Ann Reg Sci
DOI 10.1007/s00168-009-0336-1

ORIGINAL PAPER

Open space, house prices, and the tax base

Donald Vandegrift · Michael Lahr

Received: 13 October 2008 / Accepted: 9 October 2009

Abstract This paper examines the effect of public acquisitions of open space on changes in house prices and the municipal tax base using municipal-level data from New Jersey. We find that open-space expenditures yield a stream of benefits in the future but that any effect of open-space acquisitions on the tax base is immediate. Finally, we find that while higher tax rates are associated with a lower tax base, a larger tax base depresses tax rates.

JEL Classification H4 · Q3

1 Introduction

Across the US, voter interest in land conservation remains high. From 2000 to 2006, US voters considered 1,221 land conservation measures and approved 925 (76%). These measures allocated more than $23.7 billion to land conservation. In 2006, voters considered a total of 128 open-space spending measures. About 77% of the measures passed, adding $5.7 billion in new open-space spending authority. Owing at least in part to its high population density, New Jersey is among the most active states in pursuing land conservation. In November 2006, New Jersey counties and municipalities included 30 measures on the ballot and passed 20 (Trust for Public

D. Vandegrift (✉)
School of Business, The College of New Jersey,
2000 Pennington Rd., Ewing, NJ 08628-0718, USA
e-mail: vandedon@tcnj.edu

M. Lahr
Center for Urban Policy Research, Rutgers University, 33 Livingston Ave.,
Suite 400, New Brunswick, NJ 08901-1982, USA
e-mail: lahr@rutgers.edu

Journal: 168 Article No.: 0336 MS Code: ARSC-D-08-00079.2 TYPESET DISK LE CP Disp.:2009/10/21 Pages: 18 Layout: Small-X

Land 2006). As of 2007, 231 New Jersey municipalities (41% of municipalities in the state) and all 21 New Jersey counties collect open-space taxes. Annual revenues from the taxes total about $300 million. Not surprisingly, New Jersey has also preserved a substantial amount of land as open space. From May 1997 to June 2007, more than 450,000 acres of land were preserved as open space in the State of New Jersey (about 9% of the land area of the state). Most of this land has been preserved through the state's Green Acres Program, in which the state and municipalities mutually identify parcels for acquisition. The state then considers funding for the acquisition.

While the value or willingness to pay for open space has received considerable attention in the literature, economists have generally failed to consider the effect of the acquisitions on the municipal tax base and property taxes. The oversight is surprising. Debates about whether to allow development or to preserve a particular land parcel typically center on the impact development will have on the tax base and/or the tax rate. Preservation advocates assert that, via enhancement of proximate amenities, open space raises property values and. hence, adds to the tax base. With a larger tax base, the municipality can fund a fixed set of expenditures at a lower tax rate. Preservation opponents typically contend that the acquisitions are too costly and shrink the tax base by removing the land from the tax base entirely or at least by limiting a parcel of land's possible uses. Because the tax base is lower, preservation opponents contend that tax rates must rise to compensate. Of course, the two arguments are both conceptually cogent and not mutually exclusive. Thus, any determination of which side of the debate is correct must be made through observation.

In this paper, we examine the effect of open-space acquisitions on house prices at the municipal level and on municipal tax bases in New Jersey. New Jersey is highly developed; as a result property values there are likely quite sensitive to open-space acquisitions compared to other US states. This makes New Jersey a particularly viable candidate for a study of the effect of open-space acquisitions on property values and tax rates.

We conduct our investigation at the municipal level. First of all, New Jersey has a plethora of municipal governments that set their own tax rates and land use plans.[1] So a viable statistical analysis should result from an analysis of its set of 566 municipalities. Second, open-space purchases can be made by three levels of government in New Jersey—at the state, county, and municipal levels. Most municipal and county expenditures are funded via property taxes. Thus, by using municipal-level data we are able to capture the effect on property tax rates at the level of least aggregation. The use of smaller units of areal measurement, like individual properties, could have biased our analysis toward municipalities that have more properties sold in a given year, either because they have a larger number of properties or because they have higher property turnover rates.

Using properties as a focus of such investigation could lead to its own bias. Several studies of housing prices outside New Jersey show that the effects of open space are positive for houses in close proximity to the open space but that the effect weakens with distance from the open space. Thus, there could conceivably be benefits to open

[1] In fact, in the course of our analysis we were surprised to learn that is no central electronic repository for municipal plans or even their land use/zoning maps.

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space for certain homeowners (those that happen to live near the acquired parcel) but costs for other homeowners in the form of higher property tax rates (to finance the acquisition).[2] In addition, the benefits to the homeowners proximate to the open space could conceivably be less than the costs to the non-proximate homeowners, leading to a reduction in social welfare in the jurisdiction. In sum, municipalities in New Jersey are sufficiently large to capture the local effects of financing the open space and also of capturing most of the benefits of open space that is likely to be capitalized in home ownership.

This study differs from the existing literature on the effects of open space because it measures open space in expenditure terms rather than acreage terms, and we analyze house price and tax base changes over a fixed period rather than the level of house prices or the tax base at a certain point in time. Our rationale for measuring open space in expenditure terms is the basic economic principle open space is most expensive where it is scarce and when it is most useable. In sum, its price is highest where and when it is in greatest demand. Thus, a given amount of expenditure on open space can buy more land in a low population density area. Similarly, land that is less accessible or that has fewer possible uses, e.g., a steep ravine, is likely to have lower value per acre than a piece of more readily used land in the same vicinity. In essence, the public purchase of open space is likely to have smaller effects on property prices when there is a lack of demand for that land. Because property prices vary across locations, measuring expenditures (rather than quantity in acres) allows a more direct calculation of the relative value of the benefits of the open space accruing to New Jersey residents.[3] (This, of course, assumes that the benefits of open-space purchases attenuate mostly to properties within reasonable proximity of the open space itself.)

