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ABSTRACT

While residents receive similar benefits from many local government programs, only about one-third of all households have children in public schools. Below, we argue that capitalization of school spending into house prices can encourage residents to support spending on schools, even if the residents themselves will never have children in schools. We identify a proxy for the extent of capitalization based on the supply of land available for new development. Using a plausibly exogenous shock to local spending in Massachusetts, we show that house prices change more strongly in response to the demand shock in areas with little undeveloped land than in areas with plenty of undeveloped land and that communities with little available land also spend more on schools. We then extend these results using national data from school districts, showing that per pupil spending is positively related to the percentage of developed land and that this positive correlation persists only in locations with high homeownership rates and is stronger in districts with more elderly residents, who do not use school services and have a shorter expected duration in their property. These results hold with alternative measures of capitalization. Our findings support models in which house price capitalization encourages more efficient provision of public services and provide an alternative explanation for why some elderly residents might support local spending on schools.

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1 Introduction and Background

The choice of expenditures on public schools is one of the most contentious debates in local government. While many residents benefit relatively equally from expenditures on police and fire services or plowing the streets, only about one-third of all households have children in public schools.[1] Although altruism may drive some voters to support local education even if they will not directly benefit from such expenditures, one might expect that many communities will "underprovide" education from the perspective of an individual that considers demand for education over its entire lifecycle. A countervailing argument is that good schools are an amenity that is capitalized into house prices. Thus, even if a property owner does not use the schools, a future buyer of the property may care about the quality of local schools, so local residents will support education to maintain or increase their house price. Past research has strongly supported the proposition that good schools are capitalized into house prices. (See, for example, Barrow and Rouse 2004, Black 1999, Bogart and Cromwell 1997 and 2000, Cheshire and Sheppard 2004, Dee 2000, or Weimer and Wolkoff 2001.)

Below, we argue that the level of local spending on education depends on the extent to which spending is capitalized into property values. In particular, we posit that house prices respond to spending changes much more strongly in places where land for new residential construction is inelastically supplied, such as many suburbs of large cities, and thus residents in such locations are more willing to vote to provide more educational services. Previous theoretical work supports this proposition. Wildasin (1979) and Sonstelie and Portney (1980) point out that in a frictionless world homeowners have an incentive to vote for the local public good level that maximizes the values of their houses. Brueckner and Joo (1991) demonstrate that in a world with imperfectly mobile voters and in the presence of house value capitalization, the voter's ideal spending level for durable local public goods reflects a blend of his or her own preferences and those of the eventual buyer of the house.

Authors' computations from the American Housing Survey show that the median successful homebuyer outside of center cities has school-age children, even if the median resident does not. This link may explain, for example, why some voters, such as the elderly, might support additional school spending even though they have no children in public schools.

[1] According to the 1990 U.S. Census, 36 percent of all households have children below 18 years. Furthermore, the National Household Education Survey (NHES) of the U. S. Department of Education documents that for 1993, 91.2 percent of students in grades 3-12 are enrolled in public schools, while 8.8 percent of the students are enrolled in private schools.

To examine the hypothesis that the extent of house price capitalization drives expenditures on schools, we examine communities that differ in their relative availability of undeveloped residential land. This link is quite intuitive. As long as land supply is not perfectly inelastic (or perfectly elastic) and communities are not perfect substitutes, both price and quantity will adjust in response to demand shocks. However, price adjustment should be larger (and quantity adjustment smaller) in places with less available land for development. This argument is at odds with the assumption in other research that long-run house values fully reflect cross-sectional differences in the present discounted value of future tax burdens and benefits, after controlling for housing characteristics. Such an approach depends on demand factors alone and assumes that the supply of undeveloped land is inelastic and similar across locations. Only a few studies examine the possibility of variations in the supply elasticity among different locations (e.g., Malpezzi 1996 and Dreiman and Follain 2001) or the effect of differential land supply elasticity on the extent of capitalization (Bruce and Holtz-Eakin 1999).[2]

In the prototypical Tiebout (1956) world, residents would perfectly sort into the community with their exact preferences. For example, elderly households would move to communities that focus exclusively on services for the elderly. However, with a relatively small number of communities, multi-dimensional preferences, and moving costs, residents live in a second best world. In heterogeneous communities, residents often have to vote on public services that don't match their preferences. Thus elderly households may live in a community that happens to have good quality schools because the households have lived in the community for a long time or because the elderly residents take advantage of other amenities in that community besides the schools.

The implication that house price capitalization might lead elderly households to support school spending in communities with a high extent of capitalization differs from the findings of some previous research showing that per pupil educational spending is negatively correlated with the percentage of elderly residents. Evidence comes from data over the last 40 years at the state level (Poterba 1997), at the municipal level in Long Island (Inman 1978), or using historical school district data in three states (Hoxby 1998). In contrast, Goldin and Katz (1997) show that school spending at the beginning of the century grew faster in states with a greater percentage of elderly residents. Other papers show that at least part of the negative relationship between elderly residents and school spending is driven by racial heterogeneity, that is, elderly residents

[2] McMillan and Carlson (1977) examine a sample of small Wisconsin towns and show that amenities are not

are particularly unlikely to support spending on children of a different race. (See Poterba 1997, Cutler, Elmendorf, and Zeckhauser 1993, Goldin and Katz 1999, and Alesina, Baqir, and Easterly 1999.) However, Harris, Evans, and Schwab (2001) show that percent of elderly seems to have only a modest negative effect on local school spending, but a strong negative effect on state spending. They argue that the difference is due to the fact that state spending is not perceived as having any impact on house prices, while local spending matters more for house prices. Finally, Bergstrom, Rubinfeld, and Shapiro (1982) present evidence from a Michigan survey of elderly voters showing unusual support for school spending. They speculate that such support might be driven by the observation that many of these voters planned on selling their house and moving to Florida, and that bad schools bring down house prices.

Our empirical findings, which confirm the effect of land availability on the extent of capitalization and on school spending, have implications for theoretical and empirical studies in a variety of areas. For example, some authors argue that the capitalization of benefits of durable local public goods into property values can induce local governments to behave efficiently (e.g., Edelson 1976, Sonstelie and Portney 1978, and Fischel 2001) or that land value capitalization provides a mechanism to induce present generations to internalize the well-being of future generations (e.g., Oates and Schwab 1988 and 1996, Glaeser 1996, and Conley and Rangel 2001). Fischel (2001) describes homeowners as "homevoters" whose voting and local political activities are guided by their concerns about home values. Fischel's homevoter model implies "…that local property taxes are benefit taxes, (and) that locally funded schools are more efficient than state-funded systems…" Our results support such normative implications in locations with limited opportunities for new construction, but not for places where land for development is freely available.

Finally, research in many areas makes the implicit assumption of uniform capitalization, including urban quality-of-life comparisons[3] and capitalization studies of environmental amenities,[4] school spending (or school quality),[5] government subsidies,[6] and taxes.[7] Such

capitalized in a hedonic regression, a result that is consistent with the spirit of our paper, as well.

3 Urban quality-of-life comparisons use implicitly generated prices of local amenities by assuming uniform capitalization of interurban amenity differences into local land rents and wage rates in order to report quality of life rankings (see e.g., Blomquist et al. 1988, Gyourko and Tracy 1991, or Gyourko, Kahn, and Tracy 1999 for a survey of the literature).

4 See, for example, the meta-analysis by Smith and Huang (1995) or recent work by Bui and Mayer (2003).

5 A strict link between school expenditures—or more precisely school quality improvements—and house prices exists only if land supply is equally inelastic in all observed locations. While Black (1999) looks only at houses very close to attendance district boundaries where land supply might indeed be equally and completely inelastic,

conclusions may be inaccurate given that the extent of capitalization appears to vary across jurisdictions, for example, due to differences in the extent of land-use regulation (Green, Malpezzi, and Mayo 1999, Mayer and Somerville 2000, and Hwang and Quigley 2004). Our findings suggest that house price capitalization estimates cannot be easily interpreted as a household's willingness to pay for amenities when land for new development is readily available, as is often true outside of the coastal areas in the Northeast and parts of the West.

To begin, Section 2 explores the conditions under which land supply elasticity will influence the extent of capitalization and thus school spending. We examine these theoretical predictions in Section 3 using data for the Commonwealth of Massachusetts and building on the empirical framework first used in Bradbury, Mayer, and Case (2001). This procedure uses variation from a property tax limit—Proposition 2½—to generate instruments for otherwise endogenous spending changes across communities. Consistent with theory, our results show that demand shocks lead to larger changes in house prices and smaller changes to new construction in locations with little undeveloped land. Localities with little available land for new construction also vote to increase school spending at a faster rate than other communities when constrained by Proposition 2½.

Next, Section 4 examines national data on school agencies in 48 states and shows that per pupil spending is strongly and positively related to the percentage of developed land in a school district, a proxy for supply inelasticity. The coefficients suggest that a school district with little available land for development (70 percent of non-industrial land is developed) spends 9.7 percent more per pupil on schools, all else equal, than a district with a large amount of land available for development (7 percent developed land). Given the possibility that land availability is correlated with other unobserved amenities or community attributes, we examine a number of interactions that are driven by theory linking house price capitalization to school spending. For example, we show that the positive correlation between school spending and the percentage of developed land only exists in communities with higher homeownership rates. In addition, the percent of elderly residents is positively related to per-pupil school spending in districts with little

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Haurin and Brasington (1996) and Dee (2000) present estimates based on much less disaggregated data, which might be biased without controlling for land supply.

[6] Several authors have argued that location-based aid (as opposed to grants to poor individuals) can have adverse consequences, since poor residents are typically renters who will be forced to pay higher rents if the transfers are capitalized into higher house prices (e.g., Hamilton 1976 and Wyckoff 1995).

[7] For example, variation in the extent of capitalization may lead to differences in homeowner benefits from the mortgage interest deduction and have implications for other types of fundamental tax reform in the US. See

available land and in large MSAs and their suburbs, but percent of elderly residents is negatively related to school spending in smaller MSAs and non-MSA places where land for construction is likely to be more easily obtained. Furthermore, the size of the positive coefficient on the interaction between percent elderly and percent developed land rises when looking at older elderly residents who should have a shorter expected duration in their property. All of these results support the proposition that spending on schools is positively related to the extent of house price capitalization. Section 5 concludes with a brief discussion of policy implications.

2 Theoretical Framework

In the analysis that follows, we argue that the extent of capitalization of fiscal variables and amenities into house prices should be particularly high in places where supply of land for new residential construction is relatively inelastic.[8] We propose that local land availability is an appropriate proxy for the elasticity of supply of land for new residential construction and provide theoretical justifications for this proposition. We then confirm that places with little available land for new construction indeed have a more inelastic supply of single family housing permits in the empirical analysis in Section 3.

2.1 Land Supply Elasticity and House Price Capitalization

It is intuitive that both price and quantity will adjust in response to demand shocks and that the price adjustment is larger (and quantity adjustment smaller) if land supply is inelastic. This argument is illustrated in Figure 1. The figure depicts a residential land market, where—above a certain reservation price p_F (the present value of future land rents from farming)—the amount of developed residential land L increases monotonically with the price for residential land until all land in the community $\bar{L}$ is developed. Suppose that all communities in a specific region have an identical land supply curve. However, community A with plenty of available land is at the very elastic part of the residential land supply curve, while community B with little available land is at the inelastic part of the supply curve.

Capozza, Green, and Hendershott (1996) and Sinai (1998). For other tax studies, see Stull and Stull (1991), Man and Bell (1996), Palmon and Smith (1998a and 1998b), and Hilber (1998).

[8] Some have argued that the total amount of land in a community is fixed (as long as the boundaries are fixed) and therefore land supply is always completely inelastic. Moreover, land already used for residential (or industrial) purposes can be redeveloped. While both statements are true, the amount of available developable land for new residential construction is not fixed and redevelopment of land that is already used for residential (or industrial) purposes is much costly (see Novy-Marx 2004, for example).

