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The causes and consequences of land use regulation: Evidence from Greater Boston ☆

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ABSTRACT

Over the past 30 years, eastern Massachusetts has seen a remarkable combination of rising home prices and declining supply of new homes, which doesn't appear to reflect any lack of land. In this paper, we examine the increasing number of land-use regulations in Greater Boston. These regulations vary widely over space, and are hard to predict with any variables other than historical density levels. Minimum lot size and other land use controls are associated with reductions in new construction activity. These regulations are associated with higher prices when we do not control for contemporary density and demographics, but not when we add these contemporaneous controls. These results are compatible with economic theory, which predicts that production restraints on a good won't increase the price of that good relative to sufficiently close substitutes. Current density levels appear to be too low to maximize local land values.

1. Introduction

Over the past 25 years, many US cities have experienced a remarkable combination of increases in housing prices and decreases in new construction (see Glaeser et al., 2005). Boston is an extreme example of this phenomenon, with its dramatically rising housing prices. Table 1 shows that based on Office of Federal Housing Enterprise Oversight (OFHEO) repeat sales indices, three of the four metropolitan subdivisions with the greatest price appreciation between 1980 and 2004 are in the Boston region (Boston–Quincy, Cambridge–Newton and Suffolk). At the same time, as Fig. 1 shows, the total number of permits issued in the Boston metropolitan area declined from 172,000 during the 1960s, to 141,000 during the 1980s, to 84,000 during the 1990s.

The combination of rising prices and declining new supply suggests that Boston's high prices reflect more than just rising demand. After all, without increasingly inelastic supply, an increase in demand should lead to higher prices *and* more construction. One natural hypothesis is that the supply of new housing in Boston is falling because Greater Boston is running out of land. In Section 2 of this paper, we present evidence that seems to run counter to this hypothesis. Land densities are quite low in many areas of Boston, and over the past 40 years, density has not risen significantly in the Boston area. Within the Boston region, higher densities are associated with more, not less, permitting.

If increasing density levels cannot explain the decline in new construction, then one alternative hypothesis is that increasingly stringent land use regulations have made it more and more difficult for developers to build (see Ellickson, 1977; Brueckner, 1990; and Glaeser et al., 2005). The primary contribution of this paper is to add results from a new data set on land use regulations in Greater Boston to the literature that examines the impact of land use restrictions on new construction and prices (see Maser et al., 1977; Katz and Rosen, 1987; Pollakowski and Wachter, 1990; Levine, 1999; Quigley and Raphael, 2005; and Ihlanfeldt, 2007).

Data on Greater Boston is a useful addition to these studies because the area extensively uses land use controls, which are selected by particularly small towns that enjoy a great deal of control over local building. Our data set gives us exceptionally detailed data on the rules that localities have imposed on construction, which enables us to look at formal rules rather than more clearly endogenous variables like the time delay involved in getting a permit. This data was collected by the Pioneer Institute for Public Policy Research and it contains information on the remarkable array of land use regulations in 187 cities and towns within Greater Boston, including minimum lot sizes, wetlands regulations, septic

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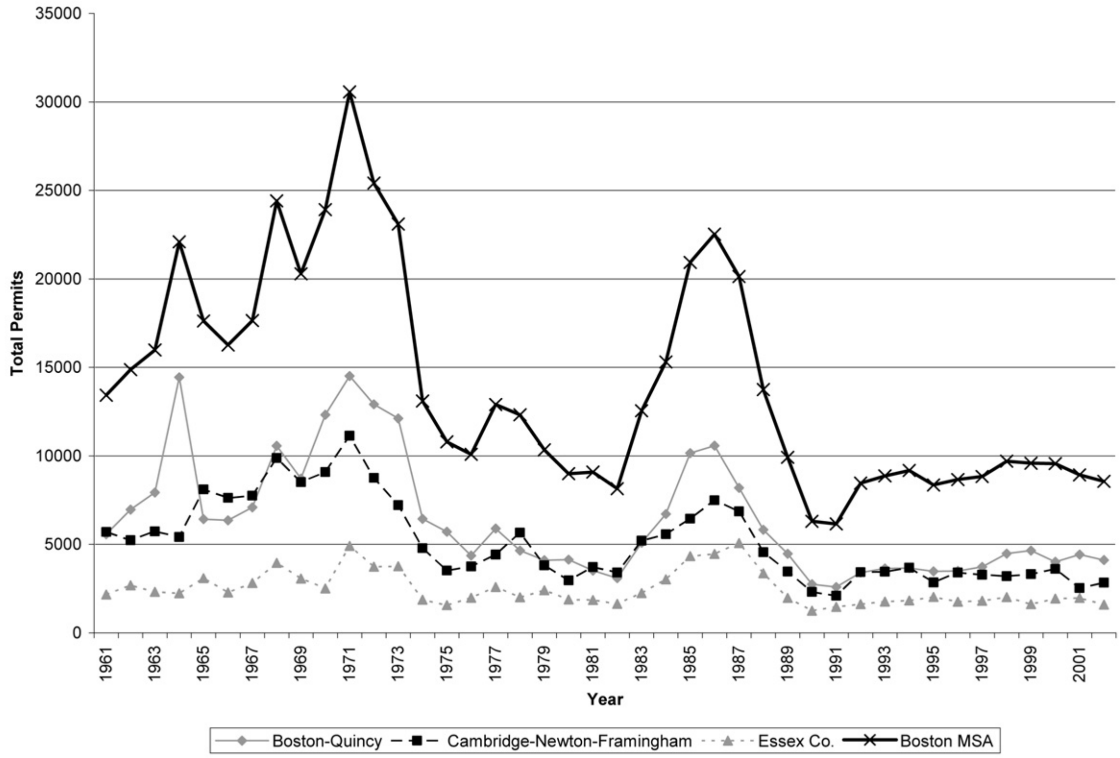


Source. US Census Bureau.

Fig. 1. Total permits in Boston metro-area, 1961–2002.

Table 1
Percent change in housing prices, 1980–2004, top 20 metropolitan areas.

Percent change in OFHEO repeat sales index, 1980–2004	Percent change in OFHEO repeat sales index, 1980–2004 (%)
Nassau–Suffolk, NY Metropolitan Division	251
Boston–Quincy, MA Metropolitan Division	210
Cambridge–Newton–Framingham, MA Metropolitan Division	180
Essex County, MA Metropolitan Division	179
Salinas, CA Metropolitan Statistical Area	162
New York–Wayne–White Plains, NY–NJ Metropolitan Division	158
Napa, CA Metropolitan Statistical Area	156
Santa Cruz–Watsonville, CA Metropolitan Statistical Area	156
Worcester, MA Metropolitan Statistical Area	149
San Luis Obispo–Paso Robles, CA Metropolitan Statistical Area	146
San Francisco–San Mateo–Redwood City, CA Metropolitan Division	138
San Jose–Sunnyvale–Santa Clara, CA Metropolitan Statistical Area	137
Santa Rosa–Petaluma, CA Metropolitan Statistical Area	131
Santa Barbara–Santa Maria–Goleta, CA Metropolitan Statistical Area	129
Providence–New Bedford–Fall River, RI–MA Metropolitan Statistical Area	129
Oakland–Fremont–Hayward, CA Metropolitan Division	116
Edison, NJ Metropolitan Division	114
Newark–Union, NJ–PA Metropolitan Division	112
Oxnard–Thousand Oaks–Ventura, CA Metropolitan Statistical Area	109
San Diego–Carlsbad–San Marcos, CA Metropolitan Statistical Area	109

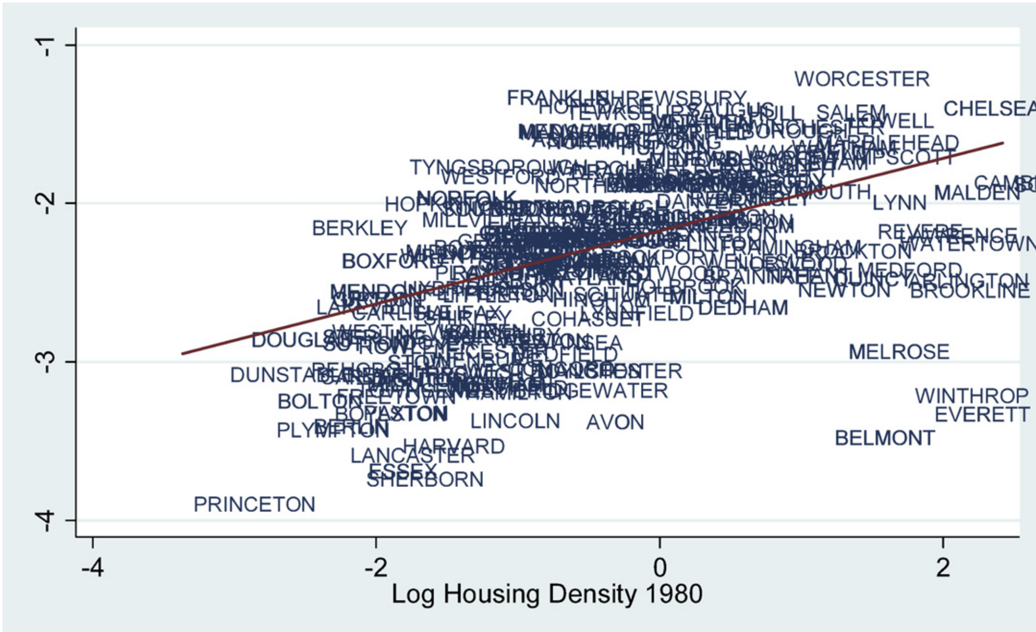
Source. OFHEO repeat sales index, raw index is adjusted for inflation using CPI minus shelter.

rules and subdivision requirements.[1] For many of the regulations, the data set also includes the dates when the regulations were imposed, so it is possible to look at changes over time.