Second, we analyze house price changes rather than house price levels because open-space expenditures are potentially endogenous to housing prices. That is, while open-space expenditures may induce municipality property values to be higher, municipalities with large tax bases may be able to make larger purchases of open space. In this vein, evidence of positive *changes* in home prices and the base that emanate from open-space purchases make a more compelling argument for open-space purchases than do higher *levels* of home prices and improved size of the base associated with them. The causality does not readily flow in the opposite direction. That is, it does not seem to make sense to test how property value changes from 1995 to 2000 affected accumulated state and municipal open-space spending prior to 1995. Consequently, we examine the impact of open-space spending (and changes in open-space spending) on subsequent *changes* in house prices and *changes* in the tax base to eliminate any possible endogeneity issues.[4]

[2] Of course, open-space acquisitions may restrain growth in municipal budgets by reducing the demand for municipal services.

[3] While prospective home buyers do not know the amounts spent on open space, they often know the quantity of open space and the land values in a particular area. Use of open-space expenditure data captures both the quantity of open space and land values.

[4] Although we do not examine municipal expenditures directly, we may infer changes in expenditures by examining changes in the tax base and the tax rate.

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2 Background

2.1 House prices and open space

Much of the literature on open space focuses on determining the relative impact of different types of open space.[5] For instance, the value of open space differs based on whether the parcel may be developed in the future (Irwin 2002), the types of uses currently permitted on the open space (Kline and Wichelns 1998; Geoghegan 2002), the distance between the open space and the housing unit (Bolitzer and Netusil 2000; Shultz and King 2001; Anderson and West 2006; Costanza et al. 2006), and the size of the open-space parcel.

Of particular interest to the current study are the findings on the effects on property value of proximity to open space. Bolitzer and Netusil (2000) and Anderson and West (2006) find that the value of open space generally declines as distance between the open space and the housing unit increases. However, parameter estimates for open space less than 100 feet from the housing unit were generally insignificant. Bolitzer and Netusil state that this is likely the result of congestion effects around public parks. Contingent valuation studies tend to yield a somewhat broader spatial extent for property value benefits of open space. On a related note, Breffle et al. (1998) find that willingness to pay (WTP) for open space decreases at decreasing rate in the distance between the homeowner's property and the open space. WTP for households 0.1 miles from the open space is twice as large as WTP for households 0.4 miles away. Also, Anderson and West find that the effect of proximity to open space on property values declines with distance from the central business district. Not surprisingly then, their findings follow those expected from Alonso's monocentric city model, i.e., that property value improvements due to proximity to open space rise with population density, income, and the fraction of the population under age 18.

Kline and Wichelns (1998) find that respondents placed higher values on preserved beach and cropland/pasture and lower values on turf farmland, wetlands, and woodlands. Lutzenhiser and Netusil (2001) and Shultz and King (2001) find that natural area parks have the largest impact on home sales prices followed by golf courses, specialty parks (parks devoted to a single activity such as boating), and urban parks. These findings support our proposition that the cost of open space is associated with local preferences for and expected welfare gains from the purchased land.

In addition to characteristics of the open space, the literature also considers the relative impact of house and homeowner characteristics on the valuation of open space. Earnhardt (2006) and Breffle et al. (1998) find that the value of open space is associated with local income levels. That is, high-income households are willing to pay more per acre of open space than are low-income households. They also found that

[5] A rather extensive literature analyzes the effects of various urban and rural amenities on the quality of life and, hence, population and employment growth. See Mulligan et al. (2004) for a broad summary, although they also make it clear that only a very small segment of this literature examines preserved land and not the effects of its recent public purchase.

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a community's housing attributes were also associated willingness to pay for open space. Owners of older houses and houses with more interior space were also willing to pay more for open space, even after controlling for household socioeconomic characteristics.

Bates and Santerre (2001) also investigate open-space purchases. But rather than estimate the impact of open space (or various characteristics of open space) on house prices, they instead estimate the determinants of open space using data from Connecticut cities and towns. They find that the demand for open space is highly sensitive to changes in income but relatively insensitive to changes in the price of open space. Surprisingly, they found that population pressures do not affect the amount of open space per capita but higher municipal populations do. This may reflect the fact that older, denser municipalities have less undeveloped land (including open space) at their disposal. This finding supports our use of a measure of open space in terms of its cost rather than its acreage.

2.2 The tax base and open space

A number of papers hint that the higher property values associated with open space may well make them self-financing (Bolitzer and Netusil 2000; Geoghegan 2002; Geoghegan et al. 2003). That is, they suggest that more open space within a given area raises local property values and, hence, property tax revenues. Thus, the increased revenues due to higher commercial and residential property values in proximity to open space may well offset the costs of purchasing and maintaining open space.

Of course, determining whether open space is self-financing is a complicated matter. More open-space acquisitions imply higher property taxes, and higher property taxes should lower home prices. Lower home prices, in turn, should reduce the tax base. Thus following logic presented thus far, it may well be that house prices in some sections of the municipality furthest from the purchased open space must fall due to the rising tax rates needed to pay for the benefits of the open space obtained by those closest to it. Of course, this assumes that tax revenues raised through the price rises enjoyed by those closest to the open space are rather modest. The matter is further complicated since there must be limits to the amount of open space that can be purchased before property tax revenues decline. If an entire municipality becomes open space, its tax revenue are necessarily zero, and its expenditures will be modest.

