In the United States, land use regulation is the responsibility of more than 18,000 local governments, mostly cities and towns. While the legal authority for such regulation lies with state governments in virtually all parts of the county, such power has been legislatively delegated to local government for almost half a century. This delegation of authority has its origins in the idea that such regulation is designed largely to manage situations where local property owners adversely affect one another through their development decisions or other actions. These externalities need some mechanism for dispute resolution—and such a role for land use regulation received early economic justification by Ronald Coase.\(^1\) He argued that with the imperfect assignment of property rights, public intervention might be needed in place of private bargaining. The powers that local governments have acquired over the years now are quite broad. In a nutshell towns can

—regulate the part of their open land that is developed for a range of uses (commercial, industrial, residential); and

We wish to thank the employees of the Massachusetts Executive Office of Environmental Affairs (EOEA) and various regional planning agencies, especially Allen Bishop and Jane Pfister, who were very helpful in obtaining and interpreting these data. Buildout data were provided by the EOEA and are part of a statewide buildout project completed between 1999 and 2002 with the assistance of the commonwealth’s thirteen regional planning agencies. Source data were supplied by the Executive Office of Environmental Affairs, MassGIS. We also wish to thank Sarah Williams at MIT, who was instrumental in helping to prepare the data for analysis.

—regulate the intensity of each use that occurs on that land (density or floor-area ratio, or FAR).

Recently it has been recognized that such broad land use controls might have impacts on the wider metropolitan economy. Clearly, if many towns choose to zone out industrial development, the economic growth of the metropolitan economy as a whole could be endangered. Likewise, if all towns set strict maximum density limits, the provision of housing for low- or moderate-income families will be difficult. Such limits also would make housing in general more expensive. Finally, if towns choose to provide extensive greenbelts or open spaces, the region as a whole becomes more spread out, with resulting increases in travel distances, times, and congestion.

The specter of such problems has led a few economists to develop simple positive (as opposed to normative) models of how and why towns decide on such regulations. Generally, they do so to increase the well-being of their own residents—without regard to broader consequences. Bruce Hamilton speculates about the objectives of towns in the setting aside of land into open space.2 Michelle J. White, Edwin S. Mills and Wallace E. Oates, and William Wheaton discuss how minimum-lot-size (MLS) zoning results from the desire of town residents to avoid the tax burden of providing services to residents with below-town-average income.3 William Fischel and Rodney A. Erickson and Michael J. Wasylenko discuss the complicated trade-off that towns make when considering how much commercial development to permit within their boundaries.4

Empirically, there has been little study of zoning regulations. In large measure this reflects the difficulty of obtaining consistent information across so many local jurisdictions. Generally, local jurisdictions are not required to report systematically their zoning categories, area so zoned, and buildouts or density. In terms of process, there also are usually no systematic data on how many zoning or variance applications each town receives, what the average process time is, or what proportion are disapproved and later appealed. With little data, the few theories that have been advanced have never been carefully tested.

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3. White (1975); Mills and Oates (1975); Wheaton (1993).
4. Fischel (1975); Erickson and Wasylenko (1980).
This research paper has two objectives. First, we describe a unique database created in the State of Massachusetts in 1999. This database used satellite technology to document the exact nature of all open land in each of the state’s 351 cities and towns. The database then geo-recorded the zoning ordinances for each jurisdiction to ascertain how this open land was zoned. The data can be used to document the proportion of open land that is zoned for residential or commercial use as well as the build-out that is allowed there.

With these data, our second objective is to establish a series of stylized facts about how towns zone. Which towns zone for the largest lot sizes? What is the income elasticity of demand for open space? What kinds of jurisdictions are most strict about commercial use? Our conclusions are:

—Existing town density and development are crucial determinants of zoned density and allowed development; thus zoning seems to follow the current market.

—Future commercial development is permitted primarily in higher-density, lower-income cities and towns.

—Town income is strongly related to the extent that towns allow development at all. Higher town income leads to significantly more land set aside in protected categories and less zoned for either commercial or residential use.

—There appears to be no significant impact of town income on the density of future development, either residential or commercial.

In the next section we review what has been written in the economics studies about community zoning, both theoretically and empirically. Then we describe the data collected in the 1999 study and those covariates also used in our study. The next section presents statistics and a series of reduced-form equations that analyze the determinants of how much land in each use towns allow, and what buildout can occur on that land. We then draw some conclusions and present a list of suggestions for future research.

**Previous Studies**

Previous studies have generally covered minimum lot sizes, provision of open space, commercial development, and housing outcomes.
**Minimum Lot Sizes**

By far the greatest number of studies on land use regulations relates to the almost universal practice of towns’ creating residential zones with minimum-lot-size (MLS) regulations. At one level it has been argued that such regulation internalizes an externality between property owners: by expanding one’s own lot, greater green space is created for all abutters. Recent evidence confirms that individual lot prices vary significantly with the characteristics of adjoining ones. In addition, such regulations provide insurance for current owners that later development will be of a predictable density. There is also considerable evidence that residents are quite willing to pay for such insurance controls. In these studies MLS zoning appears to be an efficiency-enhancing tool to help control traditional Coasian externalities.

Almost thirty years ago economists began to realize that MLS zoning also had a significant impact on the distribution of households by income across towns. With property tax financing local services, sorting across communities is not necessarily achieved. In fact towns have a strong fiscal incentive to prevent any household that has below average housing demand from developing in a town. The tool that allows them to do this is MLS zoning. By insisting that newly developing land have lot sizes that are at least as large as those currently existing, towns can enhance their fiscal surplus. Papers by White and others in a well-known volume edited by Mills and Oates explored the consequences of such “discriminatory” zoning.

While several later authors have qualified the conclusions of Mills and Oates—for example, Wheaton in 1993—the general practice of “fiscal zoning” is now widely accepted, and often highly criticized. Again, because data were lacking, there has been little documentation of exactly how widespread MLS zoning is, how binding or strict the density limits are, or how cumbersome the permitting process is. In fact, there are virtually no empirical or theoretical studies on the nature and extent of this zoning.

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Provision of Open Space

Another aspect of local land use regulation is the provision of open space by either local jurisdictions or regional governments. Open space can be acquired through direct public purchase, from donations by private parties in exchange for tax advantages, or obtained de facto by limiting development on wetlands, certain types of soil, public water frontage, and so forth. When land is acquired through this last channel, public or environmental goals must be clear before the regulatory power of government can override landowner rights.

Economists have viewed open space as a legitimate public good. At the same time, however, widespread provision of open space can alter the supply of land to urban development and thus potentially drive up housing prices. This trade-off was carefully studied empirically in the case of the California Coastal Commission’s regulation. Jan K. Brueckner also developed a theoretical model to explain how limiting land under development might work within a competitive system of cities, each gaining a public good but in so doing paying a price through the higher land values caused by a greater scarcity of accessible urban land.

Bengte Evenson and William Wheaton have been the first to combine a theoretical model explaining the incentives of towns competing for housing demand within a market to regulate land use with empirical evidence. Each town is assumed to trade off the cost of regulation with the dual benefits of a newly created public good and an increase in house prices resulting from regulation.

Recently, there have also been a few studies of town demand for open space that attempt to characterize those types of towns that, through one means or another, have acquired open space. Laurie J. Bates and Rexford E. Santerre, estimating the demand for open space in Connecticut, find, for example, that private and public provision of land are not good substitutes.

12. Evenson and Wheaton (2002) use the same data presented here later, although with different sample selection criteria. Their predictions are retested under these new assumptions in this analysis.
Commercial Development

The role that town regulations play in the development of commercial land has received even less attention than regulations limiting residential development. An early article by Fischel outlines the considerations that towns face in deciding whether to allow industrial or commercial development. Generally such developments use far less in local services than they pay in property taxes: hence they provide the town with a net fiscal gain. At the same time, however, such uses can contribute to congestion, crowding, loss of rural character, and even environmental decay. Towns ultimately must weigh these costs against the fiscal gains.