In Section 3 of the paper, we establish three basic facts about land use regulation in eastern Massachusetts. First, along most dimensions there has been a dramatic increase in regulation since 1980. For example, the share of communities with rules restricting subdivisions has increased from less than 50 percent in 1975 to almost 100 percent today. Second, as Ellickson (1977) emphasized, there is a remarkable variety in the nature of these regulations: minimum lot sizes, subdivision rules, and septic and wetlands restrictions that go significantly beyond the state standards are only the most basic of regulations. Third, land use regulations are often astonishingly vague, which increases the likelihood that there will be disputes about implementation.

We then turn to the determinants of land use regulations. Like Evenson and Wheaton (2003), we find that historical housing density is the most important determinant of minimum lot size. More manufacturing and more minorities in 1940 are also associated with smaller minimum lot sizes. Septic and wetlands regulations are associated with the historical presence of standing water. The empirical exercise of trying to explain land use restrictions did not yield any explanatory variables that can satisfy the exclusion restriction needed for them to be valid instruments for land use controls in a price or construction regression. Instead, we come away with the view that the bulk of these rules seem moderately random and unrelated to most obvious explanatory variables. The absence of good instruments and the seeming randomness of the rules lead us to use the rules directly in our empirical work on the consequences of land use regulations.

[1] The database and a detailed discussion about how it was obtained is available at http://www.masshousingregulations.com/.



Source. US Census Bureau.

Fig. 2. Relationship between log single family permits 1980–2002 per acre and log 1980 housing density.

The large number of local jurisdictions in Boston makes this setting a natural place to look at the construction impact of local land use, since there is so much variation in regulation between places that are otherwise quite similar. In Section 4, we find a robust negative effect of minimum lot size on the amount of building in an area between 1980 and 2002. As the average acre per lot increases by one, there is a 0.4 log point reduction in single-family development between 1980 and 2002. Other regulations also significantly reduce new construction. In a specification with town fixed effects, where we combine wetlands, septic and subdivision rules into a single index, we find that each extra rule reduces new construction by 0.1 log points. We have no way of knowing whether any reductions in construction associated with specific rules represent a total reduction in building across the region or just a shift from more controlled places to less controlled places. The overall decline in permitting does suggest that these controls have had some aggregate effect on the region.

The same abundance of similar, small jurisdictions that makes Greater Boston a natural place to examine the impact of land use controls on new construction makes the area a much less natural place to examine the impact of land use controls on price. There are so many close substitutes for most towns that we would not expect restricting of housing supply in one town to raise prices in that town relative to another town with similar demographics and density levels. Restrictions on building in one suburban community should not raise prices in that community relative to another town with equivalent amenities, any more than restrictions on the production of Saudi Arabian crude will raise the price of Saudi Arabian crude relative to Venezuelan crude. Of course, Saudi Arabia's quantity restrictions will still raise the global price of oil, but this cannot be seen by comparisons of prices across oil producers.

In Section 4, we also look at the connection between land use controls and prices in a hedonic price regression, where we control for structural characteristics, lot size and fixed town characteristics, we find that each acre per lot is associated with a 12 percent increase in housing prices. When we control for town demographic variables and density, this impact disappears. The impact of other regulatory barriers is significant when we don't control for the demographic variables and density, but it also disappears when we control for these variables. Our interpretation of these results is that the major way in which land use restrictions impact price is by changing the density and demographic composition of a town.

Our data enables us to examine whether towns are choosing densities to maximize land values. In some settings, land value maximization is equivalent to social welfare maximization (Brueckner, 1990). In a simple model, reducing minimum lot sizes will increase total land value in a town if the share of housing prices associated with land is greater than the elasticity of price with respect to unit lot size minus the elasticity of price with respect to town density. We find that these two elasticities sum to approximately 0.1, while land's share of total value in the sample seems to be greater than 0.5. Together these results suggest that community densities are too low to be maximizing total land value.

2. Is lack of land the limit on Greater Boston's housing supply?

In this preliminary section, we present evidence on whether the rise in price and decline in permitting in Greater Boston can be explained by a lack of land. Throughout this paper, we will use a sample of 187 cities and towns that lie between Route 495 and the city of Boston, excluding Boston itself. This sample includes all of the cities and towns that are physically closest to Boston, except for those on Cape Cod.

We first look at whether construction has been particularly curtailed in places with less developable land. Using US Census data on permits from 1980 to 2002 and housing unit density in 1980, Fig. 2 shows the strong positive relationship between initial housing unit density and later construction; the places with the most land permitted the fewest single family units. This relationship might be explained by higher demand in high density areas, but when we run a bivariate regression where we regress single family permits on both land density and price in 1980, we estimate:

$$Log\left(\frac{Permits_{1980\text{–}2002}}{Acres}\right) = \underset{(1.53)}{3.27} + \underset{(0.03)}{0.22} \cdot Log\left(\frac{Homes_{1980}}{Acres}\right) - \underset{(0.13)}{0.46} \cdot Log(Price_{1980}). \qquad (1)$$

Standard errors are in parentheses. These are 186 observations and the R-squared is 55 percent. Price is negatively associated with the amount of development, which again suggests the importance of limits on supply, for otherwise there would surely be more building in the areas where demand is stronger. Controlling for initial price has virtually no impact on the relationship between construction and initial density, which remains quite positive. How can lack of land be driving the reduction in permits if there is the least construction in areas with the most land?

A second piece of evidence supporting the view that declining construction levels don't reflect a lack of land is the existence of many towns with the combination of high prices, low density levels and low levels of new construction. Lincoln, Weston and Concord are three contiguous towns that illustrate low levels of construction in land rich areas. Together, they have 12,889 homes and cover more than 39,000 acres. Yet despite being among the most expensive towns in the state, these areas together permitted just 1746 new homes, or less than 0.045 new homes per acre, between 1980 and 2002. In our sample of 187 towns, there are another 22 localities with less than one home for every two acres that have allowed less than 30 units per year each since 1980.[2]

A third piece of evidence, running counter to the view that Greater Boston is running out of land, is that density levels have not increased very much over the past 25 years. For example, the total housing density in Suffolk County (which contains Boston) increased by 4.5 percent in the 1970s, 4.6 percent in the 1980s and 1.1 percent in the 1990s. Middlesex County (which contains Cambridge) grew more, but even its housing unit density increased by only 10.3 percent in the 1980s and by 6 percent in the 1990s.

Can such modest increases in density explain the reduction in the number of new units permitted? One approach to answering this question is to run a panel regression where an observation is a town-year. If we do not control for density, but do control for town fixed effects, we estimate that construction falls by −0.267 log points after 1990 (the standard error is 0.05). We use a post-1990 dummy variable because it is a simple and convenient way to empirically capture the decline in permitting intensity, not because there is anything special about that year. If we just control for density in the panel regressions (removing town fixed effects), then the estimated decline in permitting increases, since density is positively predicted with new permits and density is rising.

Alternatively, we can fix the coefficient on density in these regressions at different values and see how much this reduces the reduction in permitting over time. For example, if we fix to the coefficient on density as −0.1, which reflects a national regression run by Glaeser et al. (2005), then the estimated dummy variable on the 1990s falls in absolute value to −0.25. If we fix the coefficient on density at −0.25, the estimated dummy variable on the 1990s is −0.23. This is a large coefficient on density, and even with such a large coefficient, density can only explain 14 percent of the decrease in eastern Massachusetts construction in the 1990s.

A fourth piece of evidence that runs counter to the view that declining construction levels reflect a lack of land is that land is not particularly valuable in housing price hedonic regressions. If land use restrictions didn't exist, then in equilibrium, land that extends a lot would be worth the same as land that sits under a new lot (see Glaeser and Gyourko, 2003). Using data from Banker and Tradesman from 2000 to 2005, we estimate a standard hedonic regression with structural characteristics and find that an extra acre of land is associated with an extra cost of only $16,000. This is not a high value of land, given that the average home sales price is $450,000, which is approximately $270,000 more than the physical cost of building an average unit in Boston.[3]

Since the average home in our sample sits on 0.7 acres, a back-of-the-envelope calculation suggests that an acre is worth more than 300,000 dollars if it sits under a new home, but less than 20,000 dollars if it extends an existing lot. The mismatch between those two numbers suggests that Boston cannot be understood as a market where land is scare and land use is unrestricted. In that case, the value of an acre should be the same if it extends an existing lot or is used to create a new lot.