Figure 1: Exogenous Demand Shocks in a Community with Plenty and Little Available Land

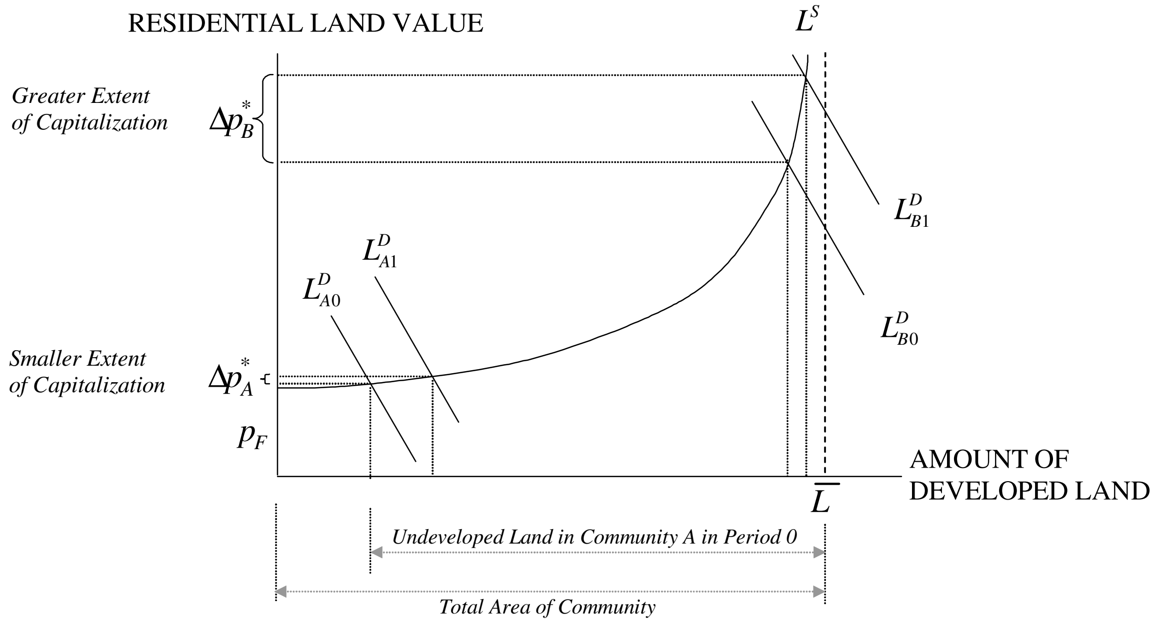

Figure 1 suggests that the incremental "cost" of building an additional housing unit increases exponentially in communities with little available land due to increasing marginal opportunity cost (lost value from redevelopment) and greater option value. This model builds on the findings of papers such as Capozza and Helsley (1989 and 1990) and Novy-Marx (2004). The intuition is straightforward. Redevelopment is costly. As demand rises in a community, the opportunity cost of parcels that are newly developed or redeveloped for more intense use also rises. Initially, builders will redevelop land that has low-value uses, but eventually they must redevelop land that is being used for relatively high-value purposes. In addition, with little remaining undeveloped land in a community, the hurdle rate required to exercise the development option rises quickly. In the extreme, when only two undeveloped parcels remain, the owner of one parcel must receive high value in order to develop, as he gives up the opportunity to be the remaining undeveloped parcel. Hence, the amount of available developable land in a community can serve as a proxy for the residential land supply elasticity.[9] As Figure 1 illustrates, an exogenous demand shock will have a stronger price effect in places with a higher percentage of already developed land.[10]

[9] One can also derive mathematically that for every residential land supply function with a strictly positive relationship between price and quantity and a positive intercept on the price axes, the land supply elasticity decreases with the amount of developed land.

[10] In an earlier version of this paper we developed a model of two communities that differ in their land supply elasticity and of mobile households that have identical incomes and tastes. The model builds upon the seminal work of Epple and Zelenitz (1981) and confirms the main prediction of the partial equilibrium model that the extent of capitalization is decreasing in the land supply elasticity.

Figure 1 is consistent with the "endogenous zoning literature" that considers land use restrictions as political outcomes determined by the pivotal voter.[11] For example, empirical estimates in Pogodzinski and Sass (1994) indicate that land-use regulations appear to "follow the market," after controlling for selection bias. Books on zoning and land-use planning such as Fischel (1985) and Rundel (1989) also come to the same conclusion; undeveloped land can be relatively easily converted into residential use in rural areas and locations at the edge of cities but not in more developed places such as large urban and suburban communities, where existing residents have relatively strong incentives to pass restrictive zoning measures and thereby effectively limit short-term supply.

The same conclusion is reached if one interprets undeveloped urban land as an exhaustible resource.[12] In fact, our framework is consistent with Hotelling's (1931) classic treatment of this problem.[13] Empirically, Nordhaus (1980) plots an oil supply function quite similar to Figure 1 in which the ratio of spot to official oil price depends on the capacity utilization rate. When capacity utilization becomes close to one, oil prices spike in response to a short-run shock to demand.

Several real estate papers provide empirical support for our theoretical framework. Mayer and Somerville (2000) point out that land supply elasticities vary across MSAs, with MSA housing permits exhibiting a lower responsiveness to prices in more highly-regulated markets. (See also Green, Malpezzi, and Mayo 1999.) Similarly, Hwang and Quigley (2004) show that price adjustment to demand shocks is larger (and quantity adjustment is lower) in more highly regulated markets such as San Francisco. Brasington (2002) provides evidence that capitalization of schooling and crime is weaker toward the edge of an urban area where housing supply elasticities and developer activity are greater.

Finally, it is important to note that our framework is based on the assumption that some portion of current spending affects the utility level of future residents. This assumption would hold if a school district purchases durable goods that benefit future residents, or if current spending decisions represent a signal or commitment to future spending. A few studies recognize that the extent of capitalization of future benefits of durable local public goods affects

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11 The literature on "economics of zoning" is founded on Mills and Oates (1975). For a general review of the literature see Fischel (1990) or Pogodzinski and Sass (1991 and 1994).

12 For example Yinger (1982) suggests that the finite size of urban areas makes land a scarce resource.

13 Hotelling shows that in order to satisfy intertemporal arbitrage conditions, as long the cost of extraction was zero, the expected growth rate of prices must be equal to the interest rate. However, Krautkraemer (1998, p.2067) points out that "…the short-run supply of a non-renewable resource may be quite inelastic, and changes in market demand will be resolved with price changes rather than quantity changes."

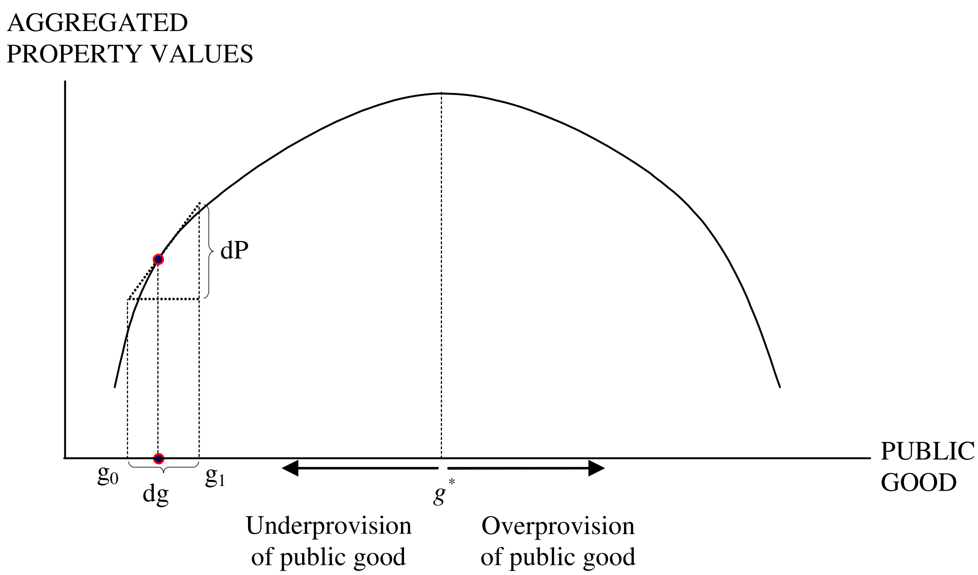
the current spending level (e.g., Sprunger and Wilson 1998, Hoyt 1999). In the case of Massachusetts under Proposition 2½ we expect this assumption to apply particularly well in that most increases in the levy (spending) limit are permanent; so if voters choose to increase the spending limit in one year, they are choosing to increase that limit in all future years as well.

2.2 A Property Tax Limit as an Exogenous Demand Shock

A. General Considerations

Brueckner (1982) notes that if local governments provide local public goods in a property-value-maximizing fashion, they will choose a spending level such that the marginal benefit of an extra dollar of spending will be exactly offset by the marginal cost of the property taxes needed to finance that spending. Brueckner's (1982) argument is illustrated in Figure 2 for the simplified case where aggregate property values are a single-peaked function of a local public good *g*. A public good level left of the peak signifies underprovision, while a level right of the peak signifies overprovision.

Figure 2: Public Goods and Aggregated Property Values



We subsequently use these considerations to analyze the effect of a tax reform that limits property taxes, as was approved in states such as California, Michigan, and Massachusetts in the 1970s and 1980s. These property tax limits were passed based on the perception that local officials had a tendency to spend more on public services than the residents wanted. According to this logic, the existence of a property tax limit will increase the utility of homeowners if a community, *k*, was indeed overproviding the public good ($\partial P / \partial g_k < 0$). However, if the limit restricts the local government from increasing spending to the optimal level, that is, $\partial P / \partial g_k > 0$, the utility of homeowners is decreased in restricted communities. In this case, restricted communities may realize gains in property values to the degree that they are able to overcome the limits.

B. The Case of Proposition 2½ in Massachusetts

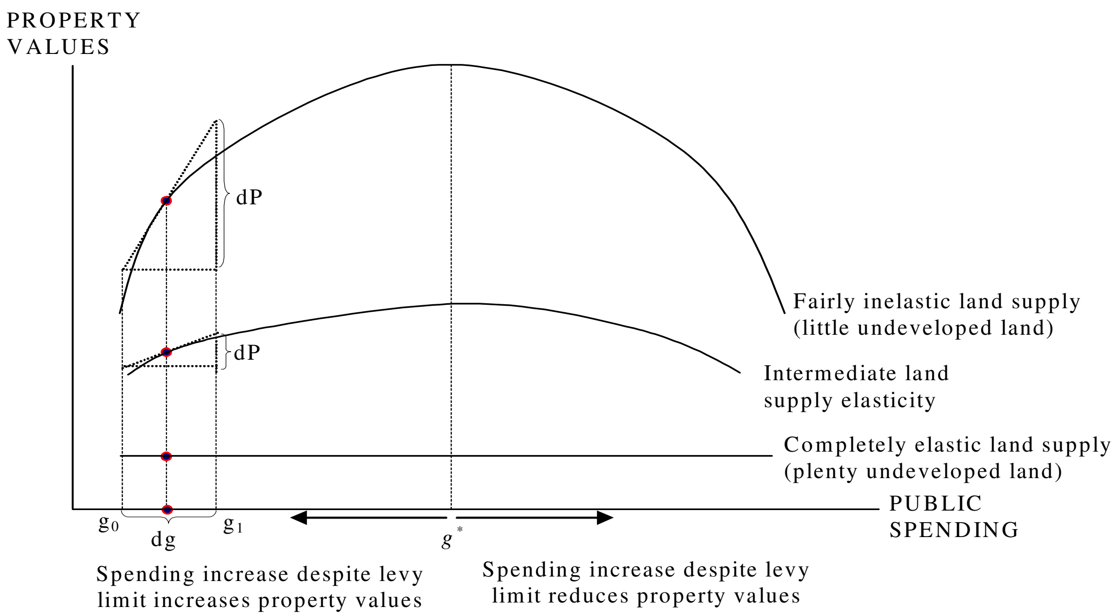
Below, we consider Proposition 2½ in Massachusetts as a specific example of a tax reform that led to an exogenous shock to demand. Proposition 2½ was passed in November 1980. It placed important limits on local municipal spending: 1) effective property tax rates were capped at 2.5 percent and 2) nominal annual growth in property tax revenues was limited to 2.5 percent, unless residents passed a referendum (called an "override") allowing a greater increase. Spending rules under Proposition 2½ applied equally to all cities and towns, yet variations in local conditions at the time of its passage have led the measure to have a very different impact on individual communities.