Empirically, a study by Helen F. Ladd validated this view by showing that communities with a large historical fraction of commercial development face a lower “tax price” for their residents and as such tend to spend more on local services (all else equal). A later study by Erickson and Wasylenko demonstrated that many towns in a particular metropolitan area effectively do zone out industrial or commercial development and that there is a distinct pattern to this practice—it is made up of wealthier towns with generally low property tax rates. This would again be consistent with Fischel’s view because such towns gain less property tax relief under the presumption that environmental valuation is income elastic.

Housing Outcomes

Although there has not been much research about the extent and character of zoning, there is a somewhat longer list of research studies about the presumed negative impacts of such regulation on the housing market. Edward L. Glaeser and Joseph Gyourko and Larry Ozanne and Thomas Thibodeau find evidence that house prices are higher in areas with greater regulation, while Christopher J. Mayer and C. Tsuriel Sommerville and Bengte Evenson conclude that housing supply is less elastic in markets with greater regulation. Although suggestive, the studies on housing outcomes do suffer from the lack of any rigorously defined measure of local regulation. Unfortunately, we are not able to test the

hypotheses of these studies because they tend to use statistics summarizing the differences in land use regulation across metropolitan areas. Our data cover parts of only two metropolitan areas.

**Zoning Statutes and the Zoning Process**

Each state in the United States designs its zoning system differently. In Massachusetts, much emphasis is placed on the statutory plan that each city or town enacts, and the degree of administrative flexibility around that plan is somewhat limited. In effect, zoning in Massachusetts is relatively rigid and not simply an open bargaining session between developer and town planning board.

Each city or town must start by preparing a master plan that includes a land use category and density level for all areas of the community. Once prepared, this plan is adopted by either city council or full town meeting. Any changes require amending the plan, which again requires the full vote of either the city council or full town meeting. Furthermore, the process of amending a plan requires a substantial period of notification, the holding of hearings, and a period of grace afterward. It cannot be done expeditiously.

Within a plan, there are generally two provisions for administrative amendments. These are special permits and variances, both of which can be granted by the planning board after public hearings. Specially permitted uses can differ from that use that an area is zoned for, but must be carefully specified in advance in the plan, and must apply to all areas that are similarly zoned. Thus a town might specify light commerce as a special permit use in one-acre residential areas, but it must be such for all areas of the town so zoned. Hearings and public input are important in determining whether special permits are granted.

Variances are complete exemptions from whatever the zoning plan intends for a particular area. As in many states, the granting of variances requires that the developer conclusively demonstrate economic hardship if the variance is not granted. Judicial precedent generally requires that such hardship involve the full loss of value rather than simply diminished value.18 In Massachusetts any aggrieved party may challenge a variance

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that is granted by a planning board if he or she feels that full hardship was not demonstrated.

With such cumbersome procedures the only real way for cities or towns to create flexible zoning is to designate broad, mixed-use districts and get them accepted into the plan. This of course assumes that local residents will assent to such a designation that effectively puts development out of their control. In the downtowns of the larger cities in the commonwealth, such flexible mixed-use districts sometimes exist, but in most smaller cities or suburban towns, single-use zones with limited special permits tend to be the most common. In most Massachusetts towns, if an area is zoned one-acre residential, developers with commercial or higher density residential intentions need not apply. In this paper we take the view that the zoning plan of the town does reflect its intentions for the future.

Data

We merge data on both current land use and its regulation in Massachusetts cities and towns into a unique new data set. All the data maps were created for use with Geographic Information Systems (GIS) software, which allows the researcher to link the graphical depiction with an underlying spreadsheet of data. Therefore, the data maps give actual land use and the regulation of land in Massachusetts in a format that can be transformed for analysis using a standard statistical package. To create our data set, we merged or intersected (or both) the maps and converted the resulting spreadsheets into a format used by the statistical program STATA. The ability to merge and intersect these data spatially means that they are incredibly precise relative to what little data have been available previously. For example, we are able to take a plot of land with a given land use designation and subdivide it into protected and unpro-

19. “These digital data represent the efforts of the Massachusetts Executive Office of Environmental Affairs [MAEOEA] and its agencies to compile or record information from the cited source materials. EOEA maintains an ongoing program to record and correct errors in these data that are brought to its attention. The agency makes no claims as to the absolute validity or reliability of these data or their fitness for any particular use. EOEA maintains records regarding all methods used to collect and process these digital data and will disclose this information upon request.”
tected status, making it easy to identify parcels as small as Boston Common, Boston Garden, and the parkway between the east- and west-bound lanes of Commonwealth Avenue separately.

Current Land Use Data

Data on current land use were interpreted from aerial photographs of the state, taken in each town in 1999 by the Massachusetts Office of Geographic and Environmental Information (MASSGIS). Each photograph was taken from a height of approximately 15,000 feet, leading to a scale of 1:25,000 inches. Each parcel was assigned one of thirty-six current land use categories, making these data both detailed and complete. We collapsed these thirty-six categories into four general land use classifications for our analysis, so that all land in the state is categorized as either residential land ($R_i$), commercial and industrial land ($C_i$), open land ($O_i$), or other land ($X_i$).20

Data on Protected Land

A separate data set on protected land was also created by MASSGIS and is maintained at the local level. The maps combine federal and state landholding with local tax assessor maps and existing open space plans. For each protected parcel the level of protection is identified as protected in perpetuity, temporarily, on a limited basis, or not legally protected. Since this last is associated with land typically assumed to be unbuildable, such as school sports fields, we identify all land in this data set as protected.21

These data were intersected with the current land use data, and protected land from each of the relevant current land use categories was

20. Open space includes land used for intensive or extensive agriculture, forests and woody perennials, participation and recreation and open land (with the exception of lands covered by power lines or used for transportation purposes, which are included in the commercial-industrial category). All else, including cemeteries and land with unknown use, was included in an “other” category. Other land includes land that cannot be built on (for example, waste disposal sites, cemeteries, and beaches), land that is already developed with an alternative use (for example, racetracks, fairgrounds, and swimming pools), and a small amount of land whose use is categorized as unknown. The subscript $i$ in each case is an index of the town, $i = 1,351$. See www.state.ma.us/mgis/lus.htm.

21. For the complete definitions of these protection levels, see www.state.ma.us/mgis/osp.htm.
aggregated into a fifth land classification \( (Z_i) \). Not surprisingly, the majority of the protected land comes out of the open land category, although the residential and commercial-industrial categories did contribute some protected land. However, this category does not include protected land from the “other” land use category since these lands cannot be built on. We ignore these lands, such as protected beaches along Cape Cod, because this paper is concerned with the regulatory division of buildable and unbuildable lands.

**Zoning Data**

Each town in Massachusetts was required to send digital zoning data to MASSGIS, which linked each map to the zoning bylaws to increase the detail and consistency of the data. These maps were submitted in June 2000, and the vast majority (97.5 percent) are current as of 1996. Further, 84 percent are current as of 1999. Local zoning codes were collapsed into twenty-one primary use codes, which we then collapsed to match our four major land use categories. These data were intersected with the current land use data (minus protected land). This allowed us to subdivide currently open land available for building into four categories: open land zoned for future residential use \( (OR_i) \), open land zoned for future commercial or industrial use \( (OC_i) \), open land protected (included in \( Z_i \)), and open land not currently zoned \( (OO_i) \).