A final piece of evidence on the land shortage hypothesis is that lot sizes for new homes in the Boston area rose from 0.76 in 1990 to 0.91 in 1998 (Jakabovics, 2006). Rising lot sizes are hard to reconcile with a land shortage. One explanation of this phenomenon is that incomes were rising, but Glaeser et al. (2008) estimate an income elasticity of demand for land among single-family homeowners of less than 0.2 and Boston area income rose by less than five percent. Those estimates predict a one percent increase in average lot size, not the 20 percent increase that is actually observed.

3. Data description and the causes of land use regulation

The combination of increasing prices and decreasing construction can't be explained by a lack of land, but perhaps it can be explained by a man-made land shortage created by an increasingly stringent regulatory environment. To consider this possibility, we now turn to the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston. This data was assembled by a team of researchers who interviewed local officials about the rules facing local developers. This data was supplemented with data from the MassGIS system which details for 1999–2000 the minimum lot size requirements throughout the state.[4] Our permitting and demographic data come from the Census.

3.1. Minimum lot sizes

Before turning to the non-lot regulations, we will begin with the basic facts about lot size requirements in eastern Massachusetts. Lot sizes are not uniform within most towns; there are generally several different planning sub-areas. We include all sub-areas where it is possible to build single family housing. Since our permitting and price information is at the town level, we aggregate sub-area data on minimum lot size using the formula:

$$LotSize_{Minimum} = \frac{TotalTownLandArea}{\sum_{Sub\text{-}areas} \frac{LandArea}{MinimumLotSize}}. \tag{2}$$

The formula essentially divides the total land area in the town by the number of homes that can be built in the town. The denominator calculates the total units that could be built in the town by summing across areas the total number of units that could be built in each sub-area, or $\frac{LandArea}{MinimumLotSize}$.

The effect of minimum lot size should be particularly striking on undeveloped land, but since Greater Boston is one of America's oldest urban areas, there is extremely little truly undeveloped land within the region. The impact of lot sizes in this region should work primarily by reducing the ability to subdivide existing properties, which is why we look at minimum lot sizes throughout the town.

There is a great deal of variation in this variable across our 187 cities and towns. One-fifth of the population and slightly under

[2] Overall, between 1980 and 2002, the total amount of permits was 313,762 units spread over 2,180,795 acres, or 0.14 new homes per acre.

[3] Gyourko and Saiz (2006) estimate that the cost of construction is less than 100 dollars per square foot in Boston and the average home in our sample is 1800 square feet.

[4] This system was used and described more thoroughly by Evenson and Wheaton (2003).

Table 2
Characteristics of municipalities, by average SF minimum lot size.

	(1) Mean SF minimum lot size	(2)	(3)	(4)
	<20,000	20–35,000	35–50,000	50,000+
Share of regional pop.	42.7	21.7	21.3	14.3
Share of regional land	12.7	18.9	28.8	39.6
Number of towns	42	38	51	55
Mean population	41,338	23,218	16,987	10,571
	[32,007]	[17,385]	[12,477]	[7851]
Pct. white	84.5	92.1	93.7	94.5
	[15.1]	[7.9]	[3.8]	[4.1]
Pct. foreign-born	13.9	7.2	6.2	5.3
	[8.5]	[4.9]	[2.9]	[3.2]
Pct. w/BA+	37.3	35.2	38.8	43.1
	[17.6]	[13.6]	[14.6]	[19.2]
Distance to Boston (miles)	14	22	24	28
	[10]	[8]	[8]	[8]
Land area (acres)	6551	10,829	12,254	15,642
	[5240]	[4651]	[5218]	[9742]
Pct. housing in SF	49.6	68.3	73.5	79
	[21.9]	[16.5]	[12.4]	[13.5]
Mean hsg price	238,160	217,818	229,635	265,444
	[91,766]	[73,394]	[74,562]	[124,045]
Mean rent	829	732	714	773
	[159]	[166]	[121]	[202]

Source. US Census, MassGIS.

one-tenth of the towns have average lot sizes of 10,000 feet or less (one quarter acre), while slightly under one-tenth of the towns have average lot sizes of 70,000 feet or more. Unsurprisingly, people tend to live disproportionately in areas with denser zoning and land tends to be disproportionately allocated to less dense zoning. Towns are particularly likely to have between 30,000 and 40,000 foot minimum lot size, which is about one acre, and which is also the average lot size of new homes found by Jakabovics (2006).

In Table 2, we show the distribution of town characteristics by minimum lot size broken into four categories. The towns with smaller minimum lot sizes are larger, with populations that are more likely to be non-white and foreign born. The towns with larger lot sizes are further from Boston, and have higher housing prices when we do not use controls. Income and education levels are mildly higher in the areas with high minimum lot sizes.

3.2. Other land use regulations

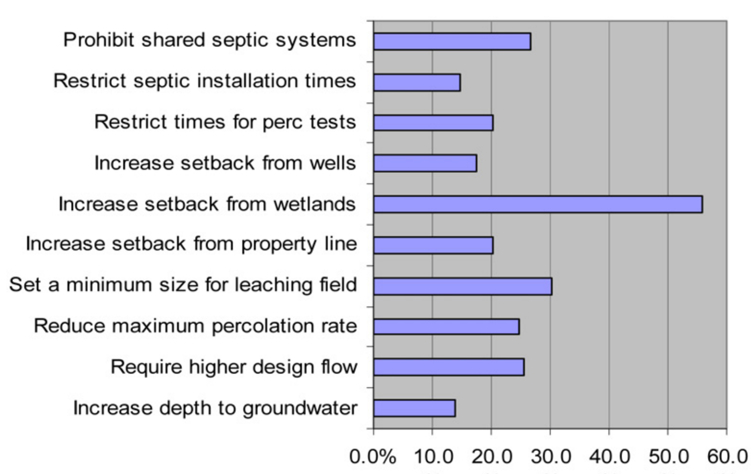
While minimum lot size is the single most important land-use regulation, Massachusetts cities and towns have increasingly adopted other rules that also impact new construction. The bulk of these rules make new development more difficult, but some rules—like cluster zoning—can make it easier to build. The Pioneer Institute survey categorized all of these rules across the 187 cities and towns.

The three largest categories of added constraints on land use controls concern wetlands, septic systems and subdivision requirements. Both wetlands and septic systems are also regulated at the state level, but our focus is on the town level rules that go beyond the state's regulations. While a majority of towns have gone beyond the state standards, there is considerably heterogeneity in town-level regulations.

For example, the state Wetlands Protection Act protects all land within 100 feet of a wetland or floodplain, which includes all land that has 10,890 cubic feet of standing water at least once per year. Of the 131 communities that have imposed wetlands regulations that go beyond the state standard, 59 of them have introduced more stringent definitions of floodplains. Eleven of them, for example, have defined floodplains as including all areas that have 5445 cubic feet of standing water. A number of them have gone to 1000 cubic feet of standing water or less. Twenty-four of these communities have adopted amorphous verbal definitions of floodplains, such as "an isolated depression... that confines standing water" (see Dain, 2006).

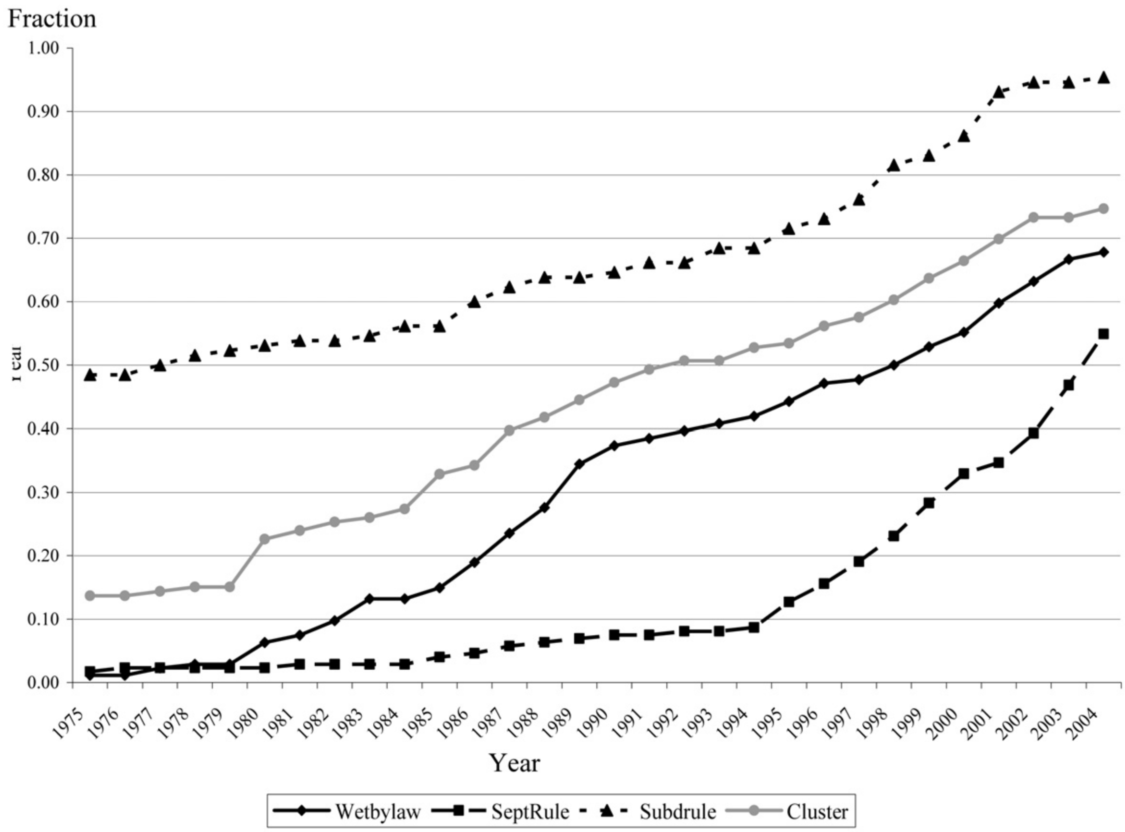
The range of rules that control septic systems is also remarkable. One hundred and nine towns go beyond the state's Title 5 septic rules. A particularly popular form of regulation is to require percolation rates below the state's maximum of 60 minutes per inch; 12 towns have imposed requirements of a maximum 20 minutes per inch percolation rate. Other septic rules increase the distance between septic systems and property lines, wetlands and wells. These regulations generally increase the amount of land needed to build. The diversity of these rules is shown in Fig. 3, which shows the share of communities that have adapted different rules. While one might think that since septic rules are justified by public health concerns there would be a relatively common standard throughout a small geographic area, the basic pattern is one in which different communities all adopt their own idiosyncratic permutations of the rules.