Bradbury, Mayer, and Case (2001) use this setting to explore the impact of spending changes on housing values, taking advantage of the tax reform to provide instruments that are correlated with local changes in spending, but are unrelated to property values. Between 1990 and 1994—the time period of our analysis—Massachusetts municipalities faced significant fiscal stress because of a 30 percent cut in real state aid and a demographically driven increase in school enrollments. In 1990, 224 out of 351 communities were at their levy limit, so that the only way to increase spending by more than 2.5 percent per year was for residents to pass an override in a general election. An override raises the levy limit for a specific year, and that increase becomes a permanent part of the levy limit, although a small number of communities passed temporary exclusions to pay for certain capital expenditures. Bradbury, Mayer, and Case (2001) have three principal findings: 1) Proposition 2½ significantly constrained local spending in some communities, with most of its impact on school spending, 2) constrained communities realized gains in property values to the degree that they were able to increase school spending despite the limitation, and 3) changes in non-school spending had little impact on property values.

One possible explanation for these findings is that the marginal homebuyer may place a higher value on school spending than the median voter, possibly because homebuyers were more likely to have children in public schools.[14] That communities were able to realize gains in property values to the extent that they were able to increase spending in spite of the limitation suggests that Proposition 2½ caused many communities to spend "too little" on local public education from the perspective of the marginal homebuyer (i.e., local spending levels in Massachusetts over this time period lie to the left of the peak of the curve in Figure 2).

This econometric framework can also be used to test our main hypothesis that the capitalization of fiscal variables and amenities varies across communities. Communities that increase spending despite Proposition 2½ should realize stronger gains in property values if their land supply curve is inelastic rather than elastic. This effect is illustrated in Figure 3.

Figure 3: Land Supply Elasticity and Capitalization



The figure shows the effect of a fiscal shock such as a property tax limit on property values for various degrees of land supply elasticity (completely elastic, intermediate elasticity, fairly inelastic). Consider a specific community that is constrained by Proposition 2½ and can only provide $g_0 < g^*$. The fiscal distortion induced by the property tax limit results in lower property values. If the community increases the public spending level despite the limitation to g_1 it realizes gains in property values. However, the change in property values for a given change in public services depends on the land supply elasticity, as is indicated by the steepness of the three

[14] See Ross and Yinger (2000) for a summary of the literature that considers both a housing market and the market for local public services in a setting with heterogeneous households.

curves.[15] A community with inelastic land supply will have a greater increase in property values than a location with more elastic land supply.

3 Empirical Analysis for Massachusetts

The theory in the preceding section predicts that house prices should change more strongly in response to a demand shock such as a change in spending on local public goods in areas with little available undeveloped land than in areas with plenty of undeveloped land, all else equal. To the extent that increases in spending result in higher house prices, communities with little available land should spend more on schools and, when faced with a public referendum, be more likely to pass an override in order to increase school spending. To test these hypotheses, we turn to data from Massachusetts and look at the impact of Proposition 2½ on property values. In doing so, we expand on the basic empirical framework in Bradbury, Mayer, and Case (2001) using data on local house prices, spending, and new construction from 1990-1994.

This setting has two particular advantages. First, we are able to estimate the impact of government spending on house values using a well-identified methodology. Community characteristics from the date of original passage of Proposition 2½ in 1980 serve as instruments for otherwise endogenous spending changes 10 years later, allowing us to estimate the impact of changes in school spending on house prices. Second, we have very detailed data on land availability in Massachusetts that allows us to directly measure the amount of available land in each community. Below, we show that the amount of available land in a community serves as a good proxy for supply elasticity and that school spending varies with available land as predicted in the previous section.

3.1 Empirical Specification

In order to examine the impact of the house price capitalization on local spending, we estimate the following system of equations:

[15] The price level of the three curves is arbitrary. However, rural communities that have elastic land supply consist of inexpensive farmland while suburban and urban communities with inelastic supply of land typically have scarce amenities and more expensive residential land.

$$\mathbf{\Delta\,price} = \alpha_0 + \alpha_1(\mathbf{\Delta\,supply}) + \alpha_2(\mathbf{\Delta\,spending}) + \alpha_3(\text{demand shifters}) + \varepsilon_{\text{p}} \tag{1}$$

$$\mathbf{\Delta\,supply} = \beta_0 + \beta_1(\mathbf{\Delta\,price}) + \beta_2(\text{supply shifters}) + \varepsilon_{\text{s}} \tag{2}$$

$$\mathbf{\Delta\,spending} = \gamma_0 + \gamma_1(\mathbf{\Delta\,pupils}) + \gamma_2(\%\text{ developed land}) + \gamma_3(\text{spending shifters}) + \varepsilon_{\text{sp}} \tag{3}$$

$$\mathbf{\Delta\,pupils} = \delta_0 + \delta_1(\text{supply shifters}) + \delta_2(\text{demand shifters}) + \delta_3(\text{pupil shifters}) + \varepsilon_{\text{pu}}\,. \tag{4}$$

All of the **bold** variables in equations (1)-(4) are endogenously determined. The demand, supply, spending, and pupil shifters are vectors of variables that will serve as instruments to allow us to separately identify the coefficients in other equations. Thus the exclusion restrictions across these equations are quite important. We discuss these restrictions below.

The direct coefficient of interest is γ_2 in equation (3), which measures how the amount of available land impacts the choice of spending levels across communities. However, we begin by estimating the housing demand and supply equations—equations (1) and (2)—separately for communities with above-median and below-median percentage of undeveloped land. This allows us to directly test the predicates of our model. In particular, we begin with the following two predictions:

<u>Prediction 3A:</u> The coefficients on changes in spending (α_2) and the demand shifters (α_3) in equation (1) will be larger in absolute value in communities with less available land (see Figures 1 and 3).

<u>Prediction 3B:</u> The price elasticity of supply (β_1) in equation (2) will be smaller in places with less available land (see Figure 1).

If the theory in Section 2 is correct, the high extent of house price capitalization of demand variables in Prediction 3A should be driven by a smaller responsiveness of new construction to price in communities with less undeveloped land. Put together, Predictions 3A and 3B suggest that demand shocks in locations with less available land should result in relatively large price changes, but relatively small quantity changes, and vice-versa for locations with more available land.

We derive equation (1) by differencing a standard hedonic house price equation.[16] By examining changes in house prices, we remove the impact of any community attributes that remain unchanged between 1990 and 1994. With a relatively short time period, we assume that most community attributes themselves as well as the coefficients on these community attributes in the standard hedonic price equation remain constant. However, the assumption that local

[16] Bradbury, Mayer, and Case (2001) provide a more detailed explanation of this specification.

attributes are unchanged does not hold for spending changes. In fact, the sample period was chosen because spending on local services varies across places in a systematic manner due to Proposition 2½, which also provides instruments for these spending changes in equation (3).[17] As with Brueckner (1982), we interpret the coefficient on (change in) school spending as the net impact on house prices of spending another dollar on schools (or other public goods), taking into account the taxes necessary to pay for the additional spending.

Equation (1) is estimated using two-stage least squares with the supply shifters from equation (2) and spending shifters from equation (3) as instruments. We measure **Δ supply** as the number of new single-family home permits issued between 1990 and 1994 in each community (measured as a percentage of total housing units) and disaggregate **Δ spending** into two parts, with separate variables for changes in school and non-school spending. Previous research suggests that changes in school and non-school spending can have very different impacts on house prices.

We include three variables as demand shifters in equation (1). All three of these variables are based on previous work which suggests that aggregate shocks in demand can have effects that vary across communities depending on the community's specific attributes (Case and Mayer 1996). For example, the aging of the baby boom and the associated echo baby boom led to an increase in aggregate public school enrollments in Massachusetts since 1990. The resulting increase in the percentage of households who have children in public schools raised the demand for houses in towns with good quality schools relative to communities with poor quality schools. Bradbury, Mayer, and Case (2001) show that the increase in demand for good schools led to rising house prices in communities with good test scores over the 1990-94 time period. Case and Mayer (1996) find the opposite result in an earlier time period when total public school enrollments were falling. Thus we include a measure of test scores as a proxy for differences in school quality across communities. In addition, Case and Mayer show that there was a growing premium associated with being close to downtown Boston as increasing job growth occurred in downtown and the surrounding suburbs along Route 95/128. We include two dummy variables measuring a community's proximity to Boston to control for changes in the value of location.

To test the hypothesis that locations with little available land should have a lower supply elasticity, we examine equation (2). The system of equations provides many instruments for **Δ price**, including the demand shifters, the spending shifters, and the pupil shifters. All of these

[17] Given that we do not have good, time-varying measures of the quality of local services and schools, we cannot

variables impact price changes, directly or indirectly, by shifting demand, but not the supply of new units. The supply shifter in equation (2) is the lagged amount of new construction. We include lagged supply as an indication of the amount of new construction allowed by regulators in various communities. We have also included the amount of available land as an additional supply shifter in the demand equation and our results are unchanged. However, we do not include the land availability measure in our base specification, despite its seeming attractiveness as a supply shifter, because we will split the sample based on this variable when we estimate equations (1) and (2) below.[18]

In assessing the results, notice that our empirical specification looks at changes in house prices over a relatively short 4-year period. To the extent that longer-run supply is more elastic than short-run supply, our empirical work might over-estimate the price effects and underestimate the quantity effects of a given fiscal change in towns with more available land. This will bias us against finding any effect of land availability on capitalization and supply elasticities.

We split the sample into two parts based on the percentage of undeveloped land in each community to examine differential capitalization as in equations (1) and (2). This land availability variable comes from a University of Massachusetts aerial survey of the entire Commonwealth of Massachusetts in 1984. All land is classified into 21 uses. We divide communities based on the percentage of open or undeveloped land, which includes farmland.

One might be concerned that our proxy for land supply elasticity is endogenously determined, so that communities with stricter zoning rules also have more developable land, and vice versa. (That is, some communities may have a lot of undeveloped land, but regulations do not allow new construction on the land.) In this case, one should find empirical evidence that communities with more developable land have a greater extent of house price capitalization. However, as will be demonstrated in the empirical section, exactly the opposite is the case. If land availability is tied to tighter anti-development regulation, it would bias against finding our predicted results.

The reader might also be worried that our measure of land availability might be correlated with other (unobserved) attributes of communities that impact changes in house prices, new construction, or school spending. We address this issue in Section 4 by including various

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include a local production function that estimates the impact of spending changes on service quality.

[18] One might be concerned that the supply shifter is the least reliable of our instruments. The only place where the supply shifter is used separately from other instruments is in equation (1) and these results are unaffected when we examine other specifications, including the removal of the endogenous supply variable altogether.

interactions driven by our model presented in Section 4.1 and also by using alternative measures of land availability. All results are consistent.

Next, we test the proposition that the percentage of developed land—and thereby the extent of capitalization—affects local spending with the following prediction:

Prediction 3C: Communities with less available land will increase spending more in response to constraints under Proposition 2½, which often require communities to cut their spending below the level that would maximize house prices.