**Buildout Data**

Data on possible future buildout were created by the Massachusetts Executive Office of Environmental Affairs in conjunction with the state’s thirteen regional planning boards. Planning board consultants worked with each of the towns in their region to create a series of uniform maps giving a detailed description of the maximum potential building that can be built on open land under current land use laws. This definition does not allow for demolition or density increases.

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22. Only two communities submitted maps dated before 1993. Monroe, an isolated town of 100 residents on less than 7,700 acres (of which 4,240 acres is state forest) is current as of only 1990. Tolland, a town of 400 residents on nearly 20,500 acres (nearly all of which is zoned residential-agricultural), is current as of only 1978.

23. For the complete definitions of the zoning categories see [www.state.ma.us/mgis/zn.htm](http://www.state.ma.us/mgis/zn.htm).

24. Under the EOEA definition, “buildout” is defined as the number of units that can be built on open land under current land use laws. This definition does not allow for demolition or density increases.
could take place in the state given current zoning laws, protection clauses, and geographic constraints. These maps were then linked to spreadsheets that summarize the data in each series.

These summary buildout statistics should be relatively accurate because the series they were calculated from consists of five extremely detailed maps for each town. These background maps are described by the EOEA as follows:

Map 1 allows communities to see how they have used the land within their municipal boundaries to date. It depicts, in varying colors, lands that have already been developed or protected as well as lands that are absolutely constrained to development. . . . [Map 2 shows the amount and location of land within a community that is available for future development.] . . . Hatched patterns indicate partial constraints to development, such as wetlands, the second 100-foot buffer zone under the Rivers Protection Act, or overlay districts, such as a water protection overlay district which limits impervious surface, bans underground storage tanks and requires that a special permit be issued for the storage of hazardous materials. . . . The third map in the buildout analysis series is intended to simplify the information seen on the first two maps. . . . Each buildout map series includes an aerial photo [map 4] of the community taken from approximately 15,000 feet above the ground. . . . [This map is] useful to examine the patterns of subdivisions, buildings, power lines, roads and other geographic features, such as recreational fields, water bodies, forests and farmlands, which are also readily apparent. The regional planning agencies (RPA) and consultants who completed the buildout analyses also used this map as a type of base map from which to derive new GIS layers and to check the accuracy of other maps produced for the buildout series. . . . [Map 5] shows a community’s current zoning. . . . Essentially, it acts as a blueprint for a community’s future development, showing how it has divided its land to accommodate varied development interests. 26

Final Land Use Data Description

The five EOEA maps for each town were combined with the corresponding maps detailing current land use, zoning, and protection. The result is a data set in which land is categorized into land that is currently in residential use, in commercial or industrial use, open, protected, or other

26. For the EOEA’s full description of each type of map and sample maps, see www.commpres.env.state.ma.us/community/cmt_main.asp?community ID=1#Absolute.
Further, open land is subcategorized by zoning regulation; checked for geographic constraints that might impede building, such as wet soil or steep slopes; and divided by the relevant minimum lot size of floor-to-area ratio to determine the maximum possible number of new buildings. This allows for the calculation of the maximum potential increase in population, students, and water use in each town.

It is important to note that these latter are hypothetical measures of growth that depend on a strict interpretation of the current zoning code. These data describe a well-defined potential growth scenario: maximum growth under the current regulatory regime. However, they do not define either the growth that is necessarily expected or the timing of the growth. The maps were developed as a visual aid to guide future development plans both within and across towns, suggesting that neither desired nor expected eventual growth patterns in Massachusetts will match these data. Rather, the data describe a set of equilibrium outcomes for the local regulatory processes at a point in time. We are using a cross-sectional data set in the standard, static sense.

**Demographic Data**

The demographic data consist mainly of Census data collected from the Massachusetts state website. However, driving distance to Boston for each town was collected from Mapquest.com, a standard software for obtaining driving directions.27

As stated earlier, the data set contains at least portions of the data for all 351 towns in Massachusetts. Unfortunately, most of the buildout data are not available for three of the cities: Boston, Worcester, and Nantucket. We argue that dropping Boston and Worcester, two of the most populated cities in Massachusetts, from the analysis should not affect the results. These cities effectively have no land use decisions left to make. It is possible that a very small decision may be made, such as not to build housing on current golf courses. In addition, renovation and revitalization decisions are not included. However, for the land we determine to be subject to a regulatory decision, the assumption that no decision is left to be made is likely to be fairly accurate.

This view is supported by the data themselves, which show that sev-

27. We used the shortest driving distance regardless of road type.
eral other densely populated cities have no open land subject to a land use decision under the current regulatory regime. Chelsea, Everett, Somerville, Watertown, and Winthrop all have no land available for additional residential development. Another fifty-one towns have no land available for commercial or industrial development. Finally, Winthrop, one of the most densely populated towns, has no land available for residential, commercial, or industrial development. In addition several cities have included redevelopment in their analysis of commercial and industrial buildout. On average, these are relatively small, more densely populated towns that are geographically closer to Boston. We check for possible bias by dropping near-Boston communities from the sample and comparing the results.

Results

We begin by reviewing the notation used for measuring current and future allowed land use in each town $i$ defined earlier.

Land Use Share Variables

$R_i =$ acres of land currently used for residential purposes.
$C_i =$ acres of land currently used for commercial or industrial purposes.
$O_i =$ acres of land currently open. This is subdivided into acres of open land zoned for residential purposes ($OR_i$), acres of open land zoned for commercial or industrial purposes ($OC_i$), acres of open land protected ($OZ_i$, included in $Z$), and acres of open land not zoned ($OO_i$).
$Z_i =$ acres of land currently protected.

Regulated Density Variables

$FR_i =$ average zoned residential density for future building (maximum potential new residences divided by $OR_i$).
$FC_i =$ average zoned commercial density for future building (maximum potential commercial or industrial square feet divided by $OC_i$).
$ER_i =$ existing residential density (units in 2000 divided by $R_i$).
$EC_i =$ existing commercial density measured as the proportion of currently built land used for commercial or industrial purposes ($C_i/(C_i+R_i)$).
In the state as a whole, 18 percent of the land is used for housing, 4 percent is used for commercial or industrial buildings, 26 percent is protected, 43 percent is open, and about 8 percent is unbuildable. Of protected land, approximately 4 percent is federally owned, 34 percent is state owned, less than 1 percent is county owned, and 21 percent is municipality owned. The rest of protected land is, for example, owned privately or is an inholding within other protected lands.

Table 1 shows the summary statistics for the share of land use regulation variables. On average, the towns in Massachusetts use 22 percent of their land for housing, 5 percent for commercial and industrial uses; 25 percent is protected, and 40 percent is left open without protection.28 Eight Boston suburbs (Arlington, Belmont, Malden, Marblehead, New-

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28. This means that approximately 8 percent of land is in the “other” (unbuildable) category.
ton, Somerville, Swampscott, and Winchester) use over 60 percent of their land for housing, while four rural communities in mid- to western Massachusetts (Hawley, Monroe, Mount Washington, and New Salem) use less than 1.5 percent. Six cities (Boston, Cambridge, Chelsea, Everett, Lawrence, and Somerville) devote more than 25 percent of their land to commercial or industrial uses, while two rural communities (Gosnold Island and Mount Washington) allow no commercial or industrial uses in their towns.

In determining future allowable land use of open land \((O_i + Z_i)\), towns, on average, devote 51 percent to housing, 9 percent to commercial and industrial uses; nearly 40 percent is protected, and less than 1 percent is left unzoned. However, these variables range widely. For example, Alford (in the western part of the state), Plympton (southern), and Richmond (western) zone over 90 percent of their open land for residences. Conway and Templeton (mid-western) zone over 75 percent their open land for commercial and industrial uses. Several towns on the Cape (Provincetown, Truro, Wellfleet) protect more than 80 percent of their open land, as do several towns close to Boston (Belmont, Medford, Quincy, Stoneham, Wellesley). The towns that zone a high percentage of open land for housing (Alford, Plympton) also protect a low percentage, less than 4.5 percent of their land.