Subdivision requirements are similarly complex. All but six of our communities have adopted subdivision rules, and while some subdivision rules are more than 50 years old, amendments are frequent. The Pioneer database focused on subdivision rules concerning roads and sidewalks. One-fifth of the sample required roads that were 32 feet wide or more. Some communities required roads



Source. Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston.

Fig. 3. Frequency of restrictions greater than Title V requirements.



Source. Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston. Communities who adopt provisions at unknown dates are excluded from fraction.

Fig. 4. Fraction of communities with wetlands, septic, subdivision, and cluster provisions, 1975–2004.

that were 22 feet wide or less. There are also restrictions on sidewalks and curb materials.

Rules regarding lot shape also restrict subdivisions. Sometimes these rules are straightforward requirements that restrict the ratio of perimeter to area. In other cases the rules are more amorphous, such as the town of Millbury's prohibition that "No pork chop, rattail, or excessively funnel-shaped or otherwise gerrymandered lots shall be allowed." Fifty-four towns have also instituted growth management policies that just act as a brake on the amount of new development.

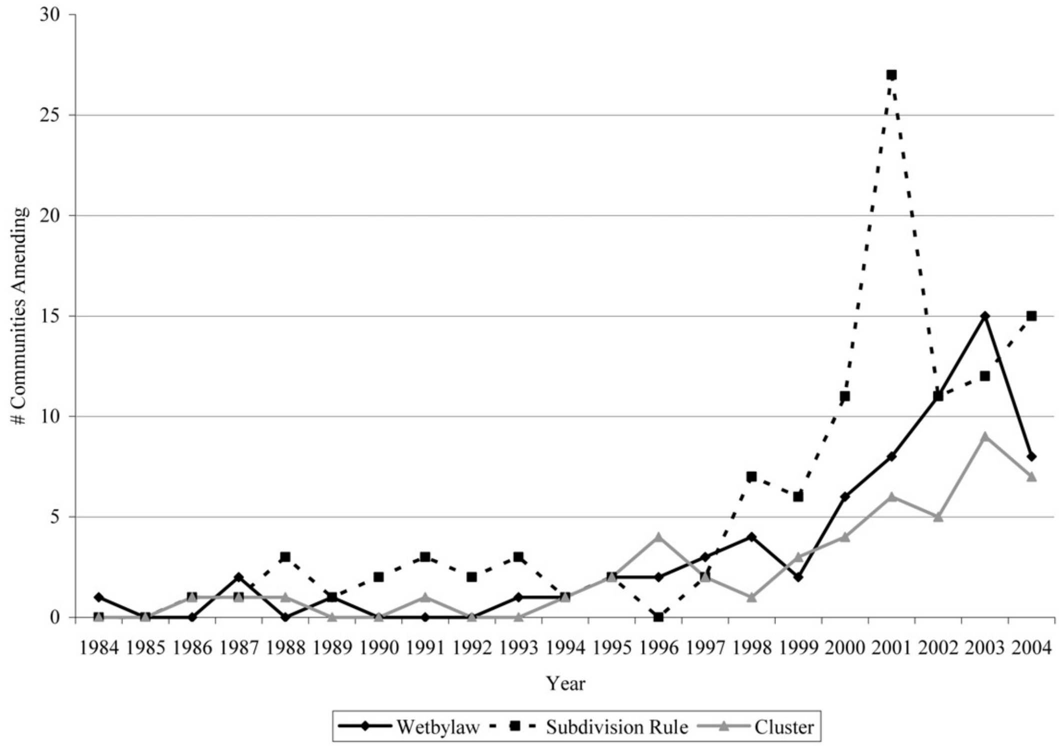
There are three sets of policies that enable developers to avoid the minimum lot size regulations. First, a large number of communities have adopted cluster zoning, which enables builders to use smaller lot sizes in exchange for setting aside some quantity of open space. In many cases, cluster zoning doesn't actually have a density bonus, because the open space set aside must be enough so that the total density of the lot size still conforms to existing minimum lot size rules. Inclusionary zoning can enable developers to avoid minimum lot size requirements if they include enough affordable units. Towns have an incentive to build these affordable units, because if they have too few units, developers can use the state rule Chapter 40B, which allows them to ignore local zoning ordinances. Still, we have only found 21 towns where builders have taken advantage of inclusionary zoning rules. A third set of rules allow builders to develop at higher densities if the units are restricted to the elderly.

In our empirical work, we will use a simple categorical variable that takes on a value of one if the town has passed a rule that goes beyond the state standards regarding septic systems, wetlands and subdivisions. We will also sum those three categorical variables together for an overall regulatory barriers index (similar to Quigley and Raphael, 2005). While there is surely information lost in using such a coarse measure, the advantage of such coarseness is that it provides a simple measure with limited opportunities for data mining. This metric attempts to capture the overall regulatory environment in each community, while avoiding the loss of statistical clarity associated with trying to look at the effects of all three regulations simultaneously. As Pollakowski and Wachter (1990) argue, "land-use constraints collectively have larger effects than individually." We also examine the impact of cluster and inclusionary zoning.

Fig. 4 shows the adoption levels of the three forms of regulatory barriers and cluster zoning. All forms of regulation show a dramatic increase over time. The subdivision rules have now become ubiquitous. Fig. 5 shows the share of communities that have amended their wetland, cluster and subdivision bylaws by year. There was a dramatic increase in the end of the 1990s. These increases were also accompanied by an increasing use of the court system by the opponents of growth. Lawsuits, particularly justified on environmental or nuisance grounds are also a perennial developer's complaint. Fig. 6 shows the results of a Lexis/Nexis search of Massachusetts Court Decisions containing all of the keywords zoning, residential and either septic or wetland from 1964 to 2004. Again, there was a steady rise in the 1990s.

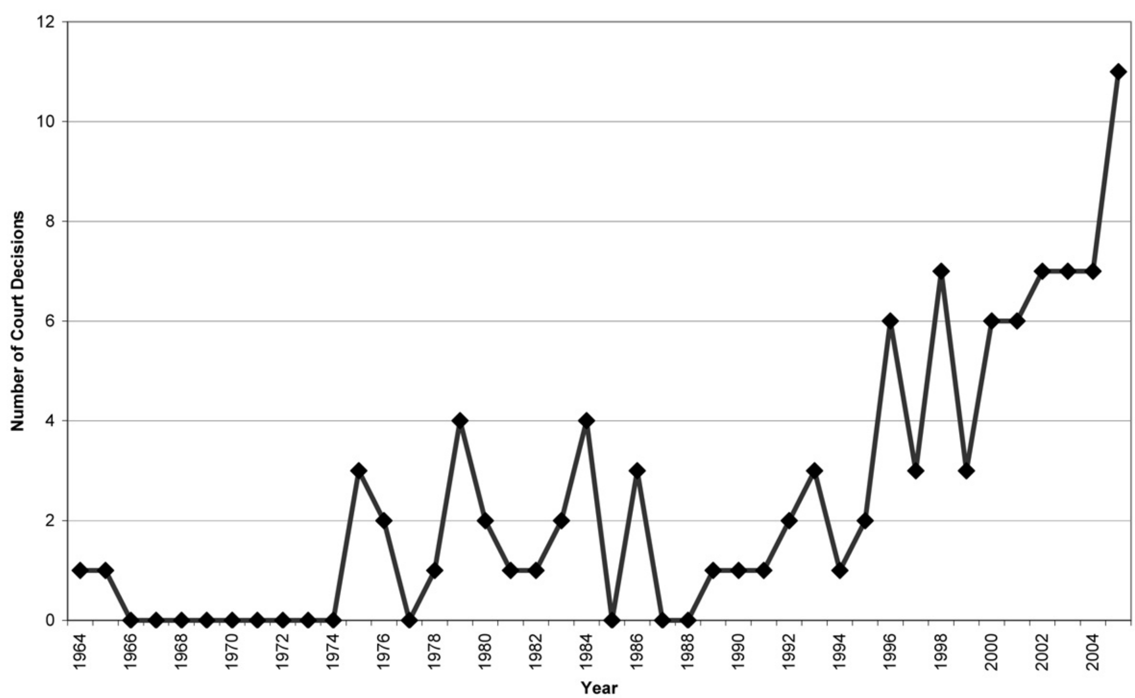
3.3. The causes of land use regulation

We now turn to the correlates of these regulations by regressing these rules on variables that predate the rules enactment. We know when the wetlands, septic and subdivision regulations were put in place, but we do not have comparable data for minimum lot sizes. However, we do know that there was an initial wave of zoning in the 1920s followed by a much greater wave after World War II. As such, 1915 characteristics can be thought of as



Source. Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston.