In light of all the apparent interest in the topic, the lack of attention in the literature to the effect of open space on the tax rates and on the tax base is rather surprising. Indeed, only a few studies estimate the determinants of municipal tax rates or the tax base, and none own a particular tilt toward open space.

This literature finds that there is a simultaneous relation between property tax rates and the property tax base. Higher property tax rates may reduce the size of the base, but a larger tax base may allow municipalities to meet their budgetary requirements with lower tax rates. Consequently, two key studies, a seminal one by Ladd and Bradbury (1988) and another by Brett and Pinske (2000), estimate a simultaneous equation

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model for tax rates and the tax base.[6] They both model the tax base as a function of municipality characteristics and the local tax rate. They model the tax rate as a function of municipality characteristics, the tax rate at other levels of government, and the tax base. The percentage of seniors is included in the tax equation as a proxy for the demand for public services. The twist that Brett and Pinske add is one of interjurisictional competition. Thus, they also include variables for tax rates at other governmental levels (i.e., the regional district), tax rates in adjoining municipalities, and characteristics of adjoining municipalities. Interestingly, their findings reveal little if any such competition.

3 Data and methods

The tax base (land and improvements) is a function of housing characteristics, neighborhood/locational characteristics, and land use variables. In addition, the tax base is also a function of the tax rate. Nevertheless, the tax base and the tax rate are determined simultaneously (Brett and Pinske 2000; Ladd and Bradbury 1988). That is, higher property tax rates may reduce the size of the base because higher tax rates deter development and the higher tax rates are capitalized into the tax base. However, a larger tax base may allow municipalities to meet their budgetary requirements with lower tax rates.

Because the tax rate and the tax base are determined simultaneously, we need instruments to identify the tax rate. We use the ratio of residential to commercial land values, percentage of population that is of school age, and population as instruments. As the ratio of residential to commercial land values rises, the tax rates should rise because residents are more intensive users of municipal services. Likewise, increases in the percentage of the population that is of school age should also cause higher tax rates. The largest budget item for most municipalities is education. Finally, population may affect tax rates because of economies of scale in the provision of services. This suggests the following empirical model:

$$R_i = f(N_i, K_i, A_i) \tag{1}$$

$$B_i = g(N_i, K_i, \hat{R}_i) \tag{2}$$

where A_i are instruments used to identify the change in the tax rate, B_i is the percentage change in the tax base over the period 1995–2000), N_i is a vector of neighborhood - locational characteristics for municipality i, and K_i is a vector of land use variables for municipality i. R_i is the equalized tax rate per $100 of property value (or the percentage change in the tax rate over the period 1995–2000), and $\hat{R}_i$ is the fitted value for R_i.

[6] Lang and Jian (2004) also consider the relation between property taxes and the tax base. Their study, however, considers the state of Massachusetts where a law limits the rate of property tax increases. Consequently, the law limits the endogeneity between property taxes and the tax base.

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In the case of house prices, Lutzenhiser and Netusil (2001), Shultz and King (2001) and Irwin (2002) specify the hedonic residential pricing model as

$$P_i = h(S_i, N_i, K_i) \tag{3}$$

where S_i is a vector of housing characteristics for municipality i. The dependent variable (P_i) is house sale price. However, house sale prices may also depend on tax rates. All else constant, higher property tax rates imply lower property values. However, municipalities with higher house prices may require fewer services (e.g., social services) and this may depress the tax rate. This suggests that we should follow the logic for Eqs. 1 to 3 and estimate the following empirical model:

$$R_i = j(S_i, N_i, K_i, A_i) \tag{4}$$

$$P_i = k(S_i, N_i, K_i, \hat{R}_i) \tag{5}$$

While theoretical models of hedonic pricing do not specify a particular empirical model or restrictions to the functional form, Cropper et al. (1988) argues that linear specifications are the best method to estimate hedonic price functions. They simulated outcomes using consumers with known utility functions and found that when some house attributes are unobserved, linear, semi-log, log–log linear, and linear Box–Cox specifications performed best. We report only the semi-log linear specifications here. The linear specification generated very similar results but the fit of the semi-log specification was better. Because many of the independent variables take on zero values, the log–log linear specification causes a large number of lost observations.

As discussed earlier in the paper, from a theoretical perspective, not only can open-space purchases alter property values, but, through the tax base, property value changes can influence the total value of open space that can be purchased. One way to avoid any possible finding of possible dual causation is to analyze the effect of prior open-space purchases on subsequent property value change.

To this end, we calculate the change in the mean house sale price over the period 1995–2000.[7] The data on single-family home sale prices were gathered from the New Jersey Department of the Treasury. The observations report the mean sale price by municipality for the State of New Jersey in the years 1995 and 2000. We perform a similar calculation for the tax base per acre and the equalized tax rate for New Jersey municipalities. The New Jersey Department of Community Affairs supplied the data on tax bases and equalized tax rates for 1995 and 2000. Total open-space expenditures and state open-space expenditures are compiled from files at the New Jersey Department of Environmental Protection (NJDEP). As of 2000, open-space acquisitions totaled

[7] New Jersey is a geographically small state and consists of just two major markets: metro NYC and metro Philadelphia. To the degree that there might be different cycles in the two markets, our variables on distance from NYC and from the Northeast Corridor should capture much of it. In addition, the two markets move cyclically with a great degree of unison in part because a surprising number of people commute between the two metro areas. In the end, we see no need to be concerned about asynchronous cyclicality across housing markets in the data set we use.

