960 was spatially concentrated in central locations within New England's cities. Anas, Arnott, et al. (1998) argue that by the mid-20th century, the economic rationale for concentrated employment in central-city locations no longer existed. Multistory factories that were built to make the best use of steam- and water-power technologies and were located on sites with ready access to rail or water transport had become obsolete, as electric motors allowed for more flexible configurations of factory space, and the introduction of trucks reduced the cost of intra- and intercity transport.[13] That may be true, but for most New England manufacturing centers, spatial concentration persisted. In cities such as Holyoke and Lawrence, even after access to canals that were part of water-power systems was no longer needed, manufacturing sites remained concentrated around them. Elsewhere, firms maintained locations in close proximity to railroads. Once firms were established, localized agglomeration economies could also prompt concentrations of employment that remained resistant to changes in the technology of power transmission or the new transport technologies.

Figures 4 and 5 illustrate the persistence of the spatial concentration of manufacturing employment in Worcester, Massachusetts, and West Hartford and Hartford, Connecticut, around. 1962. The employment data are from a georeferenced database of about 4,000 New England firms from a prominent directory of manufacturers. The spatial pattern of manufacturing employment that had emerged during industrialization in the 19th and early 20th centuries remained remarkably persistent through the early 1960s. Figure 4 shows the situation in Worcester, where manufacturing employment was heavily concentrated along

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[12] Figure 3 includes counties in New England with three or more midsize cities and excludes Suffolk County (Boston). The other excluded counties are Berkshire, Norfolk, and Plymouth in Massachusetts; Kent in Rhode Island; Litchfield, Middlesex, and New London in Connecticut; and Hillsborough in New Hampshire.

[13] Glaeser 2005 makes a similar argument for Boston. Devine 1983 argues that the "direct drive" method of power conveyance associated with steam power and water turbines was most efficient in multistory factories, where line shafts conveyed power to machinery via leather belts. By 1940, only about 15 percent of the installed horsepower in the United States used the direct drive method. Proximity to railroads saved on the cost of transporting coal, which was used to power steam plants and on-site electricity generators. Moses and Williamson 1967 is the classic study of the impact of intracity and interstate trucking on the location of manufacturing firms.

railroad lines that converged on the city from four directions. The same pattern is apparent in Figure 5 for West Hartford and Hartford.

Given the dominance of manufacturing in the economies of New England's midsize cities and the spatial distribution of manufacturing, it is not surprising that many neighborhoods included a large share of people whose jobs were in manufacturing. For the median census tract in the 27 midsize New England study cities for which census tract-level data are available from the 1960 census of population, jobs in manufacturing accounted for 41 percent of employment. In about one-quarter of the census tracts in these cities, one-half or more of the employed population worked in manufacturing.[14]

Census data from 1960 suggest that spatial concentration of manufacturing employment continued to influence commuting patterns. Already by the early 1960s, automobile ownership had diffused widely in the American population, and relatively wealthy New England was no exception. Kopecky and Suen (2010) argue that the diffusion was so widespread because of declining costs of car ownership relative to public transportation alternatives, primarily buses. In the median tract among New England's midsize cities, about 80 percent of households owned at least one car. Even at the 10th percentile among census tracts, car ownership was at about one-half of households. Nonetheless, a sizable proportion of workers still commuted either by walking (a median of 14 percent) or by taking public transportation (a median of about 14 percent). The share that either walked to work or took public transportation exceeded 40 percent in about one-quarter of census tracts. In sum, despite widespread car ownership, concentrated manufacturing employment sustained neighborhoods where a large share of workers lived close enough to either walk to work or take public transportation.[15]

Two developments from the 1960s onward are strong candidates for upsetting this equilibrium; the consequences may have included localized deterioration in neighborhood quality. The first—the construction of multi-lane limited-access highways—affected the trade-

[14] The median employment in a census tract was 1,800, and the median population was about 4,400. This discussion excludes Cambridge and Somerville, whose economies were closely tied in with Boston's.

[15] Notably, the share of manufacturing employment in a tract is strongly correlated with the share of residents who walked to work and only weakly, or even inversely, correlated with the share of residents using public transport to get to work.

off between the cost of the commute and the amount of housing the commuter could afford. Starting in the late 1950s, interstate and limited-access highway transportation spread rapidly through most of New England's midsize cities. Predecessors in Connecticut were the Merritt Parkway and the Wilbur Cross Parkway, both of which were restricted to noncommercial traffic and completed by the late 1940s. The Connecticut Turnpike, completed in 1958, traversed only the cities of Stamford, New Haven, Bridgeport, and Norwalk. As late as 1960, no other city in New England was traversed by a limited-access highway.[16] By 1970, virtually every limited-access highway now in use within New England's midsize cities had been constructed. Freeways gave commuters inexpensive access to open space for new housing and offered firms a way to make use of greenfield sites for new plants. Baum-Snow (2007) argues that this highway development alone accounted for an 18 percent reduction in the population of center cities between 1960 and 1990 for each interstate highway passing through a city. Of course, it is also likely that highway development affected the relative attractiveness of center-city locations for manufacturers. Figure 3 illustrates the long-term trends in the suburbanization of manufacturing employment in nine New England counties with three or more midsize cities from 1947 through 2012. Apparent in some counties during the 1950s, by the 1960s the general trend toward the abandonment of center-city sites in favor of those in the surrounding towns and suburbs became universal.

The second development has received less attention in the literature, although it was the occasion of much contemporary discussion as it became apparent that America's center cities were encountering strong macroeconomic headwinds. Browne and Sass (2000) note that after peaking in the mid-1960s, manufacturing employment in New England, and particularly in its center cities, began a sustained decline. The final drop in the textile/clothing and boot and shoe sector led the way, but other forms of manufacturing also began to shed employment. New England's share of employment in the U.S. manufacturing sector fell from 8.4 percent in 1967 to 4.8 percent by 2012. Employment in manufacturing fell from 1.4 million in 1963 to 545,000 in 2012. Figure 2 illustrates the impact of the decline on New England's midsize cities. The end of the defense buildup of the 1960s among other influences prompted the first

[16] The Boston Turnpike extension to the Massachusetts Turnpike, which connects the Route 128 beltline with Route 93 in the center of Boston, was completed only in 1965.

setbacks to manufacturing employment in the 1970s. The situation stabilized through the early 1980s and then deteriorated rapidly thereafter. As Bradbury (1993) notes, the recession of 1990–1991 was especially hard on the manufacturing sector. By 2012, median manufacturing employment in New England's midsize cities had fallen from about 7,600 in 1982 to 2,500.

These developments would be expected to have both macro- and microspatial impacts. The most important manifestation of the macro-level impact was the loss of population, which affected most of New England's midsize cities by the mid-1960s. Table 2 provides summary information on population change from 1950 to 2010 for four groups of cities. In the first group, which includes the former textile cities of Fall River and New Bedford, Massachusetts, and Woonsocket, Rhode Island, the median population fell from 81,000 in 1960 to 71,000 by 2010. Since 1950, the median loss of population was about 20 percent. The second group experienced a stable or growing population through the mid-1960s but experienced decline after that. The median population for this group in 2010 was about 94 percent of the 1950 population. In the third "recovery" group, the median population loss was 20 percent by 1980, but its cities experienced some recovery by 2010. The fourth and largest group, which includes many smaller cities with a suburban character, experienced more or less continual population growth between 1950 and 2010. Some large former manufacturing cities, such as Waterbury, Connecticut, Manchester, New Hampshire, and Brockton, Massachusetts, also belong to this group.

The microspatial impacts of economic restructuring included a loss of employment opportunities for a large share of the workers still walking to work or able to reach work with a short ride on public transit. In addition, as manufacturing firms closed during the 1970s and 1980s, the factory space was at best only partially utilized and in many cases abandoned. Hollander (2009, page 41) notes that changes in the use of legacy factory space may also generate local disamenities, even if the factory buildings continue to provide employment. Production sites that became largely or completely abandoned as the decline in manufacturing continued could generate more significant disamenities. Known as TOADS (Temporarily Obsolete Abandoned Derelict Sites), these products of the dramatic decline of industrial employment are the focus of an extensive literature survey by Hollander (2009, pages 4–9).

TOADS are convenient dumping grounds. They offer uncontrolled space for criminal activity and pose fire and health hazards.[17] These kinds of external impacts have not received much attention in the academic literature. Community Research Partners (2008) is an example of a study that did find substantial qualitative evidence that abandoned industrial lots can adversely affect neighborhood quality. Colten (1990) was among the first to link abandoned industrial sites with another external cost: the high risk of contamination from hazardous waste. Sites identified as brownfields face significant redevelopment costs, which both limit future redevelopment and may be viewed as a disamenity by nearby residents (see Leigh and Coffin 2000). The literature summarized by De Sousa, Wu, et al. (2009) has identified substantial gains in the value of surrounding properties once a brownfield site is remediated.

The historical narrative suggests two sources of influence on neighborhood quality over the past 50 years. The first is the drop in manufacturing employment—a "macro" shock—which may cause a citywide decline in housing demand and a steep decline in housing prices, regardless of location, via the mechanism outlined by Glaeser and Gyourko (2005). We would expect that those communities that experienced the greatest shock relative to employment at the end of World War II would have the steepest decline in housing prices—and neighborhood quality—relative to others. The decline in manufacturing employment may have also had spatially hetereogeneous impacts given its spatial concentration in New England's cities. The transformation of transportation infrastructure would likewise have differential impacts on neighborhoods depending upon their location. The quantitative analysis of the impact of manufacturing decline and the construction of freeways draws upon a new georeferenced database of block-level data from the 1960 housing census in conjunction with published block-level data from the 1990 census and tract-level data on neighborhood characteristics for the entire period 1960 through 2010. All analyses include a newly compiled data set of georeferenced employment in manufacturing firms in 1962.

A Bid-Rent Framework for Analyzing Neighborhood Change

Suppose that vectors of amenities ($\boldsymbol{z}_{ijt}^{a}$) and disamenitities (where z_{ijt}<0) characterize a location *i* in city *j* in period *t.* In this study, the subscripts *ij* reference a block or census tract *i*

[17] A tragic example is a fire in the former Worcester Cold Storage facility in 1999, which cost the lives of six firemen.

within a city *j* with assumed homogeneous quantities of amenities and disamenities. Amenities (disamenities) in this context refer to any characteristic of a location that is attractive (unattractive) to a business (b) or household (h) that would consider choosing that location within an urban area. For the period during New England's industrialization at least up through World War I, access to railroads and waterpower sources exerted a strong influence on the location decisions of manufacturing firms and their investments in fixed capital, including factory buildings. The pattern of concentrated employment in New England cities around 1960 that is documented in Figures 4 and 5 suggests that the legacy impacts of access to railroads or canals still influenced the locational choices of firms.[18] For households, $\mathbf{z}^a$ would include ready access to employment to reduce the length of the commute, which is the locational amenity that is the focus of the standard urban model. As American cities grew rapidly in the 19th and early 20th centuries, incoming immigrant groups viewed proximity to a church or synagogue, a religiously affiliated school, or other cultural amenities associated with their ethno-religious grouping as another locational amenity. Access to entertainment and the retail stores in the central business district(CBD) would be another locational amenity. Finally, proximity to public transit may also have played a role in the valuation of locations within an urban area. Disamenities included crime but also the proximity to business activities, such as large factories that generated noise, noxious odors, and air pollution. With the decline of manufacturing, proximity to TOADS could constitute another important disamenity.

