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How to Increase Housing Affordability: Understanding Local Deterrents to Building Multifamily Housing

Amrita Kulka, Aradhya Sood, and Nicholas Chiumenti

Abstract:
This paper studies how local land-use regulations and community opposition affect the trade-offs to building single-family, multifamily, and affordable housing and how their effects on rents differ from their effects on house prices. Using lot-level zoning regulations and a boundary discontinuity design at regulation boundaries in Greater Boston, we obtain causal estimates for the effects of zoning regulations on the supply of different types of housing, single-family-house prices, multifamily rents, and households' willingness to pay for higher density. We find that relaxing density restrictions (minimum lot size and maximum number of dwelling units)—either alone or in combination with relaxing maximum-height restrictions or allowing multifamily housing—is the most fruitful policy reform for increasing the housing supply and reducing multifamily rents and single-family-house prices. However, adopting multifamily zoning or relaxing height regulations alone has little effect on the number of units built or on rents. Moreover, in each land-use relaxation scenario where rents fall, house prices also fall, complicating the political economy of land-use reform. We also find that mature suburbs that are closer to a city center and have a representative town meeting structure of local governance are the most restrictive with respect to adding multi-unit housing. Furthermore, inclusionary zoning policies such as Massachusetts's Chapter 40B rarely substitute for relaxing zoning regulations, particularly restrictions on building multifamily housing.

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Keywords: multifamily zoning, height restrictions, density, house prices, rents

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Amrita Kulka (amrita.kulka@warwick.ac.uk) is an assistant professor in the Department of Economics at the University of Warwick in the United Kingdom. Aradhya Sood (aradhya.sood@rotman.utoronto.ca) is an assistant professor in the Department of Economic Analysis and Policy at the University of Toronto, Scarborough, and the Rotman School of Management. She was a visiting scholar with the Federal Reserve Bank of Boston from 2020 to 2021. Nicholas Chiumenti (nick.chiumenti@bos.frb.org) is a senior policy analyst with the New England Public Policy Center in the Federal Reserve Bank of Boston Research Department. Kulka and Sood are the primary authors of this paper (names in alphabetical order); Chiumenti provided invaluable analytical and data contributions.

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1. Introduction

In productive cities in North America, even middle-income residents struggle to find housing that they can afford. For example, from 2010 to 2018 in Greater Boston, house prices and rents increased 49 percent and 17.4 percent, respectively, outpacing wage growth by far.[1] If households cannot afford to live near productive places, they may relocate to less productive regions with fewer employment opportunities (Chetty and Hendren (2018), Chyn and Katz (2021), and Deryugina and Molitor (2021)). An important way to ensure low rents and low house prices is to increase the housing supply, which in land-constrained metropolitan areas involves constructing smaller single-family homes and multifamily apartment buildings. Local barriers such as land-use regulations, community opposition, and local government structure are crucial in determining the location and type of new housing construction, if there is any.

The importance of these local barriers has not escaped the attention of policymakers and researchers. Most of the related literature examines the effects of individual regulations on the supply and prices of single-family homes[2] and shows that the strictness of these individual regulations shapes cities by restricting construction, increasing house prices, and, in certain cases, reducing welfare. However, how various zoning regulations interact is understudied, and it is unclear if changing an individual regulation alone will yield the desired results. It is also unclear which zoning regulations most effectively restrict the supply of new housing units, particularly multifamily housing.

We study how different local barriers interact with each other to affect the supply of various types of housing and the prices of single-family homes (which are usually owned) and rents for multifamily apartments (which are usually rented). Our setting is the Greater Boston area.[3] We use a novel, lot-level land-use-regulation zoning atlas that includes 101 cities and towns, and by employing a spatial regression discontinuity

[1]Authors' calculations using data from the American Community Survey and the Federal Housing Finance Agency).

[2]For the effects of density regulations, see (Anagol et al., 2021; Gray and Millsap, 2020); for building heights, see (Brueckner and Singh, 2020; Ding, 2013); and for minimum lot sizes, see (Zabel and Dalton, 2011; Kulka, 2020).

[3]This report defines Greater Boston as the service region of the Metropolitan Area Planning Council (MAPC), a regional planning agency in the state of Massachusetts that compiled the zoning data used in this report. MAPC's service region includes the city of Boston and 100 other surrounding cities and towns.

approach, we exploit local variation in zoning regulations across space to estimate the causal effects of regulations.

Our empirical strategy studies effects at regulation boundaries with discontinuous jumps in the size and type of housing due to different types of zoning regulations. We examine regulation boundaries within towns and elementary school attendance areas to eliminate sorting of households into municipalities and school districts (Black, 1999; Schönholzer and Zhang, 2017). We demonstrate exogeneity of the regulation boundaries in our sample by showing that neighborhood amenities are continuous at these boundaries and that current land-use regulations are, for the most part, not predictive of older housing built before the introduction of land-use zoning in the early to mid-20th century. We focus on the three main regulations and their interactions affecting the residential land-use landscape. These are multifamily zoning, maximum-height restrictions, and density restrictions (minimum lot size and allowable number of units per lot) that determine the number of housing units that can be built on an acre of land.

In examining the roles of multiple regulations jointly, we find that density regulations—not regulations targeting the type of buildings (multifamily zoning)—provide binding constraints on the supply of the total number of units built, particularly multifamily units. California and Oregon and the city of Minneapolis recently adopted multifamily zoning in most or all of their jurisdictions without changing density and maximum-height regulations. [4] We find that the number of housing units increases 27 to 92 percent at boundaries where either density regulations are relaxed alone or in combination with relaxing height regulations or allowing multifamily housing. However, allowing multifamily housing alone or relaxing only height regulations does not substantially increase the number of units. Moreover, the supply effects are more substantial for smaller multifamily buildings (two or three units) than for larger apartments (four or more units). This result should not be surprising. Boston and Cambridge, which first introduced housing-type and building-height zoning in the 1910s, found that these regulations did not "sufficiently limit the housing potential of a given lot, and subsequently changed

[4] See Stephen Miller, "Ending the Single-Family District Isn't So Simple," *Star Tribune*, Jan 2, 2019; Laurel Wamsley, "Oregon Legislature Votes To Essentially Ban Single-Family Zoning," *NPR*, July 1, 2019; and "California Ends Single-Family Zoning," *The Economist*, September 25, 2021.

zoning to cap the total amount of density (floor-area ratio) of the building" (MacArthur, 2019, pg. 22).

In addition to examining the effects of various regulations on the housing supply, we study the impact on housing costs separately for single-family homeowners and multi-family renters. It is essential to consider the competing interests of current homeowners and new homebuyers and renters. On the one hand, land-use regulations can be regarded as rent-seeking on behalf of existing owners (Glaeser and Gyourko, 2018). On the other hand, relaxing regulations can create negative externalities, especially if residents have a negative willingness to pay for higher density (Diamond and McQuade, 2019; Mast, 2020). Zoning regulations can affect prices in two ways. First, they can directly affect prices by changing the size, type, and number of units constructed in a given area. We call this the direct price effect. Second, regulations can change a neighborhood's housing density and other characteristics, potentially creating negative externalities. We call this the indirect price effect. Adapting the framework laid out in Turner et al. (2014), which provides analysis both close to and farther from zoning-area boundaries, we develop a spatial regression discontinuity design (RDD) to estimate the causal effects of zoning regulations on prices at boundaries and farther from them.

To estimate the direct price effects, we focus on a narrow band around a given boundary where characteristics (including neighborhood density and neighbor demographics) are continuous, and any change at the boundary arises due to regulation differences. The direct effect is the sum of the supply effect and the option value of relaxing regulations ascribed to property owners.[5] Monthly multifamily rents fall 2.6 to 12.6 percent (or $27 to $144 on average) for each additional unit added due to relaxing density regulations alone or in combination with allowing taller building heights. For single-family homes, the effects are greater. Relaxing density regulations alone results in monthly owner costs falling 16.7 percent (or $425 on average) per unit of housing added. House prices drop 9.17 percent ($204) per unit at boundaries where density regulations are relaxed and multifamily homes are allowed, which are the two regulations

[5]In line with the recent literature (Pennington, 2021; Asquith et al., 2021), we find that the direct price effect of the regulation is dominated by supply effects outweighing countervailing effects.

used most often in combination in Greater Boston suburban communities. Examining the cross-boundary differences of the (interaction of) various regulations, we find that a decline in multifamily rents is usually accompanied by a decline in house prices, complicating the political economy of land-use zoning reform.

To estimate the indirect price effects of land-use regulations, we compare buildings farther from the boundary that are subject to the same regulation and thereby the same direct effects but experience varying indirect effects as density changes away from the boundary. Results from the hedonic "donut" RDD suggest that distaste for density is substantial among single-family homeowners. A 1 percent increase in density of two- or three-unit buildings leads to a fall in owner cost of housing, or the equivalent rental value of owner-occupied homes, of 0.17 to 0.21 percent. For renters, we find no distaste for higher density. This result lends credence to the school of thought that stricter zoning laws limit negative externalities, and relaxing zoning lowers single-family house prices through the channel of reducing perceived neighborhood quality.

Additionally, we find that zoning regulations are not a binding constraint in developing suburbs far from the central business district (CBD). We see more significant increases in the supply near the CBD, where land is most in demand per theoretical predictions. However, we find the largest decreases in prices in mature suburbs that provide an easy commute to Boston, face lower in-migration pressures, and where strict regulations lead to higher prices.[6] In 2021, Massachusetts implemented the Chapter 40A law (the Zoning Act) amendment requiring communities to zone for multifamily development and allow density of as many as 15 units per acre near metro transit stops. We evaluate the impact of this regulation change on rents and housing prices within a 0.3-mile radius of a sample of affected train stops. In line with the spatial heterogeneity results, we find the largest decreases in housing costs in the mature suburbs rather than near the CBD, with greater effects for single-family house prices than for multifamily rents.

The political economy of zoning reforms is further complicated because new hous-

[6]A monocentric model predicts a price gradient from the CBD to suburbs that is driven by commuting costs. Ahlfeldt and Barr (2021) show that relaxing maximum-height restrictions in an open city model can lead to higher prices and rents as in-migration occurs (see also Anenberg and Kung (2020)).

ing decisions in the United States are most often made at the municipal level and different forms of local governance crucially influence the effectiveness of relaxing land-use regulations.[7] Consistent with the literature, we find that the mayoral and open town meeting forms of local governance, as opposed to a representative town meeting system, are most conducive to increasing the supply of multifamily units and reducing rents (Hankinson and Magazinnik (2020)). Finally, we study how land-use regulations interact with Massachusetts's Chapter 40B law, an inclusionary zoning policy designed to overcome aspects of municipal zoning bylaws and community opposition to building more affordable units.[8] We study whether Chapter 40B is a substitute for relaxing land-use regulations and find that it is not, particularly with respect to providing affordable multifamily housing. However, the law does complement relaxed zoning regulations by allowing developers to build more units than they would otherwise.

This paper ties into many strands of the literature relating to the various effects of land-use regulations. The effect of land-use regulations and zoning on house prices has been studied for different parts of the country (Glaeser and Gyourko (2018) and Glaeser et al. (2005)) and for the Boston area (Dain (2019), (Glaeser et al., 2006), Chiumenti (2019), and Rollins et al. (2006)). However, the existing literature almost exclusively focuses on land-use regulations in the context of single-family homes, as highlighted by Molloy (2020) in her review of the literature. Notably, research on market-rate multifamily housing is largely absent. Research on the affordability of multifamily homes is limited to project-based assistance such as Low-Income Housing Tax Credit (LIHTC) buildings (Diamond et al. (2019) and Baum-Snow and Marion (2009)).[9] Like this paper, Anagol et al. (2021) use a regulation boundary design to study building-size-to-lot-area ratio zoning reform; the authors focus on reform in Sao Paulo. This paper also adds to the literature on neighborhood and house choice (Bayer et al., 2007, 2016; Albouy, 2016) by estimating owners' and renters' willingness to pay for density in their neighborhoods.

[7] A key issue in building multifamily housing is the numerous delays and uncertainty faced by developers as they seek approval of projects from local town councils (Einstein et al. (2019), Schuetz (2020b)).

[8] Inclusionary zoning policies have gained popularity in many cities including New York (Soltas, 2021) and provide a substitute for relaxing land-use regulations, which is politically challenging. See Edward L. Glaeser, "How Biden Can Free America from Its Zoning Straitjacket," *New York Times*, April 12, 2021.

[9] See Ellen (2015) and Schuetz (2020a) for a broader discussion on housing affordability.

Policies preventing new construction can have negative effects on geographic mobility, local labor markets, and growth (Ganong and Shoag (2017)). Restrictive land-use regulations have been shown to slow economic growth by distorting the flow of workers (Hsieh and Moretti, 2019). The racial segregation consequences of land-use zoning have been documented in many settings (Resseger (2013), Shertzer et al. (2016), Trounstine (2018), and Rothstein (2017)).

The paper proceeds as follows. Section 2 lays out the regulatory framework. Section 3 introduces the data. Section 4 provides the theoretical and empirical framework. We discuss the results in Section 5. In Section 6, we perform the policy counterfactual. Section 7 discusses interactions of land-use regulations with other local barriers.

2. Regulatory Framework for Multifamily Housing

2.1 Zoning Regulations

We focus on three land-use zoning regulations: whether multifamily housing is allowed or prohibited, maximum-height restrictions, and restrictions on the maximum number of dwelling units per acre (DUPAC). Each affects the construction of multifamily buildings and single-family homes, although potentially in different ways. Figure 1 shows how the three regulations vary across the municipalities in our sample in Greater Boston. While all three land-use regulations have relatively straightforward definitions, their actual implementation and interaction can be complex.

Multifamily Zoning: Multifamily housing construction can be allowed by right, by special permit, or not allowed at all (only single-family construction is allowed) on a particular lot.[10] This zoning regulation is the most common way multifamily housing is regulated in Greater Boston. It regulates the *type* of housing. Figure B.1 shows that there is considerable variation in this zoning regulation's use both within and across towns, with some municipalities prohibiting multifamily construction entirely while others allow it only in certain areas. Multifamily housing is allowed by right on only about 16

[10] We combine areas allowing multifamily construction by right with areas allowing multifamily construction by special permit and compare the effects with those in areas where multifamily housing is not allowed at all. Simply put, if a regulation is by right, it is expressly defined in the local zoning code. However, if it is not by right, a developer must request special approval from the local zoning board (MAPC, 2020).

percent of the land area in Greater Boston. It is allowed by special permit on 26 percent of the land area.

Building-Height Restrictions: Building-height restrictions indicate the maximum allowable building height in feet. Even if multifamily zoning is allowed, municipalities often limit the *size or shape* of buildings by using building-height restrictions. Bertaud and Brueckner (2005) and Brueckner and Singh (2020) show that building-height restrictions cause urban sprawl and limit housing near the economic centers. Figure B.2 shows how building-height restrictions vary across Greater Boston. Regulations for almost 70 percent of the land area in Greater Boston limit building heights to 35 feet (or 3.5 floors) or less.

Dwelling Units per Acre (DUPAC): DUPAC regulations limit *residential density and the total number of units* that can be built. DUPAC is calculated by counting the number of lots that can be constructed on an acre after taking into account *minimum lot size requirements* and multiplying this number by the maximum allowable number of dwelling units for each of those lots. Thus, this measure captures not only the land-use restrictions from *minimum lot size* requirements but also the restrictions on the *maximum number of dwelling units*, allowing comparisons of municipalities that may regulate density in different ways. Figure B.3 shows how DUPAC restrictions vary across Greater Boston. Regulations for roughly 24 percent of the land area in Greater Boston allow only one unit to be built per acre.

Interaction of Zoning Laws: While the individual effects of some of these regulations on the supply and prices of single-family homes have been documented, it is not well understood how they interact and differentially affect the supply of single-family and multifamily housing and the prices for owners and renters.[11] For example, given multifamily zoning, how do building-height restrictions interact with density restrictions to affect whether a multifamily building contains fewer than or more than nine units? We have three types of interaction scenarios. First, only one of the three zoning laws

[11] In the data, we observe single-family and multifamily housing units but not the share of residents who are renters in each of these categories. We categorize results by single-family "owners" and multifamily "renters" for simplicity, given that most single-family residents are owners and most multifamily residents are renters.

changes at the boundary segment. Second, two zoning laws change, but the other remains the same. Third, all three regulations change. Table 1 shows all seven possible zoning regulation scenarios we study. Most of the analysis focuses on scenarios 3, 5, and 6 since these are the most common regulation combinations in Greater Boston.[12] Note that, as can be seen in Figure 1, regulation scenarios 6 and 7 (DUPAC and height restrictions change and all three regulations change, respectively) are more prevalent near downtown areas, while regulation scenarios 3 and 5 (only DUPAC changes and DUPAC and multifamily zoning change, respectively) are prevalent in both downtown areas and suburban communities.

2.2 Inclusionary Zoning and Chapter 40B

Many states and cities in the United States have inclusionary zoning policies that provide incentives for developers to build affordable housing units (for example, New York City's 421-A property tax exemption (Soltas, 2021)). In Massachusetts, Chapter 40B is a state statute that enables local zoning boards of appeals to approve new housing construction under relaxed zoning laws if at least 25 percent of the units have long-term affordability restrictions. Chapter 40B is used chiefly as a zoning tool to build, for example, taller buildings or more units per acre than would otherwise be allowed. This paper studies whether Chapter 40B acts as a complement to or a substitute for relaxed zoning.

3. Data

3.1 Land-Use Data

Data on parcel-level land-use zoning regulations come from digitized zoning maps compiled by the Metropolitan Area Planning Council (MAPC) for its Zoning Atlas project. The 101 cities and towns included in the Zoning Atlas dictate our overall sample of municipalities in Greater Boston. The Zoning Atlas was constructed from 2010 to 2020 and provides a snapshot of zoning regulations. However, most zoning regulations were set during the early to mid-20th century (the first building-height regulations were put in place in the Boston area in 1918). Few changes have been made since then, and almost

[12] It is interesting to consider the conditions under which different regulations may bind. For Greater Boston, density regulations are binding. However, we would expect height restrictions to bind if households prefer space.

all have been in the direction of more restrictive zoning.[13]

To the best of our knowledge, the 2020 MAPC Zoning Atlas and 2021 Desegregate Connecticut Zoning Atlas (Bronin (2021)) are the only comprehensive zoning data sets in the United States providing all of their respective area's zoning codes and bylaws data. Twenty-six of the towns in our sample are included in the Wharton Land Use Survey (WRLURI). To give a sense of comparability, we correlate regulations in these 26 towns with the WRLURI. An increase in average DUPAC at the town level of one dwelling unit per acre in our sample corresponds to a decrease by 0.001 standard deviation in the WRLURI. A one-floor (10-foot) increase in average town-level height corresponds to a decrease by 0.05 standard deviation in the WRLURI.[14]

3.2 Housing-Market and Price Data

Housing Characteristics and Single-Family Home Prices: The data on housing units and characteristics come from town-level tax assessment records compiled by the Warren Group for the period 2010 through 2018. These records reflect the near universe of all residential and mixed-use buildings in Greater Boston. Figure A.2 plots the total number of single-family and multifamily units from the Warren Group data against the number of units from the American Community Survey (ACS). The data set contains information on the type of building (whether it is single family or multifamily), the number of units in a property, lot size and building area, the year a property was built, the tax-assessed value, sale value and date of sale, and building characteristics such as number of rooms, bathrooms, etc.[15]

We use this tax-assessor data for pricing information for single-family houses. We do this for two reasons. First, given that we look at the area within 0.3 mile of our regula-

[13] Zabel and Dalton (2011) find that there were 27 changes to minimum lot size regulations in Greater Boston from 1988 to 1997. The towns that adopted these zoning changes had higher house prices and larger lot sizes. Kulka (2020) finds that in Wake County, North Carolina, rezoning requests usually concern minimal amounts of land. Annually, about five rezonings take place. For additional details, see section 4.4.2.

[14] Allowing multifamily zoning by right or by special permit in our sample positively correlates with 0.146 standard deviation in the WRLURI. Correlating only with multifamily zoning by right gives the more intuitive correlation of –0.351 standard deviation in the WRLURI, suggesting that special permits are correlated with strict zoning.

[15] Condominiums are excluded from this analysis because they can have one or more units and so it is not easy to classify them into either single-family or multifamily categories.

tions boundaries, which are, on average, 0.1 mile long, we do not have enough sales data for the 2010–2018 period for our analysis. Second, in our sample, the assessed-value-to-sales-price ratio is similar on both sides of a boundary. Figure A.3 in the appendix plots the assessed-sales ratio for the single-family houses sold (2010 through 2018) against the sales value. The pattern observed in the figure of the assessed-sales ratio being higher for lower-sale-price homes compared with higher-sales-price homes is a nationwide phenomenon documented in Berry (2021). To compare house prices to rents, we follow the procedure laid out by the Bureau of Economic Analysis (BEA) (Katz et al., 2017) and use 6.29 percent of a house's assessed value to obtain the annual owner cost of housing.

Multifamily Rents: Unit- or building-level rental data are challenging to find, especially historical rental data. McMillen and Singh (2020), for instance, use survey data on rent. Data from CoStar provides the historical rental information for buildings with five or more units and detailed information on multifamily building characteristics such as the number of units, floors, year built, lot size, etc. For the buildings that have the CoStar market rent available (18,536 buildings in the 2010–2018 period), we use it directly. For the remaining 112,992 buildings, we impute rent using CoStar characteristics, Warren Group data, and ACS block group characteristics. Appendix A describes the procedure in detail.

3.3 School Attendance Boundaries and Inclusionary Zoning Data

Quality of school is an essential factor for household location (Black, 1999). We are therefore careful in ruling out that this channel drives our estimates. We use the 2016 elementary school attendance area boundaries from the National Center for Education Statistics (NCES) School Attendance Boundary Survey (SABS). We cannot find school attendance boundary information for 15 of the 101 municipalities in the SABS. In the final sample, we exclude these 15 towns. Figure B.4 displays the final sample of 86 towns. Data on Massachusetts's Chapter 40B law come from the Massachusetts Department of Housing and Community Development.[16]

[16] Of the 522 Chapter 40B buildings in the 86 towns in our sample, we geolocate 85.8 percent and match them with corresponding tax assessment records. We do a better job geocoding the multifamily 40B buildings (89.9 percent) than single-family 40B buildings (75.7 percent), for which house numbers are missing to preserve anonymity. Of the Chapter 40B property units, 79.2 percent are in rented multifamily

4. Model and Empirical Framework

To study how land-use regulations affect different types of housing, the number of units in a building, multifamily rents, and single-family house prices, we outline a theoretical framework in Section 4.1, discuss channels of the regulatory effects in Section 4.2, outline the empirical specification in Section 4.3, and discuss the empirical strategy in Section 4.4.

4.1 Theoretical Framework

To understand how various land-use regulations interact and affect the type of housing that is built, the housing supply, and housing costs, we adapt the framework in Turner et al. (2014) to our setting to incorporate both single-family and multifamily housing. In a monocentric model of a city, consider two neighborhoods, L and R, on either side of a regulation boundary at location $x = 0$.[17] At each location within $-\bar{x}$ and $\bar{x}$, land can be developed for single-family or multifamily use. The neighborhoods L and R share a boundary at 0. $p(x, z)$ is the price for a housing unit at location x. The price is also a function of zoning regulation vector $z \in \{z^L, z^R\}$. Vector z denotes whether multifamily zoning is allowed, the maximum building height, and the maximum number of dwelling units per acre in neighborhoods L and R. A higher z indicates less strict zoning regulations. Without loss of generality, we assume that the neighborhood to the left of the boundary is always more regulated than the neighborhood to the right such that $z^L \leq z^R$. We also assume that zoning regulation constraints are binding.

Consumers earn wage w, pay $p(x, z)$ for their chosen location, choose location x, and derive utility $V(x)$ from their location. The utility of a resident is $U(x) = u(w - p(x, z))V(x)$, where $V(x)$ is the utility derived from location x. For ease of discussion, we assume $u(x) = \exp^{w-p(x,z)}$. Consumers choose between living in neighborhood L, neighborhood R, and an outside option location with reservation utility ν. We assume that

buildings.

[17]We focus on a monocentric model of the city because we are characterizing spatial equilibrium within a metro area, and the model allows for changes in equilibrium prices when the housing supply changes due to changes in land-use regulation. This contrasts with the open-city Rosen-Roback model, where changes in housing supply result in cross-city migration, and both prices and amenities adjust to demand by new residents (Almagro and Domınguez-Iino (2019)).

there are no costs associated with moving across locations. In equilibrium, residents are indifferent between all locations within the city.

4.2 Mechanisms behind Supply and Price Effects

Four fundamental mechanisms will result in land value and price differences across regulation boundaries when land-use regulations differ. Consider the *direct effect* of land-use regulations on land value ($V^{direct}(x)$). First, there is the supply effect, where an increase in supply from relaxed land-use regulation would lower prices (movement along the demand curve) on the relaxed (R) side of the boundary, assuming there are no shifts in demand. The direct effect operates by allowing smaller housing units in areas with relaxed regulation. Second, there is the demand effect, where an increase in supply from relaxed land-use regulation would increase prices if the shift in demand outweighs the increase in supply from the relaxed regulation. This is likely to occur in locations near downtown, where land-use regulations are already more flexible, on average, and high demand is not met with sufficient supply.[18] Third, building owners receive a direct effect from relaxed land-use regulations in the form of an increased *option value*, because the land they own can now be used for both single-family and multifamily homes (or different heights, different lot sizes, etc), which increases the future sale value of the land. The direct effect creates a discontinuity at the regulation boundary $x = 0$, creating a step function if $z^L \neq z^R$.

$$V^{direct}(x, z^L, z^R) = \begin{cases} V^{direct}(z^L) & \text{if } x \leq 0 \\ V^{direct}(z^R) & \text{if } x > 0 \end{cases}$$

The fourth mechanism involves the *indirect effect* on land value ($V^{indirect}(x)$) from relaxing regulation if, for instance, households dislike higher density and relaxing regulation increases the supply of housing (Strange, 1992; Turner et al., 2014). In this case, the indirect effect of relaxing land-use regulation on land values and house prices is negative; that is, higher density would reduce prices. The indirect effect ($V^{indirect}$(x))

[18]It could occur as a consequence of shifts in demand *within* the area as well as demand from *new residents* now moving into the area as supply expands (Ahlfeldt and Barr, 2021). In our framework, we restrict attention to the first case.

is continuous at the boundary $x = 0$, as lots close to the boundary on either side are equally exposed to the regulation of the other side. The effect of regulation spillovers on the neighboring side decays as one moves away from the boundary (Irwin and Bockstael, 2002; McConnell and Walls, 2005; Pennington, 2021).

With a general formulation of the utility over income after housing expenditure (U), we define the utility of living in location x, $u(x)$ as a function of both direct and indirect effects of regulation as follows:

$$u(x) = U(w - p(x, z))V^{direct}(x, z)V^{indirect}(x, z). \tag{1}$$

Under the functional form of $U(x) = \exp^{(w-p(x))}$, the land rent gradient is then given by:

$$p(x, z) = w - \nu + \ln(V^{direct}(x, z)) + \ln(V^{indirect}(x, z)). \tag{2}$$

The existing literature uses boundary regression discontinuities (RD) to elicit the willingness to pay for characteristics that differ discontinuously at boundaries, such as school quality (for example, Black (1999)). Suppose housing supply (type and number of units) is the same across the boundary, households have homogeneous preferences and outside options, and neighborhood demand for land is perfectly elastic. If observed and unobserved neighborhood amenities are continuous at the boundary, except for one amenity, such as school quality, one can estimate the willingness to pay for that amenity. In such scenarios, housing supply shifts due to differences in zoning regulations would not affect prices across boundaries.