Fig. 5. Number of communities amending wetlands bylaws, subdivision rules, and cluster provisions, 1984–2004.



Source. Lexis–Nexis.

Fig. 6. Massachusetts Court Decisions containing keywords: Zoning, residential and septic or wetland, 1964–2004.

pre-dating minimum lot size rules for all of the towns, and 1940 characteristics will predate minimum lot sizes for most of the areas.

Table 3 first looks at the correlation between minimum lot sizes and 1915 town characteristics. Missing data from the early censuses causes us to lose a small number of cities. The most significant variable is density in 1915. As density increases by one log point, current minimum lot size decreases by about one-quarter acre. In regression (2), we show results using 1940 data. In this case, the impact of density in 1940 is quite similar. On its own, density in 1940 can explain 68 percent of the variation in current minimum lot sizes. As such, we can basically interpret current

Table 3
1915, 1940 determinants of average minimum lot size and 1970 determinants of wetland bylaws, septic rules, and cluster zoning.

	(1) Average minimum	(2) Lot size	(3) Wetland bylaws	(4) Septic rules	(5) Cluster provisions
ln(Town Area)	0.0152	0.0108	−0.0592	−0.1811	0.1803
	[0.0490]	[0.0394]	[0.1098]	[0.1726]	[0.0959]
ln(Housing Density)	−0.2425	−0.2683	0.0371	−0.3849	0.1259
	[0.0269]**	[0.0209]**	[0.0551]	[0.0846]**	[0.0470]**
Distance to Boston	0.0027	−0.0029	−0.002	−0.0085	0.0032
	[0.0027]	[0.0024]	[0.0050]	[0.0065]	[0.0039]
Pct. white	−0.0129	0.0086	0.0066	−0.048	−0.009
	[0.0108]	[0.0086]	[0.0233]	[0.0471]	[0.0191]
Pct. foreign born	−0.0063	−0.005	−0.0284	−0.0202	−0.0119
	[0.0032]	[0.0048]	[0.0183]	[0.0271]	[0.0148]
Pct. mfg	−0.0652	−0.1917			
	[0.1590]	[0.0962]*			
Pct. owner occupied		−0.0064	−0.0016	−0.0037	−0.0016
		[0.0019]**	[0.0040]	[0.0056]	[0.0031]
Pct. BA or higher			0.0076	0.0053	0.0078
			[0.0041]	[0.0055]	[0.0034]*
ln(acres water-based recreation + 1)			0.0615	0.0868	−0.0126
			[0.0253]*	[0.0341]*	[0.0196]
ln(acres water + wetlands + 1)			0.0414	0.1643	0.0492
			[0.0554]	[0.0820]*	[0.0468]
ln(acres of new development 1971–1985 + 1)			0.1104	0.0956	0.0203
			[0.0524]*	[0.0846]	[0.0393]
Constant	3.0573	−0.1748			
	[1.2204]*	[0.9382]			
Control year	1915	1940	1970 or 1971	1970 or 1971	1970 or 1971
Observations	185	182	186	186	186
R-squared	0.64	0.71			

Notes. (1) Standard errors in brackets.

(2) Dependent variable for (1) and (2) is average minimum lot size. Dependent variable for (3), (4) and (5) is a 0/1 variable indicating the existence of the regulation. Standard errors are clustered at the town level for regressions (3), (4) and (5).

(3) Data is from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston at http://www.masshousingregulations.com/, MassGIS, the Harvard Forest Survey of Massachusetts and the US Census Bureau.

* Significant at 5%.

** Significant at 1%.

rules as enforcing the level of density that was in place almost a century ago.

Other town characteristics are also correlated with minimum lot sizes, but the effects are much weaker. There is also a modest negative correlation between share of the population that works in manufacturing in 1940 and less restrictive minimum lot sizes. The same correlation appears in 1915, but the coefficient is statistically insignificant. There are two plausible explanations for this phenomenon. First, manufacturing may proxy for working class residents who were less concerned with restricting building for the poor. Second, manufacturing may proxy for the presence of businesses that have an interest in building more to keep housing prices low so that they don't need to pay workers more to compensate them for high housing costs.

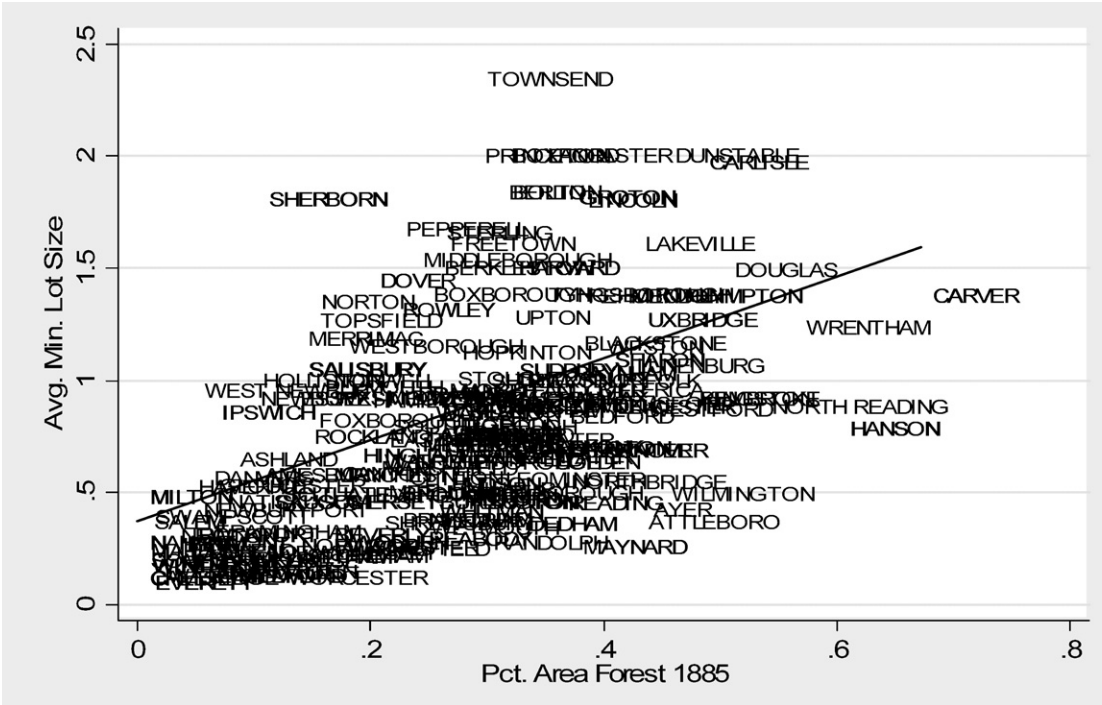
Percent white in 1940 is associated with slightly more stringent minimum lot sizes. This result does not appear in 1915 because there is almost no variation in percent white during that year. The 1915 parallel is that towns with more immigrants have less stringent minimum lot sizes. These results present weak evidence for the view that high minimum lot sizes where used by white natives to restrict homes built for blacks and foreigners. It is also useful to note the variables that don't matter. For example, distance to Boston is irrelevant once we control for housing density. The share of homeowners in the town is actually associated with less restrictive zoning, but this effect is quite weak.

The connection between historical density and minimum lot sizes prompted us to look for more ancient causes of minimum lot sizes. Using data from the Harvard Forest Survey of Massachusetts, we regressed minimum lot size today on the share of the town that was forested in 1885. There is a 52 percent correlation between this variable and minimum lot size, which is shown in Fig. 7. Forest cover in most of those towns in the 19th century was determined by the value of agricultural land, so it reasonable to think that current zoning patterns reflect, in part, whether a town was worth clearing and settling based on the value of its pre-modern agricultural productivity.

We now turn to the determinants of these land use regulations. Since subdivision requirements are so ubiquitous, we exclude those and focus on whether the town has wetlands rules, septic rules and cluster zoning. We include 1970 controls that predate these regulations. The results are shown in regressions (3), (4) and (5) of Table 3, which presents the marginal effects from probit regressions. While we have included a rich bevy of controls, almost none of these controls actually explain the adoption of these rules. This is not because we have included a large number of controls, as almost nothing is consistently, significantly correlated with these outcomes when fewer controls are included.

In the case of wetlands regulation, the variable that most reliably and significantly predicts wetlands rules is the amount of recreation water in the township. Places with more recreational water are unsurprisingly more dedicated to protecting wet spaces. They are also more likely to regulate septic systems more stringently. Septic rules are particularly negatively associated with high levels of housing density, if high density places are more likely to rely on sewers rather than septic tanks.