The bid-rent approach for explaining the market forces that allocate a location in a city to the end user employs the concept of a *sorting equilibrium*. For a location, multiple potential bids $\phi(\boldsymbol{z}_{ijt}^{a})$ by residents and businesses exist. Let us assume for the sake of argument that bids by businesses $\phi_b(\cdot)$ are fixed for the short term, and focus on bids by households ($\phi_h(\cdot)$). Variations among households in terms of income, attachment to an ethnic community, employment, and other characteristics will lead to variations in bids for these housing and locational characteristics. For any location (block or census tract), only one type of household will offer the winning bid, and that bid then becomes the market land rent $R_h(\boldsymbol{z}_{ijt}^{a})$ for that

[18] Council of Economic Advisers (U.S.). Committee on the New England Economy 1951 (pages 26–27) provides a brief discussion of this issue.

location. Of course the actual price paid for housing (denoted $P^h(\cdot)$) will incorporate both the location-specific amenities and average characteristics of structures itself. Since both amenities/disamenities and the characteristics of housing ($\mathbf{x}_{ijt}$) can change over time, any block or tract will generate a vector of housing prices (either as rents paid by tenants or the value of a unit of owner-occupied housing) that reflects levels of both amenities/disamenities and housing characteristics, or

$$(1)\ P^h_{ijt} = f(\boldsymbol{z}^a_{ijt}, \boldsymbol{x}_{ijt})$$

Housing valuations (V^h_{ijt}) may also vary over time because of changes in interest rates, property tax rates, costs of maintenance, and rates of housing depreciation. The estimation of (1) that follows will abstract from these influences and assume that they remain constant for a given geographic unit, but they will be allowed to vary by time for all geographic units.[19] The hedonic analysis of (1) undertaken here maintains one core assumption and one key insight. Rosen (1974) offers both of them. First, the observations on P^h_{ijt} are equilibrium prices that are essentially the envelope of winning bids for the unit. If that is the case, the marginal market price for a characteristic $\partial P^h_{ijt} / \partial \boldsymbol{z}^a_{ijt}$ also reflects the marginal willingness to pay for it. Second, as Yinger (2015) emphasizes, since the function (1) is an envelope defined only in characteristic and amenity space, the specification should not include influences on individual bids such as income, family size, or car ownership. That information would be included in a separate "second-stage" regression that examines influences on the marginal willingness to pay.[20]

Methods and data

This study examines the core question of whether the introduction of freeways and the collapse of manufacturing differentially affected equilibrium prices of housing in New England's midsize cities. The analysis includes the 27 New England cities for which block-level and census

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[19] Changes in property taxes at the local level could influence property valuation.

[20] Yinger 2015 offers a cogent summary of the literature on the issues that arise when trying to estimate the influences on the marginal willingness-to-pay function.

tract-level data on housing and population are available from the 1960 Census of Housing.[21] The study cities are indicated in boldface in Table 2. As the table suggests, all four patterns of population growth are represented in the dataset.

The analysis proceeds in three steps. The first step explores the characteristics of the spatial equilibrium that prevailed in 1960 by examining influences on commuting behavior and the price of rental and owner-occupied housing using tract-level data. The regression analysis of commuting focuses on the determinants of the proportion of tract residents who walked and took public transportation to work. In addition, the regression analysis asks whether the central business district (CBD) and close proximity to manufacturing employment influenced the price of housing.[22]

By 1990, manufacturing employment had declined on average about 24 percent from employment in 1960; the decline was up to 60 percent in some cities. Only a few cities showed an increase. The second step of analysis employs block-level data to examine how much changes in access to a freeway, CBD access, and the legacy of manufacturing employment influenced housing prices in 1960 and 1990 and changes between those two years. The final step of analysis uses a panel of tract-level data on rents and housing values from 1960 through 2010 to assess the long-term macroeconomic and microspatial impacts of freeway construction and the decline of manufacturing on housing prices.

Estimation of the dependent variable (the price of housing) for equation (1) used data available from the 1960 and 1990 housing censuses at the block level as well as tract-level data available from the 1960 through 2000 Censuses of Population and Housing and the 2006–2010

[21] For the 1960 Census of Housing, see United States Department of Commerce. Bureau of the Census 1961. The cities include Bridgeport, CT, Brockton, MA, Cranston and East Providence, RI, Fall River, MA, Hartford, CT, Holyoke, Lawrence, Lowell, Lynn, and Malden, MA, Manchester, NH, New Bedford, MA, New Britain and New Haven, CT, Norwalk, MA, Pawtucket, RI, Pittsfield, MA, Providence, RI, Quincy and Springfield, MA, Stamford, CT, Warwick, RI, Waterbury and West Hartford, CT, Woonsocket, RI, and Worcester, MA.Tract-level data are not available for Fitchburg in 1960. Cambridge and Somerville have been excluded from the analysis because of the difficulty of fully georeferencing the plant-level employment and because they are so closely integrated with Boston. The 1950 Census of Housing also has block-level housing data, but data are not included for eight of the study cities for which data *are* available in 1960.

[22] United States Department of Commerce. Bureau of the Census 2007 provides the digitized tract-level data from the 1960 Census.

American Community Survey.[23] Logan, Xu, et al. (2012) have developed procedures that allow a mapping of census data from 1970 through 2000 into the census tracts of 2010. Along with the limited data sets that they provide, their procedures were used to map other tract-level data to 2010 census tract boundaries.[24] The historical narrative suggests that the spatial equilibrium of 1960 would differ from the equilibrium in 1970. The construction of freeways and other limited-access highways reshaped the road networks of many New England cities during the 1960s and improved access to suburban areas. To capture conditions in the cities prior to these changes more accurately, the complete block-level data for midsize New England cities from the 1960 Census of Housing were digitized. Digital maps of the 1960 census blocks were created in ArcGIS that allowed for mapping the 1960 block-level data into the census blocks of 1990.[25] The digital maps also allowed for aggregating 1960 block-level data to the census tracts of 2010. The analysis was thus able to cover six decades of substantial urban change. Both rents and housing values were expressed in terms of the dollar's buying power for urban consumers in 1982–1984.[26] Note that census data on rents refer to the asking rent on properties occupied by renters, and the data on housing values are reported only for owner-occupied single-family housing units.

The specification of the vector **x** of housing characteristics in the hedonic relationship (1) includes information that is available from census data over a long time span. The core list of characteristics includes the density of housing (number of units per hectare), the number of rooms, and the shares of single-family and two- to four-family houses in the block or tract. In

[23] Boustan 2013 uses the self-reported rent and housing-value data from the housing censuses in her study of the willingness to pay for public goods.

[24] The data from the 1970 through 2010 censuses are available from Minnesota Population Center. National Historical Geographic Information System: Version 2.0 (2011) found at http://www.nhgis.org.

[25] The TIGER/Line Shapefiles were first developed to conform to the census blocks of 1990. Those data in digital form are also readily available. Rahul Dutt, Margaret Beaton, and Mochamad Pasha provided invaluable assistance digitizing the 1960 housing census data. Justin Valentino created the digital maps for all of the cities used in the analysis.

[26] The rent and housing value variables are expressed in real terms using the Consumer Price Index for all urban consumers. The series is CPIAUCSL and is available from the FRED database of the Federal Reserve Bank of St. Louis.

addition, the analysis of tract-level data includes the share of houses built before 1940 and the share of houses that are less than ten years old.[27]

The vector (+/-) **z** measures neighborhood amenities and disamenities. Detailed data on crime and other aspects of neighborhood quality, such as schooling, are not available at the level of detail or quality that is consistent with the time span and geographic resolution of the block-level and tract-level data sets. The analysis can include spatially relevant variables that are known to or hypothesized to influence the attractiveness of neighborhoods. These include access to the CBD, access to a freeway, and access to employment.[28] The distance to the CBD is measured in kilometers from the centroid of the block and is expected to have a negative impact on housing rents and values. Because many New England cities lacked freeways in 1960, the variable capturing access is FwyAccess ($\frac{1}{distance}$), where distance is measured in kilometers from the centroid of the block to the nearest freeway or interstate exit or on-ramp.[29] The coefficient on this variable would also be expected to be positive to the extent that access is viewed on net as an amenity. Since FwyAccess is strongly correlated with proximity to a freeway, it is possible that renters and purchasers of housing would view access as a disamenity. Research cited in Boehmer, Foster, et al. (2013) has documented that in addition to traffic noise, traffic-related air pollution is substantially higher in close proximity to highways (up to 300 meters). The evidence is not conclusive, but studies such as Gauderman, Vora, et al. (2007) and the Southern California Children's Health Study (reviewed in Chen, Salam, et al. 2015) have found that higher levels of traffic-related pollution raise the incidence of asthma and compromise lung function among young children. For both measures, the estimation of the panel data allowed for the coefficient to vary over time.

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[27] Since it was highly correlated with other variables, the density of housing variable was dropped from the panel analysis of tract data.

[28] The geographic center of the CBD is defined by the latitude and longitude found in the "Populated Places" subset of the Geographic Information Names System (GINS) master file. The file can be downloaded from http://geonames.usgs.gov/domestic/download_data.htm. According to the GINS, the geographic center of a town may be the location of a town hall, post office, main intersection, main library, or central business district.

[29] Data on on-ramps and exits are available from the 2000 TIGER/Line Files (the code is CC63). Road segments that are classified as on-ramps or exits but do not actually include access to a freeway or other limited-access four-lane highway are excluded from consideration. For the analysis of tract-level data from 1960 and the panel of tract-level data, the value of both measures of access was the weighted average of the block-level values weighted by the share of the block in the area of census tract.

One factor to consider is that the location of the freeways constructed during the 1960s in most New England cities may have been *caused* by low housing values, which could lead to the endogeneity of the freeway-access variable. A review of the available literature on freeway planning and controversies about siting in urban areas suggests two important influences for where freeways were eventually constructed. The first, and most important, is that route selection through major urban areas for the most part took place starting in the late 1940s and the 1950s with comprehensive plans that included references to corridors and potential exits. As Plotkin (1956) notes, the team of engineers that developed potential routes for the Boston Turnpike extension (and several other routes in New England) focused on minimizing trip lengths for the largest number of potential users. By the late 1950s, for example, Rhode Island had already laid out detailed plans for property acquisition and the sequencing of construction for the highways that would become the major interstates of the state (see Rhode Island. Public Works Department 1959). Massachusetts had developed similar plans for the Boston metropolitan area in the late 1940s, although planning efforts during the 1950s modified some of the routing that was originally proposed. *Daily Boston Globe* (1957) notes that for most New England states, exact routes for a large proportion of interstates were in place by 1957.