Summary statistics for the density regulation variables are shown in table 1. On average, towns allow only 2.1 residences an acre, as opposed to 2.5 residences an acre currently built. However, these are not statistically distinguishable. The future current commercial and industrial density is 0.36 acres allowed for building for each acre zoned commercial. We do not have a comparable measure of current commercial and industrial density, so we use the percentage of built land being used for commercial and industrial purposes as a proxy. On average, towns in Massachusetts are using nearly 16 percent of their built land for commercial and industrial buildings (and therefore just over 84 percent for housing). By comparison, towns in Massachusetts plan on using only about 14 percent (not statistically distinguishable) of their open land zoned for future building for commercial and industrial buildings.

We now proceed to examine some of the hypotheses from the literature. We divide the presentation of results according to the major strands.

29. These residences may include agricultural land.
in the literature. However, the discussion of all four strands relies heavily on the bivariate correlations in table 2 as well as the multivariate linear regressions presented in tables 3 and 4. In both tables 3 and 4 the first set of columns describes the entire sample, while the second set describes only cities included in the Boston CMSA. In table 3, columns 1 and 4 show the determinants of the percentage of open land zoned for residential use, columns 2 and 5 show the determinants of the percentage of open land zoned for commercial or industrial use, and columns 3 and 6 show the determinants of the percentage of open land protected from future building. In table 4, columns 1 and 3 show the determinants of maximum future residential density, and columns 2 and 4 show the determinants of future commercial and industrial density.

Does Zoning Follow the Market?

We first turn to analyzing the extent to which the zoning of future land use simply follows current land use patterns. The short answer is yes—in virtually every respect. If we examine current and zoned residential density, the bivariate correlation between $FR_i$ and $ER_i$ is, as expected, significant with a value of .74. In other words, towns with relatively high current housing densities tend to zone higher future densities. This relationship is shown graphically along with the 45° line in figure 1. Future residential density is, as foreshadowed by figure 1, significantly related to current residential density. In the multivariate regressions of table 4, this is reinforced with a very significant coefficient of 1.9.

The regression results from table 3 show that the extent of current residential development also predicts the extent of zoned future land for residential use. The greater the fraction of current land that is used for residential use ($1 - EC_i$), the greater the amount of open land that is zoned for future residential development. In addition, towns with lower current residential density also zone a significantly higher proportion of open land for future housing. Specifically, if $ER_i$ decreases by one house an acre, all things equal, then $OR_i/O_i$ is expected to increase by 1.6 percentage points. This would imply a nearly 3 percent increase in the propor-

30. Unfortunately, we are not able to capture the entire CMSA because we do not have data for towns in Connecticut, Rhode Island, or Maine. Therefore, interactions between towns, such as those that are important in Evenson and Wheaton (2002), will not be fully accounted for and coefficient estimates may be biased.
Table 2. Bivariate Correlation Coefficients for the Land Use Regulation Variables

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<th>%Ci</th>
<th>%Zi</th>
<th>%Oi</th>
<th>%ORi</th>
<th>%OCi</th>
<th>%OZi</th>
<th>%OOi</th>
<th>FRi</th>
<th>FCi</th>
<th>ERi</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%OOi</td>
<td>.1</td>
<td>.1*</td>
<td>-.1*</td>
<td>-.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRi</td>
<td>.3*</td>
<td>.4*</td>
<td>-.1*</td>
<td>-.4*</td>
<td>-.3*</td>
<td>0</td>
<td>.3*</td>
<td>.1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>FCi</td>
<td>.1*</td>
<td>.2*</td>
<td>0</td>
<td>-.2*</td>
<td>0</td>
<td>-.1*</td>
<td>-.1</td>
<td>0</td>
<td>.4*</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ERi</td>
<td>.5*</td>
<td>.8*</td>
<td>-.3*</td>
<td>-.5*</td>
<td>-.3*</td>
<td>.2*</td>
<td>.2</td>
<td>.1</td>
<td>.7*</td>
<td>.4*</td>
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<td></td>
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</tr>
<tr>
<td>ECi</td>
<td>.2*</td>
<td>.7*</td>
<td>-.3*</td>
<td>-.2*</td>
<td>-.2*</td>
<td>.3</td>
<td>-.1</td>
<td>.1</td>
<td>.2*</td>
<td>.1</td>
<td>.5*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oi</td>
<td>-.7*</td>
<td>-.4*</td>
<td>.1</td>
<td>.7*</td>
<td>.4*</td>
<td>0</td>
<td>-.4*</td>
<td>-.1*</td>
<td>-.3*</td>
<td>-.1*</td>
<td>-.4*</td>
<td>-.2*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Oi per capita 1999</td>
<td>-.5*</td>
<td>-.3*</td>
<td>.3*</td>
<td>.4*</td>
<td>.1*</td>
<td>-.1</td>
<td>-.1</td>
<td>-.1</td>
<td>-.1</td>
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<td>-.2*</td>
<td>-.1*</td>
<td>.3*</td>
<td>1</td>
</tr>
<tr>
<td>Income per capita from Boston</td>
<td>.3*</td>
<td>-.1</td>
<td>0</td>
<td>-.3*</td>
<td>-.1*</td>
<td>-.1*</td>
<td>-.2*</td>
<td>.3*</td>
<td>0</td>
<td>0</td>
<td>-.1*</td>
<td>-.3*</td>
<td>-.3*</td>
<td>-.1*</td>
</tr>
<tr>
<td>Distance from Boston</td>
<td>-.7*</td>
<td>-.5*</td>
<td>.4*</td>
<td>.5*</td>
<td>.2*</td>
<td>-.1*</td>
<td>-.1</td>
<td>-.1</td>
<td>-.3</td>
<td>-.2*</td>
<td>-.4*</td>
<td>-.2*</td>
<td>.5*</td>
<td>.5*</td>
</tr>
</tbody>
</table>

*Significance at the 5 percent level of confidence.

a. See text for explanation of variables.
Table 3. Multivariate OLS Determinants of the Proportion of Open Land Zoned for Future Residential, Commercial/Industrial, and Protected Use

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample</th>
<th>Boston CMSA sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR/Oi</td>
<td>OC/Oi</td>
</tr>
<tr>
<td></td>
<td>OR/Oi</td>
<td>OC/Oi</td>
</tr>
<tr>
<td></td>
<td>OR/Oi</td>
<td>OC/Oi</td>
</tr>
<tr>
<td></td>
<td>OR/Oi</td>
<td>OC/Oi</td>
</tr>
<tr>
<td>ERi</td>
<td>-0.016***</td>
<td>-0.0023</td>
</tr>
<tr>
<td></td>
<td>(0.0051)</td>
<td>(0.0025)</td>
</tr>
<tr>
<td>ECi</td>
<td>-0.039</td>
<td>0.370***</td>
</tr>
<tr>
<td></td>
<td>(0.112)</td>
<td>(0.093)</td>
</tr>
<tr>
<td>Oi</td>
<td>0.000012***</td>
<td>0.0000015</td>
</tr>
<tr>
<td></td>
<td>(0.0000029)</td>
<td>(0.0000024)</td>
</tr>
<tr>
<td>Oi per capita</td>
<td>0.00023</td>
<td>-0.00022</td>
</tr>
<tr>
<td></td>
<td>(0.0020)</td>
<td>(0.0013)</td>
</tr>
<tr>
<td>Income per capita 1999</td>
<td>-0.0000023*</td>
<td>-0.000002***</td>
</tr>
<tr>
<td></td>
<td>(0.0000013)</td>
<td>(0.0000007)</td>
</tr>
<tr>
<td>Distance from Boston</td>
<td>-0.00038</td>
<td>-0.00054***</td>
</tr>
<tr>
<td></td>
<td>(0.00036)</td>
<td>(0.00021)</td>
</tr>
<tr>
<td>Summary statistics</td>
<td>0.562***</td>
<td>0.12***</td>
</tr>
<tr>
<td>Constant</td>
<td>(0.067)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>N</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>R²</td>
<td>0.21</td>
<td>0.14</td>
</tr>
</tbody>
</table>

*Significant at the 10 percent level of confidence.
**Significant at the 5 percent level of confidence.
***Significant at the 1 percent level of confidence.
a. Standard errors are in parentheses.
b. See text for explanation of variables.
tion of open land devoted to future housing in the average town with a land use base that is 50 percent residential.