If households are heterogeneous in their outside options, this generates a downward-sloping demand curve near the boundary (Turner et al., 2014); that is, shifts in supply can affect prices. Outside options can be heterogeneous due to differences in income and affordability of neighborhoods and land-use regulations. For example, land-use regulations change the location of different types of buildings. So, a household looking for an apartment does not have the same outside options as a household searching for a single-family home. Building on this assumption, we now highlight how we study the effects of regulations on prices when the supply and type of buildings change across the boundary.[19]

As highlighted above, land-use regulations affect land values through the direct supply and option value mechanism (V^{direct}) and through the indirect neighborhood composition and density change mechanism ($V^{indirect}$). Figure 2 illustrates these scenarios. Figure 2a demonstrates that the neighborhood density amenity ($V^{indirect}$) is continuous at the boundary but varies away from it. In places with relaxed land-use regulation, more smaller and less expensive units are available compared with areas with strict regulation, but these differences are perceivable only away from the boundary. Figure 2b highlights that the type of housing, in particular, the size of the smallest unit available, decreases at the boundary on the relaxed side of the boundary. [20] Price per unit shifts at the boundary because regulations change the type of housing, even though other amenities at the boundary are continuous.

Close to the boundary, where there is a density spillover from the more relaxed side to the more restricted side, the direct effect on price per unit can be estimated, holding fixed the indirect spillover effect.[21] $x = -C, C$ represent the cutoff distances between the direct effect estimates (V^{direct}) and the indirect spillover effects ($V^{indirect}$). For $-C \leq x \leq C$, we can estimate the direct effect of regulation while amenities remain constant. As one moves away from the boundary, the regulation effect on land valuation cannot be easily disentangled from the direct and indirect effects. Figures 2c-2f highlight the conditions under which we can make statements about the direct and indirect effects.

Figures 2c and 2d show conditions under which households dislike neighborhood density, so the price per unit falls as density increases (if there is no preference for density, the only effect of the regulation is the direct effect). Figures 2e and 2f present the case where there is positive taste for neighborhood density. Suppose the supply effect dominates the demand effect and lowers the price per unit at the boundary, and the indirect effect is negative (Figure 2c). In that case, the framework cannot easily discern

[19] Anagol et al. (2021) also use regulation boundary RD analysis.

[20] In the case of DUPAC, the change in the figure comes from the smaller implied minimum size for the R neighborhood. If the allowable maximum height changes across the boundary, the shift would be in the number of floors.

[21] Turner et al. (2014) study different effects close to and away from the boundary on the same side of the boundary.

whether the indirect effect captures the willingness to pay for density or the supply effect for $x > |c|$. The same is true in the scenario represented in Figure 2f. If the indirect and direct effects have opposite signs (Figures 2d and 2e), the framework can compare a preference for density to the direct effect of regulation for $x > |c|$. Finally, if there is no direct effect near the boundary, the indirect effects are informative about preferences for density away from the boundary.

4.3 Empirical Specification

If one is not interested in disentangling the direct and indirect effects of regulations, Equation 2 can be estimated around the boundaries, as is standard in the literature. However, direct effects of regulations on land valuation can be different from indirect effects in sign and magnitude, and they can elicit different policy responses. We use a spatial RD design and the theoretical framework highlighted above to estimate causal (a) direct effects of regulation on prices and supply and (b) indirect effects on prices (residents' valuations of surrounding residential density). We show our main estimates for a range of bandwidths ($x = -\bar{x}, \bar{x}, -C, C$) and discuss sensitivity with respect to the chosen bandwidth. To estimate the direct effect of the regulation, note that from Equation 2:

$$p(x, z^L) - p(x, z^R) = \ln(V^{direct}(x, z^L)) - \ln(V^{direct}(x, z^R)), \tag{3}$$

if $(-C \leq x \leq C)$ and $\ln(V^{indirect}(x, z^L)) = \ln(V^{indirect}(x, z^R))$. When we take Equation 3 to the data, we estimate the direct effects of regulations in levels rather than differences: The parsimonious regression specification is given by Equation 4

$$Y_{xt} = \rho_0 + \rho_1 1\{\text{Regulation}_x\} + f_x(\text{dist}) + \lambda_x^{seg} + \tau_t + \epsilon_{xt} \quad \text{if} -C \leq x \leq C, \tag{4}$$

where Y_x is the log owner cost of housing for single-family homes and rent for multi-family houses at location x for year t. Regulation_x is either DUPAC, maximum height, multifamily allowed (0/1 dummy), or a combination of these three regulations at location x. ρ_1 captures the effect of the regulations. $f_x(\text{dist})$ is a linear function in distance away from the boundary estimated separately on either side of the boundary. λ_x^{seg} is the boundary fixed effect for boundary segment seg, which captures differences in unobserved amenities at the boundary level, and τ_t is a set of year fixed effects.

The direct effect includes all aspects of regulation that affect prices, including those discussed in Section 4.2. Since house characteristics such as lot size are endogenous to the regulation, we do not control for them in this regression.[22] While land-use regulations also change neighborhoods through sorting of households, right at the boundary, units on either side are subject to the same neighborhood quality.[23]

To study the effects of land-use regulation on housing supply, we use a linear probability version of Equation 4 where Y_x is an indicator for either two- or three-unit buildings or four-plus-unit buildings relative to single-family homes. We focus on buildings constructed after land-use regulations first went into effect for our linear probability model specification, that is, buildings constructed after 1918 or after 1956, which are two critical dates in the history of land-use regulation in Greater Boston (see Section 4.4.2).[24] We also use these years to analyze the endogeneity of the regulations in section 4.4.2.

To estimate the indirect effects of land-use regulations on house prices and rents, we focus on areas away from the boundary ($x > |C|$). From Equation 2 it follows that:

$$p(x, z^L) - p(x, z^R) = \ln(V^{direct}(x, z^L)) - \ln(V^{direct}(x, z^R)) + \ln(V^{indirect}(x, z^L)) - \ln(V^{indirect}(x, z^R)); \quad (5)$$

that is, away from the boundary, prices are a function of both direct and indirect effects. To disentangle the two effects, we estimate the following *hedonic* regression:

$$Y_{xt} = \rho_0 + \rho_1 1\{\text{Regulation}_x\} + \rho_2 \theta_x^{HD} + \rho_3 \theta_x^{GD} + \rho_4 H_x + f_x(\text{dist}) + \lambda_x^{seg} + \tau_t + \epsilon_{xt}. \quad (6)$$

[22]The appendix shows results when we control for the year a property was built, recognizing that structures built at different times can vary in quality and style that are unrelated to zoning regulations.

[23]That neighborhood quality does not change discontinuously at the boundary is a common assumption in the literature and one that we confirm in Figure 3, which shows that distance to various amenities (or dis-amenities) are continuous across regulation boundaries.

[24]See Appendix Tables B.2 and B.3 for results restricted to buildings built before 1956 and for results restricted to buildings built after 1956, respectively.

As in Equation 3, ρ_1 estimates the direct effect of the regulation differences. To study the effects of regulation differences on neighborhood density, for which households have different valuations, we consider two measures: gentle density and high density.[25] Gentle density, θ_{GD}, is given by the share of buildings within a 0.1-mile radius of a given property x that contain two or three units. High density, θ_{HD}, is given by the share of buildings within a 0.1-mile radius of a given property x that contain four or more units. ρ_2 and ρ_3 are the coefficients of interest for estimating indirect effects.

In contrast to how we estimate the direct effects in Equation 3, we follow a traditional hedonic price model and control for a rich set of unit-level attributes affecting prices to estimate indirect effects. H_x is a vector of unit-level characteristics, such as year built, lot size, building area, number of bedrooms, etc. Since neighborhood quality spills over across the boundary, and there is no change in density or neighbors at the boundary, we estimate this specification as a "donut RD" starting at $x = 0.1$ miles from the boundary on both sides. Again, we show robustness with respect to bandwidth choice.

We mention two caveats at this point. First, at present, we do not distinguish between the effect of higher density itself and the effect from changes in neighbor characteristics and neighborhood quality that follow from changes in residential density. Second, in general, we cannot distinguish between a distaste for density and the supply effect of relaxed regulation, both of which lead to negative signs on ρ_2 and ρ_3 in a hedonic model. However, as discussed in section 4.2, interpreting the indirect effects in conjunction with the direct effects allows us to qualify the spillover effects in some cases. In addition, plotting direct effects over space, that is, for various bandwidths, allows us to assess the importance of taste for density, since we expect direct effects of regulations not to change with distance on the same side of the boundary.

Differential Effects of Regulations on Supply and Prices

Not all regulations affect the supply of housing and, therefore, prices in the same manner. Here, we briefly discuss how we expect different regulations and their interactions to affect various housing outcomes. Table 2 guides our analysis. Allowing multifamily housing and the presence of maximum-height regulations affect the *size* and *type* of

[25]We follow Baca et al. (2019) in their concept and definition of gentle density.

housing, conditional on density. Consequently, we expect density and its interactions with other regulations to be the only regulations that increase the number of units directly. Regulations that do not impact supply (in terms of the number of units) are not expected to lower prices through the supply effect.[26] Finally, the impact of residential spillovers is specific to the definition of spillovers used in this paper, that is, the share of homes within a 0.1-mile radius of a building that contain two or three units or more than four units. Therefore, regulations that affect the *type* of housing or the *number of units* should affect this share. The only regulation that affects neither the type of housing nor density is the allowable maximum height on its own.

4.4 Empirical Strategy and Identification

To study the causal effects of land-use regulations on the prices ($p(x, z)$) and the supply of all housing types, we need to address endogeneity concerns. The prices of housing and rent are correlated with the underlying quality of the location, including the unobserved or latent location quality. Thus, we need a source of variation that is orthogonal to the unobserved location amenities for causal price effects. A boundary discontinuity design around the land-use zoning regulation boundaries, under certain conditions, serves this criterion. The identifying assumptions for this empirical strategy are:

1. On either side of the regulation boundary, the type of housing and density differ.

2. Close to the boundary, the unobserved quality of the location does not change, and public amenities and municipal services are continuous along the boundary.

3. The shape and location of the zoning boundary are not endogenous to the location.

To see that the regulation boundaries affect both the number of units built and the type of buildings built across the regulation boundaries, see Section 5.1, Figure 4 and Table 4. Below, we discuss assumptions (2) and (3).

[26]For single-family homes, relaxing any regulation increases the option value of the property; that is, it increases the value of the land by allowing multiple uses.

4.4.1 Amenities along Zoning Boundaries

To ensure that across regulation boundaries, major amenities associated with municipalities, such as taxes, government spending, and town-specific zoning laws on wetlands, do not change, we compare houses across regulation boundaries within municipalities. In addition, for many households, school quality is a primary location amenity that enters their utility. To control for school quality variation, we compare buildings within the same primary school attendance area. Additionally, many regulation boundaries may coincide with significant roads or geographic features. To account for this and keep the latent quality of the location continuous at the boundary, we remove all regulation boundaries or portions of boundaries that overlap with highways, major roads, or geographic features such as rivers, streams, and lakes. We removed about half of the 33,635 total possible zoning boundaries compiled from the MAPC zoning atlas because they overlap with these features, leaving 16,774 eligible boundaries with which to match residential properties. Lastly, we compare buildings within the same broader land-use-type area, either residential or mixed use. Figure 1 plots all the admissible boundaries where the multifamily regulation, maximum-height restrictions, and DUPAC change either by themselves or together.

We check the continuity of amenities across boundaries, excluding the regulation itself, by comparing buildings within 0.3 mile (or less) of the regulation boundaries on either side of them.[27] Figures 3 and B.5 plot the coefficients on the distance bins from regressing building distance to various neighborhood amenities on boundary fixed effects and bins of distance to the boundary (bins of 0.02 mile). Negative distances indicate the more regulated side of a boundary. As can be seen from the figures, the distances to rivers or lakes, the town center, major roads, the assigned primary school, and open space are continuous at the regulation boundaries. To conclude, we compare houses within the same towns and school attendance zones and confirm that neighborhood amenities are continuous at the boundary.

[27] See Section 5.3 for optimal bandwidth selection.

4.4.2 Historical Perspective on Zoning Boundaries

There is a concern that regulation zoning boundaries themselves are endogenous to location or neighborhood quality (Davidoff, 2015). For example, Shertzer et al. (2016) find evidence in Chicago that historic industrial-use zoning was disproportionately allocated to neighborhoods populated mostly by racial minorities. Our analysis compares buildings within the same towns, school attendance zones, and land-use-type areas (residential or mixed use), with the latter controlling for such a scenario. While we control for a location's observed and unobserved amenities such that they do not vary across the land-use regulation boundaries, another potential concern is that these boundaries could have been shaped around the historic building structures of Greater Boston. To address this concern, we study whether the types of buildings built (multifamily or single family) before 1918 or 1956 differ across the present-day observed regulation boundaries.

The cities of Boston and Cambridge first adopted maximum-height restrictions in 1918 (Bobrowski (2002), MacArthur (2019)) following New York's adoption of zoning regulations in 1916. The suburban Massachusetts municipalities of Brockton, Brookline, and Newton adopted maximum-height restrictions in the early 1920s.[28] In addition to 1918, 1956 became a critical year when Cambridge passed the Enabling Act and adopted the first comprehensive zoning code in the area. The linear probability model (LPM) laid out in Equation 4 tests whether present-day regulations predict the type of structures built (either two- or three-unit apartment buildings or four-plus-unit apartment buildings versus single-family buildings) before 1918 or 1956. Table 3 shows the results from the LPM model for buildings constructed before 1918 (see Appendix Table B.2 for buildings constructed before 1956). The types of structure built (single-family versus multifamily) do not vary in any statistically significant ways across boundaries where only density (DUPAC) and multifamily restrictions change. It appears the density and multifamily regulation boundaries were designed around both historic gentle-density (two- or three-unit) and high-density (four-plus-unit) buildings. This is also true, to

[28] See John Hillard, "Newton Takes Aim at Its History of Single-Family Zoning," *Boston Globe*, October 22, 2020, and Knauss (1933). Table B.1 illustrates the year zoning regulations were first adopted (mostly height restrictions) across 42 towns.

some extent, for DUPAC and height boundaries, particularly regarding historic high-density buildings. Therefore, based on these results, we are more confident in the exogeneity of only multifamily, only DUPAC, and DUPAC and height regulation boundaries compared with the boundaries where multifamily and DUPAC restrictions change.

5. Results

5.1 Regulations and Supply

As highlighted in the previous section, individual land-use regulations differ in their effect on the supply of housing (Table 2). Adopting multifamily zoning or relaxing height restrictions does not necessarily result in the building of more units, unless these regulations are accompanied by relaxing density (dwelling units per acre) restrictions.

Following Bayer et al. (2007), we run regressions of the number of units on boundary fixed effects and 0.02-mile bins of distance to the boundary. Positive distances indicate the more relaxed side of a boundary, negative distances the stricter side. We plot the distance coefficients and normalize the first bin on the relaxed side to 0. Figure 4 displays the results.[29] As can be seen in sub-figures (a), (b), and (c) of Figure 4, relaxing DUPAC alone or in combination with allowing multifamily housing or relaxing height restrictions has the largest and most significant effect on increasing supply, as measured by the number of units built. Relaxing DUPAC restrictions alone results in an average increase of 0.43 unit at 0.02 mile from the regulation boundary. Relaxing both DUPAC restrictions and allowing multifamily housing results in an average increase of 0.45 unit, and relaxing both DUPAC and height restrictions results in an average increase of 2.4 units at 0.02 mile from the boundary. For these three regulation scenarios, the effect is persistent farther away from the boundary and precisely estimated up to 0.2 mile from the boundary. While the sizes of these effects may seem small, on average, properties on either side at boundaries where only DUPAC regulations change and both DUPAC and multifamily regulations change contain an average of 1.6 units. Properties at boundaries where both DUPAC and height change contain, on average, 2.6 units. This implies that

[29] See Section 5.3.1 for robustness in bandwidth choice. The optimal bandwidth calculated using Calonico et al. (2020) lies between 0.01 and 0.03 mile for all boundary types and dependent variables. For our figures, the closest-to-the-boundary bins correspond to this bandwidth.

the changes in these three regulation scenarios result in a 27 to 92 percent difference in the supply of units at the boundary.

As expected, we see no effects at boundaries where either only height regulations change or height regulations change and multifamily homes are allowed. The number of units increases by 0.63 unit right at the boundary on the less restrictive side when only the multifamily regulation changes. However, when examining confidence intervals, it is not clear that this effect is persistent away from the boundary. This result is consistent with recent examples of regulatory zoning reforms enacted in Minneapolis, which in 2019 allowed the construction of two- or three-unit houses on land previously zoned for single-family use. The changes to Minneapolis's zoning are very recent, and so it may take time for an increase in housing supply to occur through new construction stemming from these changes. However, recent reporting on the effect of the Minneapolis reforms finds that other regulatory barriers remain in place, preventing denser housing construction. [30]. Indeed, as of August 2021, "only 23 building permits [had] been issued for new duplexes and triplexes in places they would not have previously been allowed."[31]

To study housing supply differences, it is also important to look at the type of housing, because land-use regulation reform might be more effective at increasing the supply of certain multifamily housing types relative to others. To investigate this question, we run a linear probability model (Equation 4) in which the outcome is the type of housing: gentle density (two or three units) or high density (four or more units). We focus on buildings constructed after the adoption of the first height restrictions in 1918, that is, buildings that were not grandfathered in. We interpret the effects of a given regulation as increasing the probability of a certain multifamily house type being built *compared with* single-family housing being built. Table 4 shows the results (see Table B.3 for results after restricting the estimation to buildings constructed after 1956).[32]

[30] See Christian Britschgi, "Eliminating Single-Family Zoning Isn't the Reason Minneapolis Is a YIMBY Success Story," *Reason.com*, May 11, 2022; and Yonah Freemark and Lydia Lo, "Effective Zoning Reform Isn't as Simple as It Seems," Boomberg.com, May 24, 2022.

[31] See MaryJo Webster and Michael Corey, "How Twin Cities Housing Rules Keep the Metro Segregated," *Star Tribune*, August 7, 2021.

[32] See also Figure A.4 for a neighborhood-level housing supply measure.

We find that allowing the building of multifamily homes and relaxing DUPAC restrictions increases the probability of a given property being a gentle-density building versus a single-family home. In particular, column 1 shows that the probability of a gentle-density buildings being constructed more than doubles relative to the baseline when multifamily homes are allowed. Effects for high-density buildings are similarly large but less precisely estimated (column 5), perhaps due to the smaller number of such buildings. Alternatively, this result could indicate that facilitating the supply of larger apartment buildings is complicated by other factors such as higher construction costs and community opposition.

Relaxing DUPAC restrictions by 4.4 units, the average difference across such boundaries, increases the likelihood of gentle-density-housing construction by 14.4 percent (column 2). Similarly, relaxing DUPAC by 6.3 units, the average difference across boundaries where both DUPAC and multifamily zoning regulations change, increases the likelihood of gentle-density construction by 15.8 percent (column 3).

For the supply of high-density buildings, we continue to find a substantial effect of relaxing the number of dwelling units allowed per acre, either alone or together with allowing multifamily housing. Relaxing DUPAC regulations by 4.1 units, the average difference across such boundaries, increases the likelihood of high-density construction by 34.1 percent (column 6). Similarly, increasing DUPAC by 5.9 units, the average difference across boundaries where both DUPAC and multifamily zoning change, increases the likelihood of high-density construction by 78.7 percent (column 7). We find strong effects for boundaries where DUPAC and height regulations are relaxed, but only on the likelihood of high-density construction. This is not surprising, as such boundaries are more likely to be found in areas with more high-density buildings (see Figures 1 and B.6).

In summary, we find that relaxing DUPAC alone and in combination with other regulations (especially allowing multifamily housing) reliably increases the supply of housing units of all types. In contrast, relaxing height regulations alone or in combination with allowing multifamily homes has no such effect. We focus on regulations that interact with density regulations from this point onward because, as highlighted in the previous section, other regulations do not affect supply. We focus on DUPAC regulations and combinations of DUPAC regulations with maximum-height and multifamily regulations. Zoning areas where these regulations interact and differ at the boundary contain 77 percent of the multifamily and 84 percent of the single-family properties in our sample (Table 1).

5.1.1 Spatial Heterogeneity in Supply Effects

So far, we have concentrated on the average treatment effects of a regulation, but these can be heterogeneous across space and vary depending on the distance from the central business district (CBD). For our spatial heterogeneity analysis, we adopt MAPC's definitions for community types (Figure B.7), which classify Greater Boston municipalities into one of four categories: (1) the CBD represents the inner core; (2) suburban municipalities closer to the CBD are mature suburbs; (3) municipalities farther from the CBD are developing suburbs; (4) regional centers sustain their local economy and form somewhat self-contained labor markets. These community types are defined both quantitatively and qualitatively by MAPC. Specifically, inner core communities are defined as high-density areas with essentially no vacant land and very little new development. Maturing suburbs are of moderate density and characterized by a preponderance of single-family homes on large lots. Developing suburbs have low population density, more vacant and developable land, and higher population growth. Regional centers reflect inner core areas in that they have substantial downtown commercial areas. However, these are surrounded by less dense neighborhoods. [33]

We estimate supply effects separately for each of these four types of municipalities. In particular, we estimate the number of units supplied, as in Figure 4, across towns and cities. Figure 5 shows supply effects for various boundaries. The bandwidth for these analyses is 0.2 mile on either side of the boundary. We plot statistically significant coefficients at the 5 percent level. Imprecisely estimated results are displayed in gray.

As shown in Figure 5, we find increases in the number of units across the inner core, the mature suburbs, and regional centers. There are no statistically significant increases

[33] See Metropolitan Area Planning Council, *Massachusetts Community Types: A Classification System Developed by the Metropolitan Area Planning Council*, 2008.

in the number of units in the developing suburbs. A likely explanation is that zoning regulations do not bind in the more sparsely populated areas with undeveloped land. At boundaries where only the DUPAC regulation changes, the inner core sees an increase of 1.5 units on the more relaxed side of the boundary, whereas allowing multifamily housing and changing the DUPAC leads to an increase of 0.5 to 0.7 unit in the regional centers and mature suburbs. As we highlighted earlier, the most significant increase in the number of units occurs at boundaries where maximum-height and DUPAC regulations change together, with 2.6 units added on the relaxed side of the boundary in the inner core and 2.0 units in the mature suburbs.[34] Overall, the results indicate that supply effects are more substantial in areas with more binding regulations due to high demand in the inner core and strict regulations in the mature suburbs.

5.2 Direct Effects: Single-Family-House Prices and Multifamily Rents

5.2.1 Direct Price Effects of Regulations

We now discuss how land-use regulations affect the prices of single-family homes and rents for multifamily apartments. It is possible to consider the effect on single-family house prices only when multifamily restrictions are relaxed alone or in combination with height or DUPAC regulations because, by our definition, in areas where multifamily housing is not allowed, there are no multifamily rents for comparison. See Appendix Figure B.8 for the impact of other regulations (excluding DUPAC) on house prices and rents.

Figure 6 plots the effects of regulations on the log of house prices (monthly owner cost of housing) for single-family (SF) homeowners and monthly rents for multifamily (MF) renters.[35] When only DUPAC regulations are relaxed, monthly rents for multifamily properties 0.02 mile from the boundary are 5.4 percent lower on the less restrictive side compared with rents on the stricter side. This represents an average monthly rent that is 12.6 percent, or $144, lower per unit. The monthly owner cost for a single-family

[34] The effects at boundaries where both the maximum-height and DUPAC regulations change are not statistically significant at the 5 percent level (t-statistics are 1.63 to 1.92). Nevertheless, we plot them because price effects at these boundaries are precisely estimated.

[35] The boundaries for multifamily and single-family homes are comparable. Less than 1 percent of properties in the sample lie at boundaries with no multifamily homes. Less than 2 percent of properties lie at boundaries with no single-family homes on either side.

property falls an average of 7.2 percent (or 16.7 percent ≈ $425 per unit added).[36] Given that there is also an option value for single-family homes, which increases the price when regulations are relaxed, we conclude that for single-family homes, the supply effect of density regulations is stronger than the option value effect.

When DUPAC is relaxed and multifamily construction is allowed, we can consider only the effect on single-family homes, because multifamily homes are directly banned on the strict side of the boundary (Figure 6(c)). Monthly owner costs of single-family housing fall by 4.1 percent right at the boundary on the more relaxed side, with an increasing gradient as we move farther away, indicating that negative externalities of density take over away from the boundary. These effects are substantial, amounting to a 9.2 percent drop in monthly owner cost for each unit added (a decrease of $204 per month). As before, the house-characteristics effect (C) seems to outweigh the option-value effect (B) of relaxed regulation.

When DUPAC and building-height regulations change together, rents fall an average of 6.2 percent at the boundary, while there is no detectable effect on the prices of single-family homes. Because the number of units added on the relaxed side of this boundary type is more than two, the per-unit decrease in rent is smaller, at 2.6 percent, or $27. Monthly owner costs drop 0.7 percent, or $16, though this effect is not statistically significant even near the boundary. These findings are further borne out in Table B.4, where we find negative effects on rents driven by the supply effects of DUPAC (we do not expect a change in maximum-height regulations alone to have a negative effect on prices). Returning to Figure 1, we see that boundaries where DUPAC and maximum-height regulations are relaxed together tend to be concentrated in the inner core, where there are fewer single-family homes (Figure B.6). Therefore, it is not surprising that we find a more substantial impact of this regulation type on rents than on home prices.

In Section 4.4, we showed evidence of the exogeneity of zoning regulations, in particular of maximum-height and DUPAC regulations. Nevertheless, supply can vary substantially from year to year in terms of its quality and type; that is, more recently built

[36] Table B.4 displays the per-unit difference in prices: a 0.1 percentage point decrease in rent and a 0.2 percentage point decrease in the price of a single-family home.

multifamily properties might be more likely to be luxury apartment buildings. This type of variation may not be related to regulations and can bias the direct effects. Table B.5 shows results from Equation 4, in which we control for the year built. We find that compared with the results from Table B.4, there are no quantitative differences in the effects on rents when we control for the year built. We find that the magnitudes of the effects are similar for single-family-house prices, except for the effect of allowing multifamily homes, which shrinks considerably, suggesting that housing characteristics change systematically over time along these boundaries.

5.2.2 Regulations and Building Characteristics

In the regulation-change scenarios discussed above, the direct effect of relaxing zoning operates through the supply of smaller units. Since there is no change in amenities at the boundary, these characteristics should be driving a large part of the price differences. Figure 7 corroborates this mechanism. We find, relative to the mean at boundaries where only DUPAC changes, a 3.9 percent decrease in the number of bedrooms and a 9.5 percent decrease in the number of bathrooms. At boundaries where multifamily homes are allowed and DUPAC changes, we find a a 6.5 percent decrease in living area square footage. The lot size is defined at the building level for both apartments and single-family houses, which explains why there is no effect seen in Figure 7d. Appendix Figures B.9 and B.10 further corroborate these results. Interestingly, we find almost no differences in unit characteristics at boundaries where maximum-height and DUPAC regulations change. Consequently, these boundaries seem to represent the cleanest shift in just the supply of homogeneous units.

5.2.3 Spatial Heterogeneity in Direct Price Effects

Here we highlight the spatial heterogeneity in direct price effects. We estimate the direct price effect per unit supplied by estimating the effects of the regulation combinations shown in Figure 6 on prices and divide each effect by the first stage supply effect (–0.2 to 0.2 bandwidth). Results are plotted in Figure 8 by community type.