The final location-specific amenity (or disamenity) is the access to employment in manufacturing. Several alternative measures were reviewed. One alternative was simply measuring the amount or the per-hectare density of employment in the same tract where the commuter resided. A measure of access that is discontinuous at the boundary of a tract or block would introduce unneeded measurement error into the estimation when alternative continuous measures are available. The alternative used here—the variable MfgJobAccess—is essentially the numerator of the "Jobs Proximity Index" developed by the Department of Housing and Urban Development, which is a variant of indices used in other gravity models:

$$\text{(2)}\quad \mathrm{MfgJobAccess}_{\mathrm{ij}} = \sum_0^{N_{ij}} \sum_1^{K} \frac{Employment_{k_{n_{ij}}}}{distance_{n_{ij}}^{\alpha}}$$

where *ij* indicates block *i* in town *j*, N_{ij} indexes the annuluses of 250 meters with maximum distance *n* from the centroid of block *ij*, *K* is the number of manufacturing plants *k* with employment that are located within the annulus n_{ij}, and α is a parameter that influences the amount of decay in the impact of employment as distance increases.[30] MfgJobAccess has the advantage of combining information about the spatial proximity to a site (or sites) of manufacturing employment with a measure of the amount of employment accessible at that site. The regression analysis allowed for the value of α to equal one or two. Also for analysis, it was assumed that the maximum value of distance that would matter was five kilometers. Given the compactness of New England cities, the choice of this distance seemed to capture the localized impacts of employment and factory locations.

Within the context of the canonical standard urban model, access to employment is the key determinant of residential bids for a location and thus an important influence on the site rents of land used for housing. For this reason alone, the coefficient on the measure of manufacturing employment access would be expected to be positive for the period of time when central-city manufacturing sites continued to provide employment. It should be noted that even occupied manufacturing sites have been found to generate property discounts in the 15 to 30 percent range (see Simons and Saginor 2006), so that the predicted sign of MfgJobAccess is ambiguous. The loss of employment, shifts in modes of commuting, and even abandonment of factory sites would generate even larger discounts.

The first step in creating the measure MfgJobAccess was to develop a comprehensive list of manufacturing firms, using New England (1962), which lists firms by city in one section and provides firm-specific information in the main alphabetical part of the *Directory*. The year 1962 was chosen since it was one year prior to the Manufacturing Census of 1963. The *Directory* includes information on the officers, type of products, street address of plants (or the firm), employment, and occasionally the amount of capital. The types of products listed for each firm permitted the coding of the industry of the manufacturing plant at the four-digit Standard Industrial Classification SIC level. Entries for about 5 percent of the firms lacked an address. Fortune (1961) provides valuable information on the addresses of branch facilities of large corporations such as Raytheon and General Electric. In virtually all of the remaining cases,

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[30] The HUD user site at http://egis.hud.opendata.arcgis.com/datasets/636ecbfb0ee5480ea5b68e65991e4815_0?geometry=96.248%2C8.147%2C-147.224%2C74.331 provides more information on this index. The annuluses are 500 meters wide starting at 3 kilometers distance from the block centroid.

use of city directories from Ancestry.com allowed for identification of the missing addresses. About one-third of entries either lacked employment information or provided employment information for the firm rather than for the production site. For the most part, articles in newspapers such as the *Boston Globe, Hartford Courant,* or *New York Times* provided contemporaneous evidence for larger firms that lacked information on employment. For the remaining firms that lacked data on employment, two alternative approaches were used. The first substituted the mean employment for all other firms in the same four-digit SIC category. The second substituted the median employment.[31]

The data on the locations of manufacturing firms were then geocoded with ArcGIS. Address locators were based on the 1990 TIGER/Line (street) Files for Massachusetts, since they were available. The 2000 TIGER/Line Files were used for firms in New Hampshire, Connecticut, and Rhode Island. Highway construction and other urban-renewal activities since the early 1960s have changed the configuration of streets in several of the study cities. Alternative sources such as the block maps from the 1960 housing census, Sanborn Fire Insurance Maps, city directory street listings, and digital versions of street maps allowed for the location of virtually every manufacturing facility listed in the *Directory* on the street layout of the early 1960s. Overall, the database of manufacturing firms includes about 3,800 firms with a mean employment of 139 and a standard deviation of 478.

Panel A of Figure 6 shows the spatial distribution of manufacturing employment at the census tract level for the 27 study cities. Consistent with the maps of Worcester, West Hartford and Hartford, about 24 percent of census tracts and 93 percent of all blocks did not have any manufacturing employment. As Panel A suggests, about one-fifth of the 588 census tracts in the study cities accounted for about 80 percent of manufacturing employment. Panel B illustrates the spatial concentration of manufacturing employment at the block level with a focus on the top 10 percent of the distribution. About 450 blocks, or 1.4 percent of the 32,000 blocks, accounted for 80 percent of manufacturing employment.[32]

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[31] The analysis reported here uses the second approach, since it was less likely to be distorted by the skewed distributions of employment in most SIC four-digit industries.

[32] The Lorenz curve in Panel A is based on the census geography of 1960. The Lorenz curve in Panel B is based upon the census geography of 1990.

An implicit identification assumption of the analysis is that employment elsewhere in the city was evenly distributed. We know this is not literally true, since hospitals, financial institutions, and other sources of employment existed in 1960. Compared with contemporary U.S. cities, cities in New England (and elsewhere) in 1960 still had a vibrant central business district. The data available for nine of the larger study cities suggest that employment in retail sales in the CBD alone accounted for 5.5 to 11 percent of total employment around 1960.[33] A review of city directories for the period suggests that other services, including banking, insurance agents, and legal services, and restaurants, movie theaters, and other cultural amenities, were also located in the CBD. The variable measuring access to the CBD should account for this alternative source of concentrated employment.

Results of the estimation

The first step of estimation examines core elements of the spatial equilibrium around 1960 in 27 midsize cities using tract-level data. Along with two hedonic regressions for housing values and housing rents, the estimation includes models of influences on the modal choice of commuters. Potential influences on the commuting behavior of tract residents (measured by the share that used public transit and the share that walked to work) would include income (which influences the time-opportunity cost of the commute), proxies for ethnic characteristics of a tract that may reflect spatial segregation, and measures of proximity to the CBD (measured by distance) and to manufacturing employment (measured by MfgJobAccess).[34] A substantial literature has documented the presence of significant segregation by race around 1960. The share of residents of a tract who were born in Puerto Rico may also be indicative of some spatial segregation. The share of foreign-born residents in the tract is a proxy for the strong ethnic identities that still persisted in these communities through at least 1960. The standard urban model predicts that commuting choices should be related to housing values and rents. To the extent that other unmeasured attributes influence the locational decisions of households (and the housing price that they are willing to pay), there may be cross-equation correlations in

[33] See United States Department of Commerce. Bureau of the Census 1961.

[34] The measure of MfgJobAccess was first calculated for census blocks. A weighted average using the number of housing units in each block as a weight was used to aggregate the measure for census tracts.

the standard errors of the regression equations. Unmeasured attributes could also play a role in the interaction of commuting choices and housing values and rents. For these reasons, the estimation used seemingly unrelated regressions, which relaxes the assumption that the error terms in the four estimated equations (two for housing prices and two for commuting choices) are independent. Finally, the estimation allowed for a fixed effect for each of the 27 towns in the estimation.

Table 3A includes the summary statistics for the 571 census tracts that were analyzed. New England cities had a relatively old housing stock in 1960; only 8 percent of housing units were built after 1950. Forty percent of units were single-family, and another 40 percent were found in two- to four-family dwellings. The average distance of a tract was only 2.5 kilometers to the town center.[35] Although the MfgJobAccess variable is a bit difficult to interpret, the data suggest that the median for a tract was about 1,700 and the mean was about 11,000. The value of the variable for a tract at the 75th percentile was about 15,000. Only a few cities along the Connecticut coast had freeway access, via the Merritt Parkway and Interstate 95, in 1960. The sample cities still had a large proportion of foreign-born in 1960 (about 44 percent).

The final four columns of Table 3A present the results of the estimation for 1960. The pseudo-R^2s (not reported here) for the four regressions` suggest that the eight variables (along with the town fixed effects) account for one-half to almost three-quarters of housing prices and from one-half to two-thirds of observed commuting behavior. The estimated covariances of the errors in the commuting equations (Cov(Walk,Public Transit)) and in the housing price equations (Cov(Rent,Value)) reported in Table 3B are statistically significant. Unmeasured features of housing or local amenities/disamenities are positively correlated in the housing price equations. The covariance in the commuting equations is negative, which suggests that tracts with large shares of workers walking to work are differentiated from tracts with a large share of commuters on public transit. Finally, there is a positive covariance between the share walking to work and housing values and a negative covariance between the share taking public transit to work and housing values.

[35] Rather than calculate the distances using the tract centroid, distances were calculated as a weighted average (by area) of the centroids of the individual blocks.

Although automobile ownership was widespread by 1960, the evidence on commuting behavior and rents suggests that a significant share of residents in New England's midsize cities still walked to work or rode public transit. The spatial characteristics of the tract that had the strongest influence on the share walking to work included distance to the CBD and proximity to manufacturing employment. A one standard deviation increase in MfgJobAccess would more than double the share of commuters walking to work. A standard deviation increase in distance from the CBD would decrease the share walking to work by 10 percent. Neither of these variables influenced the share of commuters taking public transit to work. Understandably, access to a freeway exit decreased the share taking public transit. Tract-level median income lowered the share walking to work and had no impact on the share using public transit. The only other tract-level variable that mattered for commuting behavior was the indicators of minority population within the census tract. Those born in Puerto Rico and African Americans were much more likely than other residents to commute using public transit.

Among the three measures of access hypothesized to influence the spatial equilibrium of housing prices in 1960—access to freeways, distance from the CBD, and proximity to manufacturing employment—only access to the CBD had a measurable influence, and that was on rents but not on housing values. Each kilometer of distance from the city center lowered rents by about 2 percent. The characteristics that were inversely correlated with distance from the CBD, including the number of units in a house and the age of the housing stock, reinforce the evidence for a premium for rental housing located close to the city center. Pockets of unsound housing were also rented at a substantial discount. None of the measures of proximity to manufacturing employment significantly affected prices for single-family housing units. Housing values in tracts with a higher proportion of newer units and a lower proportion of two- to four-family units (both correlated with distance from the CBD) were valued substantially higher than other units. In brief, for the tenants occupying the 60 percent of units that were rented, the monocentric city in 1960 was still a reality.