A similar story holds for commercial development. Towns with a higher proportion of currently built land that is used for commercial and industrial purposes tend to zone a significantly higher proportion of open land for future commercial and industrial building (figure 2). Specifically, if $EC_i$ increases by 1 percentage point, all things equal, then $OC/O_i$ is predicted to increase by 0.37 percentage point. This would be a 4 percent increase in the proportion of future commercial or industrial land in the average town where commercial use is nearly 9 percent.

The only seeming contradiction to this general pattern concerns future commercial and industrial density. Towns with a large share of current commercial use (a proxy for existing commercial density) tend to zone future commercial use at lower density (FAR) rather than a higher density as is the case with residential use.

---

**Table 4. Multivariate OLS Determinants of Future Residential and Commercial-Industrial Density**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample</th>
<th>Boston CMSA sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FR$_i$</td>
<td>FC$_i$</td>
</tr>
<tr>
<td>$ER_i$</td>
<td>1.92***</td>
<td>0.083**</td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>$EC_i$</td>
<td>-7.36***</td>
<td>-1.15***</td>
</tr>
<tr>
<td></td>
<td>(2.20)</td>
<td>(0.38)</td>
</tr>
<tr>
<td>$O_i$</td>
<td>0.000055**</td>
<td>0.0000094</td>
</tr>
<tr>
<td></td>
<td>(0.000025)</td>
<td>(0.0000064)</td>
</tr>
<tr>
<td>$O_i$ per capita</td>
<td>0.118***</td>
<td>-0.0058</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Income per capita 1999</td>
<td>-0.00000087</td>
<td>-0.0000044</td>
</tr>
<tr>
<td></td>
<td>(0.000027)</td>
<td>(0.0000043)</td>
</tr>
<tr>
<td>Distance from Boston</td>
<td>-0.011*</td>
<td>-0.0016*</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.00082)</td>
</tr>
</tbody>
</table>

**Summary statistics**

<table>
<thead>
<tr>
<th>Constant</th>
<th>FR$_i$</th>
<th>FC$_i$</th>
<th>FR$_i$</th>
<th>FC$_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.966</td>
<td>0.479*</td>
<td>0.74</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>(1.072)</td>
<td>(2.50)</td>
<td>(2.08)</td>
<td>(0.37)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>335</td>
<td>302</td>
<td>205</td>
<td>206</td>
</tr>
<tr>
<td>R$^2$</td>
<td>0.57</td>
<td>0.19</td>
<td>0.60</td>
<td>0.19</td>
</tr>
</tbody>
</table>

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*aSignificant at the 10 percent level of confidence.
**Significant at the 5 percent level of confidence.
***Significant at the 1 percent level of confidence.

a. Standard errors are in parentheses.
b. See text for explanation of variables.
Columns 4 and 5 of table 3 and columns 3 and 4 of table 4 show that virtually all these results hold up when the sample is restricted to only those cities and towns within the greater Boston CMSA.

**Is There Down-Zoning?**

In table 4 the regression coefficient of 1.9 suggests that the down-zoning observed in figure 1 is actually outweighed by the up-zoning of the few very dense near-Boston suburbs. When only suburban towns are included in the sample (those located more than fifteen miles out from Boston), the coefficient drops to 0.7 as shown in table 5. This suggests that most towns in Massachusetts allow future residential building at only about 70 percent of their currently observable housing density. The more densely developed cities and towns near to Boston, however, seem to encourage redevelopment of their limited vacant land at higher-than-existing densities. Thus while down-zoning is somewhat present in the further out suburbs, its prevalence is actually quite limited and moderate.
This explanation is further amplified in figure 3. As the few higher density cities and towns are truncated from the sample, and the graph blown up, the extent of down-zoning becomes apparent. The fitted bivariate regression line in both figures has a slope very close to the .70 of the multivariate regression in table 5.

It is interesting that there is substantial evidence of commercial down-zoning as well. To begin with, figure 2 suggests that most towns limit commercial development to have an average FAR of less than 0.5. This is despite the fact that many older towns in Massachusetts have existing commercial development that is much more dense. Next, there is little if any discernable slope in figure 2 between the extent of current commercial use and future commercial density. Finally, as shown in tables 3 and 4, towns with extensive existing commercial uses may zone more land for future such development, but they do so at lower FAR levels. Perhaps
those with experience in commercial development believe that lower densities are needed to mitigate traffic, noise, or other externalities that may arise from such uses.31

Provision of Open Space Results

In their 2002 paper Evenson and Wheaton suggest that the proportion of land protected from development ($OZ/O$) should be negatively correlated with both the current residential density and the amount of open land per capita. The intuition for the former is that when homeowners have less land, they have less incentive to increase housing values by protecting open space. The intuition for the latter is that when there is more total open space, protecting a given proportion is more costly to each current resident. In addition, Evenson and Wheaton predict that towns with less open land will protect more land because they will be

31. A current future density of more than one denotes that the buildings are multiple stories.
Figure 3. Current Residential Density and Maximum Future Residential Density Enlargements

Panel A

Maximum future residential density ($FR_i$)

Panel B

Maximum future residential density ($FR_i$)
able to capitalize the effects of regulation into house prices more effectively than towns with more total open land.\textsuperscript{32}

Only two of the three correlation coefficients are as expected. Towns with more open land tend to regulate less ($r = -0.42$, significant). Towns in which regulating a given share is more costly because there is more open land per capita tend to regulate less ($r = -0.05$), as expected, but the correlation is insignificant. However, if protected land is limited to municipally owned protected land, this correlation actually becomes significant with a value of $-0.33$. This matches Evenson and Wheaton’s prediction. Contrary to Evenson and Wheaton’s prediction, more densely populated areas, whose residents have less to gain from increased house prices because they are consuming less housing, tend to regulate more ($r = 0.24$, significant). This basic result ($r = 0.48$, significant) also holds if protected land is restricted to municipally owned land, as does the first result ($r = -0.60$, significant).

\textsuperscript{32} For clarity, we quote Evenson and Wheaton’s Review of Predicted Results. “The model generates three specific predictions about the relationship between town characteristics and land use regulation. These predictions are based on a theory which assumes all residents are the same, so the optimization problem each local government faces when determining land use is equivalent to that any individual currently residing in the town faces.

1) Towns with more open land available to future development for each current resident should choose to restrict less land from development. The intuition behind this is that towns with more current residents will be able to spread the costs of regulating a given amount of open land across residents, so that the cost each resident faces when determining the optimal amount of land use regulation is smaller.

2) Towns in which existing residential density is high should choose to restrict more land from development. The intuition behind this is that residents with lower land (housing) consumption should receive less of a benefit from the capital gains, assumed to be price times the units of land (housing) consumed, induced by regulating land use. If less housing is consumed the total benefit from the price of housing is lower.