Rents and house prices each fall 4.6 percent in the inner core at boundaries where only DUPAC changes (top panel). At boundaries where multifamily regulations and DUPAC change together, we find house prices fall 9.9 percent per unit in mature suburbs and 9.5 percent in regional centers, indicating that this combination of regulations might be a promising path to reducing prices in established suburbs from which many households commute to the inner core. We find no precisely estimated direct effects on rents under this regulation scenario. The bottom left panel shows that at boundaries where maximum-height and DUPAC regulations change together, there is a substantial effect on rents in the inner core (a decline of 3.3 percent per unit) and an even greater effect in the mature suburbs (a decline of 9.7 percent per unit). Rents fall increasingly the greater the distance from inner core, as in a monocentric city world and consistent with the results in Section 5.2. Note that the spatial pattern in the fall in prices is inverse to the increase in the number of units (Figure 5), demonstrating that, post zoning reform, more units are added in the inner core than in the suburbs, but prices are less likely to fall in the inner core due to higher demand. These figures show that the greatest potential for reducing rents and house prices lies in the mature suburbs rather than the inner core.

Summing up, we find that supply effects dominate demand effects (and the option value) when density regulations are relaxed. We find that relaxing DUPAC regulations while also allowing multifamily housing strongly impacts house prices but not rents. When both DUPAC and maximum-height regulations change, we find strong supply effects on rents and none on the prices of single-family homes. Comparing the effects on single-family-home prices (for example, Figure 6b) with those on multifamily rents (for example, Figure 6a), we see a steeper price gradient for single-family home prices farther away from the boundary compared with the gradient for rents.[37] This leads us to the discussion of indirect effects of land-use regulations.

5.3 Indirect Effects: Housing Prices and Rents

In this section, we study the indirect effects of the regulations, recognizing that zoning regulations can alter a neighborhood's perceived quality by changing its demographics and density. For example, increasing housing supply through DUPAC increases density and indirectly lowers housing costs if people prefer to live in less dense areas. This

[37] Figures A.5 and A.6 address the concern that these gradients might be driven by the next-closest regulation boundaries.

difference in housing costs can be considered a willingness to pay for density.

As highlighted in Section 4.2, if the supply effect dominates (Figure 2c) and the indirect effect is negative, the model cannot distinguish between the willingness to pay for density and the overall supply effect. These two effects cannot be disentangled without an additional factor that affects willingness to pay but not the neighborhood housing supply or density (or vice versa). In addition, there is sorting of different types of households to each side of the boundary, with potentially different degrees of willingness to pay for the same neighborhood. This section offers two methods for studying which of the two effects—supply or willingness to pay—dominates farther away from the boundary. The analysis can not directly distinguish between the effects of density per se, that is, the impact of open space and the effects of higher residential density leading to different neighborhood demographics.

5.3.1 Bandwidth Analysis

We begin by showing how the direct effect estimates vary with bandwidth choice. This analysis is more than a check of robustness concerning bandwidth selection; the distance from the boundary meaningfully alters the economic interpretation of the treatment effect of the regulation, because the interpretation incorporates spillover effects. Figure 9 plots the direct effect for the three main regulation scenarios for bandwidths ranging from 0.05 mile to 0.35 mile from the boundary in increments of 0.05 mile, following the recent literature (Shanks, 2021; Severen and Plantinga, 2018).

For renters (left panels of Figure 9), we find that the direct effect of bandwidth choice on rents is less sensitive compared with what it is for homeowners across all regulations. The relative stability of these coefficients across different bandwidths implies that taste or distaste for density is less likely to be significant for renters compared with homeowners. If this were not so, as the residential density changes away from the boundary, we would find different direct effect coefficients for renters.[38] In addition, these plots look similar to those in Figure 2e, which depicts the case where there is little to no preference for residential density. From these figures, we hypothesize that we will not see

[38]The coefficient at 0.05 mile from the boundary slightly diverges but is not statistically different from the others. Note that this is a minimal bandwidth with few properties and that the overall effects at that bandwidth are precisely estimated (see Figure 6).

strong effects on rents when we estimate Equation 6 (Section 5.3.2).

Results for owners are in the right panels of Figure 9. The choice of bandwidth matters for the size of the direct regulation effect, except for boundaries where maximum-height and DUPAC regulations change together. Such a change continues to show no impact on house prices close to the boundary. However, this is not the case for larger bandwidths that encompass more single-family homes farther from the boundary. The larger the bandwidth, the more negative is the effect of increased density on single-family-house prices (Figure 9d). This suggests that like a uniform supply effect, single-family households' *distaste* for density manifests more at an increased distance from the boundary.[39] This case corresponds to Figure 2c. Based on these figures, we expect to find a negative coefficient for residential density in Equation 6 for single-family-house prices.

5.3.2 Estimating Price Effects away from Boundary

The findings from bandwidth selection are supported by Table 5, which reports the results from estimating Equation 6. Here, buildings are considered within 0.1 to 0.3 mile of the zoning-area boundary (see Table B.6 for alternative bandwidths). Table 5 highlights the indirect price effects for different neighborhood densities—the share of buildings that are high density (four-plus units, θ_{HD}) and the share that are gentle density (two or three units, θ_{GD}) within a 0.1-mile radius of a property. We find a wide range of coefficient sizes for multifamily-housing renters—almost none of which are precisely estimated, corroborating the findings in the bandwidth analysis that there is no significant preference for residential density among multifamily-housing renters (Table 5 top panel). Therefore, the only effect of regulations on rental prices manifests through the direct effect of an increased supply.[40]

The bottom panel of Table 5 highlights the extent to which owners of single-family

[39] Density is not disliked everywhere. Anagol et al. (2021) find positive taste for density in Sao Paulo.

[40] The only precisely estimated indirect effect is a 0.1 percentage point decrease in rents for a 1 percentage point increase in the gentle-density share within a 0.1-mile radius of the buildings at boundaries where density regulations change. The average DUPAC at such boundaries is lower (12.1 units) than the average DUPAC at boundaries where multifamily and density regulations change (17.3 units) and maximum-height and DUPAC regulations change (27.8 units). Given sorting by heterogeneous households around different boundary types, renters in lower-density areas may have greater distaste for density.

homes might dislike living near higher-density buildings. These coefficients are negative and generally precisely estimated. As the bandwidth analysis suggests, we find sizable negative effects of increasing gentle neighborhood density on owner costs of housing at boundaries where density regulations change either alone or with multifamily-zoning and/or maximum-height regulations.[41] A 1 percentage point increase in the gentle-density share results in a 0.17 (0.21) percentage point fall in home prices at boundaries where only the DUPAC regulation (DUPAC and multifamily regulations) changes. This is not surprising given that these boundaries have, on average, higher density (10.3 units per acre) than the other boundaries (5.2 units per acre when only DUPAC regulations vary and 6.7 units per acre when DUPAC and multifamily regulations vary).

When evaluating different zoning reforms, it is crucial for policymakers to consider the direct and indirect effects to avoid the pitfalls of new construction that are associated with neighborhood opposition. Relaxing DUPAC restrictions alone or in combination with multifamily zoning increases supply and decreases rents and single-family-house prices. In contrast, relaxing DUPAC and maximum-height restrictions in higher-density areas reduces rents but not single-family-house prices through direct or indirect channels. Given the bandwidth analysis and indirect-effects analysis, one can reasonably conclude that single-family residents, unlike multifamily residents, do not like living in higher-density areas. These estimates align with households that dislike density sorting into suburban areas and households with less distaste for density sorting into urban centers.

5.3.3 Spatial Heterogeneity in Indirect Price Effects

In this section, we estimate indirect price effects separately by community type. It is likely that indirect effects of regulations are greater in areas that exhibit more resistance to multifamily homes. Indirect effects are estimated following Equation 6 (0.1 to 0.3 mile on each side of a boundary). Figure 10 plots the indirect price effects for homeowners. The effect of density on house prices in mature suburbs is unambiguously

[41] Counterintuitively, the magnitudes of the negative effects are larger for gentle neighborhood density than for high neighborhood density, implying that homeowners dislike two- or three-unit buildings in their immediate vicinity more than they dislike four-plus-unit buildings. Figure B.6 shows this implication is likely inaccurate and that the finding instead indicates that single-family homes rarely lie directly next to high-density properties.

negative for both high and gentle neighborhood density and across boundary types. We find the largest negative effects in mature suburbs for gentle density at boundaries where maximum-height and DUPAC regulations change together. Notably, we do not find precisely estimated negative effects for homeowners in municipality types other than mature suburbs. This finding, when paired with the previous results, implies that while mature suburbs have the greatest potential for increasing supply and lowering prices, such change is likely to come at the cost of homeowners' perceived neighborhood quality. Figure B.11 shows corresponding indirect effects for renters. While there is no impact in mature suburbs, we find negative effects of residential density in developing suburbs across boundary types. This result is puzzling because we do not find strong price or supply effects in these areas. A potential explanation involves the sorting of renters into developing suburbs who might be similar to homeowners in their preference for low-density areas.

6. Policy Effects of Relaxing Land-Use Regulations

We can apply the estimates we calculated previously to recent Massachusetts zoning reforms and estimate the potential effect of these reforms. Specifically, in this section, we evaluate the effects on housing costs of a small change in the land-use regulation within a 0.3-mile radius of select train stations in Greater Boston. This exercises is based on the 2021 Massachusetts Chapter 40A law (the Zoning Act) amendment requiring certain communities along transit lines to zone for multifamily development and allowing density of at least 15 units per acre near metro transit stops.[42] This experiment relaxes regulations on the stricter side of the boundary (L) up to location $\bar{x}$ while holding the regulations on the relaxed side fixed. The new vector of land-use regulations is denoted by z_1^L, and the old vector is denoted by z_0^L, such that for each location x for $\bar{x} < x < 0$, $x(z_1^L) = x(z_0^L) + \Delta$. $\bar{P}_1(\bar{x})$ and $\bar{P}_0(\bar{x})$ denote the average final and initial housing costs. $\bar{P}_i(\bar{x})$ is defined as $\bar{P}_i(\bar{x}, z_i^L, z_i^R) = \frac{1}{\bar{x}} \int_0^{\bar{x}} p(x) d(x)$ for $i = 0, 1$. The average change in

[42]Relaxing zoning regulations near mass transit stops has been proposed as a solution for reducing the high cost of housing in Greater Boston (Crump et al., 2020).

housing costs near the transit stations is given by:

$$\Delta \bar{P}(\bar{x}) = \frac{1}{\bar{x}} \int_0^{\bar{x}} \Big(\ln(V^{direct}(x, z^1)) - \ln(V^{direct}(x, z^0)) + \ln(V^{indirect}(x, z^1)) - \ln(V^{indirect}(x, z^0)) \Big) d(x). \tag{7}$$

Figure 11 plots the average change in monthly owner costs and rents from relaxing land-use regulations near 23 metro and commuter rail transit stops across Greater Boston. We picked transit stations that reflect various community types and regulation scenarios. Following Equation 7, we calculate the difference in prices from the time of the old regulations to the time of the new ones, stemming from the sum of differences in direct and indirect effects. We calculate the price effects for a 10 percent relaxation in DUPAC, a 10-foot (one-floor) increase in the allowed maximum height, and a switch from not allowing multifamily housing to allowing it (0 to 1). We take into account the land-use-regulation scenario and regulation levels currently in place at the location of a given transit station and calculate the price effects of a regulation change within 0.3 mile of that station. To estimate changes in indirect effects, we calculate the implied changes in the supply of two- or three-unit housing from Equation 4 and value this change using ρ_3 in Equation 6.[43]

As shown in Figure 11, monthly owner costs and prices fall by as much as $770. The figure plots changes in housing costs for the regulation scenario with the greatest impact. A small-scale relaxation of land-use restrictions almost always lowers house prices, but rents fall intermittently; the yellow points representing results with no statistical significance.[44] The decrease in rents and owner costs are smaller (not more than $100 per month) in inner-core communities. Housing costs decrease more in the mature suburbs (such as the areas around the Needham Heights station in Needham and the Wellesley Hills and Wellesley Square stations in Wellesley). The Wellesley Square station example, in particular, shows that changing maximum-height and DUPAC regu-

[43] In spatial heterogeneity analysis, we do not find statistically significant effects on the supply of four-plus-unit housing. Therefore, we focus on the supply of two- or three-unit housing.

[44] Molloy et al. (2020) also find that zoning regulations increase house prices more than rents because supply constraints increase the expected future rent.

lations together can lead to significant rent decreases ($530 per month) with almost no decline in house prices ($15 in monthly owner costs). Allowing multifamily housing and increasing DUPAC near the Wellesley Hills station would significantly decrease house prices ($766 in monthly owner costs), while increasing the allowed maximum height in combination with the allowed density would reduce rents by $600. Circling back to Massachusetts Chapter 40A, after a 10 percent relaxation in DUPAC and a change to allow multifamily homes, the area around the Newton Highlands station in Newton and the Swampscott station would reach densities of more than 10 dwelling units per acre, considerably closer to the statutory minimum of 15 units per acre. The other municipalities in the mature suburbs that we consider in this calculation are even further away from reaching this threshold. In many of those towns, reaching 15 dwelling units per acre would require a fivefold or greater increase in the allowed density, which is far from the small changes that we can consider within our framework. Overall, our estimates highlight that zoning reforms such as those included in the recent Massachusetts Chapter 40A amendment can make housing near public transportation more affordable by lowering housing costs. However, the eventual impact of this reform depends highly on how it is implemented at the local level.

7. Other Local Barriers to Reducing Housing Costs

7.1 Local Town Governance and Land Regulations

Local governments in the eastern and Midwestern U.S. states set zoning laws and review new housing projects at the municipality level. The four types of local governments in Massachusetts are the mayoral system (governing municipalities that include 40.87 percent of the sample properties), town manager system (7.26 percent), open town meeting (OTM, 18.93 percent), and representative town meeting (RTM, 32.94 percent). The OTM and RTM structures are more common in smaller towns (see Figure B.12). These local governance structures have different approval processes for new construction. For example, in an OTM, any local voter can attend meetings and vote on zoning matters, whereas voters select representatives to attend meetings and vote on zoning issues in an RTM, a town manager system, and a mayoral system. Thus, one can expect heterogeneity in the supply and price effects of zoning regulations across different forms of local governance. While we do not observe changes in town governance structure in our sample, we run our housing supply and price analysis separately by local governance structure. These results should not be interpreted as causal effects of governance structure.[45]

For municipalities with an OTM or mayoral structure, we find positive effects of increasing dwelling units per acre on both the gentle- and high-density supplies (Appendix Table B.7). We also find that allowing multifamily homes in combination with relaxing DUPAC restrictions increases both the gentle- and high-density supplies. However, we see much smaller and imprecise effects for towns with an RTM.

Municipalities with an OTM or a mayor see the highest increase in supply from relaxed regulation. Under a mayoral system, multifamily rents fall 4.6 percent when DUPAC increases by an average of 15.3 units (Appendix Table B.8). Single-family-home prices fall 8.7 percent and 1 percent when DUPAC increases by an average of 5.1 units under an OTM and mayoral structure, respectively. Similarly, along boundaries where both multifamily homes are allowed and DUPAC is relaxed, price effects are less pronounced for multifamily rents (though still negative) than for single-family-home prices. The fall in single-family-home prices at the boundary is 8.7 percent for an OTM, 7.0 percent for an RTM, and 4.3 percent for a mayoral system.[46] Additionally, we find indirect price effects along boundaries where only the DUPAC regulation changes and where both the DUPAC and multifamily regulations change. Preferences for higher density are negative throughout, particularly for single-family home prices, meaning residents dislike living in denser neighborhoods and this is reflected in lower home values. The magnitude of the effect is greater for municipalities with a mayor or RTM than for those with an OTM.

That relaxing zoning regulations would have a larger effect under a mayoral structure is in line with recent literature finding it is harder to build multifamily housing in

[45]We show results for boundaries that are the most represented across all types of towns and governance structures (DUPAC, DUPAC and multifamily). The town manager system is omitted due to the small sample size.

[46]The effect is calculated by allowing multifamily homes (0 to 1) when the average DUPAC is 4.0, 4.7, and 15.6 units, respectively.

places with a more representative town structure (Hankinson and Magazinnik (2020)). However, in our analysis, towns with an OTM structure also saw positive effects of relaxing regulations, even though this type of local governance invites the highest amount of input from residents. Our explanation for this result is that towns with an OTM model of governance have very little multifamily housing overall, and when it does exist it is highly concentrated in specific areas. Thus, relaxing zoning regulations is likely to have a greater effect because any additional unit of multifamily housing represents a large percentage increase in supply. This has more to do with the current types of homes available in OTM municipalities than it does with the effects of an OTM itself. As with our experiment of relaxing zoning regulations around transit stops, how zoning reforms are implemented matters a great deal, and municipal governance structures are key determinants of implementation. Understanding these effects has important policy implications, because relaxing regulations will have different impacts when channeled through different forms of town governance.

7.2 Inclusionary Zoning and Land-Use Regulations

Relaxing zoning regulations is just one tool available to policymakers seeking to expand the supply of housing. Inclusionary zoning laws such as Massachusetts's Chapter 40B represent an alternative.[47] To examine how Chapter 40B affects housing affordability, we study the effect that zoning differences have on the supply of Chapter 40B properties. We test if inclusionary zoning is a substitute for or complement to relaxed land-use regulations using Equation 4.[48] Results are presented in Appendix Table B.9 for boundaries where all three key regulations change, as these are the only boundaries where we find precise effects, given that Chapter 40B buildings are concentrated near city centers (Figure B.6) where this type of boundary is also found (Figure 1).

Chapter 40B single-family houses are constructed only in areas where multifamily

[47] Note that Chapter 40B is not foolproof, as projects approved under this type of law can face community opposition, and many local approvals are overturned later by state courts in lengthy litigation processes that reduce incentives for developers to use this method. See Zoe Greenberg, "Governor Baker Wants More Housing. A Fight in His Backyard Shows How Hard That Will Be," *Boston Globe*, September 26, 2021.

[48] We use a wider bandwidth ($C = 0.5$ mile) for these regressions since we were able to identify only 522 Chapter 40B buildings across 86 municipalities and even fewer around regulation boundaries.

zoning is not allowed. Chapter 40B multifamily apartments are constructed only in areas where multifamily zoning is allowed (the likelihood of a Chapter 40B multifamily building being constructed increases 0.8 percentage point). Thus, Chapter 40B acts as a complement for relaxing multifamily zoning, at least for multi-unit buildings. When multifamily housing is allowed and maximum-height and DUPAC restrictions are relaxed, the supply of all Chapter 40B buildings increases. In particular, the supply of affordable *multifamily* buildings increases by 2.1 to 25.2 percentage points.[49] Thus, Chapter 40B has acted as a complement to more relaxed land regulation.

Given the estimates from Table B.9, the total increase in the probability of a Chapter 40B multifamily building being constructed is 28.9 percentage points if we sum over all the joint effects when all three regulations change.[50] The estimate of a 28.9 percentage point increase represents an upper bound of approval rates, and in many areas this approval probability is likely to be close to zero given that in many municipalities we observe no Chapter 40B buildings. Given this probability, to increase the current Chapter 40B multifamily building stock by 50 percent to 141 buildings, an estimated 488 building applications would need to be filed, based on the approval rate cited previously. Since developers are unlikely to produce such a large number of applications, the approval probability would need to increase substantially for inclusionary policies such as Chapter 40B to contribute in a meaningful way to housing affordability. In addition, new Chapter 40B buildings are more likely to be built in less regulated areas, complementing relaxed land-use regulations and inclusionary zoning.

8. Conclusion

This paper highlights which zoning regulations might be most effective at increasing the supply of multifamily housing and reducing housing costs, thereby contributing to broader housing affordability. We find that relaxing density restrictions alone and in combination with relaxing maximum-height restrictions and allowing the construction

[49] The effect of relaxing DUPAC by an average of 17.4 units across the boundary is a 2.1 percentage point increase in the supply of affordable multifamily buildings. The effect of relaxing maximum-height restrictions by an average of 2.1 floors across the boundary is a 25.2 percentage point increase.

[50] Fisher (2007) finds that 44 percent of the 369 40B applications filed during the 1999–2005 period resulted in buildings being constructed. The remaining 205 applications were either not approved, approved but appealed, or approved but no building was constructed

of multifamily homes are the most effective ways of increasing the supply of multifamily buildings and reducing multifamily rents and single-family-home prices. However, allowing multifamily housing alone without increasing density is less likely to increase the supply of apartments and lower rents. Furthermore, the fall in prices from relaxed regulations comes from two sources: directly from the change in regulation, which changes the size and types of housing built in an area, and indirectly through changes in neighborhood density. Therefore, while lowering housing costs through zoning reforms may help first-time homebuyers and lower-income renters, it comes at the expense of—and thus will likely generate substantial political opposition from—current homeowners.

In addition, our results indicate that the impact of relaxing regulations on supply and prices is filtered through spatial and local governance differences. In line with this conclusion, we find that making small changes to zoning regulations, such as relaxing DUPAC by 10 percent near transit stations, could reduce monthly house costs and rents by as much as $770 (with an average decrease in monthly rent of $123 and an average decrease in monthly owner cost of $247); the decreases in the suburbs of Boston would be larger than those in the inner core. One should note that even with less strict zoning, very low-income households may not find housing affordable, so relaxing land-use regulations does not substitute for offering rent-subsidized housing.

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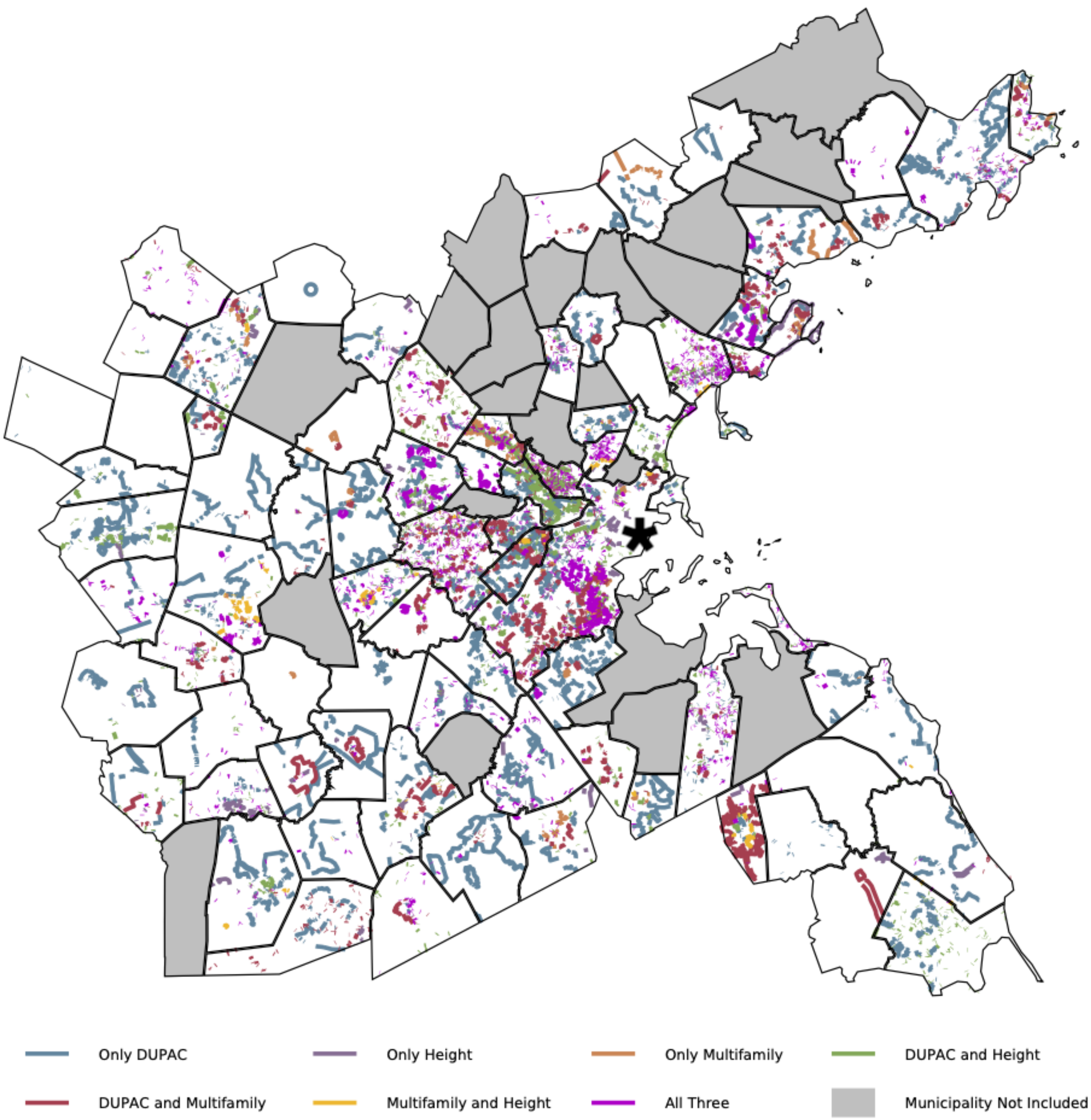
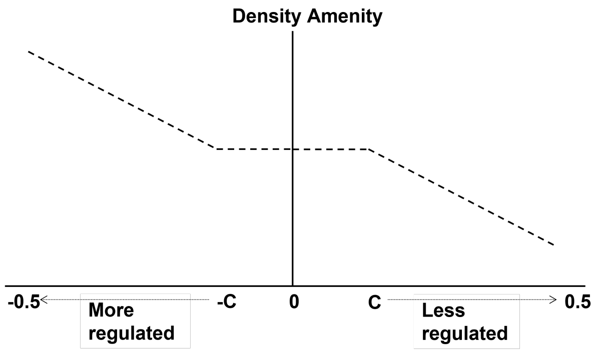
Figure 1: Admissible Boundaries with Land-Use Regulation Changes

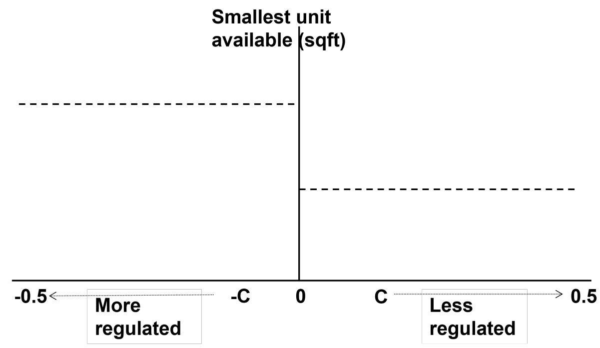


Note: This map shows the boundaries where the multifamily (MF) regulation, maximum-height restriction, or dwelling units per acre (DUPAC) restriction changes either by itself or in a combination with other regulations. These boundaries do not include regulations boundaries that overlap with major roads or geographic features. The base maps for these boundaries can be found in Appendix Figures B.1, B.2, and B.3. * denotes city of Boston.
Source(s): 2020 Metropolitan Area Planning Council Zoning Atlas.