For this prediction, we directly examine the impact of land availability separately on school and non-school spending, controlling for local characteristics that might also affect spending as in equation (3). As before, we use the demand shifters, supply shifters, and pupil shifters as instruments for the changes in the number of pupils in the school spending equation. The remaining pupil shifter is the number of children under age 5 in 1990. This variable is correlated with expected demand for changes in school services, but should be unrelated to the availability of resources to fund the schools under Proposition 2½. In the non-school spending equation, we proxy for changes in demand for services with changes in the number of residents instead of changes in the number of pupils, but the instruments remain unchanged.

Proposition 2½ provides a wealth of variables that are correlated with spending changes but uncorrelated with housing supply or demand in the 1990-1994 period. We include these variables as spending shifters. (See Table 4 for the complete list of spending shifters used in the regressions.) Most variables are taken from the early 1980s prior to the passage of Proposition 2½. However, a few variables are taken from the 1990 Census or state revenue data, including median family income, the nonresidential share of housing value, the ratio of school enrollments to population, and equalized property value per-capita. These variables are measures of community resources to support local schools or the political support for the schools. However, one could argue that these variables might not be excludable from the demand equation that uses changes in house prices from 1990-1994 as a dependent variable. Thus when we estimate the house price regression, we include only the 1980 values of these variables as instruments, a time prior to the passage of Proposition 2½. (The results are also little-changed if we exclude these variables entirely.)

Finally, we provide additional evidence on Prediction 3C by running further regressions that limit the sample to communities whose spending levels have reached their cap (the levy limit) under Proposition 2½. This test may be the most directly applicable to the theory because constrained communities must go directly to the voters in order to pass an override Proposition 2½. The dependent variable is the amount of override (conditional on being at the levy limit) and the independent variables are identical to those used in equation (3).

3.2 The Data

The analysis below includes data on house prices, construction, land availability, community characteristics, school indicators, and fiscal measures. These variables are summarized in Table 1. Even during the relatively short 1990-94 time period, communities exhibit substantial variation in many of these variables. For example, although the average community increases school spending by 15 percent, individual towns had much larger positive and sometimes even negative changes in spending.

The house price indexes presented in this paper are obtained from Case, Shiller, and Weiss, Inc. and are estimated using a variation on the weighted repeat sales methodology first presented in Case and Shiller (1987).[19] Given that the indexes involve repeat sales of the same property, they are not affected by the mix of properties sold in a given time period or differences in average housing quality across communities. The sample includes 208 of the 351 cities and towns. Communities were dropped from the sample because they had too few sales to generate reliable indexes. As such, this data limitation might lead us to underestimate the impact of supply elasticity on capitalization. Communities with relatively few transactions that are dropped from the sample are also small, often rural, communities that may have the most available land and thus should exhibit the smallest degree of residential land value capitalization.

3.3 Results

A. Land Supply and Extent of Capitalization

To begin, we estimate equation (1), but split the sample into two equally-sized parts based on the percentage of available developable land. The results—reported in Table 2—are consistent with the prediction that communities with less available land have a greater extent of capitalization. All of the coefficients in the house price equation for communities with little available developable land (column (1)) are larger in absolute value than the coefficients in locations with more available land (column (2)). Of particular interest, the coefficient on changes in school spending is more than three times larger (0.33 versus 0.10) in towns with little available land than in communities with more undeveloped land. In fact, the coefficient for change in school spending is not statistically different from zero in column (2), but is highly statistically significant in column (1). As with Bradbury, Mayer, and Case (2001), the coefficient on changes in non-school spending is not statistically significant in either regression, though it is much larger in the first column than the second one. We find smaller, but qualitatively similar results for the average test score. Good commuting locations—communities in the Boston MSA and in the suburban ring—also became relatively more valuable in communities with little available land. Finally, as expected, price changes with respect to new supply are much larger in developed communities, where much less construction takes place. A test of equality for all of the coefficients on spending and demand shifters in columns (1) and (2) rejects the hypothesis with a p-value of 0.03.

Table 3 examines differences in land supply elasticities between the same two groups of communities. The evidence shows that shocks to demand lead to greater new construction in locations with more available land. The number of single-family home permits is the dependent variable in the supply equations. Columns (1a) and (1b) report direct estimates of land supply elasticities. The coefficient on change in house prices is relatively large and significant at the 5 percent level in locations with more developable land, while it is quite small and not statistically significant in the more developed locations. The test of equality between the coefficients in columns (1a) and (1b) rejects with a p-value of 0.10. Columns (2a) and (2b) include lagged permits to control for other factors that might lead to new construction. The coefficient on change in house prices is about one third larger in locations with more available land, and the test of equality between the coefficients in columns (2a) and (2b) rejects with a p-value of 0.10. In addition, the regression constants suggest that steady-state construction is one-half as large in relatively developed regions.[20]

B. Spending and Override Regression Results

The findings in the previous section suggest that locations with little available land for development respond to demand shocks with relatively larger changes in house prices and

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19 The method uses arithmetic weighting described by Shiller (1991) and is based on recorded sales prices of all properties that pass through the market more than once during the period. The Massachusetts file contains over 135,000 pairs of sales drawn between 1982 and 1995.

20 By way of comparison, the estimated supply elasticities are much lower in this paper than other work that looks at longer time periods. (See Gyourko and Voith 2000, for example.)

smaller changes in new construction. Next, we examine whether spending changes during the 1990-1994 period are related to the availability of developable land. Our prediction is that communities with little available land spend more on public services than communities with plenty of developable land facing a shock to school spending due to Proposition 2½. Basic summary statistics support our prediction. For example, consider communities whose spending is within 0.1 percent of their levy limit in 1990 and who must pass an override in a general election in order to grow spending by more than 2.5 percent. Over one-half of constrained towns with little available land pass an override (57 percent), while only 35 percent of towns with more potentially developable land pass an override.

Table 4 reports regression estimates from the equations for percentage change in school spending and non-school spending between 1990 and 1994 for all communities in our sample, regardless of whether or not the communities are at their levy limit under Proposition 2½. To control for differences in the usage of local services, the school spending regressions include the percent change in number of students as an endogenous variable, while the non-school spending regressions include the percent change in population between 1990 and 1994. We include exogenous variables from the housing demand and supply equations in Tables 2 and 3 as instruments for percent change in pupils or population. Such variables should only impact changes in spending through the change in the number of pupils or households using local schools or other public services. Columns (1) and (2) report the equations with all of the variables described in the data section, a broad set of constraint variables from Proposition 2½, plus the percentage of developed land, the coefficient of interest. Columns (3) and (4) drop the more recent Proposition 2½ and state regulatory variables as potentially endogenous, but the results are virtually unchanged.

As predicted, in the school spending equation (columns 1 and 3) land scarcity has a positive effect on school spending that is statistically significant at the 5 percent level and is quite similar across specifications. The coefficient in column (1) suggests that a community with 10 percent more developed land in 1984 has a 2.4 percent larger increase in education spending.

Other variables perform as expected. Indeed the limitations passed under Proposition 2½ led to lower spending increases in Massachusetts cities and towns more than 10 years after its original passage. Cities and towns that were required to cut revenues for the first two or three years of Proposition 2½ (the communities that faced the largest initial constraints) increased their education spending 9 and 16 percentage points less, respectively, than communities with zero or one year of initial revenue cuts. All of the Proposition 2½ coefficients but one (at levy limit, no overrides) have the anticipated sign, and many variables are statistically different from zero.

The results for non-school spending are quite different compared to the ones for school spending. The coefficient of the land supply elasticity measure is positive but is not statistically different from zero. Only two other constraint variables are individually statistically significant. Communities that had ever passed an override increased spending by 14 percentage points more than other communities. Also, for every 1 percent that a community was required to increase school spending in 1994, non-school spending fell 0.34 percent between 1990 and 1994.

We have several potential explanations why the coefficient of the land supply inelasticity measure may not be statistically different from zero in the non-school estimates. Non-school spending, dominated in most communities by fire and police services and public works such as trash removal, street repair, and snow plowing, may have fewer discretionary items than the school budget. We also conjecture that there are fewer differences between the preferences of the marginal homebuyer and the median voter with regard to these types of services, which are used relatively equally by most groups of residents. In any case, these results are similar to those in Bradbury, Mayer, and Case (2001) in which few variables appear to impact non-school spending. Most of the budget cuts from Proposition 2½ appear to have impacted the school side of the municipal budgets, which is also consistent with the public policy discussion at that time.

Finally, we examine the relationship between land availability and the cumulative amount of overrides (per capita) passed in a community that is at its levy limit between 1990 and 1994. Rather than looking at spending in all communities, here we only examine communities that are constrained by Proposition 2½ and have bumped up against their state-mandated spending (levy) limits. Thus voters must explicitly approve increases in spending above 2½ percent per year in the form of an override. Similar to the spending regressions, we predict that land scarcity (and thereby the extent to which additional spending on schools is capitalized into house values) affects the incentives to vote for an override.

Table 5 presents four different specifications of the amount of overrides approved by voters in communities that were at their levy limit in 1990. Column (1) reports results for the base equation that does not include Proposition 2½ variables. The regression includes the percentage of developed land in 1984—our proxy for land supply inelasticity—plus other local characteristics for 1990 that may affect demand for education. Notice that communities that are at their levy limit are already constrained by Proposition 2½ and there is no necessary reason that these variables should affect incremental spending above the Proposition 2½ limits. Nonetheless, column (2) includes early 1980s Proposition 2½ variables. Column (3) then adds late 1980s Proposition 2½ variables. Finally, column (4) includes endogenous population changes in addition to the 1990 explanatory variables of the base regression.

The coefficient of the measure for land supply inelasticity (percentage developed land) is positive and statistically significant at the 5 percent level (columns (1)-(3)) or at the 10 percent level (column 4). The size of the land scarcity coefficients is quite stable among all equations. In addition to land scarcity, only a few other variables have a statistically significant effect on the cumulative amount of overrides. Given that the impact of overrides is greatest on school spending, it is not surprising that communities with a higher percentage of college-educated adults and a high ratio of school enrollment to total population are also more likely to approve bigger overrides.

4 Empirical Analysis for the National Sample

Section 3 demonstrates a pervasive relationship between land availability and school spending decisions. Below we suggest that this linkage is not limited to Massachusetts' communities that are constrained by Proposition 2½. To consider the applicability of these results in a broader setting, we turn to school district level data that covers most areas of the United States. While we lose the nicely identified setting from Massachusetts under Proposition 2½, we gain a much broader sample that allows us to examine the relationship between land availability and school spending in much more detail. In addition, we are able to better address concerns that land availability might be correlated with other unobserved amenities or community attributes that might explain the increase in school spending in communities with little land available for development.

4.1 Capitalization and School Spending

Previous theoretical research points out that in a frictionless world and in the presence of house value capitalization, voters take into account preferences of eventual buyers of their house (e.g., Wildasin 1979 and Sonstelie and Portney 1980). To the extent that public goods are not fully capitalized,[21] communities may underinvest (left of the peak of the curves in Figure 2 and 3)

[21] Several studies describe the factors that may lead to less than full capitalization or even "overcapitalization." See Hilber (1998) for an overview and a discussion of the impact of these determinants on the extent of capitalization.

because current homeowners have not enough incentives to take into account preferences of future residents (or future generations). Correspondingly, we expect that land availability should affect the extent of house value capitalization and thereby public spending, so long as the median voter is a homeowner.

The intuition behind this prediction is quite straightforward. If additional spending on schools is fully capitalized into higher house values, households might be willing to vote in favor of the spending even though they have no children. This is because these households might sell their houses in the future (possibly to families with children), pocket the proceeds, and move to a community where the public spending is ideal from a pure consumption point of view. Now consider the other extreme case with perfectly elastic land supply and thereby no capitalization. Investments in durable school facilities will attract other households to the community. Yet if land supply is perfectly elastic, house values will not rise, but instead, some previously undeveloped land will be converted to residential use. In this case, households without school-aged children will pay additional taxes without receiving any appreciable benefit. Hence, households that have no children—unless they have interdependent utility functions or are altruistic—will vote against additional spending.