Overall, the estimation suggests that in 1960, locations close to the CBD of midsize manufacturing cities of New England still commanded premia. The attractiveness of ready access to manufacturing employment did not result in higher rents for housing. Within the context of the standard urban model, it would appear that the reduced monetary cost of commuting must have just offset the increased time cost of walking to work in these tracts, so that there was neither a premium nor a discount for rental housing. In 1960, none of the measures of the locational amenities influenced housing values.

Spurred by the availability of funding from the National Interstate and Defense Highways Act of 1956, construction of freeways connecting cities and traversing cities took off in the late 1950s. By the early 1970s, most limited-access highways that are now in use had been built in New England's cities. During the 1980s, New England experienced the first significant decline in manufacturing, which hit its cities particularly hard. As Figure 2 suggests, median manufacturing employment in all midsize cities had declined from about 8,000 in the early 1960s to well under 5,000 by the early 1990s. Eleven of the study cities experienced declines of 50 percent or more between 1960 and 1990, and another six experienced declines of 40 to 50 percent. Analysis of the impact of these changes on the spatial equilibrium focuses on a more restricted data set that is derived from block-level data from the 1960 and 1990 housing censuses that have been placed into consistent geographies. The analysis includes all of the variables found in Table 3A except for the age of housing. To approximate the age of structures built during different periods of urban development, the estimation includes the number of units per hectare. This proxy reflects the fact that New England's cities typically developed outward from the urban core with decreasing densities in later years. The other variable not included in the analysis is the share of sound housing units. This kind of information was not being included in the reporting for the 1990 housing census.

As with the analysis of census tract data from 1960, the analysis of the block-level data allows for covariance between the hedonic regressions estimated for rents and housing values. Along with estimation for each year of data, the analysis includes a specification that examines the impact of level values of the proximity variables on changes in rents and housing values. The first column of Table 4 includes the summary statistics for the variables used in the analysis. The blocks are more homogeneous than census tracts, which may account for the larger coefficient of variation on the variable that describes the share of units that are single-family. Measures of proximity to employment, access to exits, and distance from the CBD are similar to the 1960 tract-level sample.

A comparison of the coefficients in regressions (1) and (2) in Table 4 (for 1960) with the coefficients for (3) and (4) (for 1990) suggests shifts that took place in how markets valued housing. Similar to 1960, the estimated covariance of the error terms in the rent and value equations is significant in both years (albeit a bit weaker by 1990). The comparison of 1960 with 1990 illustrates a decline in the market valuation that renters placed on proximity to the CBD. The per-kilometer discount of 3 percent estimated from the block-level data for 1960 was one and a half times the discount estimated using the census tract data. By 1990, that discount had disappeared. The premium that homeowners paid for freeway access that is discernible in the block-level data in 1960 disappeared by 1990. The modest discount for distance to the CBD also disappeared. Proximity to employment provided by manufacturing actually led to a discount of about 9 percent for rented units and 5 percent for owner-occupied homes in 1960. By 1990, the discount had fallen modestly for rentals and had increased for owner-occupied housing by about 0.8 percent at the sample mean of MfjJobAccess.

The most notable changes in how the markets valued neighborhood quality can be observed in the coefficients on the shares of single and two- to four-family houses in a block. For renters, the premium for a block with single-family houses remained the same, even as the discount associated with two- to four-family houses disappeared. For owners, a large discount emerged for housing units with a large share of single-family and multifamily dwellings. The excluded category (multifamily dwellings with more than four units) must have absorbed an increase in value.

With the exception of distance to the CBD and MfgJobAccess, the coefficients in equations (5) and (6) are estimated from the changes in the values of the respective variables between 1960 and 1990. The number of observations is substantially lower than in equations (1) through (4) because of attrition from the panel due to urban renewal and freeway construction and because of the withholding of data on values or rents for blocks with fewer than five units of the respective type of ownership. Consistent with the results in (1) and (3), rents reflected sharply reduced marginal valuations of access to the city center and access to a freeway exit. Rents and housing values showed a modest increase with respect to access to former centers of manufacturing employment. Rents of units in blocks with higher shares of single-family units or two- to four-family units increased, which is consistent with a fall in the rents paid for units in higher-density apartment buildings. Overall, the results underscore the dramatic decline in the importance of access to the CBD in New England's midsize cities and ambiguous results on the impact of access to freeways.

The final step of analysis took advantage of the availability of tract-level data from 1960 through 2010 to examine the influence of site characteristics and housing characteristics through half a century of changes in urban structure and manufacturing employment. Since Hausman tests rejected a random-effects specification, the estimation employed the potentially less efficient (but consistent) alternative of tract-level fixed effects. In addition to fixed effects for each year, the analysis included a variable that captured the macroeconomic impacts of city-specific declines in manufacturing. Some cities, such as Lowell, experienced a significant decline in employment prior to 1960 that may have lowered the price of housing relative to more prosperous cities. For this reason, the variable Index Manufacturing measures total manufacturing employment in the city with respect to the level of employment in 1947.[36] The specification on Index Manufacturing allowed for time-varying coefficients on this indicator. Table 5 presents the results of fixed-effects estimation of the influences on the log of real rents and the log of housing values for two alternative specifications of the MfgJobAccess variable. The first specification (found in (1) and (2)) sets the α "decay" parameter in the MfgJobAccess definition equal to 1 (see expression (2)). The second specification (found in (3) and (4)) sets the α parameter equal to 2. For the spatially fixed variables (access to a freeway exit, distance to the CBD, and proximity to manufacturing employment), time-varying coefficients were included to allow for variation in the market valuation of these amenity/disamenity variables. Both specifications allow for time-varying coefficients on the variables measuring housing features, which include the number of rooms, the age of the building—whether built prior to 1940 or built within the last ten years—and the type of structure (share of single family and two- to

[36] Data are from the Census of Manufactures for 1947, 1954, 1958, 1963, 1967, and 1972 and the Economic Censuses of 1977, 1982, 1987, 1992, 1997, 2002, 2007, and 2012. Data on the number of employees in manufacturing (including salaried employees) were interpolated to be consistent with census years.

four-family units in the tract). The maximum-likelihood estimation used seemingly unrelated regression to account for the covariance of the error term in the rent and housing value equations.

Overall, the regressions account for about three-quarters of tract-level differences in rents and virtually all of tract-level differences in housing values. The correlation between the errors on rental and owner-occupied housing is significant, which suggests that the seemingly unrelated regressions specification increases the efficiency of the coefficient estimates. Consider the impact of the index of manufacturing employment. Manufacturing employment actually depressed housing values in 1960. The coefficients on this variable suggest that cities one standard deviation below the sample average would have seen rents at about 1 percent below the average for all cities. The interaction between the (time-varying) coefficient and the decline in the index suggests that through 1990, the decline in the average employment index of 42 resulted in a decline in rents on the order of 2 percent in real terms. By 2010, the net impact was below 1 percent. The reductions in manufacturing employment by 1990 implied a modest increase in housing values of about 3 percent. By 2010, cities that maintained some manufacturing employment saw a net positive impact of manufacturing employment on housing values. At the sample average of the index of manufacturing employment, single-family housing commanded a premium of about 3 percent.

The coefficients on freeway access do not imply a premium for rental properties; for owner-occupied housing, a premium of about 1.5 percent at the sample average emerges from 1990 onward (see regression (2)). The distance to the CBD influences neither rents nor housing values from 1970 onward. Only in 2010 do we see a discount reemerging for distance to the CBD for owner-occupied housing (again in regression (2)). Finally, the legacy of spatially concentrated manufacturing employment had a much stronger impact on owner-occupied housing than on rental housing. For the first measure (found in equations (2) and (3)), the discount for rental units remains stable at about 1.0 to 1.5 percent through 2000; in 2010, it rises to a premium of 3 percent (for the first measure) and 2 percent (for the second, more concentrated measure). For owner-occupied single-family housing, the discount is similar to the rental discount in 1970, but it gradually rises, so that it is about 7 percent at the sample average by 2000. By 2010, the premium is about zero.

The upshot is that from 1980 onward, the valuation of homes fell much more rapidly than did rents. For houses at the 75th percentile of the MfgJobAccess distribution (14,000), the discount on owner-occupied housing would have grown from about 2 percent to 10 percent, while the discount on rental housing would have risen from 1.4 to 2.2 percent. Or alternatively, by 2000 the capitalization of rents into housing values had fallen a substantial amount; it only began to recover by 2010. Note that the impacts are not as dramatic for the results of regressions that use the second more concentrated measure of MfgJobAccess, where the impact of concentrated employment declines by the square of distance (α=2)). The broader geographic reach of the manufacturing legacy suggests that the demand-side impacts of the loss of employment rather than the emergence of the spatially concentrated externalities associated with TOADS had the strongest impact on neighborhood quality, particularly after 1970.

These results are suggestive of the interpretation that localized declines in demand may have influenced expectations of the future trajectory of housing prices. The decreased capitalization of rents into housing values through 2000 is consistent with this interpretation, as landlords demanded relatively higher rents (compared with housing values) to offset the expected depreciation of the asset price of a house. A shift in expectations could also have prompted changes in the behavior of homeowners, including decreasing maintenance. Overall, the manufacturing legacy of New England’s cities would have had a particularly strong impact on the deterioration of neighborhoods close to former centers of manufacturing.

The impacts of the variables capturing housing characteristics are consistent across both measures of the manufacturing legacy variable. The discount for older housing built prior to 1940 of 18 percent for rental housing and 36 percent for single-family owner-occupied housing evident in 1960 became an estimated premium of 9 percent for rental housing and almost 30 percent for owner-occupied housing by 2010. By 1990, newly built rental and owner-occupied housing commanded net premia; by 2010, newer units commanded a premium of about 100 percent on the rental market.[37] Steep discounts for neighborhoods with large shares of two- to four-family dwellings of about 40 percent in 1960 gave way to net premia of about 40 percent for rental housing by 2010.

Conclusions

This analysis of the evolution of the price of housing in the neighborhoods of New England's midsize cities from 1960 through 2010 has found that the decline in manufacturing employment and the construction of freeways played key roles in upsetting an equilibrium in 1960 that featured a continued attractiveness of the CBD for renters and a relatively large population of commuters relying upon public transit or walking to work. The macro shock of a precipitous decline in manufacturing employment since 1970 apparently led to an average decline in real rents overall of about 2 percent through 1990, with no appreciable impact on housing values. Instead, the main impact of the transition out of manufacturing in New England's midsize cities was the microspatial shock—the disappearance of nearby employment opportunities, which hit owner occupiers living in close proximity to centers of employment particularly hard, even as rents were only modestly affected. The apparent decline in the capitalization of rents into housing values meant that a unit of a given value required a higher rental income to be profitable for the landlord. It is plausible that the expected depreciation alone could have significantly altered incentives for maintenance and upkeep of owner-occupied housing, with the decline in the quality of the housing stock in the affected neighborhoods a likely outcome. The durability of housing and the history of its location matter significantly for the long-term evolution of housing prices and neighborhood quality.