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more than 62,000 acres at a total cost of more than a billion dollars (in year 2000 dollars).[8] The State of New Jersey financed about 38% of these costs.

NJDEP also supplied data on travel distance to New York City and Philadelphia. Municipality population, school-age population, median rooms per housing unit, median family income, seasonal housing units, and the proportion of housing units built before 1960 are from the US Census Bureau. Land use/land cover data is a composite of 1995/1997 land use/land cover analysis developed by NJDEP and updated for 2000 using information developed by Richard Lathrop at The Center for Remote Sensing and Spatial Analysis at Rutgers University using satellite images. Data on commercial and residential land values, and the ratios of assessed property values to market values are from the New Jersey Department of Community Affairs. We do not include housing characteristics in the tax base specifications because high-value land may contain a large number of smaller housing units or a small number of large (and expensive) housing units. Moreover, since we focus on house price change, we want to include *any* positive changes in home prices, which include those induced by differences in altered property characteristics due to proximity to an open-space purchase.

4 Results

4.1 House price and open space

Table 1 reports means and standard deviations for the dependent (*Changes in House Price, Changes in the Tax Base*) and the independent variables. In general, the highest house prices are concentrated in two corridors: one that runs northwest of the fall line between New York City and Princeton and another along the New Jersey Shore. Variation in average house prices across the state was substantial; the lowest price municipality was just under $40,000 per unit (City of Camden, Camden County) and the highest price municipality was over $1 million (Alpine Borough, Bergen County). There are six municipalities (of 566) that reported no house sale data for the year 2000.[9] During the period from 1995 to 2000, house prices increased an average of 19.4% (a simple unweighted average across municipalities) within the State (see Table 1). Five municipalities reported no house sale data in 1995.[10]

We expect that higher levels of spending on open space per housing unit will be associated with greater percentage increases in house prices. More open space

[8] New Jersey also supports a farmland preservation program that acquires development rights for agricultural land. We do not have data for these acquisitions and therefore all farmland (both preserved and unrestricted) is included in our undeveloped land variable described below. Similarly, any land or development rights acquired solely by private land preservation groups are included only in the undeveloped land category and not in the open-space expenditures variable.

[9] The missing municipalities are Audubon Park Borough; Pine Valley Borough; Tavistock Borough; Teterboro Borough; Walpack Township; and Winfield Township.

[10] The missing municipalities are: Millstone Borough; Rockleigh Borough; Stockton Borough; Saddle River Borough; and Wrightstown Borough. Because six observations for 2000 are missing, a total of 11 observations are lost in measuring the 2000/1995 house price ratio.

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Table 1 Means and standard deviations

Variable	*N*	Mean	Standard deviation
House price	560	210,786	139,732
Rooms	566	6.09	1.02
Average parcel	566	0.448	0.414
Pre-1960	566	49	21.1
Pct seasonal	566	4.51	12.84
Nyc Dist	566	48.05	31
NycPhl	566	81.28	17.53
Undeveloped	566	28.5	23.4
Open space exp	566	451.86	2,244.7
Tax base	566	367,860	434,501
Tax rate	566	2.52	0.792
Assessed to market	566	85.6	16.4
%Δ House price	556	19.43	20.26
%Δ Tax base	565	19.64	50.72
Tax rate ratio	566	1.076	0.2539
Residential/commercial ratio	565	7.44	12.72
Pct School age	566	25.28	4.42
Population	566	14,866	22,789

House price$_i$ = average price per housing unit in dollars for municipality i in 2000
Rooms$_i$ = median number of rooms per housing unit for municipality i in 2000
Average parcel$_i$ = average residential lot size in acres for municipality i in 2000
Pre-1960$_i$ = percentage of total housing units that were built prior to 1960 for municipality i in 2000
Pct seasonal$_i$ = percentage of total housing units that are seasonal units for municipality i in 2000
Nyc Dist$_i$ = distance (in miles) between the municipality and New York City
NycPhl = $[(\text{Distance to NYC})^2 + (\text{Distance to Philadelphia})^2]^{1/2}$
Undeveloped$_i$ = Undeveloped land (less acreage acquired as open space) as a percentage of total acreage as of 2000 for municipality i
Open space exp$_i$ = total real open-space expenditures (in 2000 dollars) as of 2000 per housing unit for municipality i
Tax base$_i$ = total assessed tax base (land and improvements) in dollars per acre for municipality i in 2000 multiplied by the market to assessed ratio
Tax rate$_i$ = general property tax rate per $100 of assessed value for municipality i in 2000 multiplied by the assessed to market ratio
Assessed to Market$_i$ = ratio of total market value to assessed value expressed as a percentage for municipality i in 2000
%Δ House price$_i$ = percentage change in average price per housing unit by municipality for 1995–2000
%Δ Tax base$_i$ = percentage change in the total equalized tax base per acre by municipality for 1995–2000
Tax rate ratio$_i$ = equalized property tax rate per $100 of value by municipality for 2000 divided by the equalized property tax rate per $100 of value by municipality for 1995
Residential/commercial ratio$_i$ = ratio of residential land values to commercial land values for municipality i in 2000
Pct school age$_i$ = percentage of the total population that is between the ages of 3 and 18 years of age for municipality i in 2000
Population$_i$ = total population for municipality i in 2000

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translates into greater amenities, and the value of the amenities is capitalized into the house price. In addition, increases in open space may restrict housing supply in certain locations and thereby raise house prices.