3) Towns with more open land available to future development \textit{ceteris paribus} should choose to restrict less of this land from development. There is no intuitive explanation for this result; it is simply a prediction of the model that smaller towns will be able to capitalize the effects of regulation into house prices more effectively than larger towns. It rests on the interaction between towns and the fact that smaller towns are able to increase house prices without decreasing the market-wide utility level of incoming residents (which would decrease the demand for housing and subsequently house prices in the town). This implies that smaller towns will receive a larger benefit from regulation, and so will choose to regulate more. By construction, our measure of the share of open land restricted is positively correlated to the amount of open land, so our analysis will be biased against finding this result. This is unfortunate given that this is the prediction that the model was conceived to generate in order to explain the result of several previous empirical papers.” (p. 20)
These correlations are borne out in the multivariate regression analysis, shown in columns 3 and 6 of table 3. Towns with more total open land, all things equal, zone significantly less open land. This empirical result has been surprisingly robust in recent housing supply studies. However, towns whose residential areas are more densely built out seem to protect a significantly higher proportion of open land, ignoring the fact that fewer individual benefits are accrued. Although this result would be consistent with high-density urban towns that are nearly built out, a regression excluding the near-Boston suburbs has the same effect. The effect of increasing open land per capita is only significant if protected land is constrained to that which is municipally owned, as would be expected since residents will not bear as much of the costs for open space owned privately or by a state, county, or federal government. Therefore, these results support Evenson and Wheaton’s theory fairly well.

**Commercial Zoning Results**

Erickson and Wasylenko suggest that wealthier towns have a pattern of zoning out industrial and commercial development. We first test whether the ratio \( C_i / (C_i + R_i) \), or the proportion of commercial and industrial land, has a negative income elasticity. In other words, we should expect to see less commercial and industrial land currently in use in wealthier towns. To begin with, we find that the proportion of commercial and industrial land is negatively and significantly correlated with income, with a correlation coefficient of \(-0.30\). A simple regression specified in logs yields an estimated elasticity of \(-0.83\), which is significant. However, income explains just less than 9 percent of the variation in the proportion of commercial and industrial land, and this estimate is sure to suffer from omitted variable bias.

The multivariate regression results in table 3 continue to show that wealthier towns zone significantly less of their open land for commercial purposes. These results support Evenson and Wheaton’s theory fairly well.

34. The coefficient has a value of 0.02 and is significant if protected land is unrestricted. It has a value of 0.04 and is significant if protected land is restricted to that municipally owned.
35. Evenson and Wheaton are able to use these same data with different sample selection criteria, which are better aligned with the theoretical assumptions, to find significant support for their theory.
and industrial use. This is true for both the full sample of towns and the Boston CMSA towns. Towns whose per capita income was $1,000 higher in 1999 will zone approximately 0.2 percentage point less of their land for future commercial and industrial purposes. This means that the average town, starting with a little less that 9 percent of its open land zoned for future commercial or industrial development, would decrease that proportion by 2 percent. In addition, wealthier towns significantly increase the amount of open land that is protected in both samples.

These results are consistent with Fischel’s argument that less wealthy towns have an incentive to allow commercial and industrial building because these types of land use generate relatively large tax revenues and use relatively few resources. In other words, fiscally constrained towns have an incentive to try to attract commercial and industrial tenants to help alleviate their budget constraints, but as residents become wealthier, commercial and industrial tenants are considered inferior goods in the sense that the negative environmental costs associated with such uses outweigh the benefits.

**General Income Effects**

We report the correlation of income with the proportion of protected land, with the expectation that protected open space is a normal good, so wealthier towns will have more. As expected, the coefficient is positive and significant in both the full sample and in the Boston CMSA sample.

Surprisingly, wealthier towns do not seem to require less dense building of either residences or commercial and industrial buildings in any of the samples. This result, that income does not affect zoned density, is puzzling yet robust. In effect, the very common conventional wisdom that small wealthy towns make themselves more exclusive is not sup-

37. For comparison, the average town in Massachusetts has 14,740.6 acres, which would imply a 29.5 acre decrease in commercial and industrial land for every $1,000 extra in per capita income.
39. Interestingly, towns with more open land that is not zoned for future use do not seem to protect less of their open land, suggesting that residents view protected land and unzoned open land differently (r = −.05, insignificant).
40. We tried several specifications to test the robustness of this result, including but not limited to adding nonlinear terms, splitting the sample, and changing equation specification.
ported by the data at all. This result has significant implications for theoretical studies: the assumption made in exclusionary MLS zoning that wealthy towns get a bigger tax transfer from excluding relatively poor residents through zoning regulation has not stood up to independent scrutiny of detailed zoning data.

The conventional wisdom pervades the literature, yet the data suggest that the income elasticity may be an endogenous result. Specifically, a town’s income per capita and the current residential density are codetermined, with current residential density being a much better predictor of future residential density. 41 Clearly then, more basic research on land use regulation would be a very useful addition to the future literature.

The results that open land and open land per capita both lead to increases in the density of open land zoned for future housing are contrary to the conventional wisdom. Towns with more open land per capita, holding total open land and residential density constant, have a smaller population living in a smaller area. Therefore, this result suggests that towns in which the cost of open space preservation is imposed on fewer people will zone for more dense future building (up-zone).

By the same token, towns with a greater total amount of open land, holding open land per capita and residential density constant, have a greater population. Although this result suggests that larger towns zone future building more densely, as expected from the conventional wisdom, this effect is outweighed by the former effect for residential building. For allowed future commercial and industrial density, neither effect is significant, which again does not match the conventional wisdom that smaller exclusive towns would zone less dense commercial and industrial land, when they allow commercial or industrial building at all.

Other Regression Results

As stated earlier, we also controlled for distance from Boston in the regressions and find that towns further from Boston tend to zone less of their open land for commercial and industrial uses. The result is consistent with a monocentric city model, in which residents commute from suburban communities to relatively clustered jobs. The density gradient

41. This raises several interesting questions about the timing of land use determination and the extent to which zoning regulations vary over time, which are beyond the scope of this paper.
implied by our results implies that towns that are, on average, ten miles further from Boston have about 0.5 percentage point less open land zoned commercial and industrial. The decrease in allowable commercial or industrial uses is not associated with a significant increase in residential land; but towns that are further from Boston protect a significantly higher proportion of their land. Towns that are, on average, ten miles further from Boston have about 1 percentage point more protected land.

These results are exactly reversed in the Boston CMSA sample. However, this is an artifact of the effect of the near-Boston suburbs, which tend to zone a relatively high proportion of land for commercial-industrial and protected uses.

Towns that are further from Boston also allow significantly less dense building (both residential and commercial-industrial), which was expected. The only exception is that the coefficient in the commercial and industrial density regression is not significant in the Boston CMSA sample, implying that towns further from Boston do not necessarily zone their future commercial-industrial land less densely than in the sample of “close” towns.

The implied density gradient is: for every ten-mile increase in distance, residential density decreases by 0.1 (full sample) to 0.7 (Boston CMSA sample) units an acre. This is borne out in the raw data, which shows cities like Cambridge zoning more than ten single family units an acre in some areas, versus, for example cities like Newburyport zoning about a third of a unit an acre in some areas. The commercial-industrial density results are slightly more consistent (although the significance is lost), with an implied density gradient that for every ten-mile increase in distance, commercial-industrial FAR density decreases by 0.16 (full sample) to 0.24 (Boston CMSA sample).

Summary and Conclusion

The body of empirical land use literature is relatively small due to a lack of good data with which to study the regulatory issues. We use a unique data set on Massachusetts land use, land use regulation, and buildout to examine the determinants of land use regulation. We are guided by theoretical studies on regulation, as well as the heretofore
untested conventional wisdom that currently constitutes much of our knowledge about housing supply. This paper is unique in that we are able to directly analyze multiple forms of land use regulation across a significant geographic area.