A more refined analysis that takes advantage of the data on the sector of employment could help identify more clearly the influence of short- and longer-term spatial shocks to employment on housing prices. In addition, a further test of robustness of this result would examine data at a lower level of aggregation over the same time period. Data from the Worcester housing market from the late 1980s through 2010 are available, for example, and

[37] This large premium is consistent with the perspective of Brueckner and Rosenthal 2009 discussed above. It is also consistent with increased relative scarcity of newly constructed units in New England's cities.

could be used to see whether the manufacturing legacy impact differs across time or across types of housing.

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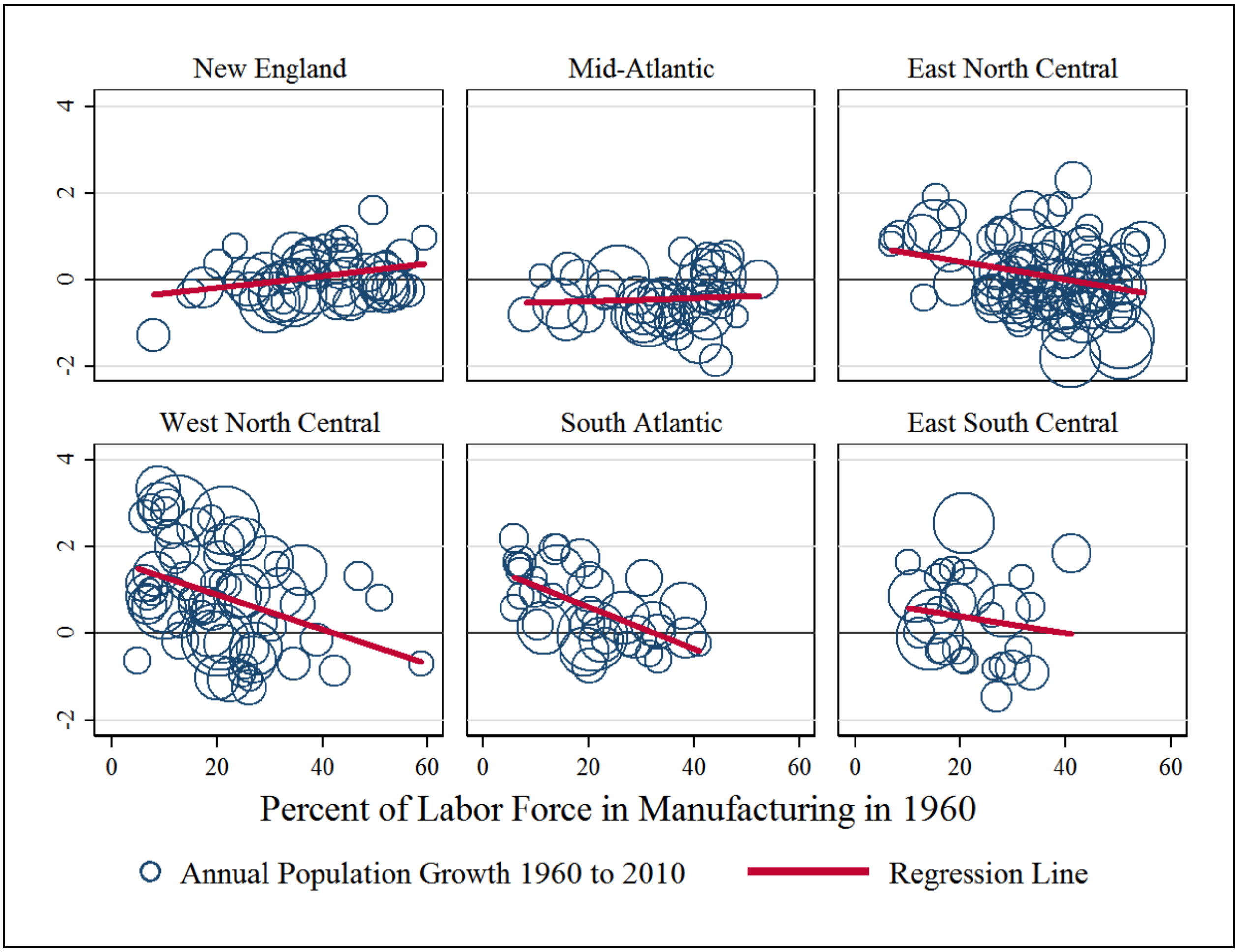
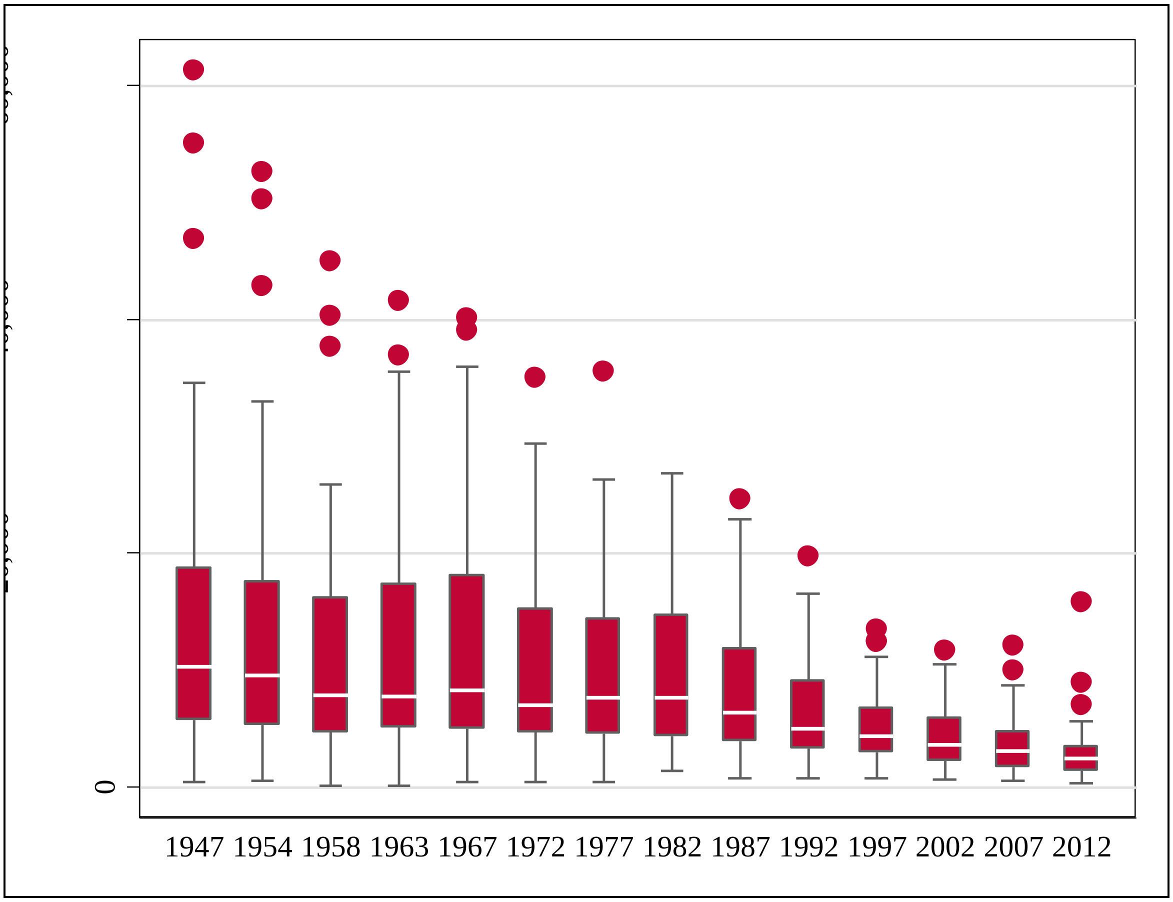
Figure 1. Economic structure in 1960 and population growth for midsize American cities from 1960 to 2010



Source: United States censuses of population for 1960 through 2010.

Notes: The graph shows the population growth for the midsize cities of six of the nine census divisions of the continental United States. Midsize cities are defined as cities with a population between 25,000 and 250,000 in 1960. The size of the circle is proportional to city population in 1960. See Table 1 for the slope coefficient of the regression lines.

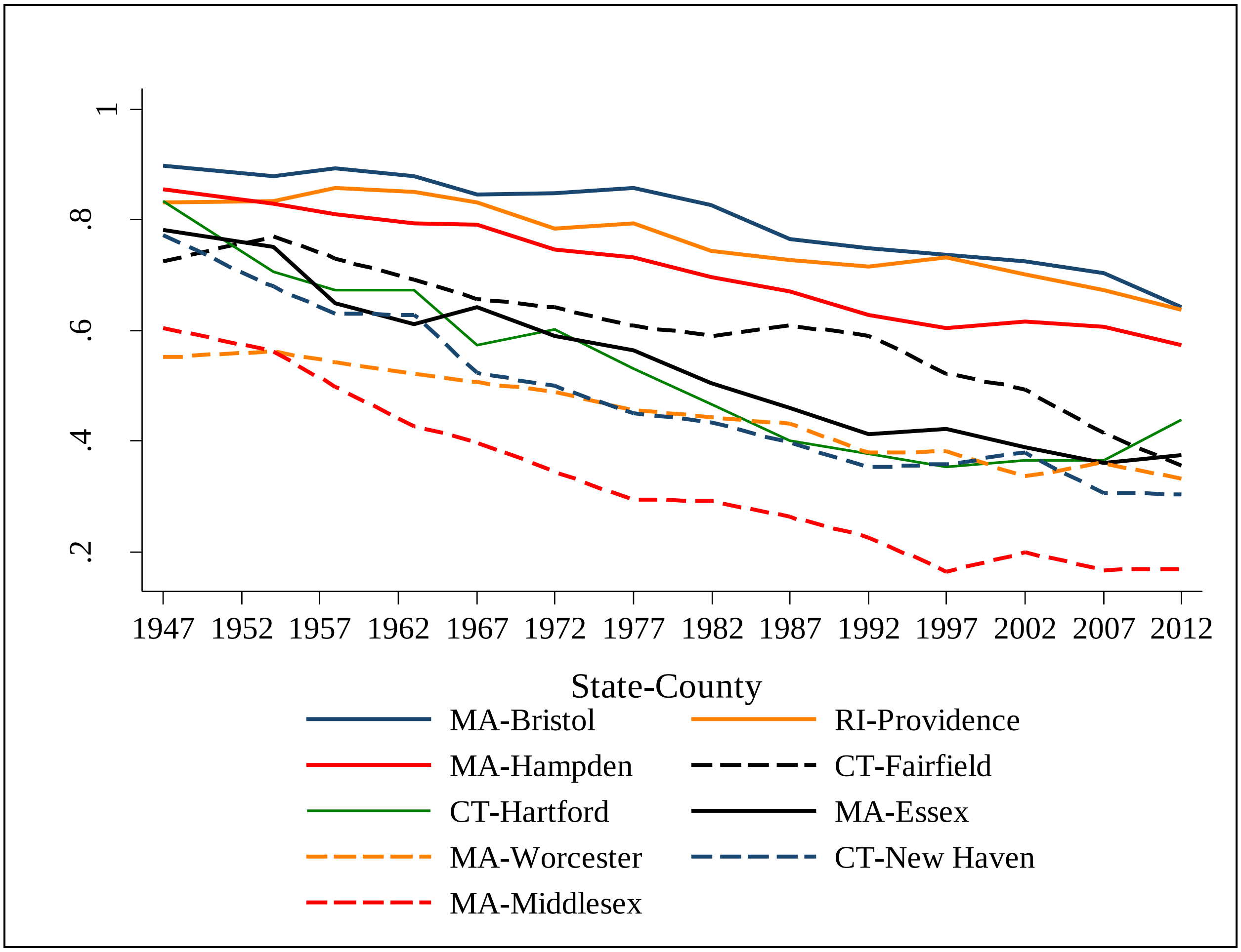
Figure 2: Manufacturing employment in New England's mid-sized cities: 1947-2012