We derive these and other predictions by analyzing the voting decision in a more formal framework. Consider a voter $i \in \{1,...,I\}$ in a local jurisdiction that has the option to vote in favor of or against an investment that aims to provide better local public school services (or any other durable local public service). If the majority of voters opt for the investment, property owners have to pay additional τ_t in each time period $t \in \{1,...,T\}$.[22] Denote voter *i* as an owner-occupant if $\pi_i = 1$; otherwise $\pi_i = 0$.[23] Assume that not all voters have children in school and thus directly benefit from the investment. Define voters with children in school as having $\lambda_i = 1$; otherwise $\lambda_i = 0$. The gross benefit for households that have children in school is assumed to be B_t, otherwise the gross benefit is zero. The discount rate is *r*. Owners of non-residential land, if they are allowed to vote, will be equivalent to homeowners with no children in public schools.[24]

Hoyt (1999) correctly points out that—in the case of overprovision—lack of capitalization may also reduce incentives of homeowners to limit government inefficiency.

22 The model assumes that property taxes are exogenous. That is, the house value that is used to calculate the amount of property taxation is fixed for a longer period of time. Alternatively, one could assume that the house value adjusts each year to the new fiscal environment without substantially changing the analysis.

23 Hence we assume that the homeownership status of the voter is exogenously given.

24 Owners of undeveloped non-residential land can be either residents or non-residents. Residents can vote and will take into account the value of all their land (residential plus undeveloped non-residential land) when they cast

Let us now consider the determination of house prices. The net benefit for the marginal homebuyer *j* may be partially or fully capitalized into house values. If the marginal homebuyer *j* does not have children in school, the net benefit is $b_{jt} = -\tau_t$ and house values will decrease; otherwise, the net benefit is $b_{jt} = B_t - \tau_t$ and house values may increase. The degree of house price capitalization $\theta_n \in [0,1]$ in jurisdiction *n* depends on the land supply elasticity ε_n^S. Places with more inelastic supply of land for residential construction are expected to have a greater extent of capitalization θ_n. The determination of housing rents is very similar. If the marginal new tenant *k* has children in school then $\lambda_k = 1$; otherwise $\lambda_k = 0$. The landlords may increase rents R_t in period *t* by up to the amount of the gross benefit B_t depending on the degree of capitalization θ_n.

Given that the duration in the house $\bar{t}_i$ of the median voter *i=m* is determined exogenously in our simple framework (e.g., based on demographics or conditions on the labor market), the median voter's payoff P_m in time period zero can be expressed as:

$$P_m = \pi_m \left(\sum_{t=1}^{\bar{t}_m} \frac{\lambda_m B_t - \tau_t}{(1+r)^t} + \theta_n \sum_{t=\bar{t}_m}^{T} \frac{\lambda_j B_t - \tau_t}{(1+r)^t} \right) + (1-\pi_m) \left(\lambda_m \sum_{t=1}^{\bar{t}_m} \frac{B_t}{(1+r)^t} - \theta_n \lambda_k \sum_{t=1}^{\bar{t}_m} \frac{B_t}{(1+r)^t} \right) \tag{5}$$

If $P_m > 0$ the local government will invest in better school services; otherwise school services and property tax rates remain unchanged.

The median voter's payoff is composed of a direct effect (net benefit of investment) and an indirect effect (capitalization effect). Whether it is advantageous for the median voter to invest depends on several factors: (a) the homeownership-status of the median voter, (b) the net benefit of the investment for the median voter, (c) the net benefit of the investment for the marginal homebuyer (or renter), (d) the extent of capitalization, and (e) the likelihood of relocation of the median voter.

This simple analytical framework generates several theoretical predictions. If the median voter is a renter with no children in school, the probability that he or she opts for the investment is zero because the payoff is always negative. This is likely to be true in most renter-dominated communities in the US, as the majority of renters do not have school-aged children. In this case

their votes. Non-resident landowners cannot directly affect local voting outcomes and are therefore probably less relevant for political decisions on investments in local public schools or other local public goods.

the extent of capitalization should not affect the probability that the median voter opts for the investment.[25]

Now consider a community where the median voter is an owner-occupant. In such a community, households with children in school typically will vote in favor of better school services. However, households with children very often do not have a majority. In this case, the payoff of elderly households may be decisive. One particular characteristic of elderly households is that they are likely to have a relatively short expected duration in their property (i.e., they have a small $\overline{t_i}$). Elderly households are aware that their house will likely be sold sooner rather than later. Equation (6) expresses the payoff of an elderly owner-occupant (or any other homeowner without children in the public school):

$$P_m = \left(\sum_{t=1}^{\overline{t}_m} \frac{-\tau_t}{(1+r)^t} + \theta_n \sum_{t=\overline{t}_m}^{T} \frac{\lambda_j B_t - \tau_t}{(1+r)^t} \right) \tag{6}$$

Equation (6) implies that elderly homeowners are more likely to support better schools if they live in a place with a greater degree of house price capitalization. In addition, the link between the extent of capitalization and school spending increases with the likelihood that the house is sold sooner rather than later, so that the older the head of the elderly household, the more likely that household should be willing to support the investment as long as the marginal homebuyer has children who will attend public schools. We examine these predictions in the empirical work below.

4.2 Empirical Specification

Our basic estimating equation for school expenditures per pupil is as follows:

$$\begin{aligned} \text{spending per pupil} = \quad & \pi_0 + \pi_1(\text{\% developed land}) + \pi_2(\text{local characteristics}) \\ & + \pi_3(\text{school characteristics}) + \pi_4(\text{state and federal revenue}) \\ & + \pi_5(\text{state}) + \varepsilon. \end{aligned} \tag{7}$$

Dollar denominated variables such as total school spending per pupil and household income are measured in logs. In addition to land scarcity we add other local and school characteristics to control for additional factors that may explain school spending, including cost variables, household income, the educational and demographic background of residents, and

[25] If the median voter is a renter with children in school, there are conditions under which it is beneficial to invest in better schools. In this case, the likelihood that the median voter opts in favor of the school improvement

state-specific effects. Also, we include several measures of racial differences and income inequality in a community that have been shown by other authors to help explain variability in school spending across communities. The first variable measures differences in racial composition between the elderly and school-aged children and is quite similar to a variable used in Poterba (1997). The variable is defined as percentage of non-whites among children aged 5-19 minus the percentage of non-white elderly among total elderly. Its value increases when there are relatively more white elderly than non-white children, which Poterba demonstrates is negatively related to school spending at the state level. Second, ethnic fractionalization, measures the probability that two persons drawn randomly from the population belong to different self-identified ethnic groups (white, black, American Indian, Asian, Hispanic, and other) and is shown by Alesina et al. (1999) to be negatively related to the school share of total municipal spending and positively related to overall municipal spending levels. We also include the Gini coefficient as a measure of income inequality within each community. Finally, we control for revenue received from state and federal sources.

While the Massachusetts spending regressions have a quasi-experimental design, the national regressions examine overall per pupil spending levels and presume that most communities in the sample are at or near their desired spending. The model in Section 4.1 suggests that desired spending (by the median voter) may itself be a function of the extent of capitalization. In this case, we examine whether the percentage developed land in a school district, our proxy for the extent of capitalization, is correlated with increased school spending.

Given the possibility that land availability might also be related to other community factors that are unrelated to land supply, we use theoretical predictions from the model in the previous section that should be specifically driven by a land supply effect, including:

Prediction 4A: School spending will be positively related to the percentage developed land, our proxy for the extent of house price capitalization.

Prediction 4B: The effect of the percentage developed land on school spending should increase with the homeownership rate of a community, as renters do not benefit from capitalization of school spending into house prices.

Prediction 4C: Owners without children in public schools, such as the elderly, are willing to support educational services if they have a relatively short time horizon in their property and the extent of capitalization is high.

decreases with the extent of capitalization into rents.

Prediction 4C1: The interaction between percentage developed land and percentage elderly residents will be positive.

Prediction 4C2: The positive relationship between percent elderly and percentage developed land should be larger for older elderly residents who have a shorter expected duration in their property.

Prediction 4C3: The percentage elderly will be associated with higher spending levels only in large cities and suburbs where land for new supply is particularly scarce.

4.3 The Data

The data used in the analysis below are drawn from the School District Data Book (SDDB) collected by the U.S. Department of Education for the school year 1989/90 and from the National Land Cover Data 1992 (NLCD 92). The SDDB provides data on a large number of school districts that includes total expenditures per pupil, cost variables (such as the percentage of children below the poverty line, the percentage of children that "speak English not well," or the percentage of children "at risk"[26]), the school district type, and the number of schools within a district. The SDDB also includes data from the 1990 U.S. Census that are geographically matched to the school district level. In particular, this data set includes the percentage of households with children, homeownership rate, median household income, college educated adults, age, race, and racial composition of various age categories.

The land availability data are derived from the NLCD 92, a 21-category land cover classification scheme that has been applied consistently over the conterminous U.S. (48 states excluding Alaska and Hawaii). The classification is provided as raster data with a spatial resolution of 30 meters derived from satellite photos mostly acquired from 1991 to 1993. The Wharton GIS Lab geographically matched the raster data to the school district level boundaries in order to provide us with our final land availability measure. The 'percentage developed land' for each school district is calculated as the ratio of developed residential land to total developable non-industrial land.[27]

[26] A child, 6 to 19 years of age, is defined "at risk" if the child is not a high school graduate and lives with a mother who is not a high school graduate, or who is divorced or separated, and whose income is below the 1989 poverty level.

[27] Land is considered non-developable if it classified as open water, perennial ice, barren, or wetland. We exclude land developed for industrial purpose, both, from the numerator and the denominator, thereby eliminating the distorting influence of industrial land use. We also ran the complete set of regressions using a 'percentage developed measure' that includes developed industrial land in the numerator and denominator. Results remain virtually unchanged and all interaction effects remain statistically significant at least at the 5 percent level.

We exclude extremely small school districts as well as school districts with implausibly low or high total expenditures per pupil.[28] Furthermore, not all school districts report total school expenditures or certain school specific characteristics. After dropping data from districts with missing values, we have a sample of 12,274 school agencies. Table 6 reports summary statistics for the variables that are included in the analysis below.

4.4 Results

To begin, we examine Prediction 4A; everything else equal, school districts with less available land for new development will have greater total expenditures per pupil. Table 7 reports estimates for total per pupil school spending as in equation (7). Column (1) reports the results for the base equation that includes the percentage developed land as proxy for land supply inelasticity. The percentage developed land is strongly and positively related to school spending, even when controlling for household income, the educational and demographic background of residents, cost variables, school agency specific characteristics, and ethnic factors. The coefficient on percentage developed land is both statistically and economically significant. Table 8 presents quantitative effects for two hypothetical school districts: a less developed school district at the 75th percentile (with 7% of all developable non-industrial land used for residential purposes) and a more developed school district at the 95th percentile (with 70% of developable non-industrial land used for residential purposes). The coefficients suggest that the more developed school district will spend about 9.7% more on schools than the less developed district. This is equivalent to $497 per pupil at the sample mean per pupil spending of $5,115.

Overall, most of the other control variables have the expected effect on school spending and are reported in the Appendix Table. In particular, cost variables such as the percentage of children below the poverty line or who speak English "not well" are positively related to school expenditures, while increases in the number of schools within a school district are associated with lower spending (at a decreasing rate), presumably due to beneficial economies of scale. School spending increases with the percentage of residents with a college education. The median household income and ethnic polarization have no statistically significant effect on school

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[28] We exclude the 5 percent smallest school districts, that is, school districts that have less than 70 students, as the cost of providing education for such a small number of students is likely to differ substantially from the costs faced by the vast majority of districts in the country. Our results are substantively unchanged if we include these small districts. Furthermore, we exclude school districts that report total expenditures per pupil below $1,000 and above $20,000.

spending.[29] Also, local districts increase total spending by only about 2.5 percent of the revenue received from state and federal sources.