Overall, the evidence supports both the current theoretical land use studies and the conventional wisdom, although the results are not always significant. We find some evidence of down-zoning by the communities, although it is not as strong as we had expected despite the conventional wisdom that extensive down-zoning is considered unethical. We also find evidence that current and future building are highly correlated, as was expected. Fischel’s theory on fiscal zoning holds up especially well in the data. Wealthier towns tend to devote less land to commercial and industrial purposes in terms of both current and future land use. We also find evidence supporting Evenson and Wheaton’s studies in 2002. In particular, we add to the empirical evidence suggesting that smaller towns have a greater incentive to impose land use regulation. We also find evidence that protected land is a normal good. Finally, we calculate implied density gradients such as those used in the monocentric city model of urban economics, using Boston as the center.

The most surprising nonresult is the total lack of evidence for fiscal zoning. We find no significant wealth effect among the determinants of either residential or commercial-industrial density. The conventional wisdom that minimum lot sizes are used to zone out relatively poor households is not borne out in the data. This may be due to a correlation between existing density and wealth, with the latter having determined both existing and future lot sizes.

An obvious further use of this data set would be to relate land use regulation to house prices, as is the focus of many current empirical studies (albeit at the metropolitan-area level). However, our results show that zoning regulations governing future building are highly correlated with current densities, town size, and other variables that will simultaneously and independently affect house prices. For example, towns with stricter land use regulations are likely to have both less commercial and industrial building and higher house prices. This endogeneity has likely led to omitted variable bias in this literature on top of the problems inherently created by the typical need to aggregate regulation into a single metropolitan-area-level summary statistic. The very distinct and time-dependent patterns of land use regulation shown here imply that a regression of house prices on
regulation needs to use an instrumental variables approach to get a good measure of the true effect.

Although these data are very detailed and distinctive, there are still many questions the data cannot answer. For example, our evidence on how binding the regulations in our data are is still very weak. There is still very little evidence on the extent to which jurisdictions grant variances, which is an important issue in planning. Although these data are supposed to represent the maximum possible future building, the code or the interpretation of it may change, or unforeseen building possibilities may arise that cannot be accounted for in this analysis.

In addition, a more in-depth analysis of each of these land use topics and the theoretical arguments surrounding their previously “black-box” relationships would be very useful. For example, we have not explored the extent to which Tiebout sorting is confounded by land use regulation, nor have we examined the implications of these regulations on the often used practice of measuring Tiebout sorting by determining the level of income sorting.
Comments

Joseph Gyourko: The first important point to make about Evenson and Wheaton’s paper is that it deals with an extremely useful topic, because how we organize ourselves spatially has important socioeconomic implications for many aspects of our personal lives and for the communities in which we live. While the analysis of land use regulation in general and zoning in particular has a lengthy pedigree in economics, the fact is that theoretical models are far better developed than empirical analyses. Evenson and Wheaton set out to alleviate the primary reason for this—the lack of good data on land use controls.

Important new data based on a 1999 satellite-based survey of all open land in Massachusetts are matched with information on zoning ordinances in a large number of local towns and cities. A few other studies have amassed data on a specific type of land use control, but this is the first of which I am aware that allows one to observe multiple forms of land use controls simultaneously and do so over an area as extended as a state.

The goals of the paper are threefold: to document a new database, to report stylized facts about how towns actually do zone and regulate land use, and to produce results on certain key issues relating to how land use regulation varies with factors such as income. The paper is most successful in achieving the first two goals. Many of the empirical results are interesting in their own right, but more structure and even better data probably are needed to convince reasonable skeptics who propose alter-

42. For analysis of land use regulations, see, in particular, Fischel (1975); Hamilton (1978).
native explanations for the findings. Even so, the work points the way to much future research for those interested in this issue and provides a valuable new data source with which researchers can try to satisfy their curiosity.

The paper includes a useful discussion of the existing studies on minimum lot size (and exclusionary zoning), on the provision of open space, on the economics of allowing commercial development, and on the impacts of land use controls on housing prices. I would be interested in seeing the discussion and analysis extended to the issue of race. We know that there is substantial racial segregation in virtually all major metropolitan areas in the United States. The extent to which this might be correlated with how communities zone seems a potentially useful line of inquiry.

The data themselves are the best that urban scholars have ever had. As noted above, the key underlying source is a 1999 satellite survey of Massachusetts. The output for this survey is then merged into a variety of current land use files that allow the authors to know existing land use patterns as well as zoned land use patterns (that is, what the current law would allow for the future). The survey includes thirty-six detailed categories that range from residential lots of at least one-half acre to two types of bogs. These data are collapsed into four categories (residential, commercial, open space, and other) for the purposes of this paper. I see no reason to require a more detailed breakdown for this initial foray with the data, but future work certainly should investigate the utility of using finer breakdowns. The zoning data themselves are current as of 1996 in virtually all cases (and are even more recent in most cases), so one can be reasonably confident that current land usage is matched with current zoning conditions.

A fairly complex set of calculations and mappings of one data set to another is employed to compute the amount of buildout permitted under existing land use regulations. I was convinced from the authors’ presentation that the results were accurate because they could pin down the correct status of various detailed parcels (for example, Boston Common). However, this fact is not entirely clear from the text, and the paper would benefit from an expanded discussion, possibly with examples from a few

43. For current land use data and collapsing procedure, see www.state.ma.us/mgis/lus.
44. For zoning data categories and collapsing procedure, see www.state.ma.us/mgis/zn.htm.
places, so that readers are convinced of the reliability of the buildout figures.

Readers would also benefit from a more detailed presentation and discussion of the data themselves. Tables 1 and 2 document the extensive heterogeneity in actual land use and prospective density. The density regulation data reported in table 2 indicate that the current mean of 2.5 residences an acre exceeds the 2.2 residences an acre that zoning for the future implies. The range across localities is huge, but most of the data are fairly tightly clustered around the mean. Some discussion of the outliers would be useful, given how extreme they are. In addition, a simple correlation table would be informative given the new and unique data involved. There are partial correlation coefficients in some later regressions, but summarizing the simple correlations in a convenient matrix upfront would help.

The fiscal zoning results in table 3 show clearly that future density follows current density. This is evident from both the simple and partial correlations. While the qualitative results themselves are interesting, better exposition of the quantitative results is needed. At present, one sees only statistical significance, when we want to know about economic significance, too. Thus, standardized marginal effects with the results translated into the implications for the change in number of units (or square footage when relevant) would be very informative.45

The key finding from table 4 indicates that, near-in Boston suburbs excepted, current regulation effectively allows future residential building at no more than 60 percent of current density. In addition, higher current residential density is associated with higher allowable future commercial buildout.46 Finally, no meaningful relation between income and zoned density is found in the data. This is a very interesting finding, but caution regarding its interpretation is appropriate. The authors rely on a single cross-section for identification, and that is asking a lot of any data. The result could be made more convincing by providing more structure to the model or by creating a panel data set. Since either task would likely be prohibitively burdensome for the authors, a reasonable alternative might be to expand the set of right-hand regressors to include a variety of other

45. The units the data are measured in are not clearly labeled in the tables.
46. The same comment made earlier regarding standardized marginal effects applies here.
socioeconomic and political variables that economists, political scientists, or urban sociologists probably would consider useful in explaining current and future land use patterns. This path recognizes the reduced-form nature of the specification while including more correlates of interest to a variety of readers.