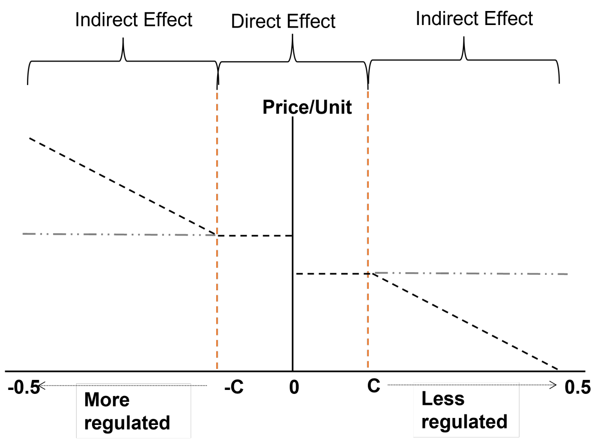
Figure 2: Price Effects at the Regulation Boundary



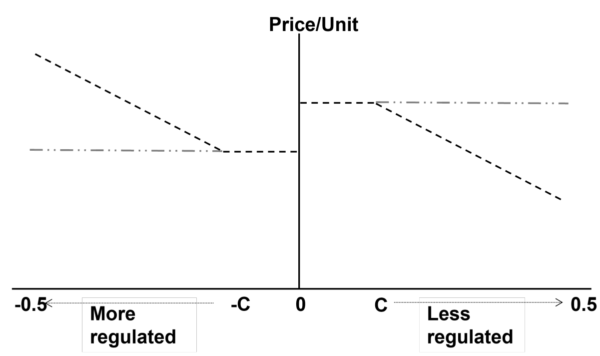
(a) Density amenity



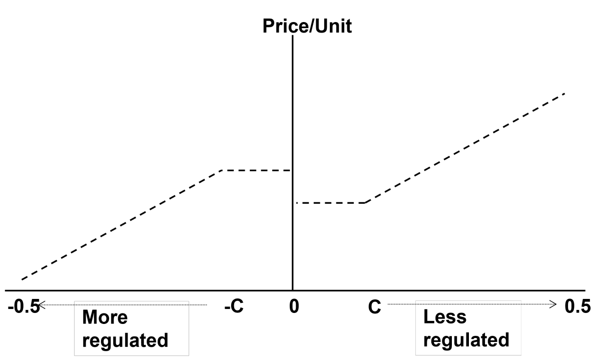
(b) Smallest available unit



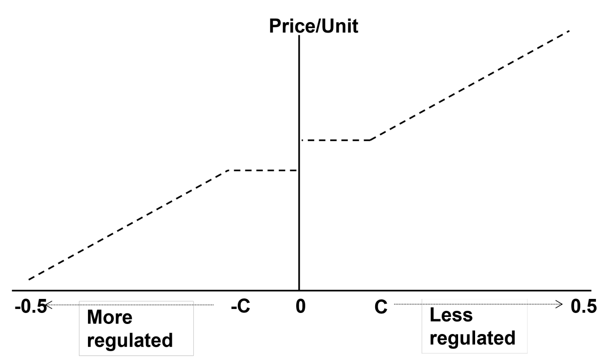
(c) Supply dominates & distaste for density



(d) Demand dominates & distaste for density



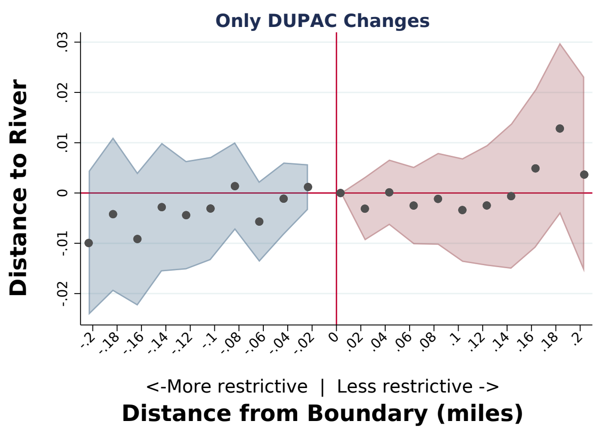
(e) Supply dominates & taste for density



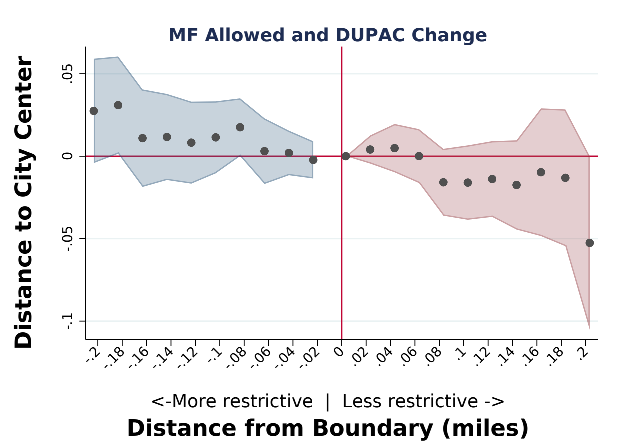
(f) Demand dominates & taste for density

Note: This theoretical figure shows how amenities (a) and supply (smallest unit available) (b) change across regulation boundaries. Subfigures (c) through (f) illustrate how price per unit changes across regulation boundaries.

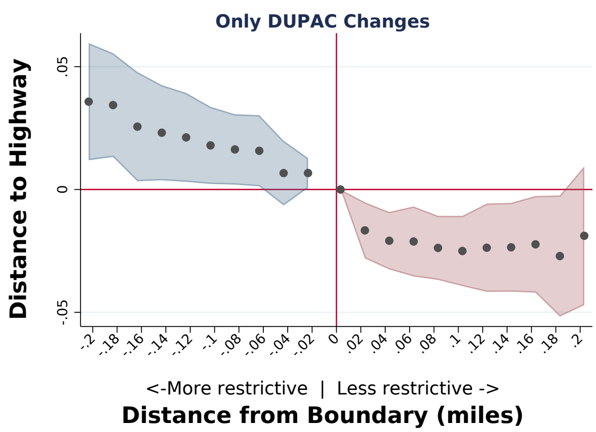
Figure 3: Amenities at Regulation Boundaries



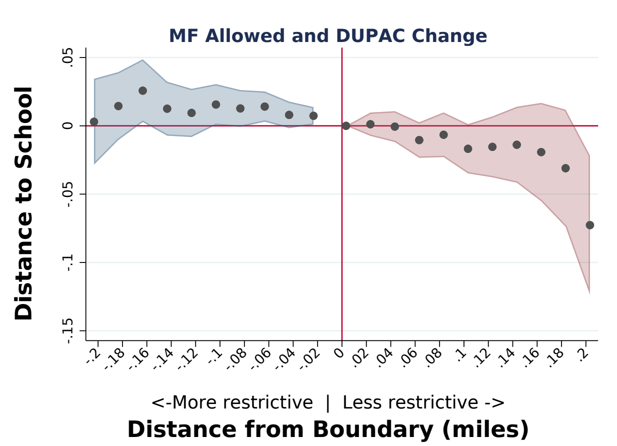
(a) River/Lake RD estimate = 0.001, (t stat = 0.52)



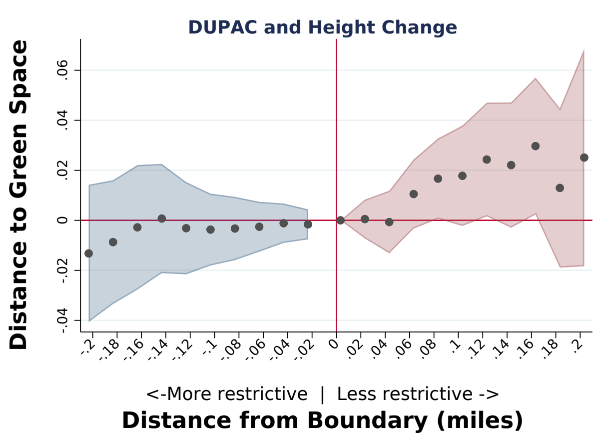
(b) Center RD estimate = -0.002, (t stat = -0.39)



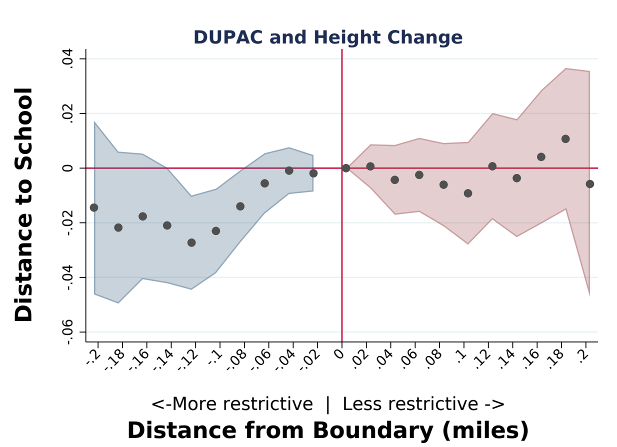
(c) Road RD estimate = 0.007, (t stat = 2.16)



(d) School RD estimate = -0.007, (t stat = 2.25)



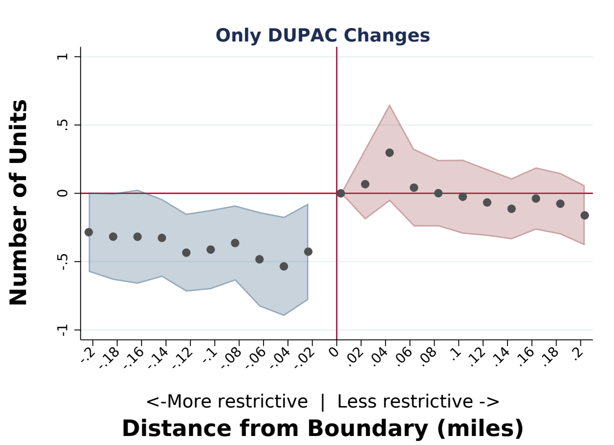
(e) Open Space RD estimate = -0.002, (t stat = -0.52)



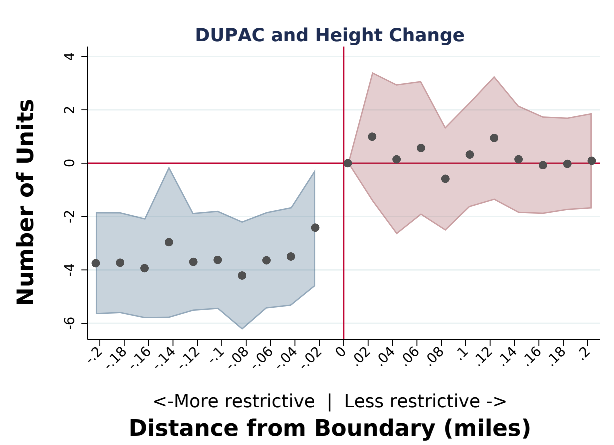
(f) School RD estimate = -0.002, (t stat = -0.56)

Note: Plots are created by regressing distance to amenities on boundary fixed effects and distance to boundary (bins of 0.02 mile). Coefficients on distance bins are plotted. Negative distances indicate more regulated side. Bin closest to boundary on less regulated side (0–0.02 mile) is normalized to 0. 95 percent confidence intervals are shown. DUPAC is dwelling units per acre, and MF is multifamily zoning.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

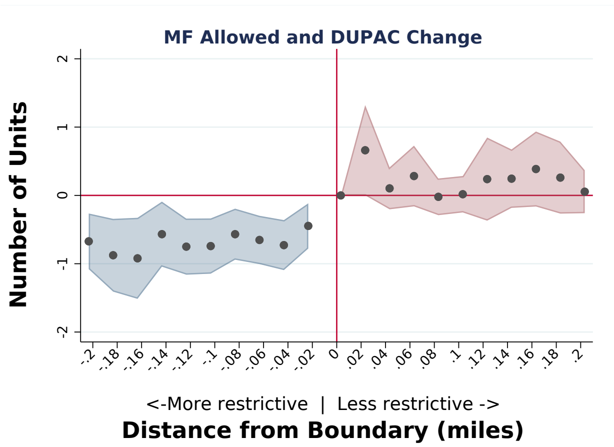
Figure 4: Effect of Regulations on Supply of Units



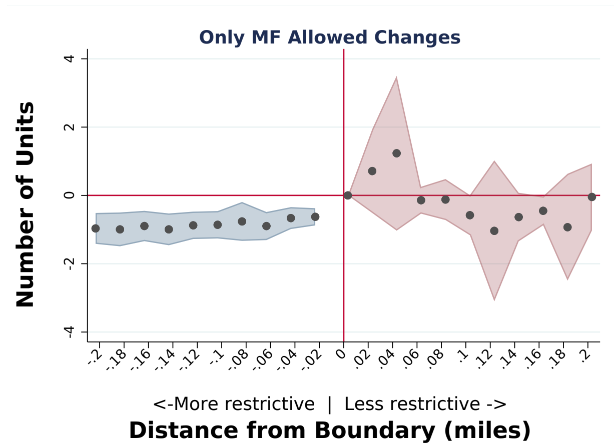
(a) RD estimate = -0.427, (t statistic = -2.37)



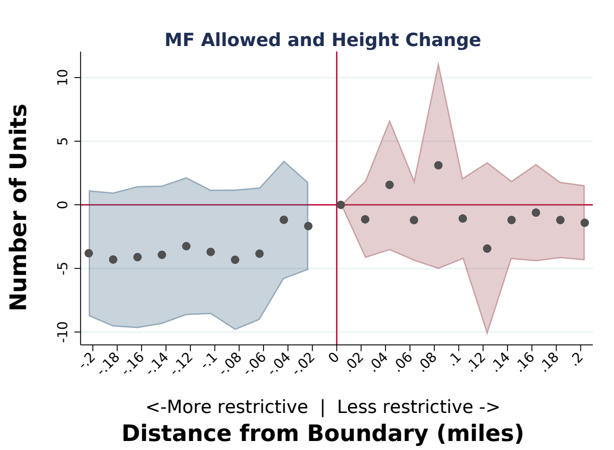
(b) RD estimate = -2.415, (t statistic = -2.17)



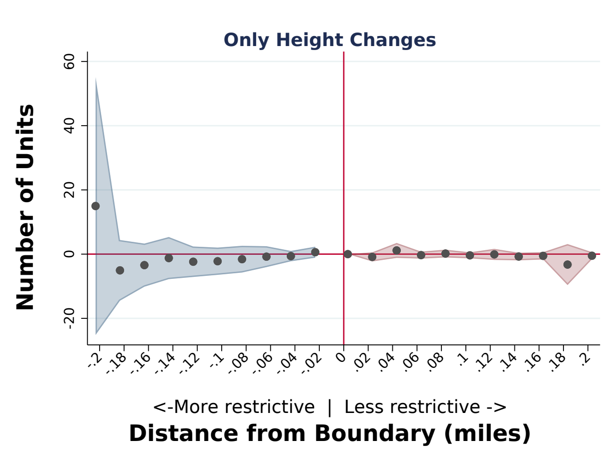
(c) RD estimate = -0.447, (t statistic = -2.65)



(d) RD estimate = -0.626, (t statistic = -4.90)



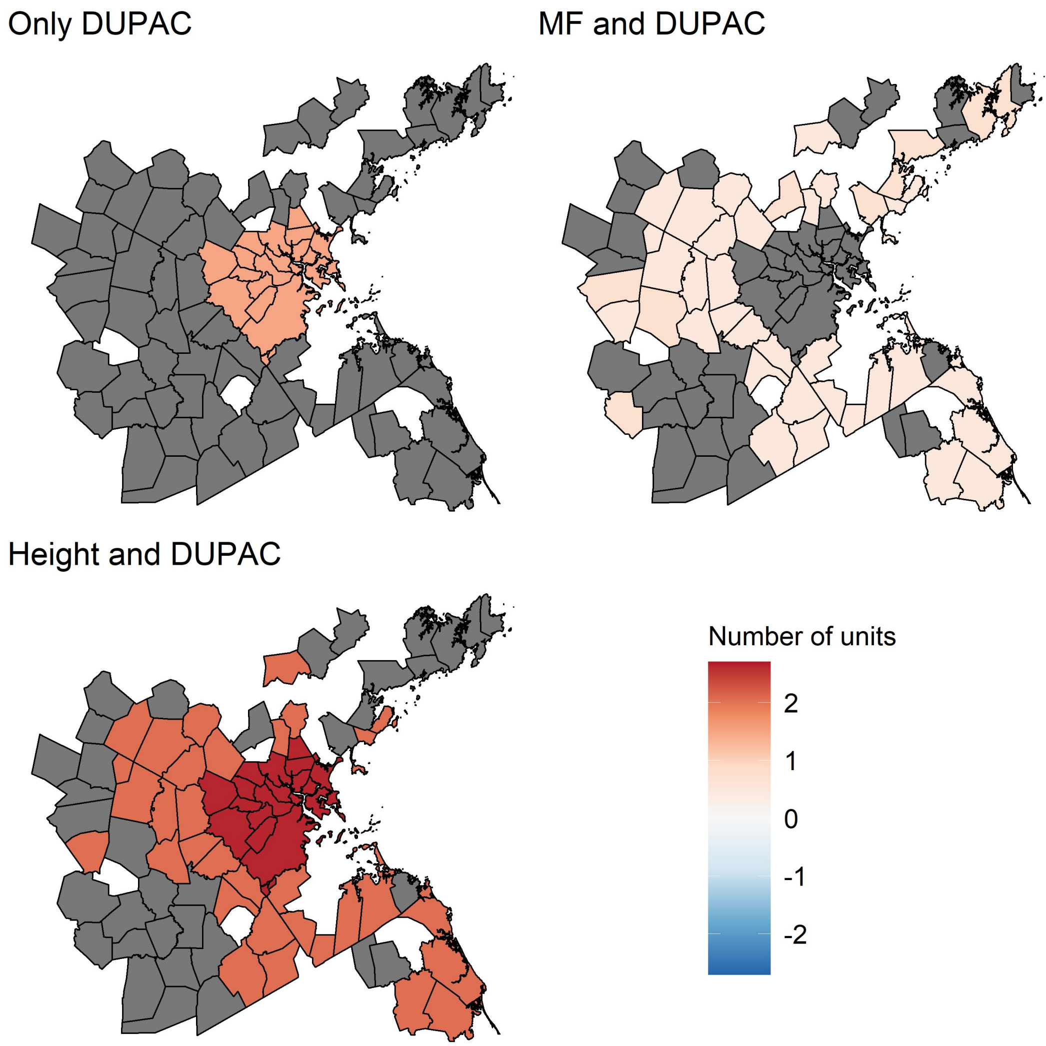
(e) RD estimate = -1.669, (t statistic = -0.97)



(f) RD estimate = 0.601, (t statistic = 0.69)

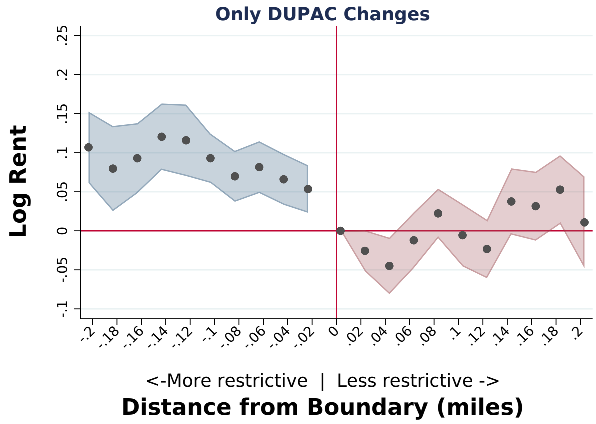
Note: Plots are created by regressing number of units on boundary fixed effects and distance to boundary (bins of 0.02 mile). Coefficients on distance bins are plotted. All buildings are built after 1918. Negative distances indicate the more regulated side. Bin closest to boundary on the less regulated side (0–0.02 mile) is normalized to 0. 95 percent confidence intervals are shown. Dwelling units per acre is DUPAC, and multifamily allowed is MF. Standard errors are clustered at the boundary level.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure 5: Effects of Regulations on Supply across Space

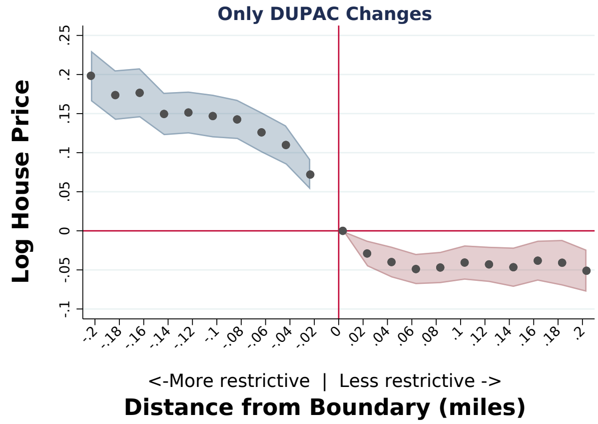


Note: These figures highlight the effects of different (combinations of) regulations on the number of units by community type. Bandwidth is 0.02 mile from the boundary, corresponding to our RD graphs in Figure 4. Gray areas represent areas without statistically significant results for the number of units or without statistically significant price results in Figure 8.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

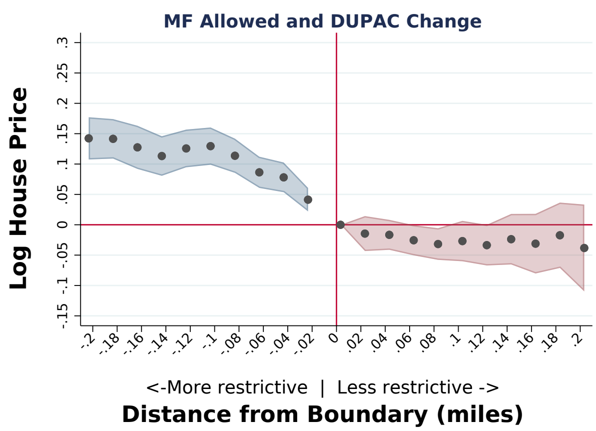
Figure 6: Effects of Regulations on Rents and Owner Costs of Housing



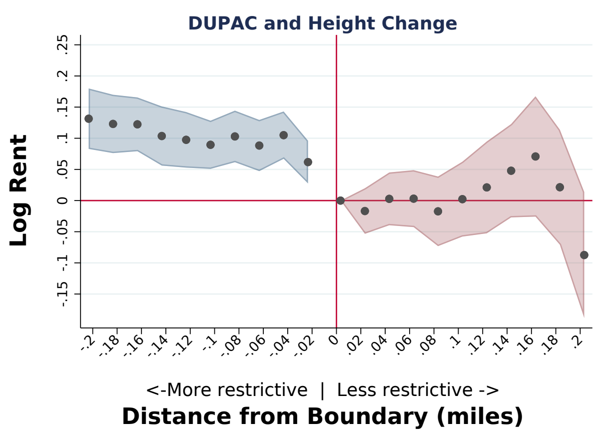
(a) RD estimate = -0.054, (t statistic = 3.44)



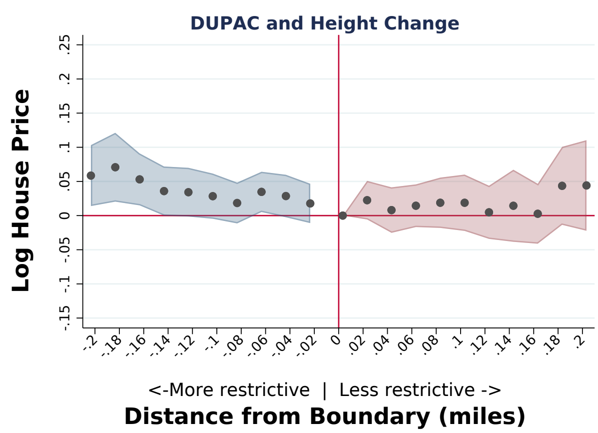
(b) RD estimate = -0.072, (t statistic = 7.27)



(c) RD estimate = 0.041, (t statistic = 4.19)



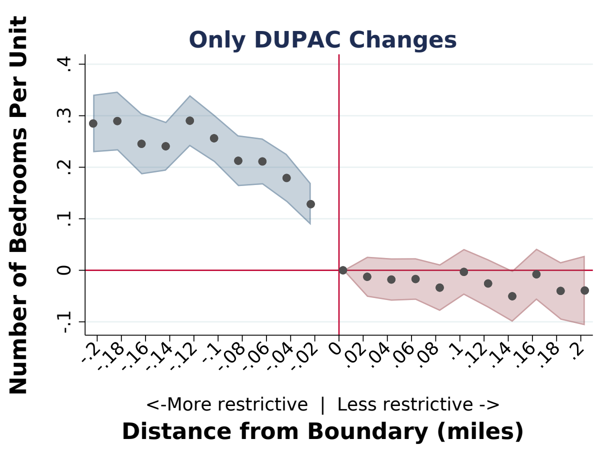
(d) RD estimate= 0.062, (t statistic = 3.53)



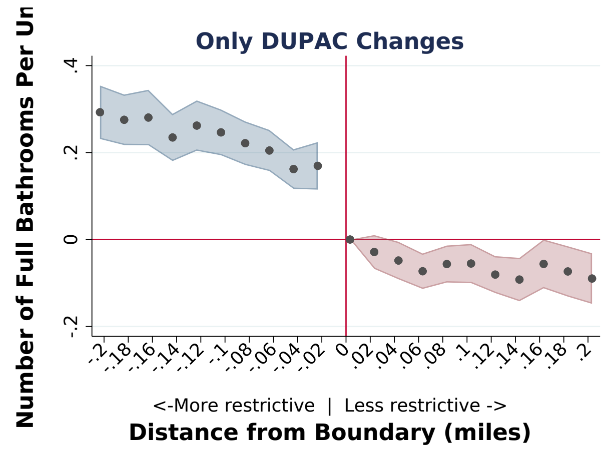
(e) RD estimate = 0.018, (t statistic = 1.21)

Note: Plots are created by regressing log prices on boundary fixed effects, year fixed effects (2010–2018), and 0.02-mile bins of distance from boundary. Coefficients on distance bins are plotted. Negative distances indicate the more regulated side of a boundary. Bin closest to the boundary on the less regulated side (0–0.02 mile) is normalized to 0. 95 percent confidence intervals are shown. Left panel indicates the effect on monthly rental prices for multifamily (MF) buildings. Right panel indicates the effect on monthly owner cost of housing for single-family houses. The unit on DUPAC (dwelling units per acre) is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

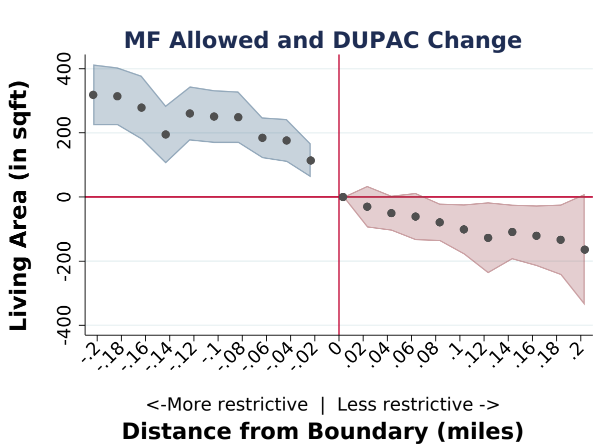
Figure 7: Housing Characteristics at Regulation Boundaries



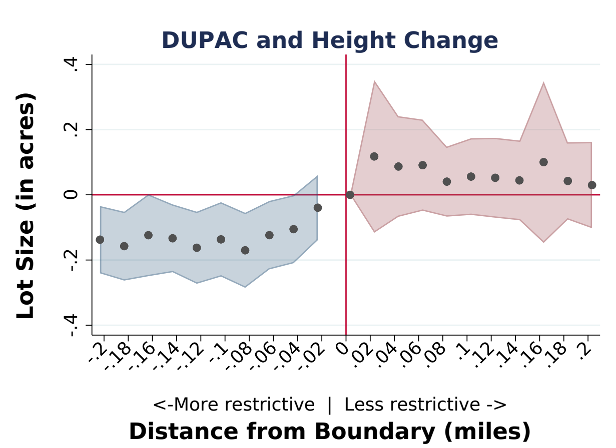
(a) Bedrooms RD estimate = 0.128 , (t stat = 6.18)