As mentioned earlier, we gauge these open-space purchases in monetary rather than acreage terms because the value of an acre of land (or an acre of open space) differs across locations. That is, an acre of land should be more valuable where residential property values are higher. Because the dependent variable is house price, we construct the open-space spending measure on a per-housing-unit basis. The statewide mean open-space expenditures are $452 per housing unit. However, there is quite a bit of variation across municipalities, and about half of New Jersey municipalities have no open-space expenditures. The average cost share (a simple unweighted average across municipalities) for the state on openspace purchases is about 40%.[11]

The remaining variables (*Pre-1960, Nyc Dist, Pct Seasonal, NycPhl*, and Undeveloped) capture various aspects of the desirability of the location of the municipality. To capture any changes in the value of the labor market opportunities and the amenities offered by New York City, we include distance from New York City (*NYC Dist*).[12] *NycPhl* is designed to capture distance from the corridor that connects New York City and Philadelphia. It is the square root of the sum of the squared distances from the municipality to Philadelphia and New York City. We employ this because, as residents in the state, we know that properties directly on the corridor tend to have lower values than those away from it due to disamenities associated with population density (e.g., traffic congestion, school quality, etc.) along this convenient corridor between two of the nation's largest cities. Thus, this variable captures changes in the value of these disamenities. We also expect that recreational opportunities associated with easy access to Atlantic beaches will raise house prices. We capture this effect with the percentage of total housing units that are seasonal (*Pct Seasonal*).

Using the open-space expenditures variable above, we construct two variables for each municipality: open-space expenditures per housing unit for the period 1995–2000 and open-space spending per housing unit for the period 1961–1995. We interpret the first variable as the change in open-space spending and the second as initial level of open space. During the period 1995–2000, 104 municipalities had open-space expenditures, and the correlation coefficient between the two open-space spending variables is 0.32. From Table 1 we see that the average property tax rate increased about 7.6% over the period. We were not able to find data for the other independent variables for 1995. Some of these variables are location variables that do not change at all over time (e.g., distance to New York City) and others like the percentage of housing units that are seasonal are likely to change only very slowly.

[11] We expected that greater state support in making open-space purchases will raise house prices because a larger fraction of the total cost will not need to be financed through local property taxes. However, this cost share was not significant explanatory variable in regressions on house prices or the tax base using the subset of municipalities ($n = 316$) that had an open-space acquisition over the period. This cost share variable is uncorrelated with the open-space spending variable ($r = -0.08$, $p = 0.12$) and its inclusion does not affect the parameter estimates on the open-space variable.

[12] Distance to Philadelphia was highly correlated with distance to New York, so we employ distance to New York in the subsequent analysis.

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Analysis of pairwise correlations of the independent variables shows that open-space expenditures are not highly correlated with either the housing or the location variables. One problem variable is average residential parcel size (*Average Parcel*). Average parcel size is highly correlated with both *Undeveloped Land* and the *Median Number of Rooms* ($r = 0.66$ and 0.56, respectively). To correct for this problem, we regress average parcel size on undeveloped land and use the residual to control for parcel size in subsequent analyses. This allows us to interpret the coefficient of *Average Parcel* as the effect of parcel size after controlling for the scarcity of land in the municipality.

Table 2 reports regressions on the log ratio of average house price, and the tax rate ratio. The log ratio of house prices is defined as the log of the ratio of average house sale price for 2000 to average house sale price for 1995 (by municipality). The tax rate ratio is the ratio of the equalized property tax rate in 2000 to the equalized property tax rate in 1995 (by municipality). Column 2 of Table 2 reports the results on log house price ratio assuming that the tax rate ratio is exogenous, column 3 reports the results on the tax rate ratio, and column 4 reports the results on the log house sale price ratio assuming that the tax rate ratio is endogenous. While we report estimates for all municipalities, running these analyses using only the municipalities that had an open-space acquisition yields the same basic results.

Tests indicate the instruments are valid. An F test of the instruments is significant (F (2,539) = 7.71, $p < 0.001$) and the partial R^2 of the instruments is 0.04. In addition, tests indicate that the system is not overidentified (Hansen J Statistic = 0.734, $p = 0.39$). We found no evidence of spatial autocorrelation in the data. To test for spatial autocorrelation, we constructed a matrix of spatial weights based on a declining exponential decay function. To test for spatial autocorrelation, we constructed a matrix of spatial weights based on a declining exponential decay function. The spatial weights matrix was constructed from X and Y coordinates for each municipality in the North American Datum 1983 State Plane projection system for New Jersey. As such, the coordinates are in feet from the central meridian and the equator. Calculation of Moran's I showed no evidence of spatial autocorrelation (Moran's $I = -0.0017$, $p = 0.35$). Calculation of the spatial autoregressive parameter (ρ) and the spatial Durbin-Watson showed similar results ($\rho = -48.8$, $p = 0.48$; $D - W = 1.0035$, $p = 0.34$).

Change in Open Space Exp is the change in open-space expenditures (i.e., open-space expenditures per housing unit 1995– 2000), and its coefficient shows a consistent positive effect on the change in house prices in both specifications. In general, a one-dollar increase in open-space expenditures per housing unit from 1995 to 2000 is associated with an increase in the house prices of 0.0037%. Using the mean value of open-space expenditures 1995–2000 of $162, this implies that the average house price in the state rose an additional 0.6% during the 1995–2000 period because of the open-space acquisitions during the period ($162 \times 0.0037 = 0.60$).