We were surprised that so few of the other variables were statistically significant. In the case of wetlands restrictions, there is a significant positive relationship between the amount of new development in the 70s and early 80s and adoption, and a marginally significant positive relationship between adoption and the share of the population with 16 years or more of schooling. More generally, these regulations which vary so much from town to town, are surprisingly uncorrelated with most town characteristics. This may either reflect an efficiency view of these regulations where they



Source. MassGIS, Harvard Forest Archive.

Fig. 7. Relationship between minimum lot size and forested area 1885.

are being tied to un-measured land characteristics or the view that these regulations are fairly random.

In the third regression, we look at the correlates of cluster zoning. In this case, bigger and denser towns are much more likely to have cluster zoning, presumably because those residents are less troubled by the occasional denser development. There is also a weak correlation with education levels which may reflect the fact that "Smart Growth" has become popular among environmentally oriented educated elites.

These results do not lead us towards any natural instruments for land use regulations. While historical density may be a reasonable instrument for total current density, it cannot be used to separately identify the impact of land use controls, since historical density is likely to have a direct impact on the amount of building in an area and prices.[5] Likewise, the presence of recreational water seems likely to impact prices directly because that water is surely an amenity. We take these regressions as suggesting that, at least when controlling for historical density, the regulations seem unpredictable enough that we are comfortable using them directly in our regressions on the consequences of land use controls.

4. The consequences of land use regulation

We now turn to the consequences of land use regulation. We first look at permitting and then turn to prices. The permitting results can only tell us whether regulations are associated with a reduction in permitting in one jurisdiction relative to another, and cannot tell us the area-wide impact of permitting. As we will discuss later, there are reasons to doubt that price level regressions will find an effect of permitting on price, at least if we control fully for other area wide characteristics.

We begin with minimum lot size and then turn to the other regulations. In the case of minimum lot size, we can only look at the cross section of towns, since we do not know when these rules were adopted. Our basic specification is to regress:

$$Log(Permits) = \alpha \cdot LotSize_{Minimum} + TownCharacteristics, \tag{3}$$

where permits represents the total number of permits issued over the relevant time periods (the 1980s, the 1990s and the entire 1980–2002 period). We will primarily focus on single family permits, but also present results for total permits. The results of these regressions can be found in Table 4.

For the regressions that include permits from the 1980s, our town controls include the logarithm of town area, distance to Boston, the logarithm of the housing stock in 1980, the share of the population that is less than 18 years old in 1980, the percent of the adult population with a college degree in 1980 and the percent white in 1980. We also include a dummy variable for whether the town has a major university, which we define as being among the top 50 universities or top 25 colleges in the 2005 US News and World Report rankings. For the regressions that look at permits in the 1990s, we use controls from the 1990 Census.

The first three regressions look at results for single family permits for 1980–2002 and for the 1980s and 1990s separately. The coefficient for the whole period is −0.4 which has a t-statistic of 2.9. The coefficient in the 1980s is also −0.4 and the coefficient in the 1990s is −0.36. The changes across specifications are too small to have any statistical meaning. These coefficients should be interpreted as suggesting that as the town increases the average lot size needed to build by one acre, the number of new permits declines by −0.4 log points or about 40 percent.

Several of the variables also reliably predict new construction. For example, the logarithm of town area has coefficient between 0.8 and 0.96, which suggests that the elasticity of permitting with respect to total land area is close to one. The coefficient on the housing stock in 1980 is also strongly positive, which gives us that

[5] The use of historic density, and other demographic variables, as instruments for current zoning, which is the approach used by Ihlanfeldt (2007), offers the possibility of reducing the endogeneity problem of zoning rules. However, changes in demographics over time also seem quite likely to be related to unobserved area level characteristics. In that case, in a regression that controls for current demographics, past demographics may not satisfy the needed exclusion restriction.

Table 4
Effect of minimum lot size on permits and housing stock, 1980–2002.

	(1) ln(total single family permits)	(2)	(3)	(4) ln(total permits)	(5)	(6)
	1980–2002	1980–1989	1990–1999	1980–2002	1980–1989	1990–1999
Acres per lot	−0.3982	−0.402	−0.361	−0.3085	−0.3123	−0.3384
	[0.1392]**	[0.1541]**	[0.1696]*	[0.1346]*	[0.1559]*	[0.1642]*
Log of Town Area	0.8498	0.7907	0.9367	0.7028	0.5834	0.9056
	[0.0892]**	[0.0987]**	[0.1101]**	[0.0884]**	[0.1023]**	[0.1138]**
Distance to Boston	0.0057	0.0053	0.0046	−0.0043	−0.0057	0.0014
	[0.0050]	[0.0055]	[0.0058]	[0.0047]	[0.0055]	[0.0057]
Major university	0.048	0.0897	−0.4595	0.1303	−0.0212	−0.3603
	[0.2306]	[0.2552]	[0.2773]	[0.2168]	[0.2510]	[0.2633]
Log of Housing Stock (Initial period)	0.3105	0.3615	0.365	0.4205	0.5336	0.3863
	[0.0745]**	[0.0824]**	[0.0968]**	[0.0769]**	[0.0890]**	[0.1032]**
Pct. <18 (Initial period)	0.0498	0.0428	0.0595	0.0447	0.0369	0.0506
	[0.0128]**	[0.0142]**	[0.0179]**	[0.0133]**	[0.0154]*	[0.0176]**
Pct. BA+ (Initial period)	−0.0044	−0.0032	−0.0005	−0.0071	−0.0099	0.0007
	[0.0031]	[0.0035]	[0.0033]	[0.0033]*	[0.0038]**	[0.0034]
Pct. white (Initial period)	0.0183	0.0052	0.0374	0.0299	0.0187	0.0253
	[0.0124]	[0.0137]	[0.0087]**	[0.0131]*	[0.0151]	[0.0090]**
Share of single family housing (1980)				−0.0086	−0.006	−0.0049
				[0.0032]**	[0.0037]	[0.0036]
Constant	−6.5124	−5.7276	−10.5979	−5.9161	−5.2229	−8.607
	[1.4627]**	[1.6188]**	[1.3023]**	[1.4615]**	[1.6920]**	[1.2536]**
Observations	185	185	185	185	185	185
R-squared	0.69	0.62	0.66	0.71	0.68	0.65

Notes. (1) Standard errors in brackets.
(2) Dependent variable for regressions (1)–(3) is the ln(single permits) for the years indicated above, and the dependent variable for regressions (4)–(6) is the ln(total permits) for the years indicated above.
(3) Data from US Census Bureau, MassGIS, and the 2005 *US News and World Report* college and university rankings.
* Significant at 5%.
** Significant at 1%.

places with more housing in 1980 have built more since then.[6] Major universities are negatively correlated with development in the 1990s, but not before then. Percent white is positively correlated with development in the 1990s. Towns with lots of young people built more across both time periods.

In regressions (4)–(6), we turn to the logarithm of total permits. In this case, we also control for the initial share of the housing stock that is multi-family in an attempt to control for any long-standing tendencies to build high rise buildings. In this case, the coefficient falls to −0.3 over the entire sample. The coefficient is slightly higher for the two other time periods.[7] Overall, acres per lot is negatively associated with permitting in all of our specifications and the coefficients are always statistically significant.

We can also look at the relationship between acres per lot and total housing density in 2000, controlling for housing density in 1940. A simple regression across 187 cities and towns estimates:

$$Log\left(\frac{Homes_{2000}}{Acres}\right) = \underset{(0.03)}{0.51} \cdot Log\left(\frac{Homes_{1940}}{Acres}\right) - \underset{(0.08)}{0.36} \cdot LotSize_{Minimum} + OtherControls. \tag{4}$$

The other controls include distance to Boston, the presence of a major university and the log of land area in the town. Standard errors are in parentheses. As the acres per lot increases by one, the logarithm of housing units in 2000 falls by 0.36 log points, which can be interpreted as suggesting a reduction of housing growth by thirty six percent over the entire 1940–2000 time period.

Table 5 provides results for our other regulatory measures. Since we know when these regulations were imposed and since we have permits by year, we are now able to run panel regressions both with and without town fixed effects. When we exclude town fixed effects we include 1970-era controls, as we did in the regression explaining these variables, which includes town area, housing stock, share of the population below age 18, share of the population that is white and share of the population with college degrees. We also include the dummy variable indicating the presence of a major university. All standard errors are clusters by town.

The first two regressions show the three types of rules included simultaneously. In the specification with town controls, wetlands and subdivision rules are negatively but insignificantly correlated with development. Septic rules are extremely weakly positively associated with development. In the specification with town fixed effects, all three coefficients negatively predict development, but only the subdivision rules are statistically significant.

In regressions (3) and (4), we aggregate these variables into an index by just adding them together. In the specification without fixed effects, the coefficient is −0.067, which is statistically insignificant. In the specification with town fixed effects, the coefficient rises to −0.11 which has a t-statistic of two. This specification suggests that each new regulation is associated with about a ten percent reduction in new construction. Of course, we cannot be sure that these restrictions are actually causing the reduction in new construction. The decline in new construction might reflect a general anti-growth atmosphere that reflects itself in both new regulations and a reduction in permits.[8]

The estimated coefficient of −0.1 suggests new construction falls by about ten percent with each new regulation. We think this estimated effect is fairly large. However, since the variation in new permitting is also quite large, the estimate remains imprecise. This

[6] Controlling for the housing stock in 1980 is essentially controlling for the impact that land use controls have had on building prior to that point. If we control instead for housing density in 1940, the coefficient on acres per lot rises in magnitude to approximately −0.5.