(b) Bathrooms RD estimate = 0.17, (t stat = 6.08)



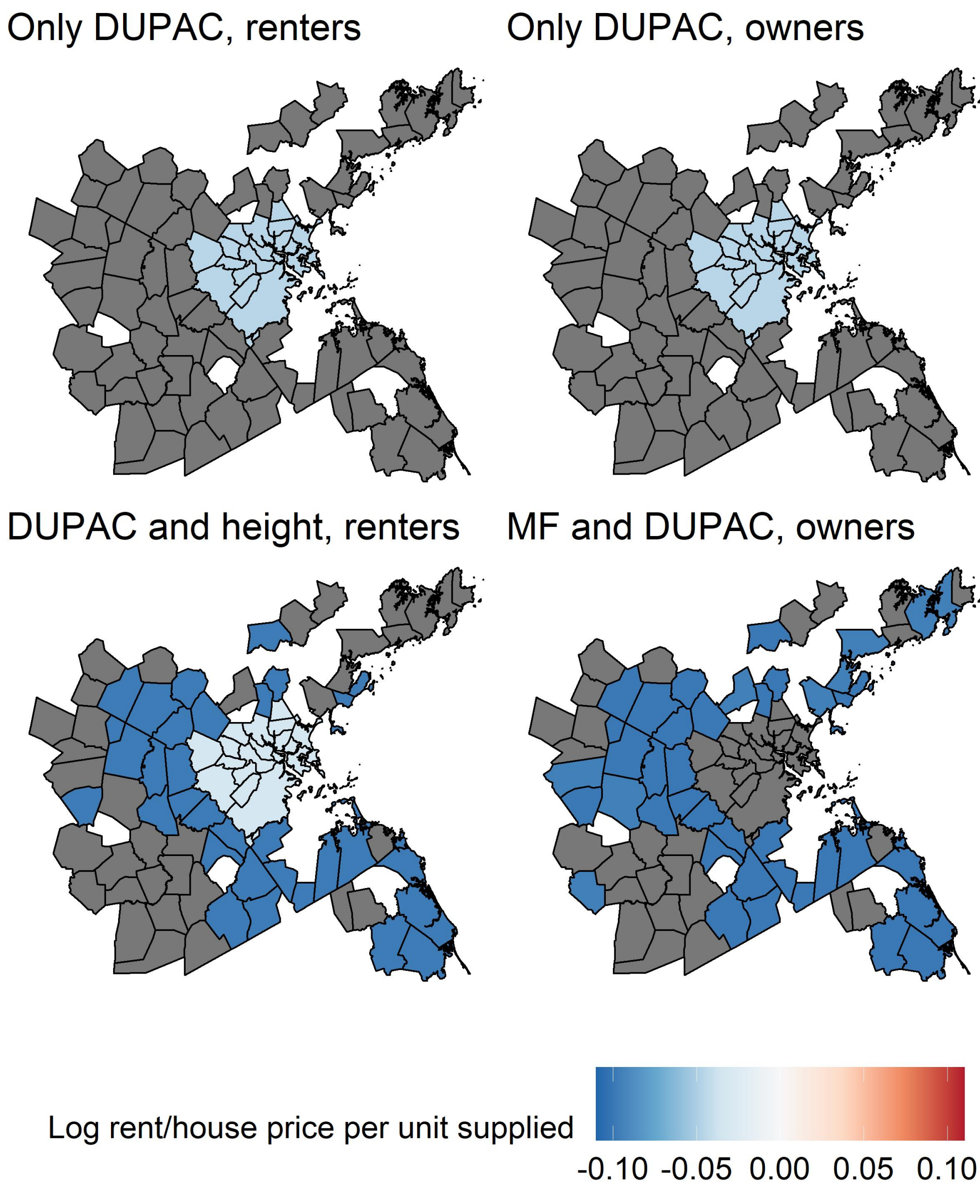
(c) Living Area RD estimate = 113.8, (t stat = 4.23)



(d) Lot Size RD estimate = -0.04, (t stat = -0.78)

Note: This figure plots building characteristics across regulation boundaries. Plots are created by regressing unit characteristics on boundary fixed effects and distance to boundary (bins of 0.02 mile). Coefficients on distance bins are plotted. Negative distances indicate more regulated side. Bin closest to boundary on less regulated side (0–0.02 mile) is normalized to 0. 95 percent confidence intervals are shown. DUPAC is dwelling units per acre, and MF is multifamily zoning.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

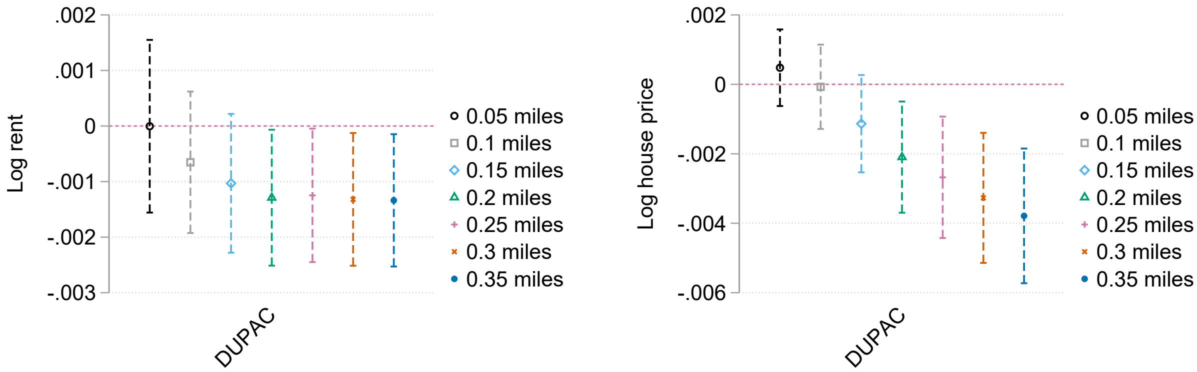
Figure 8: Direct Effects of Regulations on Prices across Space



Note: These figures highlight the effects of regulations on the housing costs (log monthly rents for multifamily units on left and log monthly owner cost of housing for single-family houses on right) across space per unit added due to the regulation, that is, divided by the results from Figure 5. DUPAC is dwelling units per acre, and MF is multifamily zoning. Gray areas represent no statistically significant results.

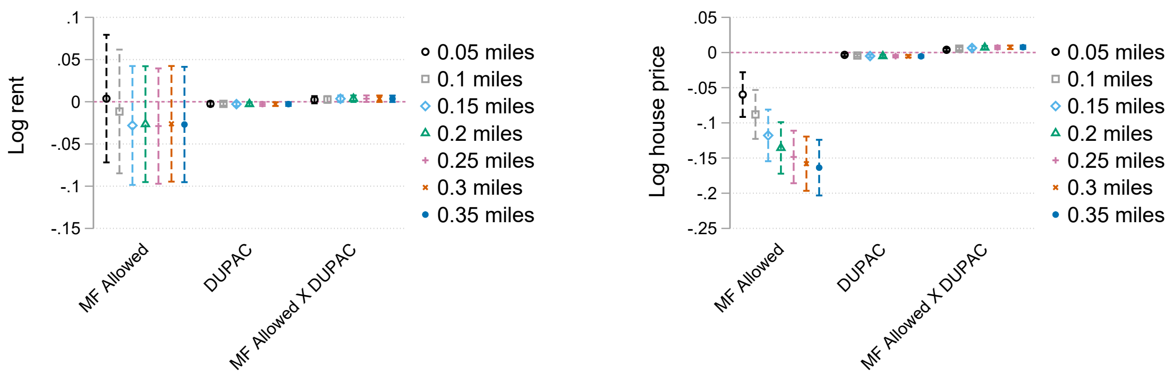
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure 9: Price Effects across Various Distance Bandwidths



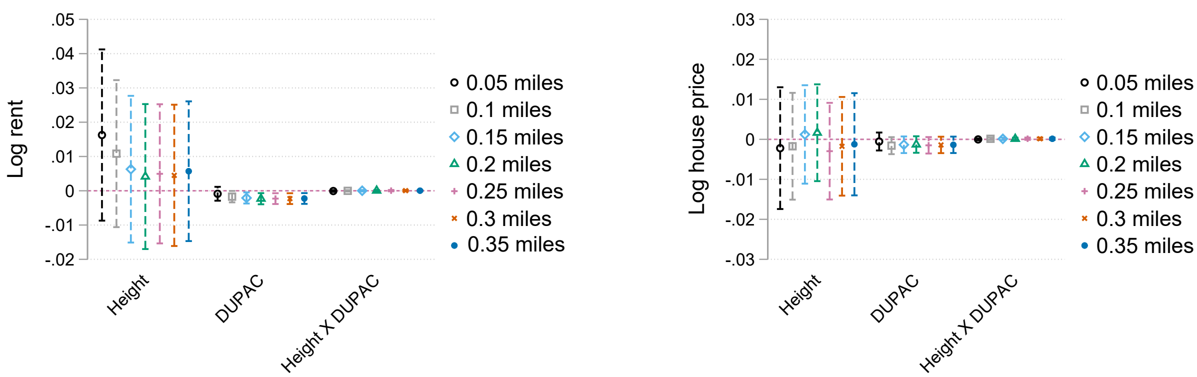
(a) (b)

Change in DUPAC Regulation Boundaries



(c) (d)

Change in DUPAC and Multifamily Regulation Boundaries

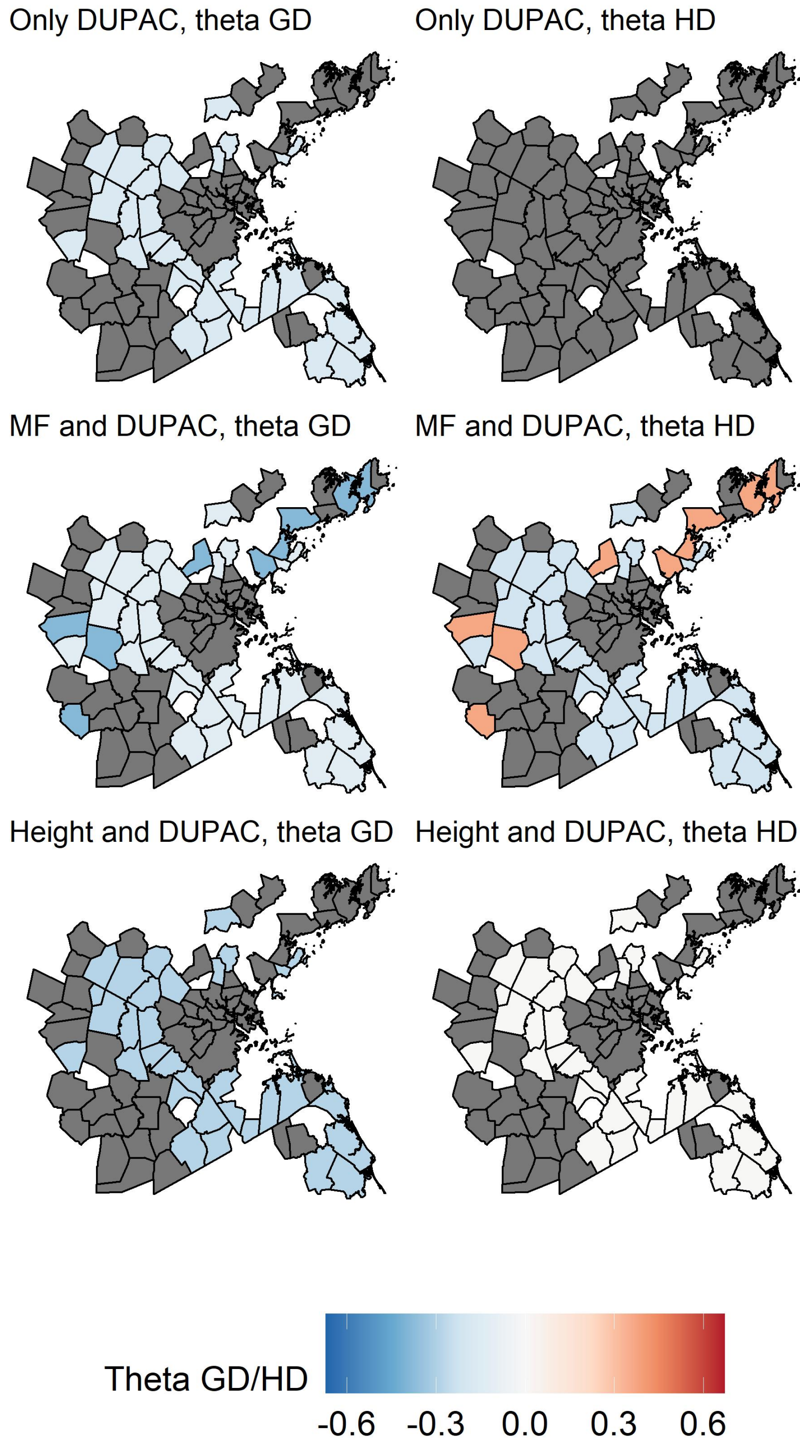


(e) (f)

Change in DUPAC and Height Regulation Boundaries

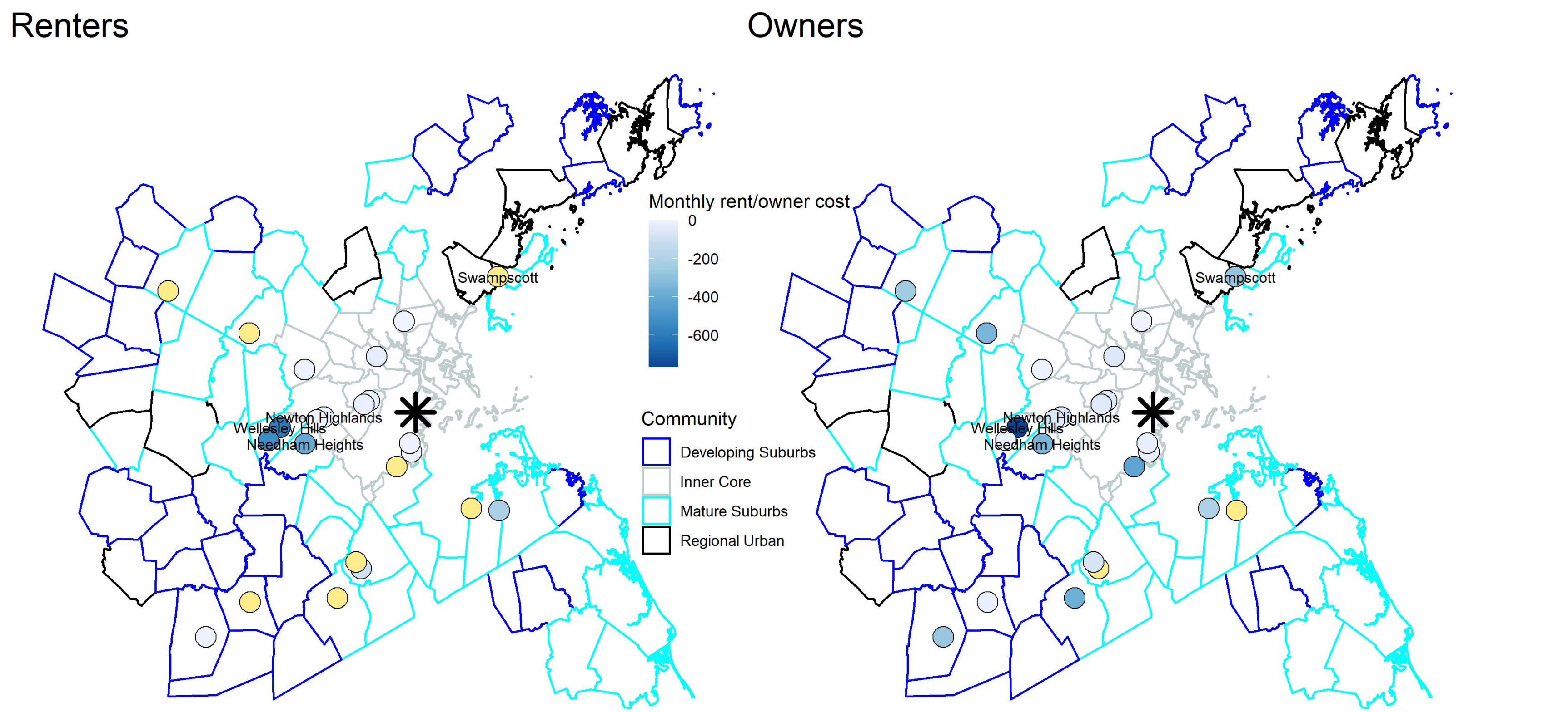
Note: This figure plots coefficient on multifamily (MF), height, and dwelling units per acre (DUPAC) when the regulation RD boundary varies from 0.05 to 0.35 mile. Coefficients for log monthly rents are plotted left (a,c,e). Coefficients for log monthly owner cost of housing are plotted right (b,d,f). The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure 10: Indirect Effects of Gentle and High Density on Owners



Note: These figures plot coefficients (θ^{GD}, θ^{HD}) of the indirect price effects of only DUPAC (dwelling units per acre), DUPAC and height, and DUPAC and multifamily (MF) regulations on log monthly owner cost of housing for single-family houses for increases in gentle density (two to three units) or high density (four or more units) in a 0.1-mile radius around the house on left and right, respectively. Gray areas represent no statistically significant results.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure 11: Policy Effects: Relaxing Regulations Near Transit Stops



Note: This figure plots average change in monthly owner costs for single-family houses and multifamily rents from relaxing regulations near 23 transit stops. Yellow represents statistically insignificant results. Star indicates city of Boston. Price differentials are plotted for regulation scenario with highest impact. Stations where dwelling units per acre (DUPAC) is relaxed: Shawmut* (Boston), Fairbanks Street^{o} (Brookline), Porter Square^{o} (Cambridge), Malden Center^{o} (Malden), Waltham^{o} (Waltham), Canton Junction^{o}, Wellesley Square^{o}, Norfolk^{o} (Norfolk), Franklin/Dean College^{o} (Franklin). Stations where multifamily and DUPAC are relaxed: Beaconsfield^{o} (Brookline), Ashmont^{o} (Boston), Eliot^{o} (Newton), Newton Highlands^{o} (Newton), Needham Heights^{o} (Needham), South Acton^{o} (Acton), Capen Street^{o} (Milton), Swampscott^{o} (Swampscott), Wellesley Hills^{o}, Lincoln^{o} (Lincoln), Sharon^{o} (Sharon), Weymouth Landing^{o} (Weymouth). Stations where height and DUPAC are relaxed: Canton^{+} (Canton), Ashmont^{+} (Boston), Beaconsfield^{+} (Brookline), Fairbanks Street^{+} (Brookline), Porter Square^{+} (Cambridge), Malden Center^{+} (Malden), Eliot^{+} (Newton), Newton Highlands^{+}, Waltham^{+} (Waltham), Needham Heights^{+} (Needham), Wellesley Hills^{+} (Wellesley), Wellesley Square^{+} (Wellesley), East Weymouth^{+} (Weymouth), Franklin/Dean College^{+} (Franklin). * indicates renters and owners, $^{+}$ only renters, ^{o} only owners.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas, MassGIS MBTA Rapid Transit and Railway Stations.

Table 1: Interaction of Various Zoning Regulation Scenarios

Regulation Scenarios	Multifamily Changes	Height Changes	DUPAC Changes	Rent (# Obs.) (Multifamily)	Prices (# Obs.) (Single-Family)
Scenario 1	X			-	55,130
Scenario 2		X		16,061	44,277
Scenario 3			X	181,297	928,989
Scenario 4	X	X		5,613	23,700
Scenario 5	X		X	128,945	353,901
Scenario 6		X	X	140,600	148,654
Scenario 7	X	X	X	116,288	148,599

Note: This table represents the interaction of various zoning regulation scenarios as well as the percentage of rents and house price observations under each of these scenarios. DUPAC is maximum dwelling units per acre.

Table 2: Regulations and Their Effects on Supply and Prices

		Δ Single Regulation			Δ Multiple Regulation		
		MF	H	DU	MF & DU	MF &H	DU & H
Supply		–	–	↑	↑	–	↑
Prices	Supply/Demand	–	–	↓	↓	–	↓
	Option Value (SF)	↑	↑	↑	↑	↑	↑
	Spillovers	↓	–	↓	↓	↓	↓

Note: This figure illustrates how supply and prices change under various combinations of regulation scenarios. MF is multifamily, H is maximum height, and DU is dwelling units per acre (DUPAC) regulation boundaries. MF & DU, MF & H, and DU & H are boundaries where MF and DUPAC both change, MF and H both change, and H and DUPAC both change, respectively.

Table 3: Type of Housing Built before 1918

	2-3 units (Gentle Density)				**4+ units (High Density)**			
	Only MF	Only DU	MF & DU	H & DU	Only MF	Only DU	MF & DU	H & DU
MF allowed	0.016		0.114***		0.007		0.043*	
	(0.092)		(0.032)		(0.048)		(0.017)	
Height (H)				0.011				0.010
				(0.013)				(0.010)
DUPAC (DU)		-0.000	0.001	0.001		-0.000	0.001	0.005***
		(0.001)	(0.002)	(0.001)		(0.001)	(0.001)	(0.001)
MFXDU			-0.005*				-0.003*	
			(0.002)				(0.001)	
HXDU				-0.000				0.000
				(0.000)				(0.000)
N	2,918	29,485	17,833	16,821	1,373	19,054	10,440	8,461
R^2	0.374	0.296	0.294	0.237	0.323	0.369	0.208	0.378
$\mathbb{E}(y)$	0.566	0.397	0.436	0.568	0.078	0.067	0.037	0.141

Note: This table presents the results from a linear probability model where dependant variable value of 0 is a single-family house and value of 1 is either a two- or three-unit building or a four-or-more-unit building 0 to 0.3 mile from the boundary on either side of the boundary. All buildings are built before 1918. Only MF are boundaries where only multifamily (MF) regulation changes, and Only DU are boundaries where only dwelling units per acre (DUPAC) regulation changes. MF & DU and H & DU are boundaries where MF and DUPAC both change and height and DUPAC both change, respectively. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table 4: Supply: Types of Housing across Regulation Boundaries (Built after 1918)

	2-3 units (Gentle Density)				**4+ units (High Density)**			
	Only MF	Only DU	MF & DU	H & DU	Only MF	Only DU	MF & DU	H & DU
MF allowed	0.418***		0.044*		0.033		0.002	
	(0.073)		(0.021)		(0.017)		(0.009)	
Height (H)				-0.011				-0.007
				(0.010)				(0.007)
DUPAC (DU)		0.002**	-0.008**	-0.002		0.001**	0.000	0.004*
		(0.001)	(0.003)	(0.002)		(0.000)	(0.001)	(0.002)
MFXDU			0.012***				0.002*	
			(0.002)				(0.001)	
HXDU				0.0003*				-0.000
				(0.0001)				(0.000)
N	5,838	92,046	35,194	13,101	5,006	87,697	30,129	9,878
R^2	0.457	0.397	0.371	0.509	0.405	0.490	0.271	0.522
$\mathbb{E}(y)$	0.157	0.061	0.159	0.290	0.017	0.012	0.015	0.067

Note: This table presents the results from a linear probability model where dependant variable value of 0 is a single-family house and value of 1 is either a two- or three-unit building or a four-or-more-unit building 0 to 0.3 mile from the boundary on either side of the boundary. All buildings are built after 1918. Only MF are boundaries where only multifamily (MF) regulation changes, and Only DU are boundaries where only dwelling units per acre (DUPAC) regulation changes. MF & DU and H & DU are boundaries where MF and DUPAC both change and height and DUPAC both change, respectively. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table 5: Price Effects Away from Regulation Boundaries

	Only MF	Only DUPAC	MF & DUPAC	DUPAC & Height	All
			Multifamily (rents)		
High Density (θ^{HD})	-	0.168	0.092	-0.100	-0.137
		(0.119)	(0.141)	(0.093)	(0.134)
Gentle Density (θ^{GD})	-	-0.101*	-0.059	0.040	-0.060
		(0.051)	(0.041)	(0.047)	(0.061)
N		43,993	31,391	35,347	30,114
$\mathbb{E}(y)$		$1,049	$971	$1,017	$943
$\mathbb{E}(\theta^{HD})$		0.054	0.043	0.079	0.058
$\mathbb{E}(\theta^{GD})$		0.388	0.465	0.532	0.555
			Single-Family (owner cost of housing)		
High Density (θ^{HD})	-0.495	-0.103	-0.102	-0.097	-0.051
	(0.250)	(0.092)	(0.060)	(0.056)	(0.095)
Gentle Density (θ^{GD})	0.159	-0.166***	-0.213***	-0.056	-0.213***
	(0.102)	(0.038)	(0.048)	(0.043)	(0.062)
N	20,517	446,515	147,523	63,495	63,695
$\mathbb{E}(y)$	$2,710	$2,519	$2,256	$2,321	$2,494
$\mathbb{E}(\theta^{HD})$	0.010	0.001	0.010	0.023	0.016
$\mathbb{E}(\theta^{GD})$	0.061	0.053	0.104	0.192	0.150

Note: This table shows the coefficients on the share of buildings that are high density (four-plus units) (θ^{HD}) and the share of buildings that are gentle density (two or three units) (θ^{GD}) within a 0.1-mile radius of a house across different regulation boundaries from Equation 6 for buildings 0.1 to 0.3 mile from the regulation boundary on either side of the boundary. Top panel presents results where dependent variable is log monthly rents. For bottom panel it is log monthly owner cost of housing. Standard errors are clustered at the boundary level. MF is multifamily. DUPAC is dwelling units per acre. All is boundary where MF, DUPAC, and height regulations all change. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

How to Reduce Housing Costs: Understanding Local Deterrents to Building Multifamily Housing

by Amrita Kulka, Aradhya Sood, and Nicholas Chiumenti

ONLINE APPENDIX

A. Data Appendix

A.1 Rent Imputation

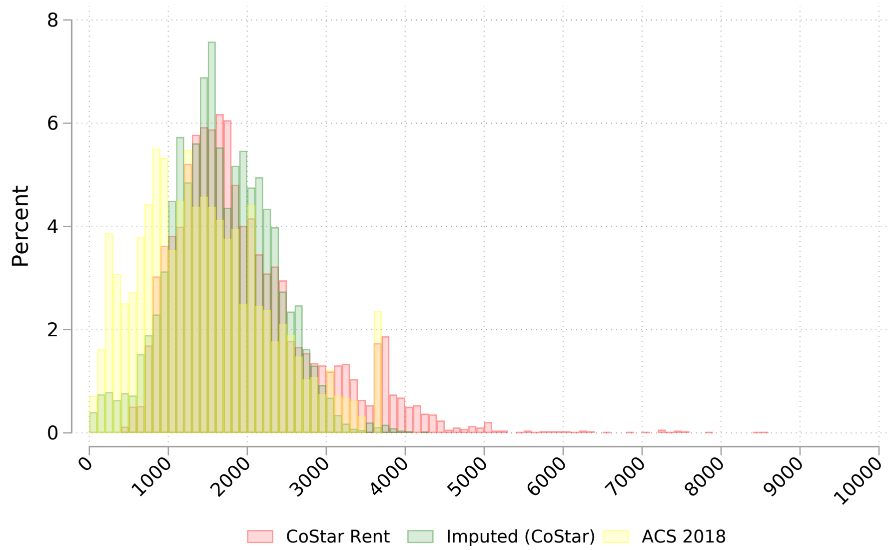
For the buildings that have CoStar market rent available [18,536 buildings from 2010 through 2018], we use it directly. CoStar uses websites such as Apartment.com and field visits and surveys to obtain market rental data. For the remaining 112,992 buildings, we impute rent using CoStar characteristics, Warren Group data, and American Community Survey (ACS) block group characteristics. The distribution of CoStar market rent is in red in Figure A.1 panel (a) plotted against the 2018 ACS block-group-level rent (yellow). For the buildings that have detailed CoStar data, we impute rent employing a linear regression model that uses the detailed characteristics from CoStar, Warren Group, and ACS block-group characteristics and CoStar data on market rent. This distribution is plotted in green in Figure A.1. As can be seen in Figure A.1 panel (a), CoStar's rental distribution leans toward the higher-end rental market. To capture the entire distribution of rents for the remaining buildings, particularly multifamily buildings with two to four units, we proceed in two steps.