Open Space Exp represents the level of open-space expenditures (i.e., open-space expenditures per housing unit 1961–1995), and its coefficient shows a consistent positive effect on the change in house prices in both specifications. In general, a one-dollar increase in open-space expenditures per housing unit 1961–1995 is associated with an increase in the house price ratio of 0.0025%. Using the mean value of open-space

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Table 2 Regressions on the change in house prices and tax rates 1995–2000

Dependent variable:	ln(House price ratio)	Tax rate ratio	ln(House price ratio)
Constant	0.178 (0.129)	1.99*** (0.19)	0.594 (0.38)
House price 1995[c]	−0.00038*** (0.000014)	−0.0010*** (0.00021)	−0.00056*** (0.00021)
Change in open space exp	0.000038* (0.000022)	0.000010 (0.000010)	0.000037* (0.000021)
Open space exp	0.000025*** (0.000009)	0.0000007 (0.000013)	0.000025*** (0.000009)
Nyc Dist	−0.0028*** (0.0010)	−0.000012 (0.0015)	−0.0028*** (0.0011)
Nyc Dist squared	0.000012 (0.000010)	0.0000054 (0.000014)	0.000012 (0.000010)
NycPhl	0.0036 (0.0026)	0.0022 (0.0035)	0.0038 (0.0025)
NycPhl squared	−0.000020 (0.000016)	−0.000025 (0.000022)	−0.000024 (0.000016)
Pct seasonal	0.0040*** (0.00071)	-0.0053*** (0.0012)	0.0028** (0.0013)
Pre-1960	0.00039 (0.00031)	0.00057 (0.00048)	0.00044 (0.00032)
Undeveloped	0.00013 (0.00034)	−0.00079** (0.00037)	0.00012 (0.00035)
Rooms	0.034*** (0.0090)	−0.057*** (0.014)	0.025** (0.012)
Average parcel[a]	0.072* (0.041)	−0.016 (0.043)	0.071* (0.041)
Tax rate ratio[b]	−0.105*** (0.036)		−0.29* (0.16)
Tax rate 1995	−0.060*** (0.013)	−0.28*** (0.031)	−0.11*** (0.046)
Residential/commercial ratio		0.0019*** (0.00074)	
Pct school age		0.010*** (0.0034)	
R^2	0.35	0.46	0.28
N	556	555	555

[a] Residual, [b] Fitted value in col. 4, [c] In thousands

expenditures 1961–1995 of $288, this implies that the average house price in the state rose an additional 0.72% during the 1995–2000 time period because of the level of open space in the municipality prior to 1995 ($288 \times 0.0025 = 0.72$). These results also do not change depending on whether the tax rate is included as a dependent variable. In addition, estimates of the effect of open-space acquisitions do not vary based on whether we include controls for the average cost share for the state.

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If we consider only those municipalities that had an open-space acquisition over the period ($n = 104$), the estimates on the level of open-space spending rise slightly and remain significant at the 0.01 level. However, the estimates for the change in open-space spending are roughly the same, but the estimates are no longer significant ($p = 0.15$). In addition, the effect of the change in open-space expenditures per housing unit on the percentage change in house prices estimate is sensitive to outliers. If we delete the 13 municipalities that had more than 60% increases in house prices over the period,[13] the estimated effect of the change in open-space purchases 1995–2000 is no longer significant. While the level of open-space expenditures (expenditures 1961–1995) remains significant, the parameter estimate decreases from 0.0025 to 0.0013 ($p = 0.06$). If we delete the 12 municipalities that had more than 7.0% decreases in house prices over the period, the estimated effect of both the open-space variables in unchanged. This suggests that open-space expenditures raise house prices in the long run and that the effect does not diminish over time.

The parameter estimates on the remaining variables suggest that municipalities that were closer to New York City had a higher median number of rooms, larger average parcel size, and a higher percentage of units that were seasonal units were associated with larger increases in average house prices over the period. A one-room increase in the median number of rooms is associated with an increase in the house price ratio of about 2.5%. A one-acre increase in the average parcel size is associated with an increase in the house price ratio of 7%. A one-mile decrease in the distance to New York City is associated with a 0.3% increase in the house price ratio. A one percentage-point increase in the number of seasonal housing units 0.3% increase in the house price ratio. Finally, there is some evidence of convergence toward the mean. Houses with higher prices in 1995 showed significantly less price appreciation over the period.

In both specifications, the ratio of the equalized property tax rate (*Tax Rate Ratio* = equalized tax rate 2000/equalized tax rate 1995) shows a significant negative effect on the log ratio of the house price. The estimates in column 4 show that a 0.1 increase in the tax rate ratio is associated with a 2.9% decrease in house prices over the period. If we instead treat the tax rate as exogenous, we get a smaller effect. The estimate of the effect of a purportedly exogenous tax rate ratio on the house price ratio shows that a 0.1 increase in the tax rate ratio is associated with a 1% reduction in the house price ratio. The corrected estimate thus shows an impact that is about 1.9% points greater because it removes the effect of the house prices on the tax rate. This suggests that higher house prices depress tax rates.

4.2 The tax base and open space

The average tax base per acre (a simple unweighted average) across New Jersey municipalities in 2000 is $367,860 (see Table. 1). We construct the *Tax Base* as a measure of each municipality's tax base on a per-acre basis because of the possibility that lower

[13] Recall, while we are using municipal averages, it may be that the average house prices reported for some municipalities in a given year may be based on just a very few actual sales. Thus, such a robustness check is certainly warranted.