[7] While the effect of acres per lot is somewhat weaker on overall permitting than it is on single family permitting, this change does not imply that acres per lot is positively correlated with multi-family permits. Acres per lot is also negatively associated with multi-family permits if those permits are treated separately.

[8] Alternative ways of defining indices tended to yield broadly similar results.

Table 5
Effect of additional zoning on annual total permits, 1980–2002.

	(1) ln(total permits)	(2)	(3)	(4)	(5)	(6)
Wetlands bylaw	−0.055	−0.092				
	[0.0737]	[0.0856]				
Septic rule	0.0559	−0.0117				
	[0.0973]	[0.1023]				
Subdivision rule	−0.1488	−0.2196				
	[0.0924]	[0.0974]*				
Combined regulation index			−0.0668	−0.1094	−0.0745	−0.14
			[0.0494]	[0.0526]*	[0.0604]	[0.0677]*
Cluster					0.2408	0.1137
					[0.1062]*	[0.1066]
Inclusionary					0.251	0.0449
					[0.1392]	[0.1386]
Constant	−10.9794	3.5201	−10.9199	3.4646	−9.9282	3.4665
	[1.1458]**	[0.0862]**	[1.1314]**	[0.0780]**	[1.1940]**	[0.1042]**
Town controls	Yes	No	Yes	No	Yes	No
Town FE	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2507	2530	2507	2530	1732	1755
R-squared	0.49	0.64	0.48	0.63	0.51	0.65

Notes. (1) Robust standard errors in brackets.
(2) Standard errors are clustered on town.
(3) Dependent variable is ln(total permits) in each year for 1980–2002.
(4) Town controls include minimum lot size, ln(town area), ln(hsg 1980), major university dummy, pct. < 18 1980, pct. white 1980, and pct. BA+ 1980.
(5) Towns who adopt regulations at unknown dates are excluded.
(6) Data is from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston at http://www.masshousingregulations.com/, the US Census Bureau and the 2005 *US News and World Report* college and university rankings.
* Significant at 5%.
** Significant at 1%.

variation helps us to understand why using annual permit data to estimate regulation effects will always be difficult.

In regressions (5) and (6) we add cluster and our inclusionary zoning measure. In the first specification, with town controls but without town fixed effects, both coefficients are positive and cluster zoning is statistically significant. In the town fixed effect specification, neither coefficient is statistically significant, but the coefficient on the regulatory barriers index increases in magnitude to −0.14. Cluster zoning still has a sizable coefficient that is just imprecisely measured. We take this as suggestive evidence supporting the view that these rules may be having a positive effect on construction.

4.1. Price effects

In Table 6, we turn to the correlation between lot size and sales prices. We use Banker and Tradesman data on housing price transactions between 2000 and 2005. Our basic regression is:

$$Log(SalesPrice) = \alpha \cdot LotSize_{Minimum} + HouseandTownCharacteristics. \quad (5)$$

Our home characteristics include the year of construction, total number of rooms, interior square footage and lot size. Our town characteristics include the year 2000 set of characteristics used in the other regressions in Table 4.

Just as in the case of permits, there is a question of whether land use restrictions will impact town-level prices or region-level prices. In the case of permits, it is quite possible that local land use restrictions limit building in one town, but just more that building to another locale. In the case of prices, it is possible that land use restrictions have no impact on prices in one locale, relative to a close substitute town, but still have an impact on area level prices. The basic economics of price restrictions tells us that we should not expect the price of a good to rise relative to a perfect substitute if that goods supply is restricted. The question, then, is whether how close these small towns in Massachusetts are to being perfect substitutes for one another. While we cannot answer this question fully, we are confident that as we control for more area level characteristics, such as density and demographics, the towns are more likely to be closer substitutes and we are less likely to find an effect of land use restrictions on prices.

To see this, we present two types of regressions. First, we control only for the relatively fixed attributes of the town: land area, distance to Boston, and the presence of a major university. We then add in controls for contemporaneous density, share of the population that is under 18 years old, share of the population that is white and share of the adult population with a college degree. In the first regression, the coefficient on acres per lot is 0.12, which is marginally significant at 10%. This coefficient means that each extra acre per lot is associated with a twelve percent increase in the value of a house. This supports the view that minimum lot size rules do increase value for existing homeowners, and helps to explain why homeowners find minimum lot sizes so appealing.

In the second regression, we include our control for contemporaneous demographics and density, the coefficient flips sign and loses statistical significance. As such, there is certainly no impact of minimum lot size on prices once we make areas roughly comparable. We interpret this finding as supporting the basic economic view that quantity limitations shouldn't raise prices when houses are compared to very similar units.

In the third regression, also found in Table 6, we include both acres per lot and the regulation index. In this case, both variables have a positive effect on prices. The impact of the regulation index on prices is statistically significant; the impact of minimum lot sizes is not. An interpretation of this finding is that different types of land use regulations are positively correlated, but that the non-lot size regulations are more effective at limiting the types of development which would reduce prices, such as multi-unit subdivisions that could change the demographic mix of the town. This finding supports the view that it is important to measure a wide range of barriers beyond minimum lot size. However, it is worth emphasizing that the coefficient on acres per lot in regression (3) is not statistically distinct from the coefficient on acres per lot in

Table 6
The effect of minimum lot size and additional regulations on sales prices, 2000–2005.

	(1) Ln(Sales Price, $2005)	(2)	(3)	(4)
Acres per lot	0.1218	−0.0685	0.0548	−0.0685
	[0.0659]	[0.0439]	[0.0704]	[0.0438]
Combined regulation index			0.085	−0.0001
			[0.0345]*	[0.0152]
ln(Total Number of Rooms)	0.2432	0.1632	0.2386	0.1632
	[0.0403]**	[0.0263]**	[0.0392]**	[0.0262]**
ln(Interior Square Feet)	0.6103	0.5071	0.6074	0.5071
	[0.0313]**	[0.0210]**	[0.0314]**	[0.0209]**
ln(Lot Size)	0.0967	0.0757	0.0906	0.0757
	[0.0166]**	[0.0093]**	[0.0163]**	[0.0092]**
ln(Town Area)	−0.069	−0.0291	−0.0973	−0.0291
	[0.0507]	[0.0251]	[0.0473]*	[0.0277]
Distance to Boston	−0.0143	−0.0085	−0.0147	−0.0085
	[0.0046]**	[0.0016]**	[0.0042]**	[0.0017]**
Major university	0.4117	0.1067	0.4137	0.1067
	[0.1019]**	[0.0363]**	[0.0844]**	[0.0363]**
Pct. $<$18 years old (2000)		−0.0063		−0.0063
		[0.0025]*		[0.0025]*
Pct. white (2000)		0.0016		0.0016
		[0.0009]		[0.0008]
Pct. BA+ (2000)		0.0125		0.0125
		[0.0006]**		[0.0006]**
Log of Housing Stock (2000)		0.0155		0.0155
		[0.0212]		[0.0217]
Constant	7.4231	7.5798	7.636	7.5797
	[0.4075]**	[0.2274]**	[0.4029]**	[0.2354]**
Observations	55296	55296	55296	55296
R-squared	0.31	0.37	0.31	0.37

Notes. (1) Robust standard errors in brackets. Standard errors are clustered by town.
(2) Year Fixed Effects were included.
(3) Excludes towns $>$30 miles away from Boston.
(4) Dependent variable is the log of sales prices for 2000–2005 housing sale transactions, in 2005 dollars.
(5) Data from Data is from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston at http://www.masshousingregulations.com/, Banker and Tradesman data on housing transactions, the US Census Bureau, MassGIS and the 2005 *US News and World Report* college and university rankings.
* Significant at 5%.
** Significant at 1%.

regression (1). In regression (4) of the table, we include the other town variables and again find that the price effects disappear.

How do these effects compare with the existing literature? The papers on California land use controls (see Katz and Rosen, 1987, and Quigley and Raphael, 2005) have generally looked at much larger jurisdictions and found significant price effects of limitations on growth. These findings are quite consistent with ours, if houses are much less likely to be substitutes between those larger jurisdictions. Maser et al. (1977) look at smaller areas, but they are focused on type of use zoning, not restrictions on density, and they do not try to estimate a zoning effect separate from the uses in the area. Their results are closer in spirit to our regressions (1) and (3). Pollakowski and Wachter (1990) find that there are spillovers across areas, which supports the view that price effects of land use restrictions could be much higher than the price effects at the town level.

5. Do current density levels maximize land values?

The previous regressions suggest that land use restrictions reduce construction activity, and increase prices, although the latter effect works through changing densities and the demographic composition of a town. However, these results tell us nothing about whether these land use restrictions are optimal or not. If there are negative externalities associated with increased densities, then the free market is unlikely to come to a socially optimal density level. Land use controls that restrict development may be an optimal response to these externalities, as in Fischel (1978, 2001).