Source: Censuses of manufactures and economic censuses: 1947-2012

Notes: The graph shows the distribution of the employment across 27 midsize cities. The median among the cities is the white bar. The "box" of the box-and-whiskers plot shows the interquartile range. The three outlier cities with very high manufacturing employment in 1947 through 1958 are Providence, RI; Worcester, MA; and Bridgeport, CT.

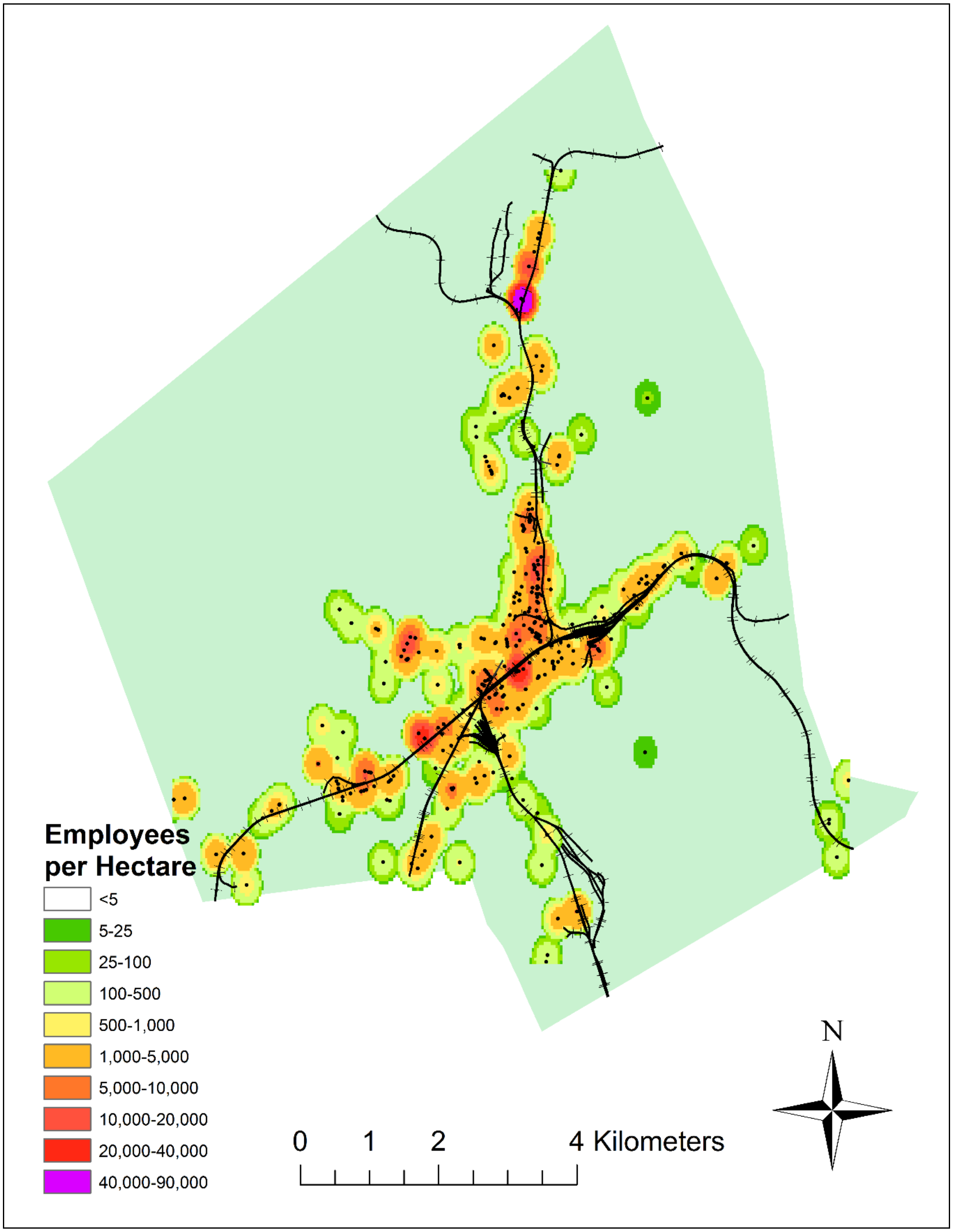
Figure 3. Midsize cities' share of county manufacturing employment: 1947–2012



Source: Census of manufactures and economic censuses, 1947–2012.

Notes: The share of total manufacturing employment in the county is for the midsize cities in the county.

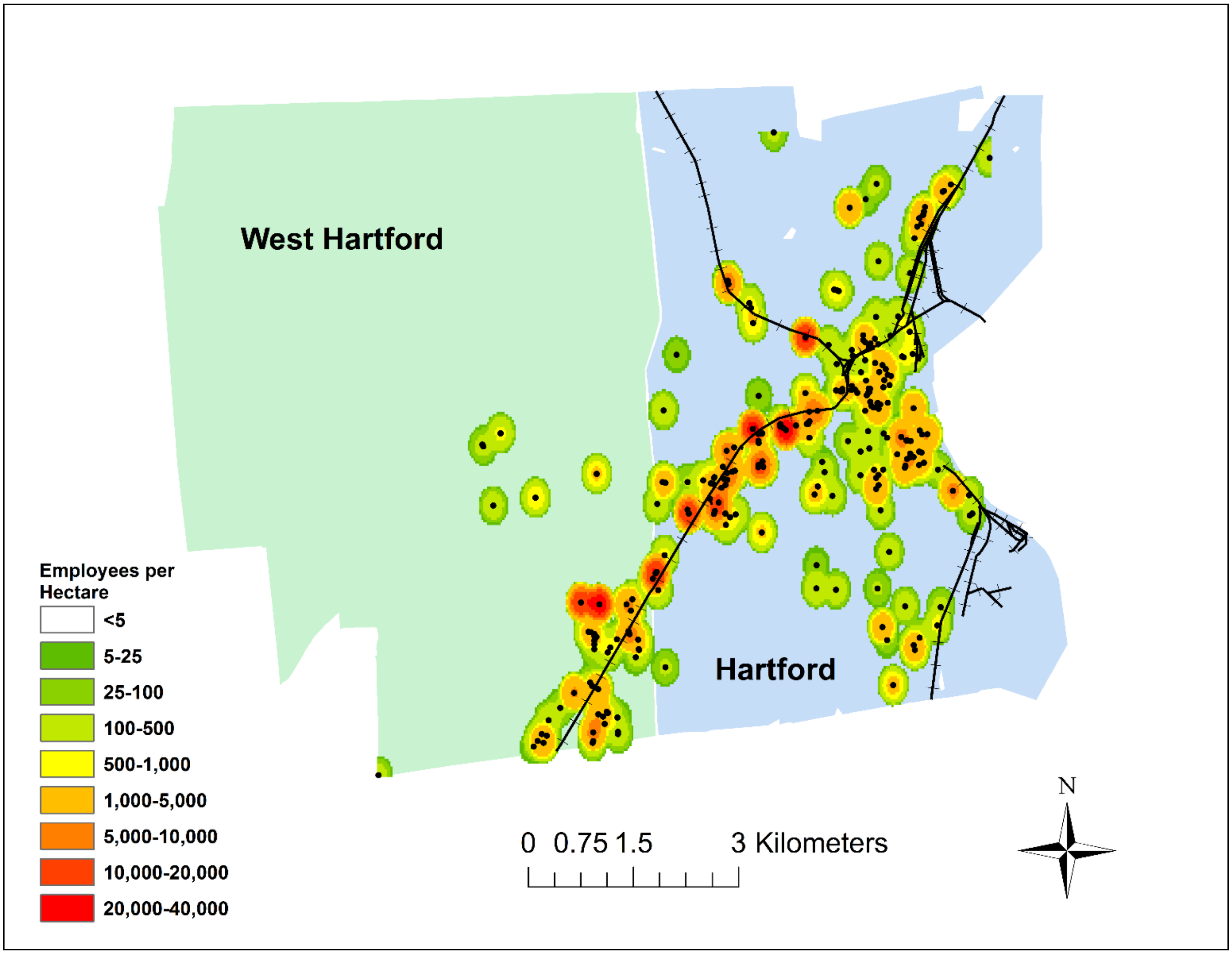
Figure 4. The spatial concentration of manufacturing employment in Worcester, Massachusetts, ca. 1962



Source: Georeferenced database of manufacturing employment in 1962.

Notes: Each dot represents one firm.

Figure 5. The spatial concentration of manufacturing employment in West Hartford and Hartford, Connecticut, ca. 1962

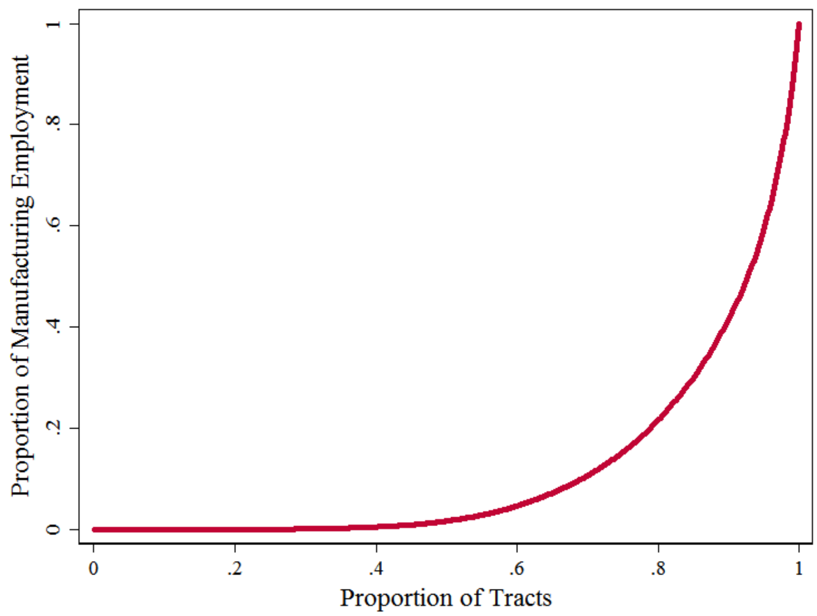


Source: Georeferenced database of manufacturing employment in 1962.