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taxable acreage due to open-space acquisitions might reduce the tax base. To derive market values, we multiply the assessed tax base by the ratio of market to assessed values. In general, the highest tax bases per acre are clustered near New York City, Philadelphia, and along New Jersey's shoreline. Variation in tax bases per acre across the state was substantial; the lowest tax bases per acre were $177 and $716 (Walpack Township, Sussex County and Washington Township, Burlington County) and the highest tax bases per acre were $3,347,824 and $3,939,823 (Hoboken City, Hudson County and Guttenberg Town, Hudson County).[14]

Recall that, from a theoretical perspective, the effect of higher open-space spending on the tax base per acre of land is indeterminate. On the one hand, higher open-space expenditures are associated with higher house prices (see above). With higher house prices, the tax base is also higher. On the other hand, the acquisitions remove land from the tax rolls and thereby lower the tax base.

We expect that higher levels of spending on open space per housing unit will be associated with smaller percentage increases (or decreases) in the tax base. As noted above, open-space spending takes land off the tax rolls and lowers the base. During the period 1995–2000, the average percentage increase in the tax base per acre was 20.84 (a simple unweighted average across municipalities) for the state (see Table 1). Table 2 reports regressions on the log ratio of the tax base and the tax rate ratio. The log ratio of tax base is defined as the log of the ratio of the market value of the tax base for 2000 to the market value of the tax base for 1995 (by municipality). *Tax Rate Ratio* is defined as above (the ratio of the equalized property tax rate in 2000 to the equalized property tax rate in 1995).

Column 2 of Table 2 reports the results on log *Tax Base Ratio* assuming that the tax rate ratio is exogenous, column 3 reports the results on *Tax Rate Ratio*, and column 4 reports the results on the log *Tax Base Ratio* assuming that the tax rate ratio is endogenous. While we report estimates for all municipalities, running these analyses using only the municipalities that had an open-space acquisition yields the same basic results. Tests indicate the instruments are valid. An F test of the instruments is significant ($F(2,550) = 3.37$, $p = 0.03$) and the partial R^2 of the instruments is 0.04. In addition, tests indicate that the system is not overidentified (Hansen J Statistic $= 1.07$, $p = 0.30$). We found no evidence of spatial autocorrelation in the data. To test for spatial autocorrelation, we once again used a matrix of spatial weights based on a declining exponential decay function. We found no evidence of spatial autocorrelation in the data. Calculation of Moran's I showed no evidence of spatial autocorrelation (Moran's $I = -0.0025$, $p = 0.99$). Calculation of the spatial autoregressive parameter (ρ) and the spatial Durbin–Watson showed similar results ($\rho = -277.7$, $p = 0.98$; $D - W = 1.005$, $p = 0.99$).

The change in open-space expenditures (i.e., open-space expenditures per housing unit 1995–2000) shows a consistent negative effect on the change in the tax base in both specifications. In general, a one-dollar increase in open-space expenditures per housing unit 1995–2000 is associated with a decrease in the tax base of 0.00046%.

[14] Walpack Township is a special case. The Tocks Island dam (now deauthorized) was slated for construction in an area that includes Walpack Township. The expectation that the land would be inundated caused property owners to sell out. Including Walpack Township has no impact on the results.

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Using the mean value of open-space expenditures 1995–2000 of $162, this implies that the average tax base in the state fell 0.075% during the 1995–2000 period because of the open-space acquisitions during the period ($16 \times 0.00046 = 0.075$). If we consider only those municipalities that had an open-space acquisition, the estimates on the change in open-space spending remain about the same. If we delete the 16 municipalities that had more than a 60% increase in the tax base over the period or the 18 municipalities with more than a 7% decrease in the tax base, the estimated effect of the change in open-space purchases 1995–2000 is about the same.

Despite the significant effect of changes in open-space acquisitions on the tax base ratio, the level of open-space expenditures (i.e., open-space expenditures per housing unit 1961–1995) shows no significant effect on the tax base ratio. This suggests that any effect of open-space acquisitions on the tax base is immediate. In essence, open-space acquisitions have the immediate effect of reducing the tax base as land is removed from the tax rolls, but older open-space acquisitions do not cause future declines in the tax base by making development less desirable.

In both specifications, the ratio of equalized property tax rate (tax rate 2000/tax rate 1995) shows a significant negative effect on the log ratio of the tax base over the period. The estimates in column 4 show that a 0.1 increase in the tax rate ratio is associated with a 4.2% decrease in the tax base over the period. If we, instead, treat the tax rate as exogenous, we get a smaller effect. The estimate of the effect of a purportedly exogenous tax rate on the tax base shows a 0.1 increase in the tax rate ratio is associated with a 2.6% reduction in the tax base. The corrected estimate thus shows an impact that is about 1.6% points greater because it removes the effect of the tax base on the tax rate. This suggests that the municipalities do tend to depress tax rates as the tax base rises. That is, when revenue surpluses arise, municipal executives in New Jersey do cut taxes at least somewhat rather than use the surplus revenues strictly to expand municipal services.

Among the remaining variables, *Pre-1960*, and *NYC Dist* show a statistically significant effect on the log ratio of the tax base. Higher percentages of houses built prior to 1960 were associated with decreases in the log ratio of the tax base. A one-percentage point increase in housing units built before 1960 is associated with a 0.21% reduction over the period.