A standard result in the urban literature is that policies that maximize local land values will also maximize social welfare (Brueckner, 1983). Maximizing land values means maximizing the consumer surplus in an area, at least if there are not cross-jurisdictional externalities where development in one town hurts (or helps) its neighbors. Those cross-jurisdictional externalities are outside the scope of this paper, but we do have enough information to test whether localities are choosing the density levels that are maximizing total land values, if land values are understood as the difference between housing sales prices, denoted $P(D)$ where D represents density, and total construction costs. We will focus on whether density levels maximize land values and not try to figure out any ancillary effects of other regulations, such as septic controls or wetlands rules.

In principle, the marginal cost of building a new home can be rising with density, especially once the town is filled with multi-story apartment complexes. We will assume that construction costs are fixed at C dollars per unit, which is a reasonably accurate assumption for the single family detached houses that are the norm in suburban Boston. If the amount of land in the town is normalized to equal one, then total land values equal $D(P - C)$, where D denotes housing density and P denotes housing price. We assume that the price level is a function of density, $P(D)$, because higher densities mean both smaller lot sizes and more congestion. If prices rose with density, then the land value maximizing density level would be infinite. Increasing density raises land value if and only if:

$$\frac{P(D) - C}{P(D)} > -\frac{DP'(D)}{P(D)}. \tag{6}$$

As long the elasticity of price with respect to density is less than the share of housing prices that are not construction costs, then

Table 7
Effect of density on sales prices, 2000–2005.

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln(Sales Price, $2005)					
Log of Housing Density (2000)	−0.1246	−0.0042	−0.0994	0.019	−0.1609	−0.0518
	[0.0337]**	[0.0165]	[0.0399]*	[0.0254]	[0.0349]**	[0.0611]
ln(Total Number of Rooms)	0.2451	0.1757	0.2532	0.1828	0.2423	0.2437
	[0.0431]**	[0.0266]**	[0.0431]**	[0.0269]**	[0.0431]**	[0.0441]**
ln(Interior Square Feet)	0.6739	0.5565	0.6826	0.5582	0.6609	0.7016
	[0.0338]**	[0.0197]**	[0.0334]**	[0.0199]**	[0.0351]**	[0.0401]**
Distance to Boston	−0.0195	−0.0086	−0.0172	−0.0075	−0.0221	−0.014
	[0.0040]**	[0.0016]**	[0.0048]**	[0.0017]**	[0.0043]**	[0.0058]*
Major university	0.3939	0.0967	0.3822	0.0957	0.4104	0.3635
	[0.0982]**	[0.0384]*	[0.0979]**	[0.0375]*	[0.0964]**	[0.1039]**
Year	0.0871	0.0854	0.0867	0.085	0.0872	0.0868
	[0.0023]**	[0.0023]**	[0.0023]**	[0.0023]**	[0.0023]**	[0.0023]**
Pct. <18 years old (2000)		−0.0065		−0.0043		
		[0.0025]**		[0.0033]		
Pct. white (2000)		0.0017		0.0024		
		[0.0009]		[0.0012]		
Pct. BA+ (2000)		0.0126		0.0126		
		[0.0006]**		[0.0006]**		
Constant	−166.7604	−163.1347	−166.069	−162.4988	−166.796	−166.5293
	[4.6199]**	[4.5109]**	[4.6581]**	[4.5347]**	[4.6091]**	[4.6478]**
IV for ln(Housing Density 2000)	None	None	Avg. min. lot size	Avg. min. lot size	ln(Town Density in 1915)	ln(Forest Cover in 1885)
Observations	56,204	56,204	55,299	55,299	56,204	55,448
R-squared	0.31	0.37	0.3	0.37	0.3	0.3

Notes. (1) Robust standard errors in brackets. Standard errors are clustered by town.
(2) Excludes towns >30 miles away from Boston.
(3) Dependent variable is the log of sales prices for 2000–2005 housing sale transactions, in 2005 dollars.
(4) Data is from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston at http://www.masshousingregulations.com/, Banker and Tradesman data on housing transactions, the US Census Bureau, the Harvard Forest Survey of Massachusetts, MassGIS and the 2005 *US News and World Report* college and university rankings.
* Significant at 5%.
** Significant at 1%.

more density increases local land values. The density level that maximizes total land values will cause Eq. (6) to hold with equality.

To estimate, whether Eq. (6) holds for our sample of cities we must both know the elasticity of housing prices with respect to density and the share of housing prices that are not accounted for by construction costs. We can estimate the value of $\frac{P(D)-C}{P(D)}$ for our sample using price and construction cost data. In 2004, in our sample, the average home cost $450,000 and had 1800 square feet of interior space. Using R.S. Means data on construction costs, Gyourko and Saiz (2004) estimate a 97 dollar per square foot cost of new construction for the Boston area. These figures suggest that the physical structure in the average home costs 174,600 dollars and that $\frac{P(D)-C}{P(D)}$ equals 0.61. We cannot be confident about the R.S. Means figure, but if construction costs were as high as 150 dollars a square foot, then that ratio would still be equal to 0.4.

Table 7 provides our estimate of the total effect of area density on housing prices. We do not control for unit lot size, since one of the effects of higher density is to reduce unit lot size, and theory requires us to include that effect in our estimate of the overall impact of density on prices. We control for interior square feet, the number of rooms, distance to Boston and the presence of a major university.[9]

The first regression shows the estimated ordinary least squares estimate of −0.12. In the second regression, we include controls for share of the population that is less than 18, share of the adult population with college degrees and share of the population that is white. With these controls, the estimated coefficient is essentially zero. Controlling for contemporaneous demographics eliminates the density effect, which suggests that density is primarily important as a sorting device to change the composition of an area.

These results are potentially compromised since density levels may be driven by omitted housing characteristics that increase demand. Larger lot sizes may be the result of cheaper prices. This concern means that standard hedonic regressions may understate the true negative impact of density on housing prices. To address this concern, we use instruments for current density level using three instruments. Our first instrument is our own minimum lot size variable. In regression (3), we repeat regression (1) using the minimum lot size variable as an instrument for housing density. The estimated density elasticity changes to −1. In regression (4), we repeat regression (2) and include other controls, but use minimum lot size as an instrument. In this case, the estimated elasticity is 0.02. Again, there is no effect of lot size once we control for the demographics of the town.

In regressions (5) and (6), we use the log of town density in 1915 and the forest cover of the town in 1885 as instruments. We do not include other controls, but if we did they would again lead to coefficients of close to zero. When we use 1915 density as an instrument, we estimate a coefficient of −0.16. When we use forest cover, we estimate a coefficient of −0.05. Our range of estimated density elasticities, therefore, lies between 0.02 and −0.16.

Even if we believe that controlling for demographics is inappropriate because those variables themselves reflect density levels, the density coefficients are much lower than the estimated land share of housing costs. Localities seem to have density levels that are too low to currently maximize land values. To us, this is the primary puzzle produced by this paper: why aren't communities choosing density levels to maximize their land values?

One possible explanation of this fact is that densities are based on historical conditions that don't reflect current demand. A second explanation is that zoning decisions are made without the

[9] Since town areas are often larger for places with lower density levels, we exclude town area as a control. Our results are not sensitive to this exclusion.

possibility of transfers between builders and current owners.[10] The absence of these transfers, which are essentially illegal in Massachusetts, makes it difficult for existing homeowners to reap many benefits from new development.

These results do not imply that the current situation is suboptimal. There may be externalities associated with new development that have impacts outside of the local area and these may mean that it is desirable to restrict new construction below the level that would maximize land values. A fuller accounting of all the global externalities from new building would be necessary to make any clear welfare claims, and that is beyond the scope of this paper.

6. Conclusion

Over the last 25 years, Greater Boston has seen a remarkable increase in housing prices and a decline in the number of new units. This change reflects increasingly restricted supply. The reduction in supply doesn't reflect an exogenous lack of land. There has been no significant increase in density levels associated with declining construction.

Development is greater in dense places. Lot sizes are increasing, not falling. The value of land when it extends an existing lot is not great. Instead, the decline in new construction and associated increase in price reflects increasing man-made barriers to new construction.

In this paper, we catalog the barriers to new construction. Minimum lot size is the most important of these measures, but increasingly new barriers have been added, like wetlands and septic rules. These barriers have all increased over time, but there is little clear pattern about where they have been adopted beyond. Recreational water increases water-related barriers. Current minimum lot sizes mainly reflect historical density patterns.

The impact of lot size on new development is quite clear. Each extra acre per lot is associated with about 40 percent fewer permits between 1980 and 2002. The impact of other controls on construction is weaker, but it does appear in a specification with town fixed effects that each extra rule reduces new construction by about 10 percent. Minimum lot size and other regulations are associated with higher prices, but as urban theory predicts, this effect disappears when we control for a wide range of area level variables.

Regulations do appear to increase prices, but the impact of density on prices is generally quite modest. As a result, communities seem to have density levels that are far too low to be maximizing their land values. This suggests the possibility that current land use controls are suboptimally restrictive, and it leaves us with the puzzle of understanding why communities are not choosing to maximize land values.

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[10] Fischel (1978) is the classic analysis of the property rights issues surrounding land use controls.