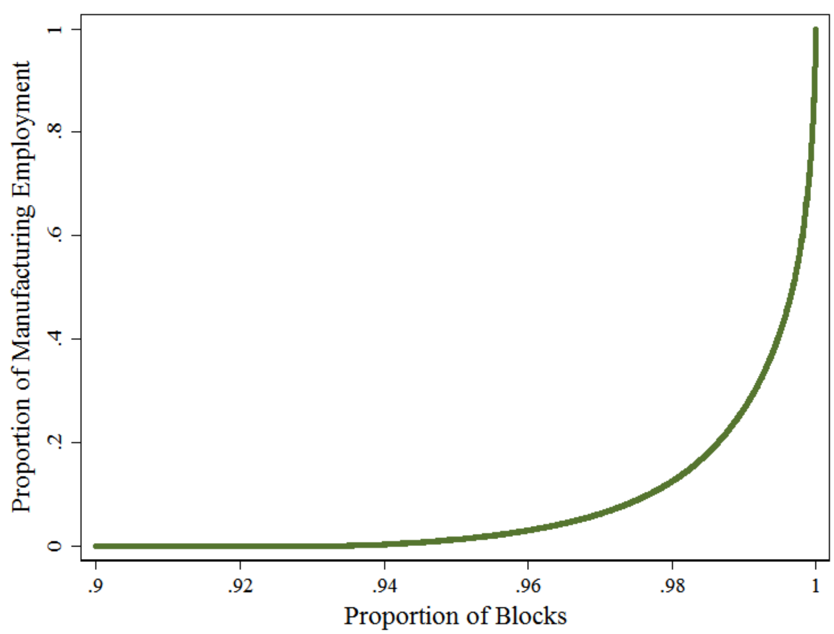
Notes: Each dot represents one firm.

Figure 6. The spatial distribution of manufacturing employment in 1962 in New England's midsize cities

Panel A



Panel B



Source: Database of manufacturing firm employment and location in 1962.

Notes: The distribution of manufacturing employment is represented by a Lorenz curve, which shows the cumulative distribution of manufacturing employment on census tracts or census blocks.

Table 1. Economic restructuring in America's midsize cities, 1950–2010

Census Division	Employment in Manufacturing as Share of All Employed in Midsize Cities (Median)					Impact of Manufacturing Employment Share on Population Growth Rate (1960–2010)†
	N	1950	1960	1970	2010	
New England	50	40.4	38.1	33.3	10.2	0.014 (0.006)
Mid-Atlantic	46	41.4	37.3	35.5	9.8	0.003 (0.007)
East North Central	94	41.3	39.3	35.8	15.1	-0.021 (0.007)
West North Central	37	19.8	21.5	19.1	10.5	-0.040 (0.012)
South Atlantic	66	19.2	20.2	19.6	6.9	-0.048 (0.011)
East South Central	29	20.9	20.9	21.9	10.2	-0.019 (0.024)
United States: All Midsize Cities	454	30.9	28.5	25.1	8.8	-0.019 (0.004)

†Slope of the regression of the rate of population growth on the share of manufacturing employment

Source: United States censuses and FRED. The final column shows the results of ordinary least square regressions of annual average population change from 1960 to 2010 on manufacturing as a percentage of all employment in 1960.

Notes: The results include all cities that matched the midsize city criteria in 1960 (population between 25,000 and 250,000). The impact is the estimated coefficient on the share of manufacturing in employment in this regression: $PopulationGrowthRate=\alpha+\beta MfgShare+\varepsilon$. The regression for all midsize cities in the United States included divisional dummy variables. The table excludes these census divisions: Pacific, West South Central, Mountain, and Hawaii and Alaska.

Table 2. Population of New England's midsize cities relative to 1950

Pattern of Population Change: 1960 to 2007	Cities	Population Relative to 1950 Median Population of Group (in 1,000s) 1960	1980	2000	2010
Continuous decline	**Fall River**, **New Bedford**, **Holyoke**, **Hartford**, **New Haven**, **Woonsocket**	0.93 81	0.83 71	0.82 73	0.79 71
Stable through 1960s, then decline	Chicopee, Fitchburg, **Pittsfield**, **New Britain**, **Springfield**	1.08 61	0.97 55	0.94 55	0.94 55
Decline, then recovery	**Bridgeport**, Haverhill, **Lawrence**, **Lowell**, **Lynn**, **Malden**, **Pawtucket**, **Providence**, **Quincy**, **Worcester**	0.94 89	0.80 82	0.87 89	0.90 90
Continual growth	Attleboro, Bristol, **Brockton**, Concord (NH), **Cranston**, Danbury, East Hartford, **East Providence**, Leominster, **Manchester**, Meriden, Methuen, Middletown, Nashua, **Norwalk**, Norwich, Peabody, Revere, **Stamford**, Taunton, Torrington, **Warwick**, **Waterbury**, **West Hartford**, West Haven, Westfield	1.17 41	1.43 53	1.65 54	1.69 56

Source: Decennial censuses of the United States.

Notes: The number in boldface below the population ratio is the median population of the group in 1,000s. Midsize cities in Maine and Vermont are not included in the table. Somerville, Cambridge, Medford, and Newton, MA, are not included in the table. Data from cities in boldface were used in the empirical analysis.

Table 3A. Influences on commuting behavior (walking and public transit) and housing rents and values in 1960 in 27 New England cities

Variable	Mean (St. dev.)	Means of Travel to Work: Share Walking (0.14)	Share Public Transit (0.15)	Log(Monthly Rent) $55 ($18.35)	Log(Value) $14,099 ($5,641)
FwyAccess	0.45	0.000651	-0.00163	-0.00192	0.00499
	(1.98)	(0.000630)	(0.000563)	(0.00326)	(0.00605)
Km. distance	2.50	-0.0118	-0.00391	-0.0183	-0.0122
to CBD	(1.53)	(0.00580)	(0.00408)	(0.00746)	(0.0116)
MfgJobAccess	11.7	0.0103	-0.000724	-0.00307	-0.000119
	(8.1)	(0.00192)	(0.000915)	(0.00213)	(0.00458)
Rooms per unit	4.94			0.0505	0.162
	(0.84)			(0.0242)	(0.0389)
Share sound	0.79			0.484	0.363
units	(0.19)			(0.0759)	(0.145)
Share units	0.08			0.112	0.374
built>1950	(0.12)			(0.102)	(0.145)
Share units	0.77			0.215	0.280
built <1940	(0.26)			(0.0705)	(0.159)
Share single-	0.40			0.0284	-0.288
family	(0.31)			(0.114)	(0.111)

Share 2- to 4-	0.41			-0.284	-0.632
family	(0.24)			(0.122)	(0.110)
Family income	6.92	-0.0110	-0.00178		
(in $1,000s)	(2.09)	(0.00429)	(0.00378)		
Share foreign	0.44	0.0334	0.0325		
born	(0.10)	(0.0817)	(0.0358)		
Share born in	0.01	0.134	0.241		
Puerto Rico	(0.02)	(0.252)	(0.0899)		
Share Black	0.05	-0.0621	0.145		
	(0.11)	(0.0492)	(0.0277)		
Constant		-0.0449	0.198	3.520	8.765
		(0.1000)	(0.0440)	(0.0963)	(0.402)
Observations		577	577	568	563

Table 3B. Estimated variance-covariance matrix ($\hat{\sigma}_{ij}$)

	Share Walk	Share Public Transit	Log Rent	Log Value
Share Walk	0.00379 (0.000389)			
Share Public Transit	-0.000888 (0.000189)	0.00153 (0.000209)		
Log Rent	0.000223 (0.000701)	0.000124 (0.000311)	0.0223 (0.00198)	
Log Value	0.00205 (0.00109)	-0.00104 (0.000514)	0.00903 (0.00138)	0.0412 (0.00754)

Source: Results of maximum likelihood estimation of seemingly related regressions. Standard errors clustered by town are in parentheses. The value of the log pseudolikelihood function is 2293.9.

Notes: The estimation also includes dummy variables for each city.

Table 4. Influences on block averages of rents and home values: 1960 and 1990

	Mean in 1960	1960		1990		Change 1960 to 1990	
		(1)	(2)	(3)	(4)	(5	(6)
Independent Variables	(Standard Deviation)	Log rent	Log Value	Log rent	Log Value	ΔLog rent	ΔLog Value
FwyAccess	5.31	-0.000824	0.000842	-0.000556	-0.000166		
(1/Distance in Km.)	(70.1)	(0.000314)	(0.000312)	(0.000425)	(0.000420)		
Distance to CBD	2.75	-0.0307	-0.00619	-0.00429	-0.000229	0.00950	0.00128
(in Km.)	(1.69)	(0.00311)	(0.00249)	(0.00242)	(0.00217)	(0.00354)	(0.00227)
MfgJobAccess	9.53	-0.00826	-0.00597	-0.00649	-0.00678	0.00331	0.00182
	(7.67)	(0.000735)	(0.000719)	(0.000671)	(0.000693)	(0.000755)	(0.000656)
Units per hectare	16.3	1.24e-06	1.54e-06	2.18e-06	-4.93e-07		
	(79.1)	(3.19e-07)	(6.94e-07)	(5.51e-06)	(3.17e-07)		
Number of rooms	5.34	0.0726	0.154	0.0746	0.130		
	(1.11)	(0.00425)	(0.00324)	(0.00327)	(0.00331)		
Share single-family	0.52	0.141	-0.0289	0.140	-0.235		
	(0.31)	(0.0242)	(0.0247)	(0.0229)	(0.0257)		
Share 2- to 4-family	0.36	-0.306	-0.387	-0.0778	-0.469		
	(0.24)	(0.0225)	(0.0295)	(0.0247)	(0.0310)		
Change in units per	-18.2					-2.69e-05	8.39e-07
hectare	(1086)					(5.14e-05)	(3.67e-07)

Change in rooms	5.42					0.00370	0.0194
	(1.17)					(0.00309)	(0.00235)
Change in share single	-0.048					0.112	-0.00944
	(0.20)					(0.0304)	(0.0149)
Change in 2- to 4-family	-0.02					0.0965	-0.0163
	(0.16)					(0.0283)	(0.0190)
Change in FwyAccess	13.9					0.00107	0.000286
	(112.7)					(0.000225)	(0.0000260)
Constant		4.141	9.189	6.035	11.61	0.526	0.640
		(0.0329)	(0.0367)	(0.0347)	(0.0383)	(0.0282)	(0.0197)
Covariance		0.0290		0.0140		0.0118	
($\hat{\sigma}_{Rent,Value}$)		(0.00136)		(0.000824)		(0.00118)	
Log psuedolikelihood		- 1056	-1056	-4996	-4996	-3601	-3601
Observations		13,448	18,448	26,281	26,281	11,190	16,244

Source: Results of maximum likelihood estimation of seemingly unrelated regressions. The errors are clustered at the census tract level. The estimation includes fixed effects for individual towns.