Given that a number of people in the audience clearly believed that existing regulations are meant to be negotiated or surmounted or both, it would be interesting to see if certain demographic, economic, and political factors influenced the spatial pattern of regulation. This strategy also seems natural to apply to the results regarding open land. The authors emphasize that their finding that open land and open land per capita both are associated with increases in the density of open land zoned for future housing contradicts the conventional wisdom in the industry. Given the somewhat counterintuitive result, it would be useful to see if it stands up when other demographic, economic, and political variables are included in the estimation.

In sum, Evenson and Wheaton are to be (loudly) applauded for amassing a unique database on multiple land use patterns. Its utility should be obvious to all, as it holds great promise for a host of future research endeavors that will help us better understand how and why we organize ourselves and our businesses spatially within and across communities. I look forward to an even more detailed presentation of the data and results that provide insights into the role of additional socioeconomic and political forces that might be able to explain the variation in land usage across towns.

**John M. Quigley:** The Evenson-Wheaton paper is a tentative description of land use facts and land use rules from a single state. The interest in the paper derives at least as much from the tools employed in data gathering and information assembly as from the new results presented.

The paper begins with a review of the sketchy economics literature on community zoning of land uses. The authors review the theoretical and empirical studies on minimum lot size (MLS) rules for new development, the provision of open space, the regulation of commercial development, and the linkage between regulation of land and housing markets.

Economists have done the most thinking about MLS rules, arguing that with property tax financing these regulations could, in principle at least, convert an ad valorem property tax into a benefits tax. Even when
this is not possible, the practice of requiring the marginal house to consume more land than the average house can improve the fiscal surplus of current residents.

Regulations requiring open space can surely benefit existing properties by providing the externalities of a local public good to residents and their residences. When landowners, collectively or through their local government, acquire this land at market prices, they face the appropriate incentives for public goods provision. When they acquire this land through condemnation, whether through wetland protection or rules about preservation, existing landlords can extract a surplus from owners of undeveloped land.

The limited literature on regulation of commercial and industrial zoning follows the analytics of MLS zoning in residential land—towns regulate commercial activities to maximize their fiscal gain, trading off tax revenues to preclude crowding and so forth. The positive effects of these rules on house prices have been subject to a variety of tests, noted and criticized by Evenson and Wheaton. In some part, the deficiencies of these empirical tests arise because land use regulations are themselves imperfectly measured.

The contribution of the Evenson-Wheaton paper is in the development of systematic positive measures of land use and zoning. Both arise painstakingly from complicated empirical research. First, on the matter of land use, aerial photographs taken from some 15,000 feet by the state of Massachusetts permit each parcel to be allocated into one of thirty-seven categories. The nuts and bolts of the taxonomy are described in general.47 Joseph Gyourko notes that the categories are fine and include a category for cranberry bogs. I note that two different cranberry bogs are distinguished: those located in woods and in cleared areas. The authors sensibly aggregate parcels to the level of town and land use to four types: residential, commercial-industrial, open space, and unusable. Open space is further divided into that protected from building and that available for building.

I should note that these highly original data sources, aerial photographs, are beginning to be generally used in economic analyses of space. The Evenson-Wheaton effort is the tip of the iceberg. Satellite

47. For detail on current land use data categories and collapsing procedure see www.state.ma.us/mgis/lus.
photographs are now available for many of the world’s urbanized areas. They can be bought from NASA for $500 to $1,000 each. They are fully digitalized, so the location of each pixel can be mapped to a location, and the shading of the pixel can be related to the intensity of land use. So it is now possible to follow land use changes, especially in the developing world, through systems like this.

The Evenson-Wheaton analysis takes the building block of land uses in each town and relates it to the detailed regulations governing usage. This is done by relying on digitized maps of open space and its regulation by the ordinances of each town. Finally, town-level data on land use and its regulation were matched to information on the maximum potential development that could take place under current law. Apparently the big advantage of this exercise was the idea of “potential development,” given that these rules were consistently measured across the state. So, Evenson and Wheaton have a data set of remarkable detail about land uses, the rules governing them, and permissible future development—all gathered at roughly the same time in a consistent way.

The authors present some simple summaries of the data, noting for example that 43 percent of land in Massachusetts is open space without protection from development. Interestingly, the cities in Massachusetts allow only 2.2 residences an acre to be built on unprotected vacant land, while there are 2.5 residences an acre on land already developed for residential purposes. These regulations seem like attempts to generate fiscal surpluses for existing homeowners.

The analytical part of the paper is a sequence of regressions and figures relating the regulation of open land and the current regulation of future land uses to current land use types and incomes. In table 3 the authors show that the distribution of currently built-up land predicts the zoning of undeveloped land. Towns with higher residential densities permit a smaller portion of open land for housing. Towns with more commercial activity today permit a larger portion of open land for commercial activity. These results are true for the state and also for the Boston metro area. Income and the amount of vacant land seem irrelevant. Analogous results are presented for the determinants of the extent of development permitted. Outside of the very dense suburbs surrounding Boston, cities in Massachusetts permit future residential building at almost 60 percent of current density. Higher current residential densities are associated with higher permitted growth in commercial activity.
The statistical results about the insignificance of income in current zoning or current permission for future development puzzle the authors. I am less puzzled. To the extent that the current residential densities are determined by incomes—that is to the extent that Tiebout sorting already operates in Massachusetts—this is, already reflected in the statistical results. Towns with high residential densities protect more of their open space from development. This seems sensible, yet the authors find it counterintuitive.

There are three things that would improve the usefulness of this extremely interesting excursion into the difficulties of data collection on land use and zoning rules. Two of them can be done easily. First, the paper would benefit from some explication of the fiscal federal structure of Massachusetts. Many of the studies noted by the authors derive from the fiscal incentives faced by median voters. How does this play out in Massachusetts? For example, what are the rules for sales tax distribution and how does this affect the incentives for zoning in or zoning out commercial structures? What is the link between property tax rules for residences—Proposition 2½ and so forth—and the fiscal choices? For those who do not know these details about Massachusetts, many of these incentives are unclear.

Second, the paper would benefit from more description. There is a fair amount of description of the data collection exercise. That is perhaps understandable, given the difficulties of data assembly. But much of the interest centers on the spatial distribution of rules and the availability of space for development. Much of the motivation for these rules, which are chosen independently, is to affect the distribution of firms and households in a local housing and labor market. Cities are involved in a strategic game, choosing rules to attract some households and to repel others and rules to attract some kinds of nonresidential activity. Some clever maps and tables of local markets (Boston, Worcester) would be very helpful. What is the distribution of rules between markets relative to the distribution of rules operating within a housing or labor market?

Third, this paper would be more useful if there were some consideration of the meaning of these land use rules so carefully constructed. In California, for example, the published zoning ordinances are not really rules at all—they are invitations to deal in a complicated game in which developers petition to obtain a permit and a variance in return for some exaction. These games are complicated, and the ordinances signal some-
thing. Variations in the ordinances are differences in the first move in some N-player game among jurisdictions in a regional market. But the published rules have almost no relation to what can be built where. Anthony Downs has suggested that this phenomenon is widespread and this limits the economic value of the data collection supervised by Evenson and Wheaton. But I hope the next version of this paper considers the link between the rules and the reality of development.

In closing, I should note the potential value of data description for the regulations and impacts of land use rules. About a dozen years ago Anita Summers and her ten closest friends in Philadelphia undertook a large survey of existing land use rules. These data were then used in a couple of books by the data gatherers and in a series of papers by people completely divorced from the original data-gathering effort. Steve Malpezzi succeeded in building models to predict the values of restrictiveness across other jurisdictions, and this gave more “legs” to the Summers indexes.

We should hope that this analysis by Evenson and Wheaton will lead to a second generation of land use rules. Developing some measures of the stringency of regulation, and the determinants of regulations, based on the kind of data Evenson and Wheaton are collecting, can have a large social payoff.
References