The results in column (2) of Table 7 support Prediction 4B in that the relationship between percentage developed land and school spending is tied to homeownership. When we interact the homeownership rate of the community with percentage developed land, the coefficient on the interaction is positive and significant at the 5 percent level, while the coefficient on percentage developed land is no longer statistically significant. We use the overall homeownership rate in the interaction since it is not possible to observe the attributes of the median voter in each community.[30] These results support Prediction 4B and suggest that the positive relationship between percentage developed land and spending only exists in communities where residents are more likely to be homeowners. Note that the coefficient on homeownership is also positive, but that several other theories predict that communities with high homeownership rates might spend more on schools. For example, owners can deduct property taxes from their federal tax returns. However, such theories are not tied to land availability. According to Table 8 (Row 2), a one standard deviation increase (10.6 percentage-points) in the homeownership rate is associated with a much larger increase in spending in the more developed district (+3.4 percent increase) than in the less developed place (+1.3 percent), which is in line with the predictions of our model in Section 4.1.

Next, in columns (3) to (5) we confirm that elderly residents who do not use school services but have a shorter expected duration in their house appear to be positively related with high school spending in more developed school districts.[31] We interact percent elderly with percentage developed land for elderly residents aged 65 and above, 75 and above, and 85 and above. Predictions 4C1 and 4C2 suggest that the interactions will be positive and increase in size for the older elderly residents who have an even shorter expected duration in their property. In all three columns, the interaction between percent elderly and percentage developed is positive

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[29] The coefficient on ethnic polarization is not inconsistent with Alesina et al. (1999), who find that ethnic polarization is negatively related to the school share of total spending at the city level, but positively related to overall spending. Their model has an ambiguous prediction about the impact of ethnic polarization on the overall level of school spending.

[30] Alternatively, if we include a dummy variable for districts in which the homeownership exceeds fifty percent, our conclusions remain unchanged. That is, the coefficient on the interaction between communities with a homeownership rate greater than fifty percent and percentage developed land is strongly positive and statistically significant, while the coefficient on percentage developed land is no longer significant (results are available from the authors, upon request).

[31] Sinai and Souleles (2001) use a similar strategy to show that rent volatility reduces the likelihood of homeownership, demonstrating that elderly residents who are likely to be especially sensitive to rent risk are more likely to be homeowners in places with a higher volatility of rents.

and statistically significant at the 98 percent level or above. Furthermore, as expected, the size of the coefficient on this interaction rises with the age we use for the definition of percent elderly. Consistent with previous papers, the direct effect of percent elderly is always negative, although statistically insignificant. Table 8 shows that increases in percent elderly are associated with more school spending in a school district with little available land for new development, but with decreases in spending in a district with plenty of open land.

As noted earlier, one possible concern might be that land availability, our preferred measure for land supply elasticity, is related to other factors that affect school spending. We therefore use two alternative measures that proxy for land supply elasticity. The first measure is population density. While this variable is more easily available than the land availability measure, it may be a less good proxy because cross-sectional differences in commercial development and regulation could weaken the relationship between potential new supply and population density. In an earlier version of this paper we reported the complete set of regression results using population density as a proxy measure for land supply inelasticity. Consistent with our theory, quantitative effects reported in Table 8 and significance levels are slightly smaller when using population density instead of the percentage developed measure. However, all reported results are qualitatively the same as the ones reported in Table 7.

Table 9 takes our predictions one step further. All of the equations in this section use land availability to proxy the elasticity of supply. As an alternative, we use information about the types of locations, dividing communities into seven types, including central city of large MSA (population over 1 million in MSA), suburb of central city in large MSA, central city of medium-sized MSA (MSA population between 250,000 and 1 million), suburb in medium-sized MSA, central city of small MSA (MSA population below 250,000), suburbs of small MSA, and non-MSA locations. According to the summary statistics in Table 6, over one-half of the districts in our sample are in the last category; that is they do not serve an MSA. Prediction 4C3 proposes that percent elderly should only matter in places where new land is relatively difficult to obtain, which we would generally expect to occur in the largest MSAs, but not in smaller MSAs. Table 9 includes location type dummy variables as well as interactions between percent elderly and each of the location types. Notice that in most cases, central cities of large MSAs and suburbs of large MSAs have higher spending on a per pupil basis than all other district types, even after controlling for all other covariates included in the regressions in Table 7.

Consistent with our earlier results, and Prediction 4C3, the interaction between percent elderly and community type is positive and statistically significant at the 99 percent level in the large MSAs, both the central cities and suburbs, but negative in all other locations, including medium and small MSAs, as well as non-MSA locations.[32] These results hold whether we drop the percentage developed land (column 1) or include this variable (column 2), or even include the interaction between homeownership and percentage developed land in column (3). Interestingly, the coefficients on percentage developed land, homeownership, and their interaction are very similar to those in Table 7, column (3), which excludes all of the elderly interactions. Thus, even within these different types of districts, we still find a strong positive correlation between school spending and the interaction of homeownership and percentage developed land.

Finally, we examine the possibility that our results might be driven by the exclusion of crime data. In particular, some have suggested that elderly households or homeowners might be willing to spend more money on schools if it reduced the crime rate in their community and the crime rate might well be correlated with density or the percentage developed land. To examine this hypothesis, we obtain crime rates at the zip code level in as many jurisdictions as possible from the FBI.[33] Crime data is considerably more problematic than other variables because not all jurisdictions report crime data and jurisdictions vary in scope both for school districts and police forces. For example, some communities have local schools, but their crime rates are only reported at the county level. Given the difficulties of using disaggregated crime statistics that are unlikely to be accurate for particular locations, we only consider school districts where the crime data are reported at the city level or below. These exclusions decrease our sample by one-third, leaving us with 7,979 remaining school agencies. Empirically, the greatest loss of observations is for rural places without their own police forces.[34]

The regressions show that the inclusion of crime rates or crime rates interacted with the homeownership rate or percent elderly has virtually no effect on the coefficients on percentage developed land or on the percentage developed land interactions. While the percentage

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[32] The implication that fiscal variables and amenities are capitalized to a greater extent in highly urbanized areas is consistent with the fact that many central cities in the U.S. are declining. Due to the durability of the housing stock, housing supply is quite inelastic during economic downturns (see Glaeser and Gyourko 2001).

[33] The crime data come from U.S. Dept. of Justice, Federal Bureau of Investigation. Uniform Crime Reporting Program Data: United States—Offenses Known and Clearances by Arrest, 1990, compiled by the U.S. Dept. of Justice, Federal Bureau of Investigation. ICPSR ed. Ann Arbor, MI: Inter-university Consortium for Political and Social Research (producer and distributor), 1997. We also used zip code information from ESRI Inc. and Geographic Data Technology, Inc. to help match the crime data with the school agency information.

[34] All of the results with crime rates are similar if we apply county-level crime rates to individual agencies, although we believe this approach to be less accurate.

developed land coefficient is slightly smaller than in our total sample, possibly because we have to remove many smaller places, it is always statistically significant. For example, when we include murder rate and the murder rate interacted with the homeownership rate or the percent elderly, the coefficients on percentage developed land and the interaction terms between percentage developed land and homeownership or the elderly are either unchanged, or are slightly larger in magnitude. The coefficient on the murder rate itself is positive and statistically significant at the 90 percent level; suggesting that locations with higher crime rates spend more on schools, but the coefficient on the interaction between elderly and murder rate or homeownership and murder rate is negative and marginally statistically significant. Our findings with regard to percentage developed land and its interactions are unchanged if we use all crimes and crimes committed by juveniles instead of the murder rate.

5 Conclusion

In this paper we present theoretical predictions and supporting empirical work showing that school spending depends on the extent of house price capitalization within a community or school district, and that the extent of capitalization itself is tied to the supply of available developable land. In particular, we argue that capitalization of fiscal variables and amenities should be especially high in developed areas where there is little available land for new construction and capitalization should be quite low in locations where land is more readily available. Hence, localities with little available land should spend more on local public goods such as schools if this spending is capitalized into house values.

We examine these theoretical predictions using two alternative data sources. First, we take advantage of a unique shock to local spending, Proposition 2½ in Massachusetts. Consistent with the theory, we find that fiscal variables and amenities are capitalized to a much greater extent in towns with little available land, and confirm that these locations have a lower elasticity of land supply. We then show that these communities also spend more on schools and voters in these cities and towns are more likely to pass spending overrides in order to undertake new spending.

Next we examine school spending data for the school year 1989-1990 from 48 states and show that per pupil spending is higher in school districts with less available land. The estimates are quite large. For example, a community with 70 percent developed land spends \$497 (9.7 percent) more per pupil than a town with 7 percent developed land. The estimated positive relationship between percentage developed land and spending becomes larger in places with high homeownership rates. Finally, we demonstrate that elderly voters are not necessarily averse to public school spending. A higher percentage of elderly voters in more developed locations is correlated with increased spending on schools, but more elderly residents in undeveloped (rural) areas are associated with unchanged or even lower school spending levels. The correlation between spending and the interaction of percent elderly and percentage developed becomes larger when one examines older elderly citizens who have a shorter expected duration in their house.

These findings raise questions about the future of school spending in the U.S. A number of authors (see Poterba 1998, for example) have speculated that the coming increase in percentage of elderly voters might prove problematic for programs such as education that depend on the support of an increasing percentage of households who do not use this service.[35] Our results suggest that an increasing percentage of elderly voters does not necessarily portend lower school spending in all locations, especially more developed places. However, projecting these results into the future relies heavily on the assumption that the marginal homebuyer will continue to value public schools in most communities. If the increased number of elderly voters leads to greater Tiebout sorting, then the prognosis of future school spending reductions, at least at the municipal level, might not be a problem in some communities with more young households. However, even if the elderly sort at the local level, support for state-level spending on schools might still be stymied. Additional research on the link between overall demographics, school spending reforms, and household mobility is needed to help disentangle these issues.

More generally, these results support models in which house prices encourage the efficient provision of public services. In this regard, the fact that voters care about the preferences of future generations of (marginal) homebuyers provides positive incentives to provide a variety of services that may be consumed by only a minority of current residents. It also discourages communities from financing their services by imposing burdens on future generations of residents or home buyers.

[35] Poterba (1998) notes that house price capitalization might serve as a counterweight to his projection that an increasing percentage of elderly voters would be associated with strong reductions in real school spending.