Notes: The standard error of the coefficients is in parentheses.

Table 5. Influences on rents and housing values in New England cities with two alternative definitions of MfgJobAccess: 1960–2010

Independent Variables	Mean (Std. Dev.)	MfgJobAccess A†		MfgJobAccess B†	
		(1)	(2)	(3)	(4)
		Rent	Value	Rent	Value
1970		0.247	5.382	0.228	5.316
		(0.151)	(0.158)	(0.152)	(0.158)
1980		-0.0303	5.383	-0.0921	5.335
		(0.151)	(0.194)	(0.148)	(0.193)
1990		0.107	5.793	0.0529	5.697
		(0.157)	(0.171)	(0.153)	(0.172)
2000		0.300	5.056	0.211	4.866
		(0.210)	(0.200)	(0.207)	(0.207)
2010		0.0924	5.560	0.0440	5.450
		(0.165)	(0.206)	(0.164)	(0.210)
Index Manufacturing Employment [1947=100]	89.4	0.000430	-0.000548	0.000403	-0.000680
(MfgEmp-1960)	(27)	(0.000466)	(0.000433)	(0.000459)	(0.000432)
MfgEmp-1970	87.7	-0.000131	-0.00138	-0.000125	-0.00142
	(45.4)	(0.000317)	(0.000247)	(0.000310)	(0.000245)
MfgEmp-1980	78.0	0.000343	-0.000110	0.000368	-0.000149
	(57.1)	(0.000209)	(0.000208)	(0.000209)	(0.000212)
MfgEmp-1990	57.5	0.000211	-0.000695	0.000193	-0.000698
	(50.6)	(0.000235)	(0.000185)	(0.000235)	(0.000189)
MfgEmp-2000	35.4	0.000536	0.000133	0.000590	0.000302
	(38.9)	(0.000285)	(0.000274)	(0.000285)	(0.000285)
MfgEmp-2010	21.9	0.00130	0.00141	0.00120	0.00133
	(25.2)	(0.000549)	(0.000451)	(0.000546)	(0.000453)

FwyAccess-1960	1.737	0.00242	-0.000349	0.00246	9.21e-06
(1/Distance)	(0.29)	(0.00457)	(0.00526)	(0.00443)	(0.00523)
FwyAccess -1970		0.0103	0.00836	0.0103	0.00828
		(0.00485)	(0.00498)	(0.00482)	(0.00497)
FwyAccess -1980		0.00642	0.00178	0.00597	0.00180
		(0.00426)	(0.00582)	(0.00427)	(0.00581)
FwyAccess -1990		0.00218	0.00811	0.00188	0.00771
		(0.00425)	(0.00539)	(0.00425)	(0.00534)
FwyAccess -2000		0.00199	0.00933	0.00129	0.00798
		(0.00490)	(0.00538)	(0.00483)	(0.00537)
FwyAccess -2010		-0.00371	0.0104	-0.00390	0.0100
		(0.00655)	(0.00647)	(0.00655)	(0.00639)
Distance to CBD (km.)	2.618	0.0102	-0.0111	0.0105	-0.0112
(Dist CBD)-1970	(1.55)	(0.00856)	(0.00925)	(0.00874)	(0.00935)
Dist CBD-1980		0.00237	-0.0186	0.00211	-0.0187
		(0.00944)	(0.0118)	(0.00953)	(0.0119)
Dist CBD-1990		-0.00155	-0.0109	-0.00250	-0.0116
		(0.00971)	(0.00945)	(0.00986)	(0.00961)
Dist CBD-2000		-0.00818	-0.0102	-0.00872	-0.00983
		(0.0114)	(0.0119)	(0.0115)	(0.0120)
Dist CBD-2010		-0.0110	-0.0248	-0.0121	-0.0258
		(0.0112)	(0.0131)	(0.0113)	(0.0132)
Proximity to					
employment	10.78	-0.00109	-0.00138	-0.000177	0.00113
(MfgJobAccess)-1970	(7.56)	(0.00109)	(0.00156)	(0.000897)	(0.00120)
MfgJobAccess-1980		-0.00165	-0.000299	0.000968	0.00169
		(0.00122)	(0.00196)	(0.000939)	(0.00127)
MfgJobAccess-1990		0.000982	-0.00236	0.00317	0.00153
		(0.00153)	(0.00157)	(0.00105)	(0.00116)

MfgJobAccess-2000		-0.00161	-0.00732	0.00219	0.000469
		(0.00167)	(0.00242)	(0.00121)	(0.00177)
MfgJobAccess-2010		0.00308	0.000890	0.00466	0.00463
		(0.00186)	(0.00274)	(0.00131)	(0.00190)
Rooms per unit					
(Rooms)	5.01	0.0567	0.0408	0.0549	0.0380
	(0.85)	(0.0176)	(0.0199)	(0.0176)	(0.0198)
Rooms-1970	4.98	-0.0308	0.0174	-0.0326	0.0190
	(0.73)	(0.0518)	(0.0249)	(0.0528)	(0.0252)
Rooms-1980	5.29	-0.0480	-0.00236	-0.0436	-0.00234
	(0.88)	(0.0201)	(0.0318)	(0.0200)	(0.0318)
Rooms-1990	4.97	-0.0112	-0.00976	-0.00670	-0.00695
	(0.79)	(0.0229)	(0.0231)	(0.0231)	(0.0233)
Rooms-2000	5.01	-0.105	0.0559	-0.0956	0.0734
	(0.81)	(0.0519)	(0.0357)	(0.0521)	(0.0365)
Rooms-2010	5.18	-0.0504	0.0189	-0.0455	0.0267
	(0.81)	(0.0274)	(0.0341)	(0.0275)	(0.0338)
Share built <1940					
(Pre1940)	0.744	-0.176	-0.358	-0.160	-0.347
	(0.26)	(0.132)	(0.144)	(0.135)	(0.151)
Pre1940–1970	0.65	0.0222	-0.0722	0.0279	-0.0741
	(0.25)	(0.165)	(0.138)	(0.170)	(0.143)
Pre1940–1980	0.52	0.253	-0.153	0.242	-0.157
	(0.23)	(0.133)	(0.160)	(0.136)	(0.165)
Pre1940–1990	0.435	0.313	0.366	0.289	0.355
	(0.216)	(0.133)	(0.142)	(0.136)	(0.148)
Pre1940–2000	0.390	0.352	0.701	0.327	0.676
	(0.19)	(0.145)	(0.161)	(0.147)	(0.167)
Pre1940–2010	0.463	0.261	0.641	0.235	0.615

	(0.23)	(0.141)	(0.158)	(0.143)	(0.165)
Share built within	0.155	0.0102	-0.446	0.0127	-0.457
10 years (Built<10)	(0.18)	(0.173)	(0.184)	(0.175)	(0.190)
Built<10-1970	0.118	0.153	0.223	0.155	0.230
	(0.12)	(0.262)	(0.190)	(0.263)	(0.193)
Built<10-1980	0.108	0.333	0.0183	0.338	-0.000972
	(0.11)	(0.176)	(0.219)	(0.177)	(0.222)
Built<10-1990	0.11	0.389	0.558	0.385	0.571
	(0.09)	(0.180)	(0.189)	(0.182)	(0.194)
Built<10-2000	0.044	0.770	0.865	0.770	0.875
	(0.047)	(0.300)	(0.280)	(0.302)	(0.287)
Built<10-2010	0.034	1.780	1.420	1.763	1.417
	(0.045	(0.266)	(0.280)	(0.269)	(0.283)
Share single-	0.424	-0.447	-0.196	-0.495	-0.263
family (Single)	(0.30)	(0.0981)	(0.102)	(0.102)	(0.106)
Single-1970	0.370	0.0140	0.0592	0.0355	0.101
	(0.28)	(0.159)	(0.112)	(0.157)	(0.115)
Single-1980	0.382	0.380	0.116	0.411	0.158
	(0.26)	(0.100)	(0.150)	(0.102)	(0.150)
Single-1990	0.228	0.400	0.213	0.443	0.279
	(0.22)	(0.113)	(0.108)	(0.116)	(0.111)
Single-2000	0.377	0.699	0.0265	0.737	0.0698
	(0.26)	(0.201)	(0.151)	(0.201)	(0.153)
Single-2010	0.388	0.638	0.120	0.682	0.184
	(0.263)	(0.121)	(0.146)	(0.122)	(0.145)
Share 2- to 4-	0.400	-0.432	-0.417	-0.462	-0.459
family (2to4)	(0.23)	(0.0913)	(0.0934)	(0.0934)	(0.0981)
2to4-1970	0.407	-0.0201	0.187	-0.0165	0.204
	(0.21)	(0.130)	(0.0958)	(0.127)	(0.0971)

2to4-1980	0.359	0.0528	0.242	0.0632	0.263
	(0.20)	(0.0851)	(0.118)	(0.0857)	(0.118)
2to4-1990	0.410	0.380	0.268	0.409	0.299
	(0.22)	(0.0837)	(0.0878)	(0.0852)	(0.0911)
2to4-2000	0.357	0.578	0.162	0.586	0.144
	(0.20)	(0.132)	(0.135)	(0.130)	(0.133)
2to4-2010	0.346	0.738	0.280	0.776	0.321
	(0.20)	(0.0989)	(0.137)	(0.0982)	(0.137)
Test MfgJobAccess (χ^2 DF=10)		62.53		36.0	
Covariance		0.00626		0.00621	
($\hat{\sigma}_{Rent,Value}$)		(0.000679)		(0.000667)	
Log pseudolikelihood		-13412		-19388	
N Tracts		610		610	
N Observations		3,660		3,660	

†For MfgJobAccess A, the value of α in the formula is 1. For MfgJobAccessB, the value of α is 2.

Source: Result of maximum likelihood estimation of a fixed effects specification of eq(1) under the assumption of seemingly unrelated regressions.

Notes: Standard errors are in parentheses. The dependent variables are the log of median rent and the log of median housing value. The panel of 27 cities is balanced.