5 Conclusion

Open-space programs are generally popular with voters, and a relatively large literature in economics suggests why: proximity to open space raises house prices. But questions about open-space programs remain. The literature shows that the effects of open-space purchases are highest for houses nearest open space. But while open-space purchases may raise house prices for houses near the open space, they could conceivably do so at the expense of other houses in the jurisdiction that are further away, by means of higher property taxes. If higher property taxes reduce house prices, as some researchers have suggested, then open-space purchases could conceivably cause the municipality's average house price to fall. In addition, open-space purchases could conceivably reduce the tax base, forcing a rise in the tax rate as the municipality must

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finance its public services from a smaller tax base. We investigate concerns that open-space purchases harm average homeowners by reducing the available tax base and forcing a rise in property tax rates.

This study differs from the existing literature on the effects of open space because it measures open space in *expenditure* terms rather than *acreage* terms and we analyze house price and tax base changes over a fixed period rather than the level of house prices or the tax base at a certain point in time. Because the value of an acre of land can vary radically with location, measuring open space in expenditure terms allows a more direct assessment of the net fiscal benefits of open-space purchases at the

Table 3 Regressions on the change in tax base and tax rates 1995–2000

Dep var:	ln(Tax base ratio)	Tax rate ratio	ln(Tax base ratio)
Constant	0.751***	1.28***	0.965***
	(0.161)	(0.164)	(0.322)
Tax base 1995[c]	−0.00019	−0.00011***	−0.00021
	(0.00015)	(0.000043)	(0.00015)
Change in open space exp	−0.0000050***	0.0000014	−0.0000046***
	(0.0000015)	(0.0000024)	(0.0000018)
Open space exp	−0.0000049	−0.000021*	−0.0000091
	(0.000013)	(0.000012)	(0.000012)
Nyc Dist	−0.0051**	−0.0013	−0.0056**
	(0.0025)	(0.0024)	(0.0024)
Nyc Dist squared	0.000032	0.000027	0.000040
	(0.000025)	(0.000022)	(0.000026)
NycPhl	0.0030	0.0048	0.0040
	(0.0050)	(0.0044)	(0.0044)
NycPhl squared	−0.000024	−0.000043	−0.000033
	(0.000031)	(0.000027)	(0.000027)
Pct seasonal	0.0020	−0.0027**	0.0015
	(0.0015)	(0.0014)	(0.0018)
Pre-1960	−0.0022***	0.0010	−0.0021***
	(0.00079)	(0.0083)	(0.00087)
Undeveloped	−0.00053	−0.00028	−0.00057
	(0.0020)	(0.00064)	(0.0020)
Tax rate ratio[b]	−0.26***		−0.42*
	(0.056)		(0.23)
Tax rate 1995	−0.038***	−0.13***	−0.058**
	(0.014)	(0.039)	(0.028)
Residential/commercial ratio		0.0019**	
		(0.00097)	
Population[c]		0.0010**	
		(0.00055)	
R^2	0.12	0.21	0.11
N	565	564	564

[a] Residual, [b] Fitted value in col. 4, [c] in thousands

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municipal level. We analyze house price changes rather than house price levels because open-space expenditures are potentially endogenous to housing prices. That is, while open-space expenditures may raise municipality property values, municipalities with higher house prices may be able to make larger purchases of open space.

We find that open-space purchases appear to induce house price rises. The level of open-space expenditures per housing unit (i.e., expenditures prior to 1995) shows a significant positive effect on the change in house prices over the period 1995–2000. We find that the average house price in the state rose an additional 0.72% during the 1995–2000 time period because of the level of open space in the municipality prior to 1995 (about $1,500). This suggests that open-space expenditures yield a stream of future benefits.

By contrast, the *level* of open-space expenditures (i.e., open-space expenditures per housing unit 1961–1995) shows no significant effect on change in municipal tax base between 1995 and 2000 (Table 3). Instead, the *change* in open-space expenditures (i.e., open-space expenditures per housing unit 1995–2000) shows a significant negative effect on the change in the tax base. We find that the average tax base in the state fell 0.075% during the 1995–2000 period because of the open-space acquisitions during the period. This suggests that any effect of open-space acquisitions on the tax base is immediate. Therefore, unlike its benefits, the costs of open space to a municipality do not appear to spill over into future years.

In addition, we find that higher equalized tax rates are associated with a lower tax base, and that a rising tax base depresses tax rates. Interestingly, we also found that, ceteris paribus, rising tax rates depress the tax base. Increasing the equalized tax rate by 10% over from 1995 to 2000 reduced the tax base per acre by about 4.2% and the average house price by 2.9% over the period.

Because we find that changes in open-space expenditures cause reductions in the tax base, the acquisitions likely divert development activity. Future studies should attempt to evaluate the manner in which the activity is diverted. That is, future studies should attempt to determine the extent to which open-space acquisitions cause development of other greenfields in less desirable locations (or out of state), redevelopment of brownfields, more intensive use of already developed lands, and/or more efficient use of existing space.

Acknowledgments The authors gratefully acknowledge support from the Lincoln Institute of Land Policy and the New Jersey Department of Environmental Protection. Samuel Taylor, Pingli Jiang, and Cory Yemen provided valuable research assistance. Rexford Santerre, Lori Lynch, Gregory Ingram, and an anonymous reviewer at the Lincoln Institute of Land Policy provided valuable comments. Thanks also to William Mates, Steve Jandoli, Jorge Reyes, Eric Knudsen, Leo Korn, Martin Rosen, Robert Stokes, and Henry Mayer for advice and data.

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