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Summary Statistics and Regression Tables

Table 1
Variable List and Means
N=208

Variable	Mean	Standard Deviation	Minimum	Maximum
Endogenous Variables:				
Percent change in house prices, FY1990-94	-.077	.057	-.208	.071
Percent change in school spending, FY1990-94	.15	.09	-.15	.54
Percent change in non-school spending, FY1990-94	.083	.158	-.323	.680
Single family permits, 1990-94, per 1990 housing unit	.046	.038	.001	.230
Fiscal Variables:				
Effective property tax rate, FY1980	.031	.009	.012	.086
Dummy, one year of initial levy reductions, FY1982	.46	.50	0	1
Dummy, two years of initial levy reductions, FY1982-83	.12	.32	0	1
Dummy, three years of initial levy reductions, FY1982-84	.034	.181	0	1
Excess capacity as percentage of levy limit, FY1989	.018	.036	1.1e-7	.20
Dummy variable, at levy limit and no overrides, FY1989*	.44	.50	0	1
Dummy variable, passed override(s) prior to FY1990	.11	.31	0	1
Dummy variable, "unconstrained" in FY1989*	.46	.50	0	1
Equalized property value per capita, 1980 (000)	16.4	6.2	6.3	44.1
Nonresidential share of property value, FY1980	.19	.09	.04	.60
Percentage of revenue from state aid, FY1984	.26	.10	.05	.52
Percentage of revenue from state aid, FY1981	.19	.08	.05	.43
Percentage increase in state aid, FY1981-84	.43	.31	-.44	3.38
Community Characteristics:				
School test scores, 1990*	2690	168	2160	3080
Fraction of 1980 population under age 5	.062	.013	.032	.11
Fraction of 1990 population over age 65	.13	.034	.027	.22
Dummy variable, in Boston metro area (PMSA)	.45	.50	0	1
Dummy variable, in Boston suburban ring*	.19	.40	0	1
Fraction developed land in community, 1984*	.88	.054	.74	.97
Single family permits per 1990 housing unit, 1989	.008	.007	.000	.038
Enrollment/population ratio, 1981	.20	.04	.08	.42
Median family income, 1980 (000)	21.0	5.6	11.5	47.6
Dummy variable, member of regional district	.26	.44	0	1
Dummy variable, member of regional high school	.19	.39	0	1
Percent of adult residents with college education, 1980	.20	.12	.05	.60

Notes, marked with asterisks:
"At levy limit" is defined as levy within 0.1 percent of levy limit.
"Unconstrained" communities are not at levy limit in FY1989 and have passed no overrides prior to FY1990.
School test scores is combined math and reading MEAP test score for 8th graders in 1990.
Boston suburban ring is defined as within MSA but outside PMSA.
Developable land is defined as open land (including farmland) or public land.
Sources: Massachusetts Department of Education; Massachusetts Department of Revenue, Division of Local Services, Municipal Data Bank; U.S. Department of Commerce, Bureau of the Census.

Table 2
House Price Regression Results Using Land Scarcity and Density as Proxies for Land Supply Elasticity
Dependent Variable: Percent Change in House Prices, Fiscal Years 1990-1994

Specification	Sample divided by percentage of open and public (developable) land	
Explanatory Variable	Less Developable Land (1)	More Developable Land (2)
Single family permits, 1990-1994, per 1990 housing units	-.70 ** (.22)	-.11 (.17)
Percent change in school spending, FY 1990-94	.33 ** (.12)	.099 (.11)
Percent change in non-school spending, FY 1990-94	.075 (.086)	.017 (.061)
Combined math and reading MEAP test score, 8th grade students, 1990 (x 10^3)	.14 ** (.029)	.11 ** (.031)
Dummy variable, in Boston metro area	.097 ** (.012)	.074 ** (.011)
Dummy variable, in Boston suburban ring	.11 ** (.022)	.036 ** (.0091)
Constant	-.55 ** (.077)	-.43 ** (.078)
Number of observations	104	104

Notes: Numbers in parentheses are robust standard errors. * Significantly different from zero with 90 percent confidence. ** Significantly different from zero with 95 percent confidence. **Bold** variables are endogenous. Instruments in column (1) and (2) are: lagged permits in 1989 per 1990 housing units, effective tax rate in 1980, equalized property value per capita 1980, enrollment per population 1981, median family income 1980, percentage of revenue from state aid 1981, non residential share of property value 1980, percentage of adults with a college degree 1980, percentage increase in state aid 1981-1984, dummies for regional school district or high school, dummy variables for the number of years required to reduce spending due to Proposition 2½, percentage of population less than 5 years old 1990. An F-test of equality between the coefficients of the spending variables and demand shifters in columns (1) and (2) rejects with a p-value of 0.026.

Table 3
Land Supply Elasticity Regression Results
Dependent Variable: Single Family Permits, 1990-1994, per 1990 Housing Units
Sample divided by percentage of open and public (undeveloped) land in each community

Specification	Base set of instruments (without lagged supply as exogenous variable)		Base set of instruments (with lagged supply as exogenous variable)	
Explanatory Variable	Less Developable Land (1a)	More Developable Land (1b)	Less Developable Land (2a)	More Developable Land (2b)
Percentage change in house prices, 1990-1994	.014	.16 **	.13 **	.18 **
	(.055)	(.079)	(.038)	(.046)
Single family permits, 1989, per 1990 housing units			4.9 **	3.6 **
			(.44)	(.43)
Constant	.043 **	.064 **	.017 **	.032 **
	(.0056)	(.0086)	(.0050)	(.0061)
Number of observations	104	104	104	104

Notes: Numbers in parentheses are robust standard errors. * Significantly different from zero with 90 percent confidence. ** Significantly different from zero with 95 percent confidence. **Bold** variable is endogenous. The instruments are all of the exogenous variables in the demand equation in Table 2 (i.e., combined math and reading MEAP test scores, dummy variable in Boston metro area, and dummy variable in Boston suburban ring), the percentage of population less than 5 years old in 1990 plus the following spending shifter-instruments from the demand equation in Table 2: effective tax rate in 1980, equalized property value per capita 1980, enrollment per population 1981, median family income 1980, percentage of revenue from state aid 1981, non residential share of property value 1980, percentage of adults with a college degree 1980, percentage increase in state aid 1981-1984, dummies for regional school district or high school, dummy variables for the number of years required to reduce spending due to Proposition 2½.

Table 4
Spending Regression Results for Massachusetts
Dependent Variable: Percent Change in School or Non-School Spending, Fiscal Years 1990-94

Explanatory Variable	School Spending (1)		Non-school Spending (2)		School Spending (3)		Non-school Spending (4)	
Percentage of developed land in 1984	.24	**	.24		.25	**	.29	
	(.12)		(.18)		(.12)		(.20)	
Percent change in number of students, 1990-94	.74	**			.77	**		
	(.17)				(.16)			
Percent change in population, 1990-94			1.2	**			1.1	*
			(.61)				(.63)	
Equalized property value per capita, FY1990 ($x10^{-7}$)	7.4		4.5		8.2		10.0	
	(5.0)		(7.4)		(5.6)		(7.5)	
Ratio, enrollment to population, FY1990	.59	**	-.42		.70	**	-.20	
	(.29)		(.44)		(.28)		(.45)	
Median family income (in ‘000), 1990	-.0029	**	-.00033		-.0034	**	-.00010	
	(.0012)		(.0020)		(.0013)		(.0020)	
Percentage of revenue from state aid, FY1984	.26	**	.025		.26	**	-.13	
	(.10)		(.22)		(.099)		(.20)	
Percentage increase in state aid, FY1981-84	-.0094		.033		-.00015		.055	*
	(.15)		(.029)		(.013)		(.030)	
Nonresidential share of property value, FY1990	.015		-.0093		-.025		-.057	
	(.076)		(.12)		(.079)		(.13)	
Dummy variable: member of regional school district	.053	**	-.027		.053	**	-.058	
	(.027)		(.073)		(.026)		(.066)	
Dummy variable: member of regional high school	-.019		-.014		-.021		.026	
	(.025)		(.069)		(.025)		(.064)	
Percent of adult residents with college education, 1990	.18	*	-.12		.18	*	-.058	
	(.097)		(.17)		(.10)		(.19)	
Effective property tax rate, FY1980	1.7		-1.4		2.4	**	-.32	
	(1.1)		(2.2)		(1.1)		(2.0)	
Dummy variable, required one year of initial levy reductions, FY1982	-.013		.022		-.021		.012	
	(.014)		(.030)		(.014)		(.031)	
Dummy variable, required two years of initial levy reductions, FY1982-83	-.088	**	-.015		-.094	**	-.013	
	(.028)		(.048)		(.030)		(.046)	
Dummy variable, required three years of initial levy reductions, FY1982-84	-.16	**	.051		-.17	**	.042	
	(.051)		(.072)		(.049)		(.073)	
Excess spending per pupil (required>actual spending), FY1994	.0070		-.34	**				
	(.083)		(.17)					
Excess capacity as a percentage of levy limit, FY1989	.43		-.11					
	(.30)		(.32)					
Dummy variable, at levy limit and no overrides, FY1989	.045	**	.046	*				
	(.017)		(.027)					
Dummy variable, passed override(s) prior to FY1990	.058	**	.14	**				
	(.020)		(.034)					
Constant	-.33	**	-.055		-.31	**	-.18	
	(.13)		(.20)		(.13)		(.21)	
Adjusted R-squared	.15		.22		.081		.12	
Number of observations	208		208		208		208	

Notes: Numbers in parentheses are standard errors. * Significantly different from zero with 90 percent confidence. ** Significantly different from zero with 95 percent confidence. **Bold** variables are endogenous. Spending equations (1) and (2) include fiscal variables from the early 1980s, Proposition 2½ variables from 1989, and the excess spending per pupil in 1994 (required>actual spending). Spending equations (3) and (4) include fiscal variables from 1990 and early Proposition 2½ variables. Instruments include the demand shifters from the demand equation in Table 2 (i.e., the combined math and reading MEAP test scores and dummy variables for the Boston metro area and the suburban ring) plus the quantity and pupil shifters (i.e., the lagged permits in 1989 per 1990 housing units and the percentage of population less than 5 years old in 1990).

Table 5
Override Regression Results Including Percentage of Developed Land As Independent Variable
Dependent Variable: Cumulative Amount of Overrides Passed in a Community per Capita, FY 1990-1994

Explanatory Variable	OLS Base Equation (1)		OLS Base Equation Plus Early 80s Prop. 2½ Var. (2)		OLS Base Equation Plus Late 80s Prop. 2½ Var. (3)		2SLS Endogenous Population Change (4)	
Percent change in population, 1990-94							-296.3	**
							(144.0)	
Percentage of developed land in 1984	106.1	**	117.5	**	118.0	**	75.2	*
	(47.6)		(52.0)		(52.8)		(46.5)	
Equalized property value per capita, FY1990 ($x10^{-3}$)	.45		.38		.33		.51	*
	(.32)		(.34)		(.32)		(.29)	
Ratio, enrollment to population, FY1990	192.1	*	167.9		126.6		261.2	**
	(114.4)		(117.9)		(112.9)		(120.2)	
Median family income (in '000), 1990	-.48		-.41		-.33		.41	
	(.66)		(.67)		(.67)		(.75)	
Percentage of revenue from state aid, FY1984	71.2		68.3		67.7		54.9	
	(54.4)		(51.3)		(47.8)		(52.5)	
Percentage increase in state aid, FY1981-84	6.2		7.7		2.3		10.5	
	(17.0)		(17.9)		(16.5)		(16.4)	
Nonresidential share of property value, FY1990	-72.7	*	-59.3		-46.1		-107.1	**
	(42.3)		(43.2)		(44.6)		(42.8)	
Dummy variable, member of regional school district	9.3		5.8		6.1		18.4	
	(19.3)		(19.5)		(17.9)		(18.8)	
Dummy variable, member of regional high school	7.2		9.6		7.9		4.6	
	(17.5)		(17.9)		(17.5)		(17.0)	
Percent of adult residents with college education, 1990	168.2	**	166.7	**	156.5	**	95.0	
	(67.9)		(68.2)		(71.2)		(68.8)	
Effective property tax rate, FY1980			-159.7		-102.8			
			(556.5)		(566.0)			
Dummy variable, required one year of initial levy reductions, FY1982			-7.7		-6.4			
			(8.2)		(8.8)			
Dummy variable, required two years of initial levy reductions, FY1982-83			-.10		-3.1			
			(13.4)		(14.6)			
Dummy variable, required three years of initial levy reductions, FY1982-84			-12.2		-14.0			
			(18.7)		(19.8)			
Excess spending per pupil (required>actual spending), FY1994					5.5			
					(29.8)			
Excess capacity as a percentage of levy limit, FY1989					-1.6			
					(260.6)			
Dummy variable, at levy limit and no overrides, FY1989					4.0			
					(8.2)			
Dummy variable, passed override(s) prior to FY1990					27.0	**		
					(13.4)			
Constant	-160.8	**	-158.1	**	-156.8	**	-154.0	**
	(52.0)		(54.7)		(52.8)		(51.3)	
Adjusted R-squared	.42		.43		.46		.45	
Number of observations	155		155		155		155	

Notes: Numbers in parentheses are standard errors. * Significantly different from zero with 90 percent confidence. ** Significantly different from zero with 95 percent confidence. Regressions include only communities that are at their levy limit. Equation (1) is base equation. Equation (2) additionally includes early 1980s Proposition 2½ variables. Equation (3) additionally includes late 1980s Proposition 2½ variables. Equation (4) includes endogenous population changes. **Bold** variable is endogenous. Instruments include the demand shifters from the demand equation in Table 2 (i.e., the combined math and reading MEAP test scores and dummy variables for the Boston metro area and the suburban ring) plus the quantity and pupil shifters (i.e., the lagged permits in 1989 per 1990 housing units and the percentage of population less than 5 years old in 1990).