First, we use the U.S. Bureau of Economic Analysis (BEA) imputation of 6.29 percent of the assessed value for *all* multifamily buildings. This distribution is plotted in pink against the 2018 ACS rent distribution (yellow) in Figure A.1 panel (b). Second, we impute rent employing a linear regression model that uses the Warren Group and ACS block-group characteristics and CoStar data on market rent.[1] The ACS imputed rent distribution is plotted in blue in Figure A.1 panel (b). Since the BEA imputation matches the ACS rental distribution better than the imputed ACS rent distribution, we use the BEA imputed rent for the non-CoStar buildings.[2]

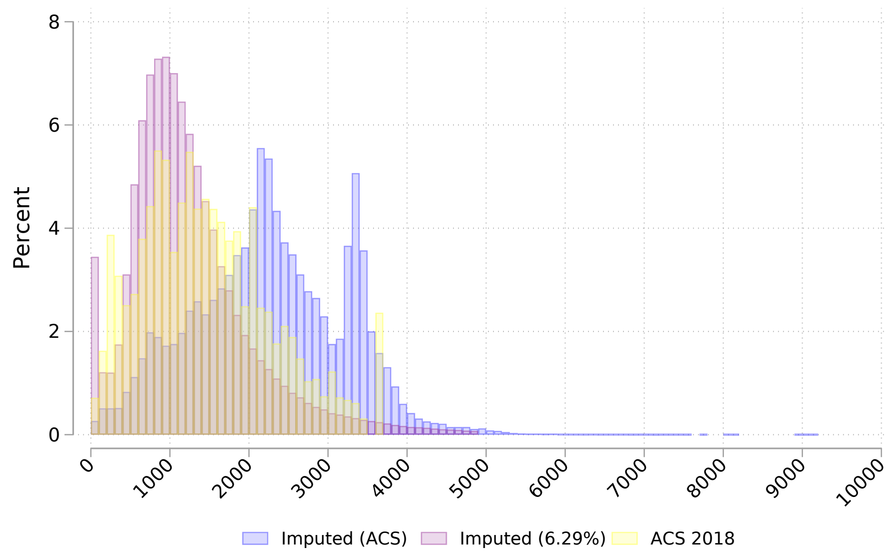
[1] These buildings do not have detailed CoStar building characteristic data.

[2] Baseline results use CoStar actual market rent data and the BEA imputation for the remaining build-

Figure A.1: Rent Imputation for Multifamily Houses



(a) CoStar Imputation

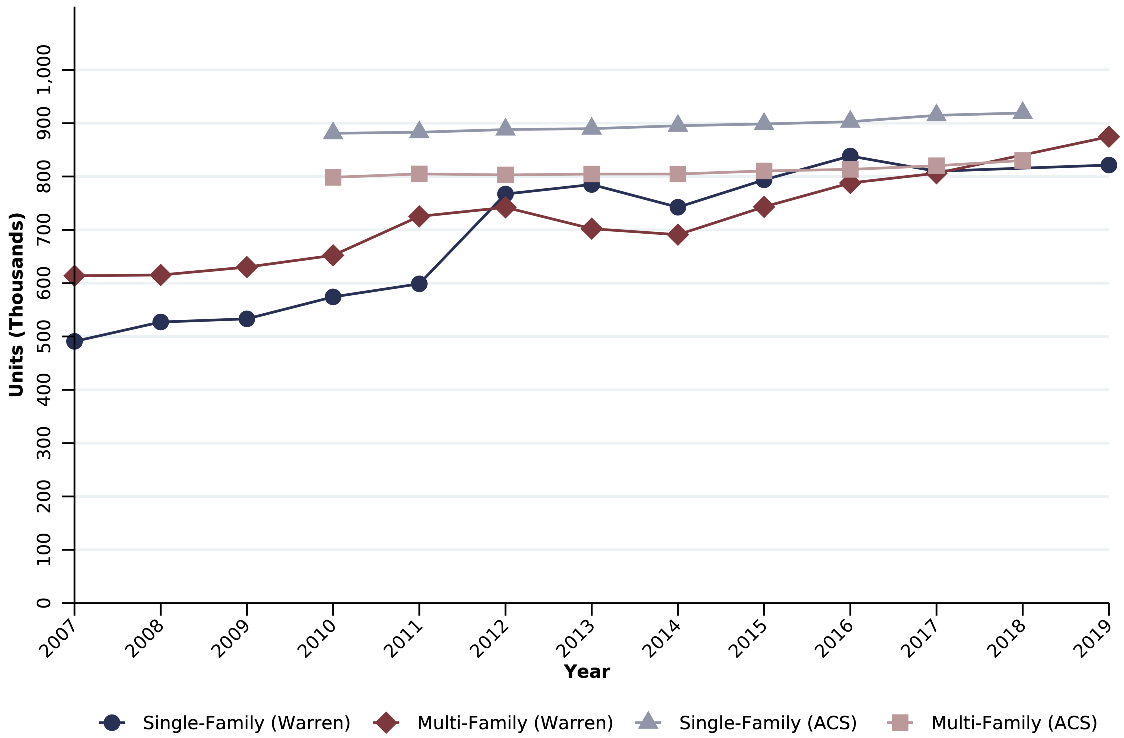


(b) BEA and ACS Imputation

Note: Panel (a) plots the rental data from CoStar against the imputed rental values using CoStar variables and against the ACS (2018) rental distribution. Panel (b) plots the ACS (2018) rental distribution data against the ACS variables and the 6.29 percent BEA estimation.
Source(s): 2010–2018 Warren Group tax assessment records, 2018 American Community Survey 5-year estimates, 2018 CoStar Multifamily rent data.

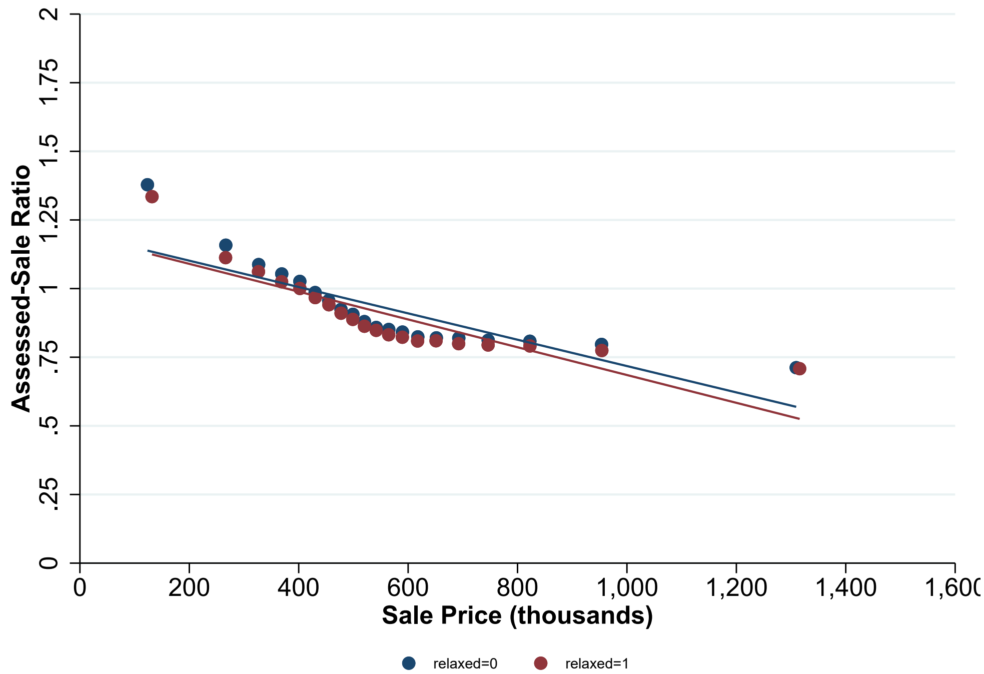
ings. For robustness, we also use CoStar reported and imputed rent data along with the BEA imputation, but results don't change significantly compared with the baseline rental measure.

Figure A.2: Total Units by Housing Type: Warren and ACS Data



Notes: Single-family units from ACS include all one-unit housing units (attached and detached). Single-family units in Warren include property addresses with one unit listed. All other types are counted as multifamily. Includes only housing units located in Massachusetts counties within the Boston-Cambridge-Newton MSA (2007–2019).
Source(s): 2001–2018 Warren Group tax assessment records, 2018 American Community Survey 5-year estimates.

Figure A.3: Sales and Assessed Values for Single-Family Houses

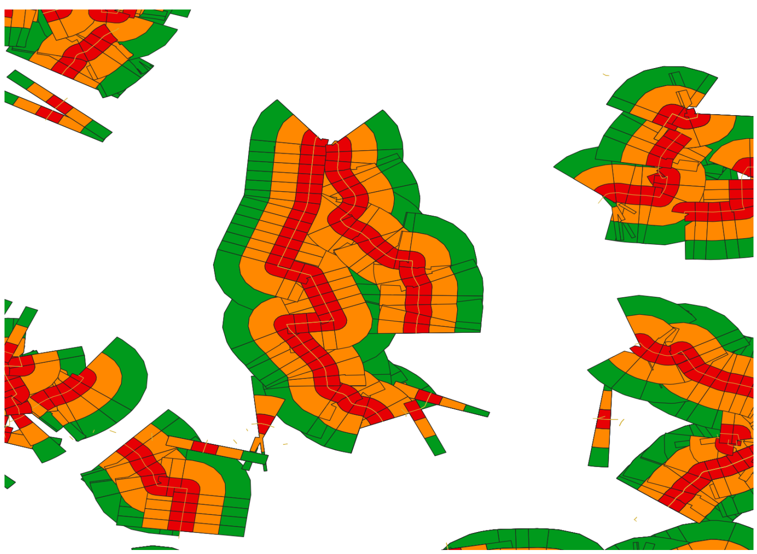


Note: Plots assessed-sales ratio against sale prices for single-family houses sold 2010–2018 in Greater Boston for houses on relaxed (relaxed=1) and restricted (relaxed=0) side of the regulation boundary. Town fixed effects are included. Following the literature (Berry (2021)), we drop the top and bottom 2 percent of the sample.
Source(s): 2010–2018 Warren Group tax assessment records

A.2 Regulations and Supply: Neighborhood Level

In addition to using a linear probability model to study the effect of land-use regulations on supply, we also run regressions at the neighborhood level. A neighborhood is a 0.1- X 0.1-mile or 0.1- X 0.3-mile or 0.1- X 0.5-mile box on either side of the boundary (see Figure A.4). In each box, neighborhood density is measured as a share of total gentle- or high-density lots, unit-level density (total units /total lots), or area-level density (total building area /total lot area). The empirical model is given by Equation 4. Qualitatively, these results are similar to the results presented in Table 4 and Figure 4. Note that this is not chosen to be the primary specification because about half of our boundaries are 0.1 mile or smaller. Use of this specification, thus, results in the omission of about half of the boundaries.

Figure A.4: Example Construction of Neighborhood Density



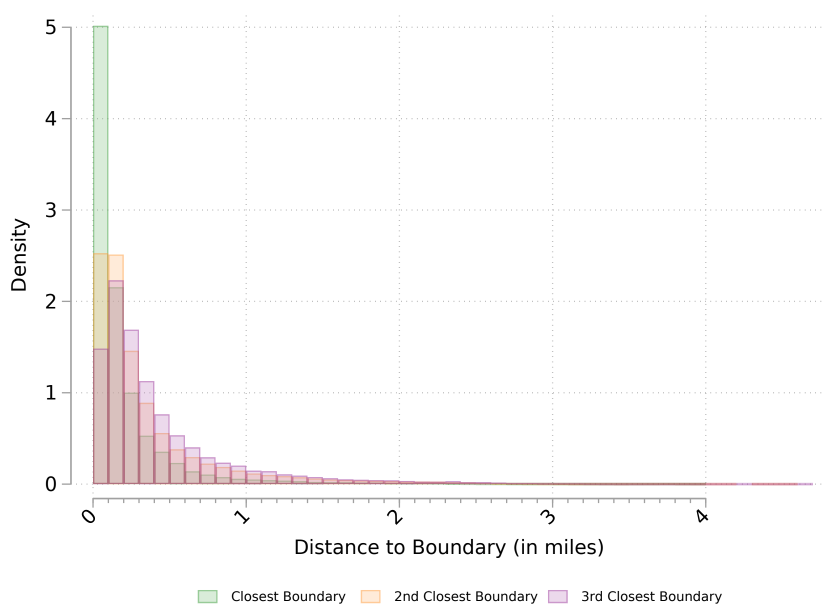
Note: This figure plots a sample of boundaries and the construction of neighborhood density around these boundaries. Red indicates 0.1- X 0.1-mile boxes around the boundary. Orange indicates 0.1- X 0.3-mile, and green indicates 0.1- X 0.5-mile.
Source(s): 2020 Metropolitan Area Planning Council Zoning Atlas

A.3 Distance to Nearby Boundaries

Identifying the direct effect of the zoning regulation in a boundary RD framework depends on other factors not varying discontinuously at the boundary (for example, Figure 3). In terms of the indirect effect, a possible confounding factor is that it might be capturing changes in residential density from other nearby zoning regulation boundaries. Figure A.5 shows a histogram of the distance to the closest, second- closest, and third-closest boundaries in our sample. The second-closest boundary is, on average, 0.376 mile away. The third closest boundary is 0.464 mile away. This may seem concerning since we estimate indirect effects at 0.1 to 0.3 mile from the boundary.

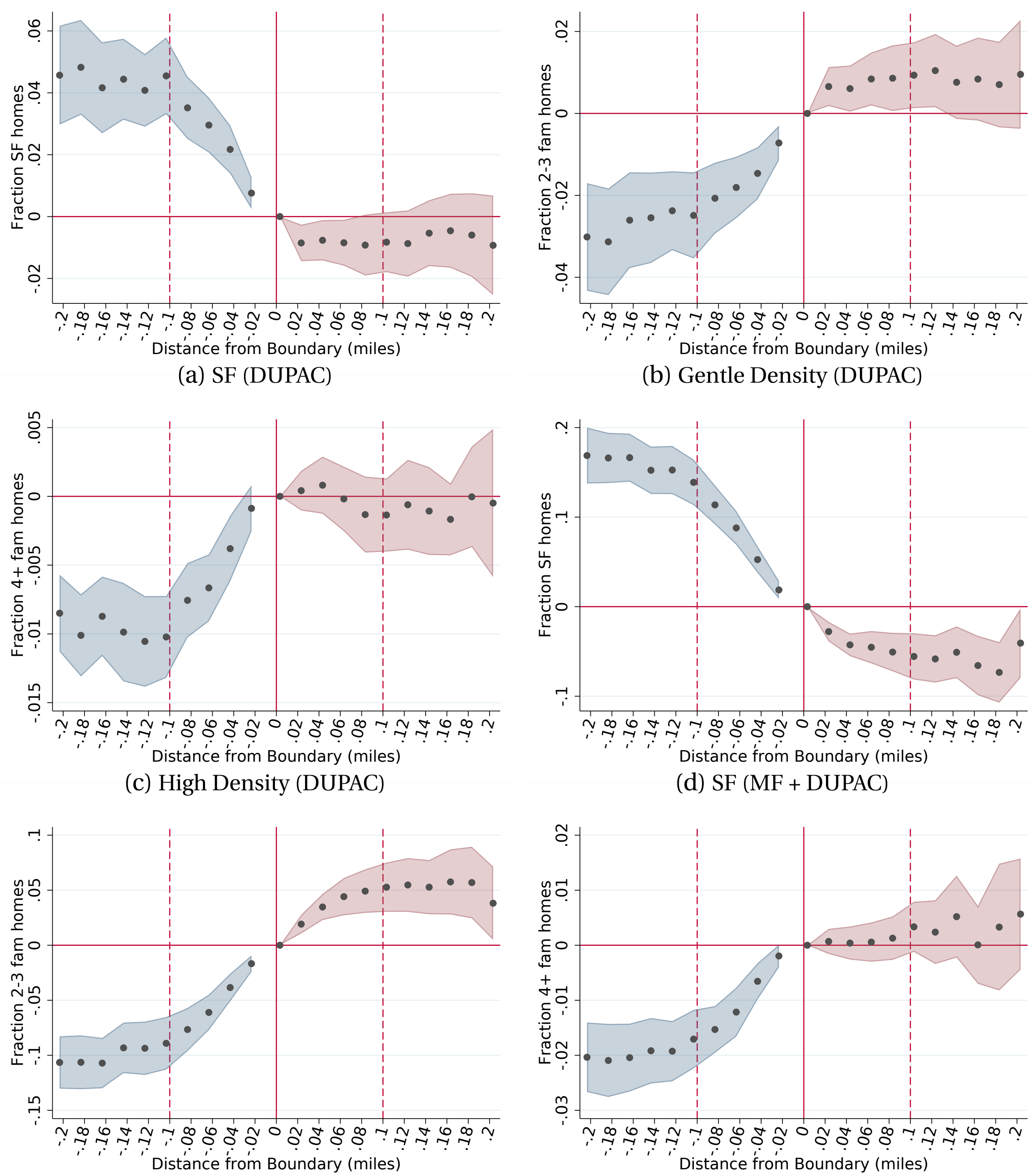
Figure A.6 shows how the shares of homes that are single family, gentle density, and high density within a 0.1-mile radius evolve over space away from the boundary. Since we show that boundaries lead to sharp changes in the type and number of homes, if our estimates of indirect effects were driven by proximity to the next regulation boundary, we would expect to see large gradients in the shares away from the boundary. On the contrary, we see that the share of different types of homes is quite flat up to 0.2 mile from the boundary (which includes homes up to 0.25 miles from the boundary). Therefore, we are reassured that indirect effects are driven by the density of homes induced by this zoning regulation and not the next closest one.

Figure A.5: Building Distance to Nearby Boundaries



Note: This figure plots the distance to the first-, second-, and third-nearest boundaries for all buildings in the sample.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure A.6: Shares of Homes That Are Single Family, Gentle Density, and High Density



(a) SF (DUPAC)

(b) Gentle Density (DUPAC)

(c) High Density (DUPAC)

(d) SF (MF + DUPAC)

(e) Gentle-Density (MF + DUPAC)

(f) High-Density (MF + DUPAC)

Note: This figure plots the shares of homes that are single family, gentle density (two or three units), and high density (four or more units) along the boundary. Shares are calculated as the fraction of homes of a given type within a 0.1-mile radius of every property. Plots are created by regressing shares on boundary fixed effects, and bins of distance to the boundary (bins of 0.02 mile). Coefficients on the distance bins are plotted. Negative distances indicate the more regulated side of a boundary. The bin closest to the boundary on the less regulated side (0 to 0.02 mile from the boundary) is normalized to 0. 95 percent confidence intervals are shown. Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

B. Additional Tables and Figures

Table B.1: Adoption of Zoning Laws across Towns

Town	Year	Town	Year
ARLINGTON	1924-8-30	MEDFORD	1925
BEDFORD	1928	MELROSE	1924-5-6-7-8
BELMONT	1925-6-7	MILTON	1022-6
BOSTON	1918-23-4-9-30-1-2-56	NATICK	1931
BROOKLINE	1922-4-8	NEEDHAM	1925-6-31
CAMBRIDGE	1924-5-6-7-8-9-30-56	NEWTON	1922-5-6-9
CHELSEA	1924	REVERE	1925-9
CONCORD	1928	SALEM	1925-7-8-9
DEDHAM	1924	SOMERVILLE	1925-9
EVERETT	1926-8	STONEHAM	1925-6-7-8-9-30-31-32
FRANKLIN	1930	SUDBURY	1931
GLOUCESTER	1926-7	SWAMPSCOTT	1924
HUDSON	1927	WAKEFIELD	1925-7-9
HULL	1931-2	WALPOLE	1925-8
LEXINGTON	1924-9	WALTHAM	1925-8-9
LINCOLN	1929	WATERTOWN	1026-7-9-30-1
LYNN	1924-5-6-9	WELLESLEY	1925
MALDEN	1923-6-32	WESTON	1928
MARBLEHEAD	1927-8-30	WESTWOOD	1929
MARLBOROUGH	1927	WINTHROP	1922-8-9
MARSHFIELD	1926	WOBURN	1925

Note: This table provides the dates of first height restrictions or other types of zoning adoption across towns in Greater Boston. Data are from Knauss (1933).

Table B.2: Type of Housing Built before 1956

	2-3 units (Gentle Density)				4+ units (High Density)			
	Only MF	Only DU	MF & DU	H & DU	Only MF	Only DU	MF & DU	H & DU
MF	0.233*		0.117*		0.026		0.019*	
	(0.105)		(0.028)		(0.023)		(0.009)	
H				0.004				0.003
				(0.011)				(0.007)
DU		0.001	-0.004	0.001		0.000	0.001	0.004***
		(0.001)	(0.002)	(0.001)		(0.000)	(0.001)	(0.001)
MFXDU			0.002				-0.001	
			(0.002)				(0.001)	
HXDU				-0.000				-0.000
				(0.000)				(0.000)
N	6,653	67,656	38,323	25,281	4,388	53,614	26,535	14,234
R^2	0.470	0.396	0.340	0.332	0.280	0.399	0.177	0.386
$\mathbb{E}(y)$	0.361	0.236	0.323	0.498	0.031	0.036	0.022	0.108

Note: This table presents the results from a linear probability model where the dependant variable value of 0 is a single-family house and the value of 1 is either a two- or three-unit building or a four-plus-unit building within 0 to 0.3 mile of the boundary. All buildings are built before 1956. Only MF are boundaries where only multifamily (MF) regulation changes, and Only DU are boundaries where only dwelling units per acre (DUPAC) regulation changes. MF & DU and H & DU are boundaries where MF and DUPAC both change and height and DUPAC both change, respectively. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table B.3: Supply: Types of Housing across Regulation Boundaries (Built after 1956)

	2-3 units (Gentle Density)				4+ units (High Density)			
	Only MF	Only DU	MF & DU	H & DU	Only MF	Only DU	MF & DU	H & DU
MF	0.250***		0.042*		0.066		0.011	
	(0.066)		(0.019)		(0.035)		(0.014)	
H				-0.011				0.004
				(0.011)				(0.008)
DU		0.002**	0.003	0.001		0.002*	0.000	0.003
		(0.001)	(0.003)	(0.003)		(0.001)	(0.002)	(0.002)
MFXDU			0.004				0.003*	
			(0.002)				(0.001)	
HXDU				0.000				-0.000
				(0.000)				(0.000)
N	2,103	53,875	14,704	4,641	1,991	52,957	13,946	4,189
R^2	0.384	0.274	0.318	0.510	0.574	0.487	0.410	0.650
$\mathbb{E}(y)$	0.081	0.025	0.069	0.165	0.030	0.008	0.018	0.075

Note: This table presents the results from a linear probability model where the dependant variable value of 0 is a single-family house and the value of 1 is either a two- or three-unit building or a four-plus-unit building within 0 to 0.3 mile of the boundary. All buildings are built before 1956. Only MF are boundaries where only multifamily (MF) regulation changes, and Only DU are boundaries where only dwelling units per acre (DUPAC) regulation changes. MF & DU and H & DU are boundaries where MF and DUPAC both change and height and DUPAC both change, respectively. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table B.4: Effects of Regulation on Prices

	Multifamily (rents)			Single-Family (owner cost)			
	Only DU	MF & DU	DU & H	Only MF	Only DU	MF & DU	DU & H
MF allowed		-0.027		-0.040		-0.136***	
		(0.035)		(0.022)		(0.019)	
Height (H)			0.004				0.002
			(0.011)				(0.006)
DUPAC (DU)	-0.001*	-0.003*	-0.002**		-0.002*	-0.005***	-0.001
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
MFXDU		0.004				0.007***	
		(0.002)				(0.001)	
HXDU			0.000				0.000
			(0.000)				(0.000)
N	174,726	125,098	135,593	49,853	771,615	304,340	129,779
$\mathbb{E}(y)$	$1,142	$1,017	$1,057	$2,446	$2,520	$2,228	$2,171
R^2	0.617	0.632	0.630	0.696	0.732	0.768	0.871

Note: This table presents the results from Equation 4, where the dependent variable is either the log of monthly owner cost of housing or monthly rent within 0 to 0.2 mile of the boundary. Controls are boundary fixed effects and year fixed effects. Standard errors are clustered at the boundary level. Only MF are boundaries where only multifamily (MF) regulation changes, and Only DU are boundaries where only dwelling units per acre (DUPAC) regulation changes. MF & DU and H & DU are boundaries where MF and DUPAC both change and height and DUPAC both change, respectively. Since there are no renters on one side of a boundary where allowing multifamily homes changes, we do not show results on rents for that type of boundary. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table B.5: Effects of Regulations on Prices (with Year Built)

	Multifamily (rents)			Single-Family (owner cost)			
	Only DU	MF & DU	DU & H	Only MF	Only DU	MF & DU	DU & H
MF allowed		-0.030		-0.018		-0.093***	
		(0.027)		(0.017)		(0.014)	
Height (H)			0.006				0.001
			(0.009)				(0.006)
DUPAC (DU)	-0.001	-0.002*	-0.002***		-0.003***	-0.003***	-0.002
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
MFXDU		0.003*				0.004***	
		(0.002)				(0.001)	
HXDU			0.000				0.000
			(0.000)				(0.000)
N	171,945	124,088	133,766	49,701	769,028	303,811	129,547
$\mathbb{E}(y)$	$1,145	$1,019	$1,062	$2444	$2,515	$2,227	$2,168
R^2	0.659	0.690	0.713	0.782	0.807	0.825	0.894

Note: This table presents the results from Equation 4, where the dependent variable is either the log of monthly owner cost of housing or monthly rent within 0 to 0.2 mile of the boundary. In addition to boundary fixed effects and year fixed effects, we also control for year-built fixed effects. Standard errors are clustered at the boundary level. Only MF are boundaries where only multifamily (MF) regulation changes, and Only DU are boundaries where only dwelling units per acre (DUPAC) regulation changes. MF & DU and H & DU are boundaries where MF and DUPAC both change and height and DUPAC both change, respectively. Since there are no renters on one side of a boundary where allowing multifamily homes changes, we do not show results on rents for that type of boundary. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table B.6: Price Effects away from Regulation Boundaries: Robustness

	Only MF	Only DUPAC	MF & DUPAC	DUPAC & Height	All
		Multifamily (rents): bandwidth 0.1-0.2 miles			
θ^{HD}	-	0.225	-	-0.104	-
		(0.151)		(0.112)	
θ^{GD}	-	-0.081	-	0.029	-
		(0.048)		(0.052)	
N		33,486		27,652	
		Multifamily (rents): bandwidth 0.1-0.35 miles			
θ^{HD}	-	0.079	-	-0.067	-
		(0.108)		(0.105)	
θ^{GD}	-	-0.102*	-	0.025	-
		(0.051)		(0.039)	
N		46,268		36,870	
		Single-Family (owner cost of housing): bandwidth 0.1-0.2 miles			
θ^{HD}	-0.274	-0.070	-0.120	0.081	-0.099
	(0.155)	(0.094)	(0.069)	(0.068)	(0.068)
θ^{GD}	0.022	-0.151***	-0.197***	-0.068	-0.197***
	(0.132)	(0.039)	(0.044)	(0.04)	(0.056)
N	15,275	289,725	98,090	44,646	42,467
		Single-Family (owner cost of housing): bandwidth 0.1-0.35 miles			
θ^{HD}	-0.364	-0.130	-0.119*	-0.111	-0.047
	(0.283)	(0.092)	(0.06)	(0.058)	(0.087)
θ^{GD}	0.131	-0.169***	-0.211***	-0.069	-0.224***
	(0.082)	(0.041)	(0.044)	(0.04)	(0.058)
N	22,386	496,837	162,598	68,595	70,288

Note: This table plots coefficient on share of buildings that are high density (four-plus units) (θ^{HD}) and the share that are gentle density (two or three units) (θ^{GD}) within a 0.1-mile radius of a house across different regulation boundaries from Equation 6 for buildings within either 0.1 to 0.2 mile or 0.1 to 0.35 mile of the boundary on either side of the boundary. The preferred specification with bandwidth of 0.1 to 0.3 mile is in the main paper. Top panel presents results where the dependent variable is log monthly rents. For the bottom panel it is log monthly owner cost of housing. Standard errors are clustered at the boundary level. Only MF are boundaries where only multifamily (MF) regulation changes. Only DUPAC are boundaries where only dwelling units per acre regulation changes.

Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Table B.7: Town Governance Heterogeneity: Supply

		OTM		RTM		Mayor	
		2-3	4+	2-3	4+	2-3	4+
Only DU	DU	0.016***	0.008*	0.001***	0.000	0.002	0.006***
		(0.004)	(0.004)	(0.000)	(0.000)	(0.003)	(0.002)
	N	22,937	22,681	11,223	11,116	11,981	11,618
	MF	-0.069**	-0.028***	0.048	-0.017	0.207**	0.119*
		(0.028)	(0.011)	(0.056)	(0.018)	(0.086)	(0.056)
MF X DU	DU	-0.034***	-0.008*	0.020	-0.020	0.005	0.006*
		(0.012)	(.004)	(0.029)	(0.014)	(0.004)	(0.003)
	MF X DU	0.036***	0.009***	-0.004	0.019	-0.004	-0.001
		(0.009)	(0.004)	(0.026)	(0.012)	(0.004)	(0.003)
	N	4,849	4,686	3,734	3,623	4,351	3,904

Note: This table presents results from Equation 4 for different forms of local government: open town meetings (OTM), representative town meetings (RTM), or mayoral system (Mayor). The dependent variable is an indicator for the supply of different types of buildings. We control for boundary fixed effects. Standard errors are clustered at the boundary level. MF is multifamily regulation. DU is dwelling units per acre (DUPAC). The unit on DUPAC is in 1 housing unit.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas, Massachusetts Municipal Association Municipal Forms of Governance.

Table B.8: Town Governance Heterogeneity: Price Effects

		OTM		RTM		Mayor	
		MF	SF	MF	SF	MF	SF
	DU	-0.008	-0.017***	0.004***	-0.001	-0.003***	-0.002*
		(0.004)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)
Only DU	N	19,537	324,427	15,969	211,798	119,211	275,067
	θ^{GD}	-0.246	-0.033	0.011	-0.344***	-0.073	-0.133***
		(0.113)	(0.047)	(0.107)	(0.103)	(0.063)	(0.051)
	θ^{HD}	-0.237	-0.082	-0.126	-0.337	0.199	-0.310**
		(0.211)	(0.100)	(0.288)	(0.211)	(0.120)	(0.116)
	N	7,251	156,638	4,121	100,858	23,848	102,691
	MF	-0.105	-0.199***	-0.004	-0.131***	-0.014	-0.183***
		(0.104)	(0.054)	(0.070)	(0.032)	(0.047)	(0.032)
MF X DU	DU	-0.009	-0.025	0.029	-0.012	-0.002	-0.007***
		(0.017)	(0.017)	(0.020)	(0.017)	(0.001)	(0.001)
	MF X DU	0.015	0.028	-0.029	0.013	0.003	0.009***
		(0.018)	(0.014)	(0.019)	(0.014)	(0.003)	(0.002)
	N	8,268	85,280	10,100	77,119	108,846	161,811
	θ^{GD}	-0.109	-0.107*	0.086	-0.201***	-0.046	-0.197***
		(0.157)	(0.047)	(0.102)	(0.065)	(0.043)	(0.079)
	θ^{HD}	-0.281**	-0.142*	0.314	-0.136	0.320	-0.133
		(0.113)	(0.068)	(0.226)	(0.146)	(0.218)	(0.108)
	N	2,785	37,176	3,305	32,550	22,128	52,254

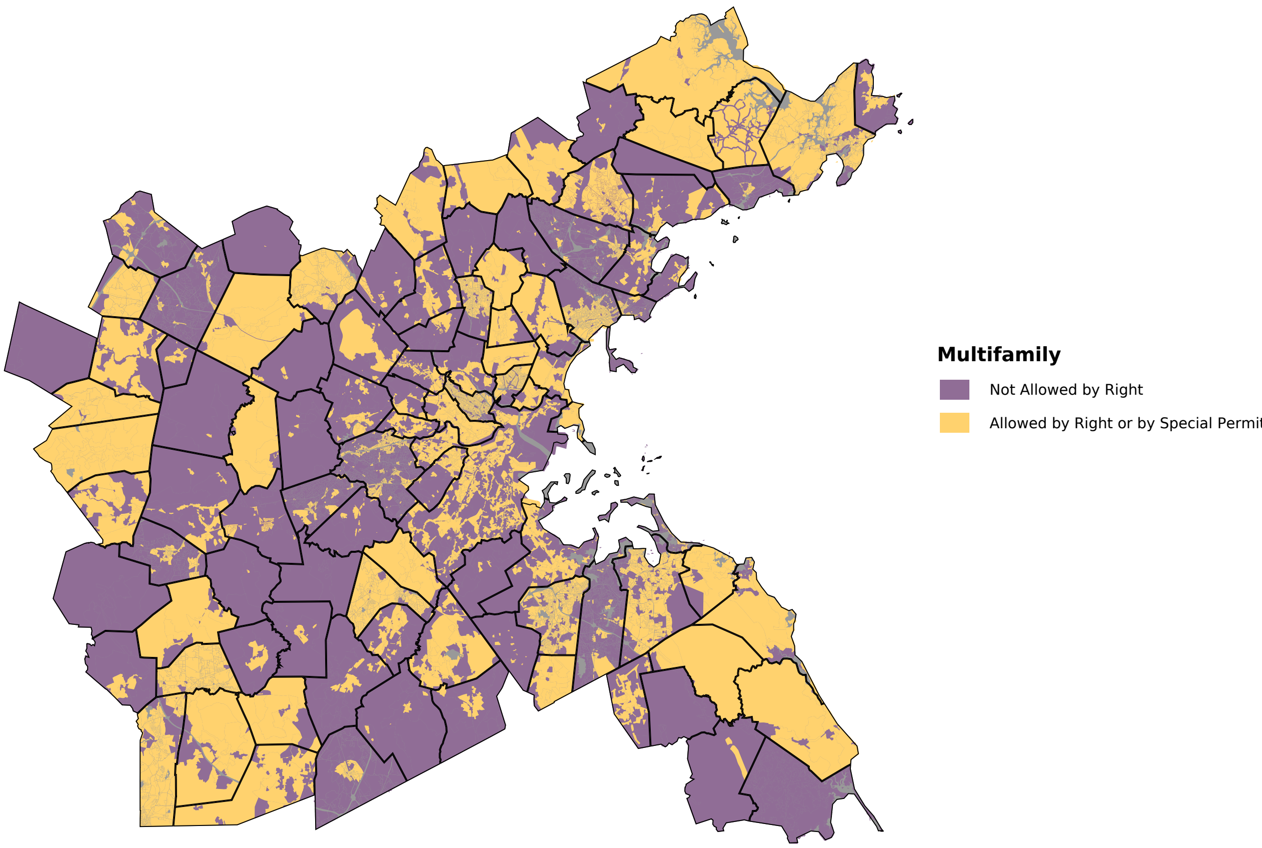
Note: This table presents results from Equation 4 & 6 for different forms of local government: open town meetings (OTM), representative town meetings (RTM), or mayoral system (Mayor). The dependent variable is the log of either monthly owner cost of housing (single family) or monthly rent (multifamily (MF)). We control for boundary fixed effects. We also use year fixed effects. Standard errors are clustered at the boundary level. MF is multifamily regulation. DU is dwelling units per acre (DUPAC). The unit on DUPAC is in 1 housing unit.
Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas. Massachusetts Municipal Association Municipal Forms of Governance.

Table B.9: Land Regulation and Inclusionary Zoning (Chapter 40B)

	MF	H	DU	MF X H	MF X DU	H X DU	MF X H X DU	R^2	E(y), N
All	-0.336*	0.005	0.000	0.080*	0.008*	-0.0005*	-0.001*		0.004
	(0.158)	(0.004)	(0.000)	(0.036)	(0.004)	(0.00002)	(0.001)	0.418	6,392
MF	-0.827***	0.017	0.002	0.209***	0.019***	-0.001***	-0.004***		0.006
	(0.168)	(0.010)	(0.001)	(0.043)	(0.005)	(0.000)	(0.001)	0.819	3,770

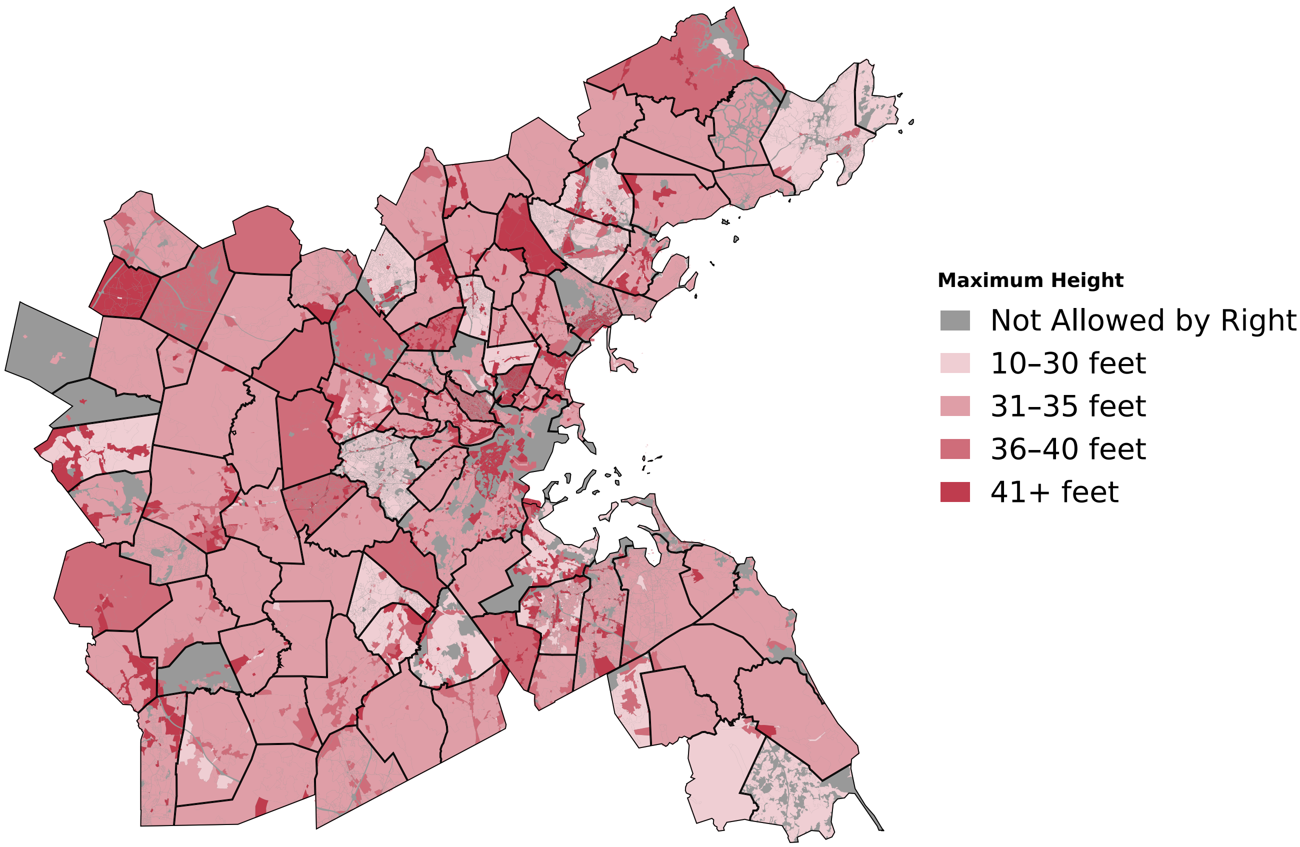
Note: This table presents the results from Equation 4 for buildings within 0 to 0.5 mile of the boundary. The dependent variable is an indicator of whether a property was built using Massachusetts's Chapter 40B inclusionary zoning policy to override local zoning rules. We control for boundary fixed effects. Standard errors are clustered at the boundary level. Results presented here are for boundaries where all regulations change at the same time. "All" indicates any building built using Chapter 40B's comprehensive permitting procedure. "MF" indicates multifamily buildings built using this procedure. Each column shows the effect of a different zoning policy on the supply of properties built using Chapter 40B. MF indicates multifamily. DU is dwelling units per acre, and H is height. The unit on height is in 10 feet, and DUPAC is in 1 housing unit. Standard errors are clustered at the boundary level.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas, MA Department of Housing and Community Development Subsidized Housing Inventory 2018 active properties.

Figure B.1: Multifamily Zoning in Greater Boston



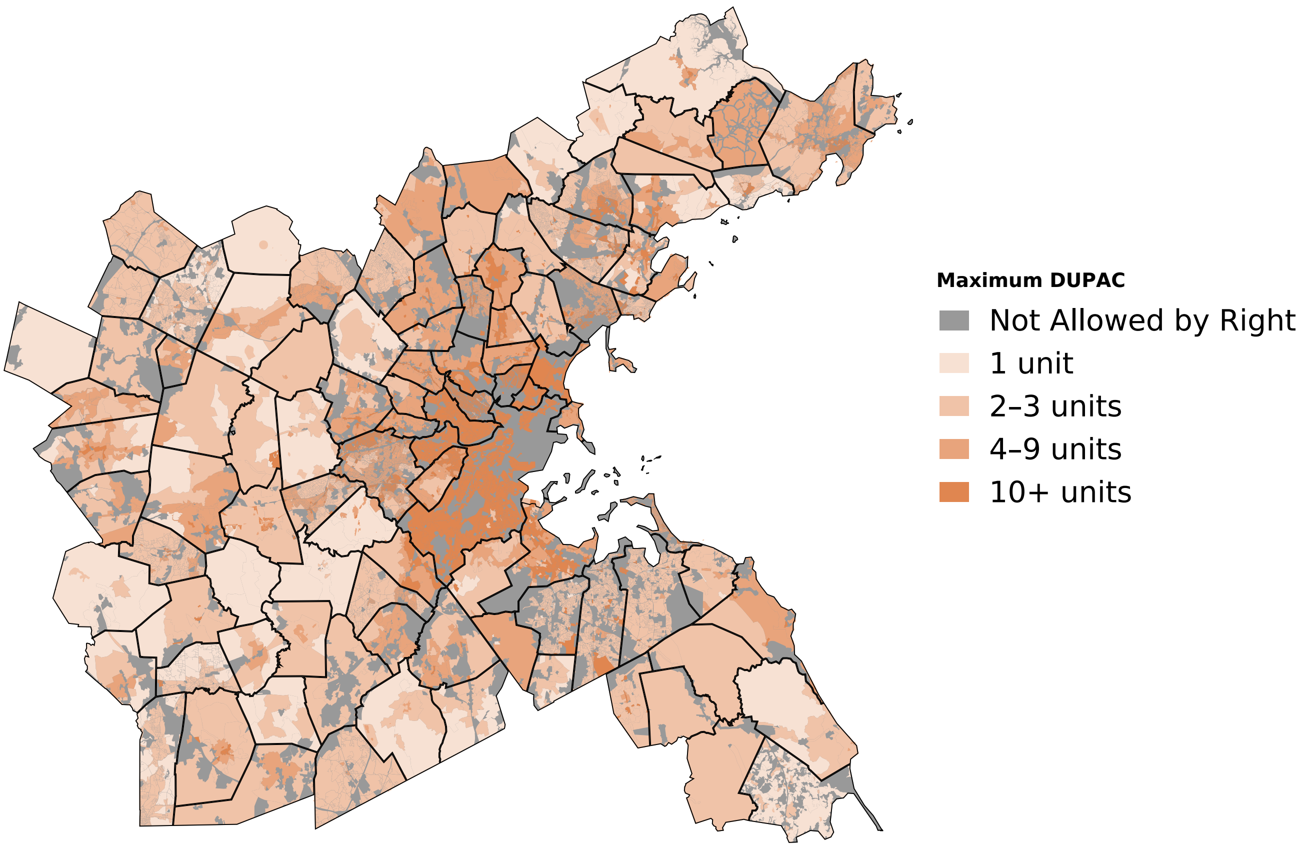
Note: This figure plots the multifamily zoning in Greater Boston. Allowed includes areas where multifamily construction is allowed by right and by special permit.
Source(s): 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.2: Maximum Height Restrictions in Greater Boston



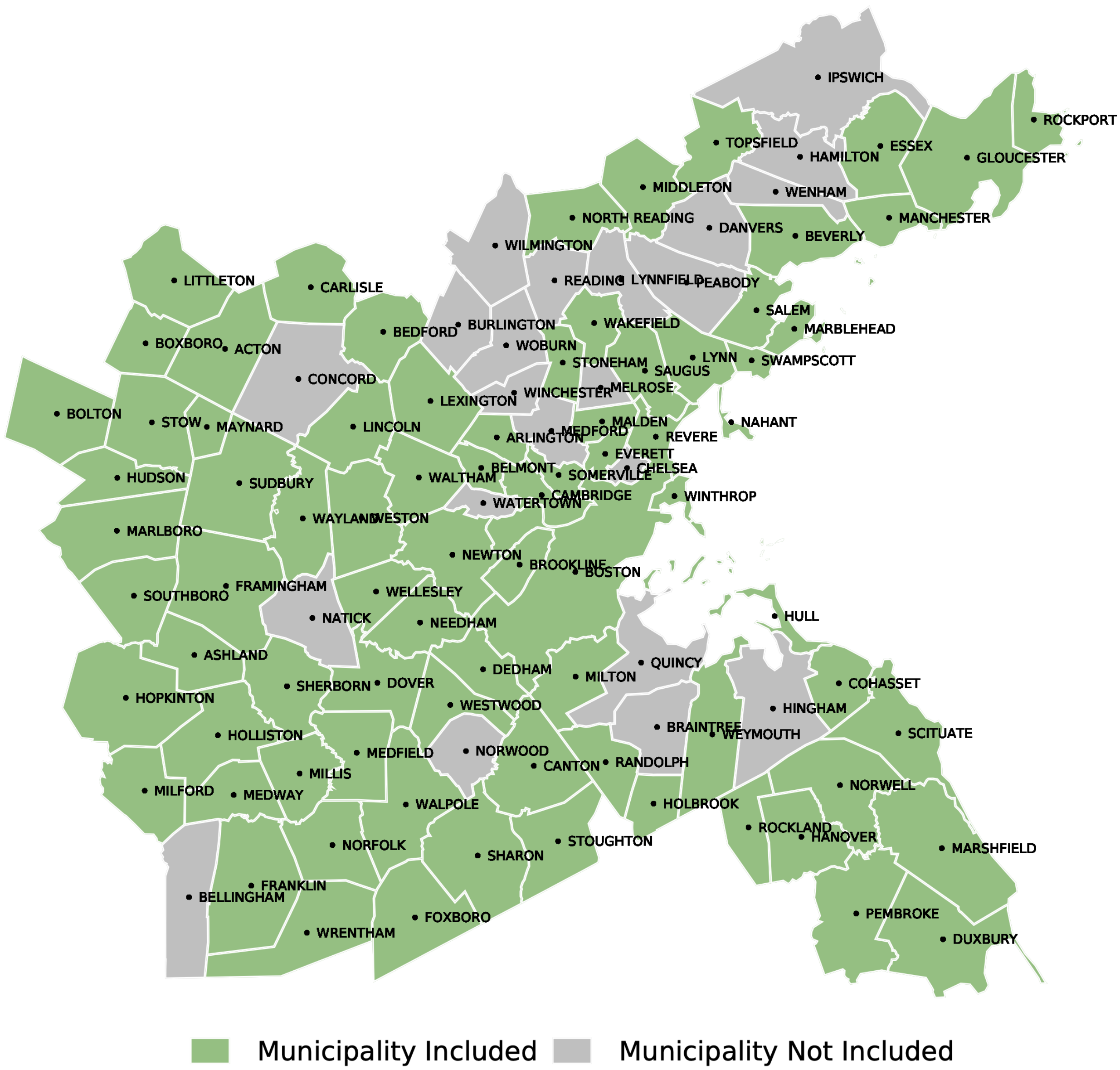
Note: This figure plots the maximum height restrictions in Greater Boston in feet.
Source(s): 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.3: Maximum Density (DUPAC) Restrictions in Greater Boston



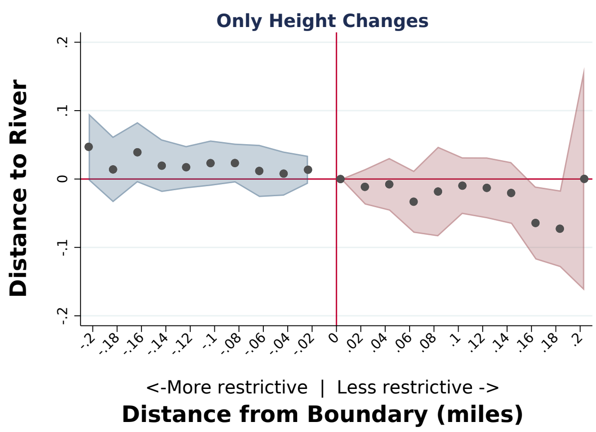
Note: This figure plots the maximum DUPAC (dwellng units per acre) restrictions in Greater Boston.
Source(s): 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.4: Municipalities Included in Sample

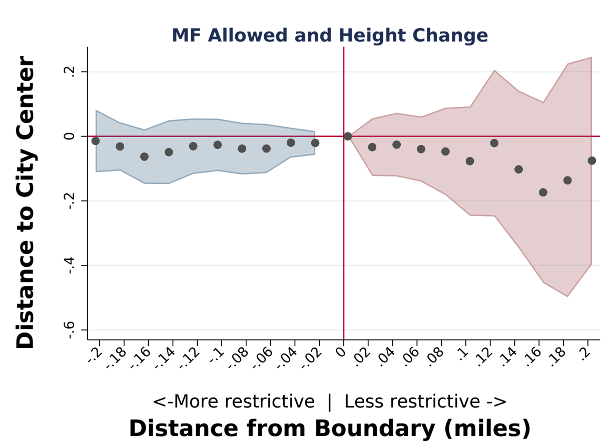


Note: Municipalities are included if they had either open enrollment school attendance policies or elementary school attendance boundary data included in the 2016 School Attendance Boundary Survey (SABS). Municipalities were excluded if they lacked school attendance boundary data and did not have open enrollment.

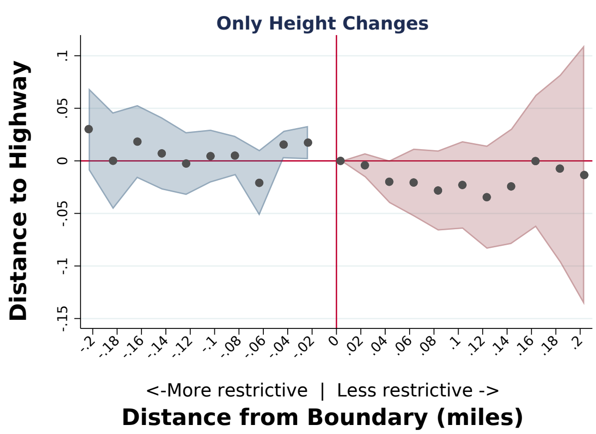
Figure B.5: Amenities at Regulation Boundaries



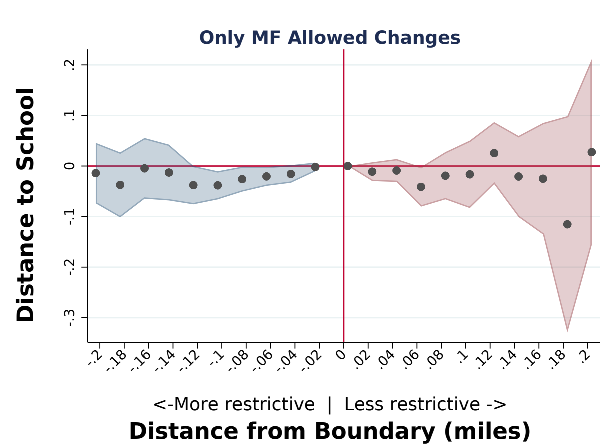
(a) River/Lake RD estimate = 0.014, (t stat = 1.32)



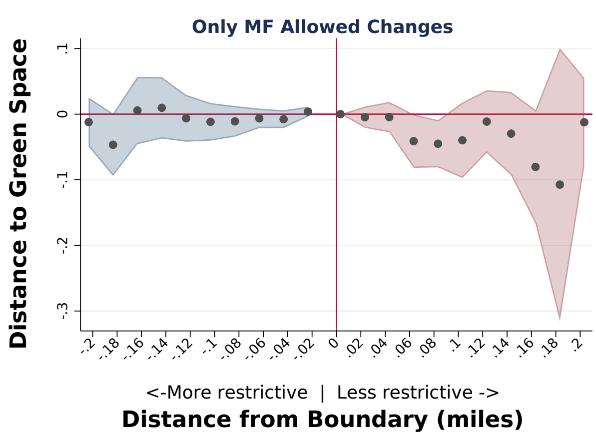
(b) Center RD estimate = -0.021, (t stat = -1.11)



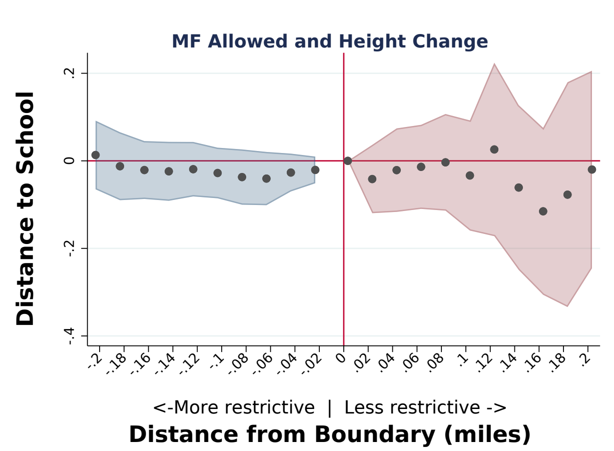
(c) Road RD estimate = 0.017, (t stat = 2.17)



(d) School RD estimate = -0.002, (t stat = -0.43)



(e) Open Space RD estimate = 0.004, (t stat = 0.98)

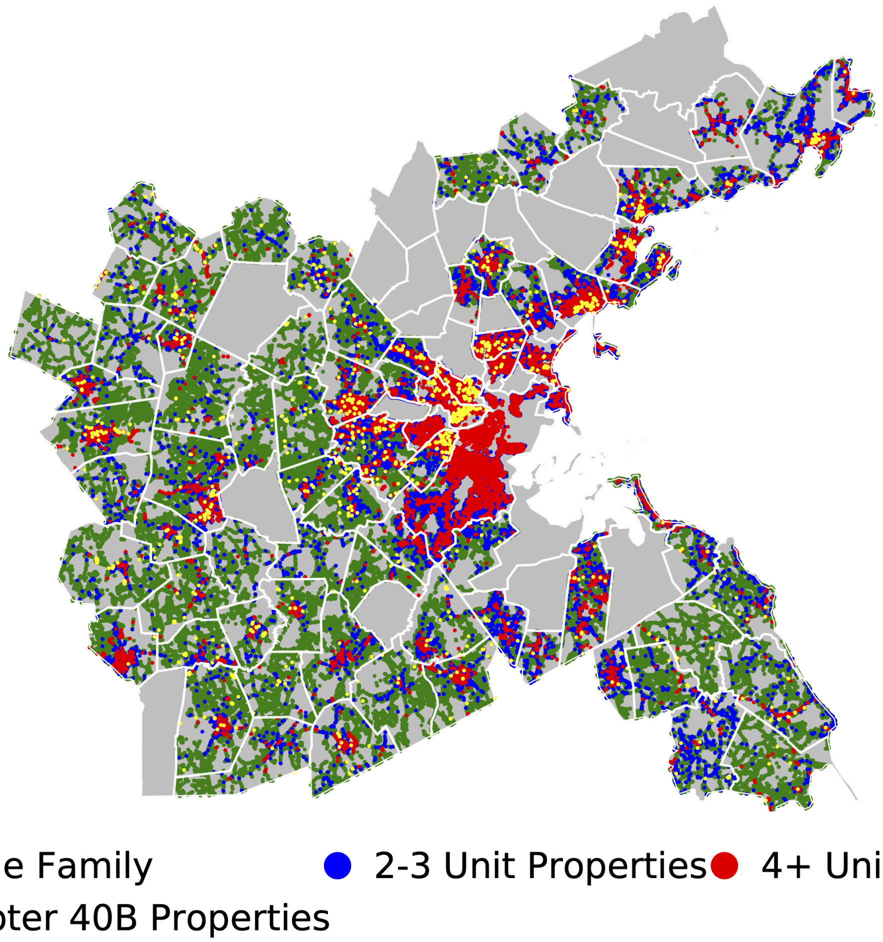


(f) School RD estimate = -0.021, (t stat = -1.36)

Note: Plots are created by regressing distance from various amenities on boundary fixed effects and bins of distance from boundary (bins of 0.02 mile). Coefficients on distance bins are plotted. Negative distances indicate more regulated side of boundary. The bin closest to the boundary on the less regulated side (0 to 0.02 mile from boundary) is normalized to 0. 95 percent confidence intervals are shown. DUPAC is density units per acre, and MF is multifamily zoning boundaries. Standard errors are clustered at the boundary level.