Table 6
Variable List and Means of National School District-Level Sample
N=12,274

Variable	Mean	Std. Dev.	Min.	Max.
Spending and Revenue Variables of School Districts:				
Total expenditures per pupil, SY 89/90	5,115	1,952	1,176	19,682
State and federal revenue per pupil, SY 89/90	2,432	1,152	26	14,993
Characteristics of School District, School Year 89/90:				
Developed residential land as percentage of total developable non-industrial land, 1991-1993	0.11	0.22	0	1
Number of schools in school agency	6.2	16.6	1	998
Agency is independent local school district	0.90	0.30	0	1
Agency is union component local school district	0.094	0.29	0	1
Agency is supervisory union administrative center	0.0024	0.049	0	1
Agency is regional education service agency (omitted)	0.00033	0.018	0	1
Percentage students enrolled in special education school	0.0010	0.0098	0	0.45
Percentage students enrolled in vocational schools	0.00057	0.0091	0	0.29
Percentage students enrolled in other/alternative school	0.00094	0.011	0	0.60
Percentage children speak English not well	0.010	0.023	0	0.36
Percentage children below poverty line	0.17	0.12	0	0.95
Percentage children at risk (e.g., divorced parents)	0.032	0.043	0	0.68
District primarily serves central city of large MSA*	0.0023	0.048	0	1
District primarily serves suburbs of large MSA*	0.041	0.20	0	1
District primarily serves central city of medium sized MSA *	0.013	0.11	0	1
District primarily serves suburbs of medium sized MSA *	0.11	0.31	0	1
District primarily serves central city of small MSA *	0.014	0.12	0	1
District primarily serves suburbs of small MSA *	0.068	0.25	0	1
District primarily serves Non-MSA location *	0.57	0.50	0	1
Demographics of Residents of School District:				
Homeownership rate, 1990	0.74	0.11	0	1
Median household income, 1990	28,363	11,520	5,599	142,211
Percentage households with children (<18), 1990	0.39	0.074	0.028	0.90
Percentage households with age >65, 1990	0.14	0.052	0.00071	0.71
Percentage households with age >75, 1990	0.061	0.028	0	0.30
Percentage households with age >85, 1990	0.014	0.010	0	0.094
Percentage college educated residents over 25, 1990	0.15	0.10	0	0.81
Difference % non-whites among children in school age (5-19) - % non-whites among elderly residents over 65	0.060	0.090	-0.71	0.67
Ethnic fractionalization, 1990	0.16	0.17	0	0.73
Percentage Black population, 1990	0.048	0.11	0	0.99
Percentage Asian population, 1990	0.0087	0.022	0	0.50
Percentage Hispanic population, 1990	0.049	0.12	0	1
Gini coefficient, 1990	0.39	0.045	0.19	0.62

Notes, marked with asterisks: MSA is defined as large if the population size is > 1 million residents, as medium sized if the population size is between 250,000 and 1,000,000, and as small if the population size is smaller than 250,000 residents. Data source: School District Data Book (SDDB), School Year 1989/90. National Center for Education Statistics, Office of Educational Research and Improvement, U.S. Department of Education.

Table 7
School Spending Regression Results with Interactions, Total Expenditures, National Sample

Dependent Variables: Log of Total School Expenditures per Pupil, SY 1989/90

Explanatory Variable	(1)		(2)		(3)		(4)		(5)	
Percentage developed land , 1992	.15	**	.031		-.049		-.049		-.068	
	(.013)		(.053)		(.059)		(.061)		(.060)	
Homeownership rate, 1990	.14	**	.11	**	.11	**	.11	**	.10	**
	(.033)		(.038)		(.038)		(.037)		(.037)	
Percentage developed land x Homeownership rate			.17	*	.15	*	.20	**	.22	**
			(.074)		(.073)		(.073)		(.074)	
Percentage age 65 or older, 1990	-.0019		-.025		-.086					
	(.088)		(.088)		(.089)					
Percentage developed land x Percentage age 65 or older					.62	**				
					(.22)					
Percentage age 75 or older, 1990							-.42	**		
							(.13)			
Percentage developed land x Percentage age 75 or older							1.1	*		
							(.44)			
Percentage age 85 or older, 1990									-2.0	**
									(.31)	
Percentage developed land x Percentage age 85 or older									4.8	**
									(1.5)	
Controls [a)]	Yes		Yes		Yes		Yes		Yes	
Adjusted R-squared	.57		.57		.57		.57		.58	
Number of observations	12,274		12,274		12,274		12,274		12,274	

Notes: Numbers in parentheses are standard errors. * Significantly different from zero with 95 percent confidence. ** Significantly different from zero with 99 percent confidence. [a)] All regressions control for demographic characteristics of the residents of the school district, school district specific characteristics, and state fixed effects (see the Appendix Table for a full list of control variables). "Percentage developed" is defined as percentage of residential developed land divided by the total non-industrial developable land in a school district in 1992.

Table 8
Quantitative Effects

Change	Specification	Little developed school district (75th percentile: 7.3% developed)	Highly developed school district (95th percentile: 69.6% developed)	Δ Highly developed versus little developed school district
		Percentage change in spending per pupil (1)	*Percentage change in spending per pupil* (2)	*Additional spending per pupil in highly developed district due to change** (3) = (2) – (1)
Effect of percentage developed residential land on school expenditures per pupil (little versus highly developed district)	T 7 (1)	Baseline	9.7%	9.7%
Homeownership rate increases by 1 standard deviation	T 7 (2)	1.3%	3.4%	+2.0%
Elderly population (over 65) increases by 1 standard deviation	T 7 (3)	-0.1%	2.4%	+2.5%
Elderly population (over 75) increases by 1 standard deviation	T 7 (4)	-0.8%	1.9%	+2.8%
Elderly population (over 85) increases by 1 standard deviation	T 7 (5)	-1.5%	2.3%	+3.7%

Notes: Total average school spending per pupil in regression samples is $4,825. "Percentage developed" is defined as percentage of residential developed land divided by the total non-industrial developable land in a school district in 1992. All quantitative effects are measured at the regression sample averages. * The quantitative effects reported in columns (1) and (2) do not always precisely add up to the differential percentage value reported in column (3) due to rounding errors.

Table 9
School Spending Regression Results with Location-Age Interactions, National Sample

Dependent Variable: Log of Total School Expenditures per Pupil, School Year 1989/90

Explanatory Variable	(1)		(2)		(3)	
Percentage developed land , 1992			.12	**	-.019	
			(.014)		(.053)	
Homeownership rate, 1990	.11	**	.15	**	.11	**
	(.032)		(.032)		(.038)	
Percentage developed land x Homeownership rate					.20	**
					(.073)	
School district primarily serves central city of large MSA, 1990	.12	*	.13	**	.13	**
	(.050)		(.051)		(.051)	
Percentage age 65 or older x School district primarily serves central city of large MSA	1.3	**	1.4	**	1.5	**
	(.53)		(.54)		(.52)	
School district primarily serves suburbs of large MSA, 1990	-.046	**	-.039	*	-.037	*
	(.016)		(.016)		(.016)	
Percentage age 65 or older x School district primarily serves suburbs of large MSA	1.5	**	1.6	**	1.6	**
	(.50)		(.50)		(.50)	
School district primarily serves central city of medium sized MSA, 1990	.0033		.019		.016	
	(.036)		(.036)		(.036)	
Percentage age 65 or older x School district primarily serves central city of medium sized MSA	-.14		-.23		-.19	
	(.30)		(.30)		(.30)	
School district primarily serves suburbs of medium sized MSA, 1990	-.049	**	-.034	**	-.033	*
	(.014)		(.014)		(.014)	
Percentage age 65 or older x School district primarily serves suburbs of medium sized MSA	-.21		-.20		-.21	*
	(.11)		(.11)		(.11)	
School district primarily serves central city of small MSA, 1990	-.040		-.017		-.022	
	(.039)		(.039)		(.038)	
Percentage age 65 or older x School district primarily serves central city of small MSA	-.57	*	-.64	**	-.62	*
	(.26)		(.26)		(.26)	
School district primarily serves suburbs of small MSA, 1990	-.064	**	-.048	**	-.046	**
	(.016)		(.016)		(.016)	
Percentage age 65 or older x School district primarily serves suburbs of small MSA	-.18		-.17		-.18	
	(.11)		(.11)		(.11)	
Percentage age 65 or older x School district primarily serves Non-MSA location	-.45	**	-.33	**	-.33	**
	(.054)		(.056)		(.056)	
Adjusted R-squared	.57		.58		.58	
Number of observations	12,274		12,274		12,274	

Notes: Numbers in parentheses are standard errors. * Significantly different from zero with 95 percent confidence. ** Significantly different from zero with 99 percent confidence. Both regressions control for demographic characteristics of the residents of the school district, school district specific characteristics, and state fixed effects.

Appendix

School Spending Regression Results for Base Specification, National Sample

Dependent Variable: Log of Total School Expenditures per Pupil, School Year 1989/90

Explanatory Variable	All Districts	
Percentage developed land, 1992	.15	**
	(.013)	
Homeownership rate in school district, 1990	.14	**
	(.033)	
Log of median household income, 1990	.016	
	(.023)	
Gini coefficient	-.16	
	(.10)	
Percentage of households with children	-.32	**
	(.069)	
Percentage of population, age 65 and up	-.0019	
	(.088)	
Percentage of children who "speak English not well"	.46	**
	(.17)	
Percentage of children below poverty	.33	**
	(.045)	
Percentage of children at risk	-.32	**
	(.095)	
Percentage of adult residents with a college education	.75	**
	(.043)	
Difference % non-whites among children in school age (5-19) -	.16	**
% non-whites among elderly residents over 65	(.049)	
Ethnic fractionalization, 1990	.031	
	(.033)	
Percentage Black population	.054	
	(.036)	
Percentage Asian population	-.52	**
	(.12)	
Percentage Hispanic population	.028	
	(.039)	
Number of schools in school agency	-.0020	**
	(.00029)	
Number of schools in school agency, squared (in '000)	.0023	**
	(.00066)	
Percentage of students enrolled in special education schools	.23	
	(.25)	
Percentage of students enrolled in vocational schools	.28	
	(.18)	
Percentage of students enrolled in other schools/alternative schools	-.023	
	(.36)	
Agency is independent local school district, SY 89/90	-.13	**
	(.047)	
Agency is local school district component of supervisory union, SY 89/90	-.13	**
	(.048)	
Agency is supervisory union administration center or a county superintendent,	-.22	**
SY 89/90	(.057)	
Log of state and federal revenue per pupil, SY 89/90	.025	**
	(.0078)	
State Fixed Effects	Yes	
Constant	8.2	**
	(.27)	
Adjusted R-squared	.57	
Number of observations	12,274	

Notes: Numbers in parentheses are standard errors. * Significantly different from zero with 95% confidence. ** Significantly different from zero with 99% confidence.