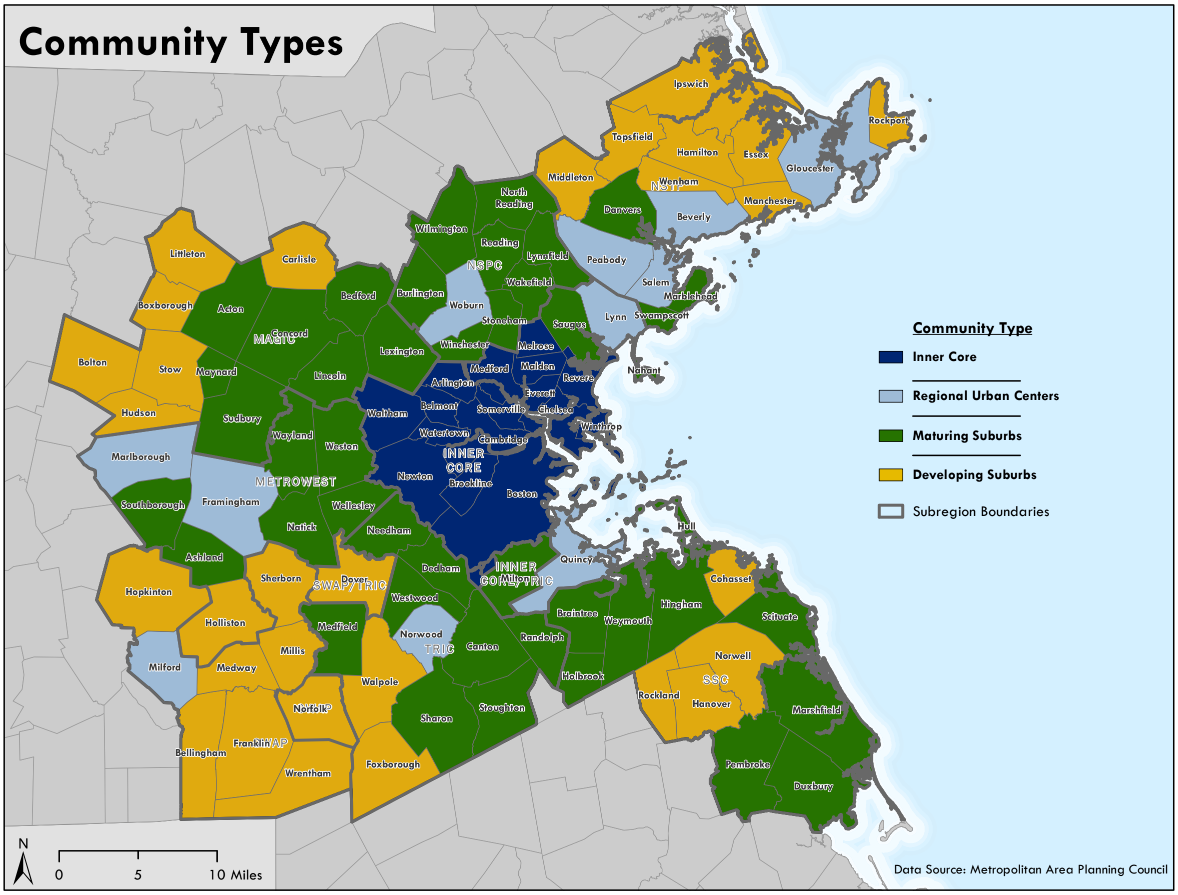
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.6: Housing Types over Space



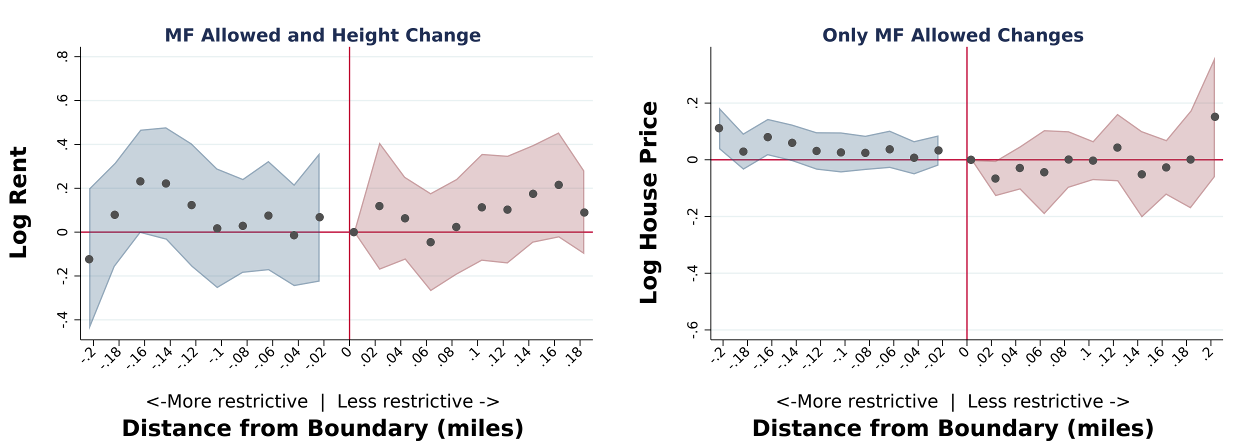
Note: Single-family properties are those classified as single family on their 2018 tax assessment record. two- or three-unit properties and four-plus-unit properties are those classified as such on their tax assessment record, or as mixed use or other residential properties with two or three units or four or more units, respectively. Chapter 40B properties are buildings built under Massachusetts's inclusionary zoning law. Chapter 40B properties are magnified for better illustration. Properties shown include only those within 1 mile of a zoning boundary. Excludes municipalities that were not included in the analysis.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas. MA Department of Housing and Community Development Subsidized Housing Inventory 2018 active properties.

Figure B.7: Greater Boston Community Types



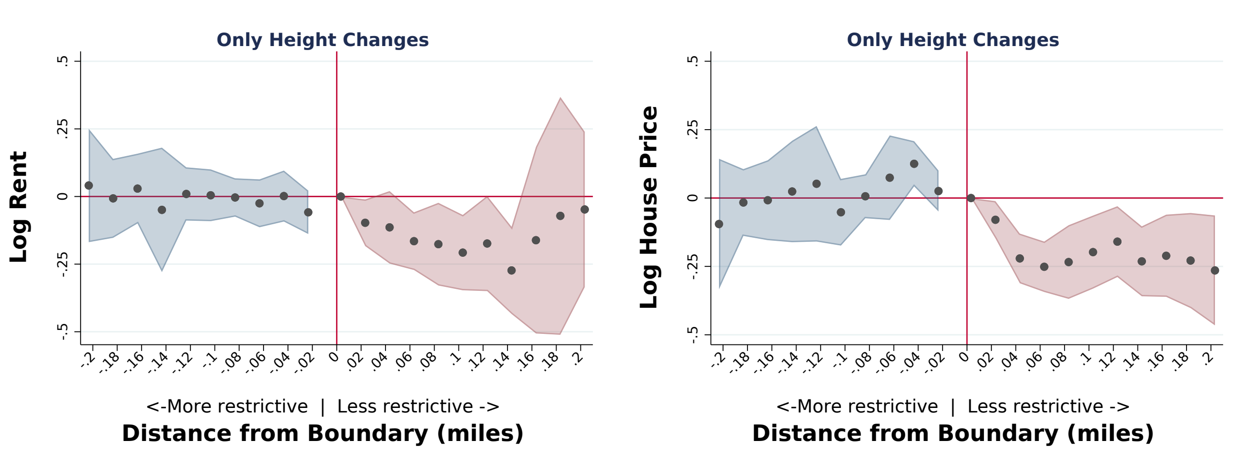
Notes: This figure highlights how the Metropolitan Area Planning Council (MAPC) divides municipalities in Greater Boston into four distinct community types.
Source(s): Metropolitan Area Planning Council

Figure B.8: Effects of Height and Multifamily Regulations on Housing Costs



(a) RD estimate= 0.068, (t statistic = 0.46) (b) RD estimate = 0.033, (t statistic = 1.22)

Change in Only Multifamily or Multifamily and Height Regulations

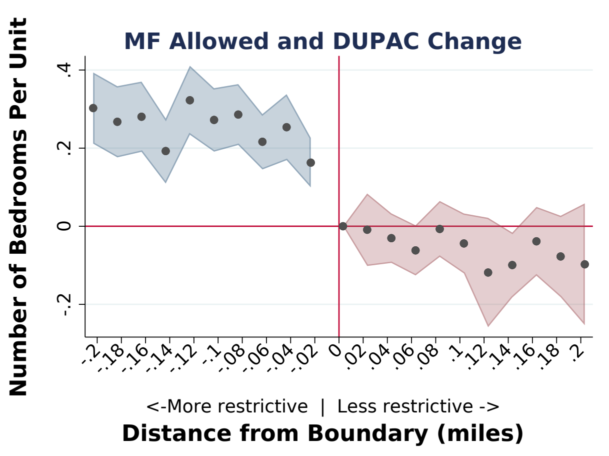


(c) RD estimate= -0.058, (t statistic = -1.44) (d) RD estimate = 0.026, (t statistic = 0.67)

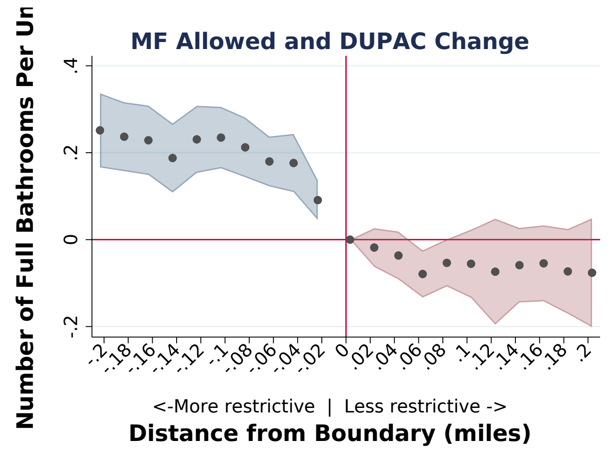
Change in Only Height Regulation Boundaries

Note: Plots are created by regressing log prices on boundary fixed effects, year fixed effects (2010–2018), and bins of distance from the boundary (bins of 0.02 mile). Coefficients on the distance bins are plotted. Negative distances indicate the more regulated side of a boundary. The bin closest to the boundary on the less regulated side (0 to –0.02 mile from the boundary) is normalized to 0. 95 percent confidence intervals are shown. Left panel indicates the effect on monthly rental prices for multifamily buildings. Right panel indicates the effect on monthly owner cost of housing for single-family houses. The unit on height is in 10 feet, and DUPAC (dwelling units per acre) is in 1 housing unit. Standard errors are clustered at the boundary level. Source(s): 2010–2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

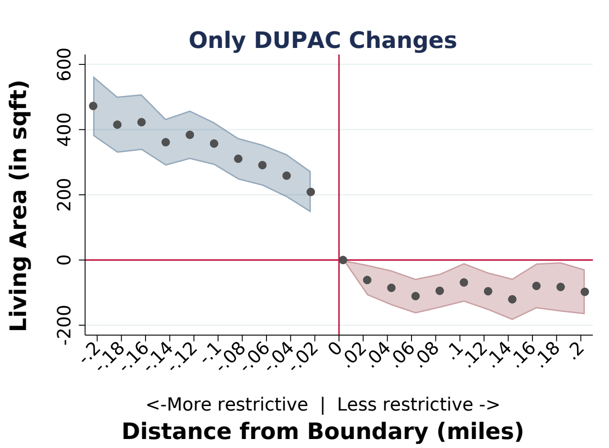
Figure B.9: Housing Characteristics at Regulation Boundaries



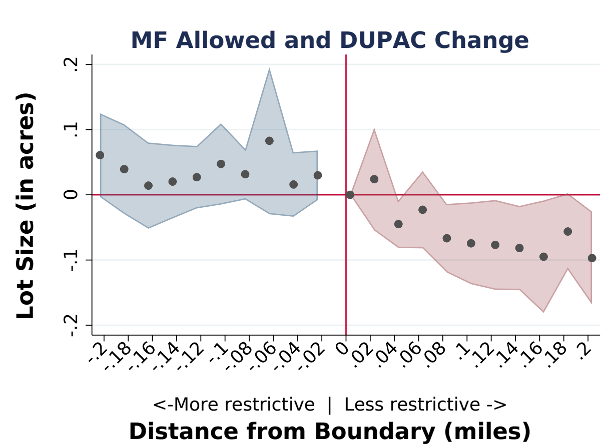
(a) Bedrooms RD estimate = 0.163, (t stat = 5.04)



(b) Bathrooms RD estimate = 0.091, (t stat = 3.90)



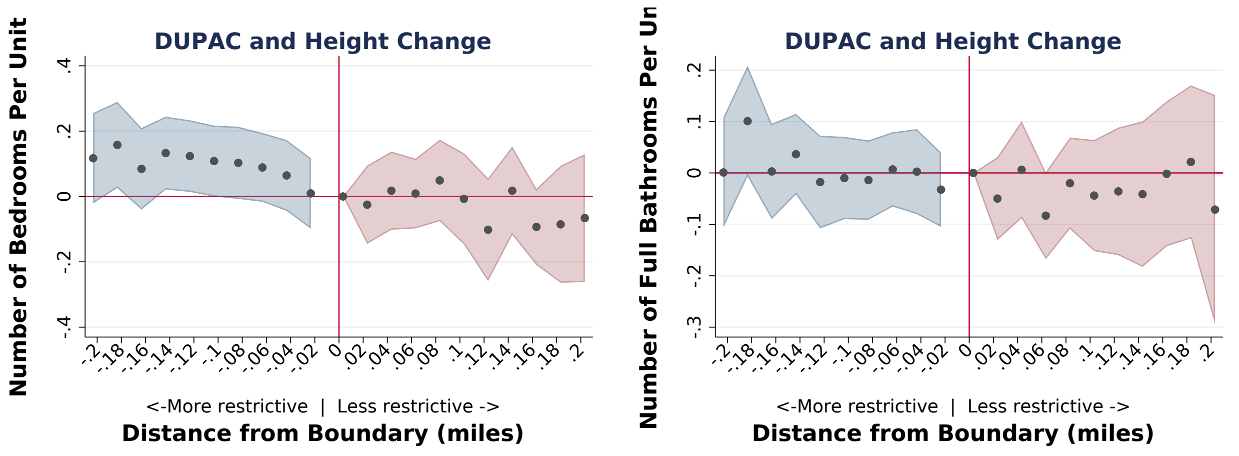
(c) Living Area RD estimate = 208.9, (t stat = 6.47)



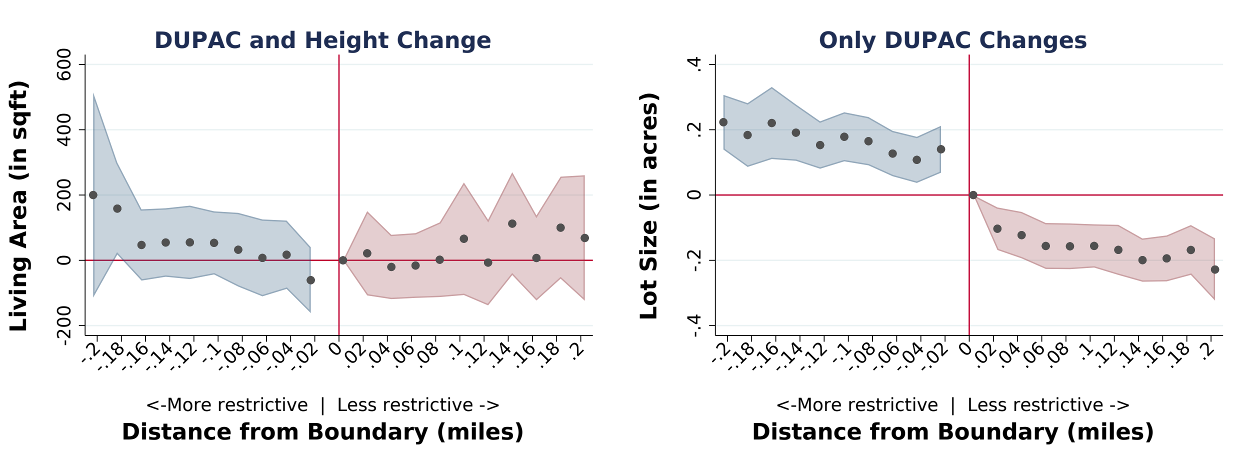
(d) Lot Size RD estimate = 0.03, (t stat = 1.54)

Note: This figure plots building characteristics across regulation boundaries. Plots are created by regressing unit characteristics on boundary fixed effects and distance from boundary (bins of 0.02 mile). Coefficients on distance bins are plotted. Negative distances indicate the more regulated side of the boundary. Bin closest to boundary on less regulated side (0 to 0.02 mile) is normalized to 0. 95 percent confidence intervals are shown. DUPAC is dwelling units per acre, and MF is multifamily zoning.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.10: Housing Characteristics at Regulation Boundaries: Continued



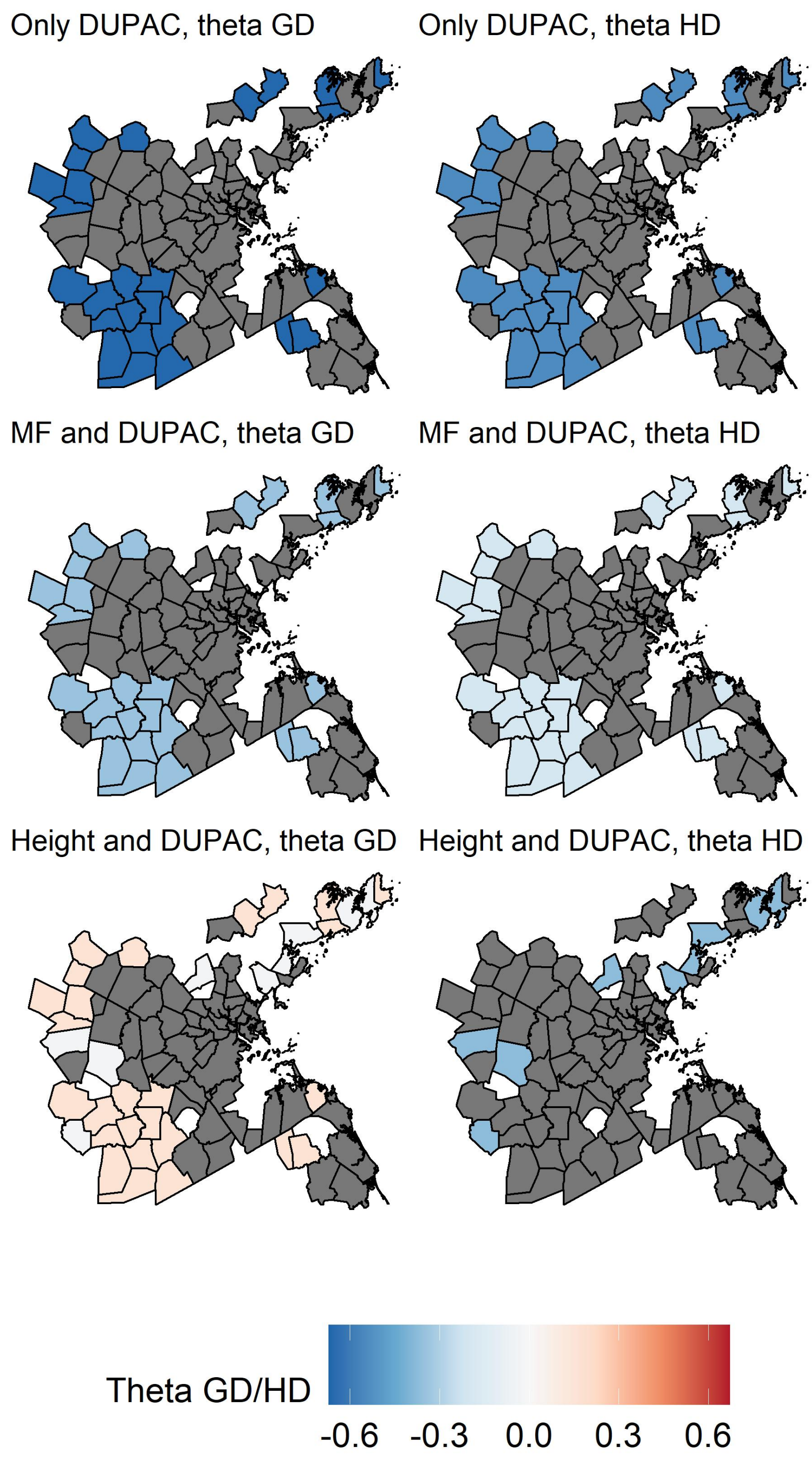
(a) Bedrooms RD estimate = 0.009, (t stat = 0.17) (b) Bathrooms RD estimate = -0.-33, (t stat = -0.88)



(c) Living Area RD estimate = -60.79, (t stat = -1.18) (d) Lot Size RD estimate = 0.140, (t stat = 3.83)

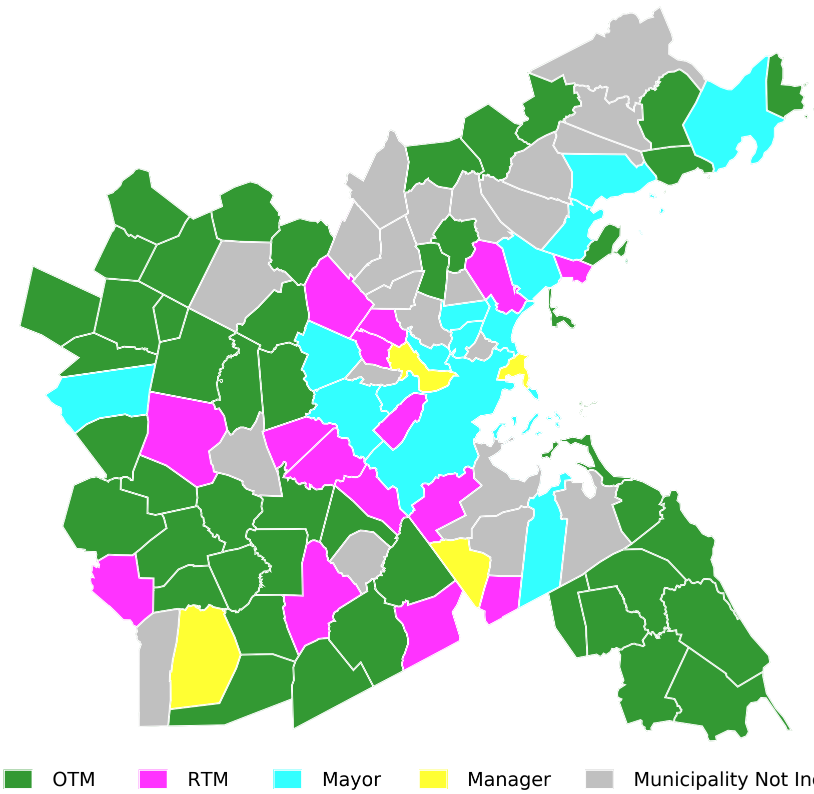
Note: This figure plots building characteristics across regulation boundaries. Plots are created by regressing unit characteristics on boundary fixed effects and distance from boundary (bins of 0.02 mile). Coefficients on distance bins are plotted. Negative distances indicate the more regulated side of the boundary. Bin closest to boundary on less regulated side (0 to 0.02 mile) is normalized to 0. 95 percent confidence intervals are shown. DUPAC is dwelling units per acre, and MF is multifamily zoning.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.11: Indirect Effects of Gentle and High Density on Renters



Note: These figures plot coefficients (θ^{GD}, θ^{HD}) of the indirect price effects of only DUPAC (dwelling units per acre), DUPAC and height, and DUPAC and multifamily (MF) regulations on log monthly rents for multifamily houses for increases in gentle density (two or three units) or high density (four or more units) in a 0.1-mile radius of the house on left and right, respectively. Gray areas represent no statistically significant results. Standard errors are clustered at the boundary level.
Source(s): 2018 Warren Group tax assessment records, 2020 Metropolitan Area Planning Council Zoning Atlas.

Figure B.12: Systems of Local Municipal Governance



Notes: This figure plots the different forms of local municipal governance in Greater Boston. OTM is open town meeting structure. RTM is representative town meeting structure. The other two local-governance systems are mayoral and town manager (Manager). Source(s): Massachusetts Municipal Association Municipal Forms of Governance