Land-Use Controls, Natural Restrictions, and Urban Residential Land Prices

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Abstract: Research has focused on how variations in land-use controls explain interurban variations in prices. With the notable exception of the work by Rose (1989a, 1989b), virtually no attention has been focused on how natural restrictions (bodies of water, mountains, etc.) impact land prices. The purpose of this paper is to examine the impact of both land-use controls and natural restrictions on interurban variation in residential land prices. Our results indicate that, as expected, land prices are significantly higher as the land supply decreases both as a result of natural and man-made restrictions.

I. INTRODUCTION

A substantial body of literature has developed on urban residential land prices. This literature has been both theoretical (see, for example, Brueckner 1990, White 1975, and Turnbull 1991, among others) and has included empirical tests of the models (see, for example, Pollakowski and Wachter 1990, Kau and Sirmans 1981, and Shilling, Sirmans, and Guidry 1991, among others). The empirical literature has concentrated on both intra-urban variations (Kau and Sirmans 1981) and interurban land variations (Witte 1975).

Research has focused on how variations in land-use controls explain interurban variations in prices (see Fischel 1989 for a substantive review). With the notable exception of the work by Rose (1989a, 1989b), virtually no attention has been focused on how natural restrictions (bodies of water, mountains, etc.) impact land prices. Rose (1989a, 1989b) clearly documents that a substantial portion of the interurban variations in land prices can be explained by natural restrictions on the supply of urban land.[1]

The purpose of this paper is to examine the impact of both land-use controls and natural restrictions on interurban variations in residential land prices. Using data collected by the Urban Land Institute on the level of supply restrictions by urban areas through land-use controls and the natural supply indexes developed by Rose (1989a), we estimate interurban land price equations. The results indicate that, as expected, land prices are significantly higher as the land supply decreases both as a result of natural and man-made restrictions.

In this paper, we undertake the following plan of investigation. Section 2 presents a literature review on the subject of urban residential land prices. Section 3

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[1]According to Brueckner (1987) and Wheaton (1974), this result is sensitive on whether the city is open or closed to migration. Natural restrictions will increase land values only if the city is "closed." However, wages must fall as natural restrictions increase for the same result to be true in "open" cities.

contains a description of the model and data, which is followed by the empirical results in Section 4. Conclusions are presented at the end of the paper.

II. THE PRICE OF URBAN RESIDENTIAL LAND

The price of urban residential land is a function of the supply and demand for the land. Witte (1975) and Kau and Sirmans (1981) contend that the demand for the land is a derived demand; thus, "differences in the price of urban residential land may occur because of differences in demand for housing, differences in supply of other inputs, or differences in the supply of urban residential land" (Witte 1975, p. 353).

A great deal of literature has focused on the price effects of limitations on the supply of land. These limitations fall into two categories: natural restrictions and land-use controls. Natural restrictions are geographic features, such as bodies of water, mountains, etc., that reduce the amount of land available for development. With the notable exception of the work by Rose (1989a, 1989b), virtually no attention has been focused on natural restrictions and their impact on land prices.[2] In one paper, Rose (1989a) develops a method for measuring the effect that large bodies of water have on the supply of urban land, based on the theory of a monocentric city with a perfectly competitive land market. He calculated "supply indices" for several of the most populous urban areas in the U.S. The index tended toward 1.000 in landlocked areas; in areas surrounded by water, the index was a fraction. Rose (1989a) clearly documents through the application of supply indices in a multiple regression analysis that a substantial portion of the interurban variations in land prices can be explained by natural restrictions on the supply of urban land.

Land-use controls are those controls that are "man-made." That is, they are restrictions enacted by a governmental body to reduce the amount of land available for development and/or to divert people to other areas. The effect of land-use controls on the price of land is widely documented in the literature, both theoretical and empirical.

Theoretical literature concerning land-use controls has identified two sources for their positive impact on real estate prices: (1) controls create excess demand; and (2) controls create "amenity" value. Static models, such as those formulated by Sheppard (1988) and Cooley and La Civita (1982), have attempted to model growth controls and their impact on land prices. Brueckner (1990) and Capozza and Helsley (1989) use an open-city model to cement these observations into theory. Turnbull (1991) and Frankena and Scheffman (1981) specifically focus on the effect of minimum lot size restrictions.[3]

The empirical literature has also documented the direct effect that land-use controls have on residential land values. Research has concentrated on both

[2]Only two other studies [Muth (1969) and Ozanne and Thibodau (1983)] use dummy variables to indicate whether an urban area is bordered by a major body of water. Regression results were inconclusive.

[3]Some authors argue that deed restrictions—private covenants placed into the public record to limit the nature or use of land—replace some of the functions of public zoning. Regulation can only be thoroughly measured by including both public and private restrictions in a study of land values. However, it is impossible to measure intercity "private zoning" (see Speyrer 1989 and Hughes and Turnbull 1996 for details).

interurban variations (Witte 1975) and intra-urban variations (Kau and Sirmans 1981). Work by Shilling, Sirmans, and Guidry (1991) focuses on how state land-use controls explain variations in urban land prices using a system of simultaneous equations. Pollakowski and Wachter (1990) examine the effect of land-use controls on housing prices in the Washington, D.C. area. Even Rose (1989b) attempted to include three measures of man-made land-use controls (a variable representing the number of local governments and two Fischel concentration ratios) in conjunction with his supply indices in a multiple regression analysis. Results were weak.

III. QUANTITY OF URBAN RESIDENTIAL LAND DEMANDED

Following Rose (1989b), it is posited that the quantity of urban residential land demanded is a function of the following explanatory variables: price of the land (P), population (N), and income (Y). Therefore, assuming a logarithmic functional form:

(1) $$\ln D = \ln a_0 + a_1 \ln P + a_2 \ln N + a_3 \ln Y,$$

where D is the quantity of land demanded, while $a_1 < 0$, $a_2 > 0$, and $a_3 > 0$. In equilibrium, quantity supplied (S) equals quantity demanded, thus

(2) $$\ln P = \left(\frac{1}{a_1}\right)\ln S - \left(\frac{\ln a_0}{a_1}\right) - \left(\frac{a_2}{a_1}\right)\ln N - \left(\frac{a_3}{a_1}\right)\ln Y.$$

We also include an independent variable representing growth. It is reasoned that areas that are labeled "high growth" (in terms of change in population and change in civilian employment) have higher land prices. We then test the null hypothesis that the supply of urban residential land, as limited by various restrictions—both land-use controls and natural restrictions—has no effect on price.

Data were collected for twenty-six U.S. cities for the years 1975, 1980, 1985, and 1990. The dependent variable is taken from reports published by the Urban Land Institute (ULI). The prices represent the estimated market value of an "improved 10,000 square foot lot located in a suburban fringe area, zoned for single-family detached development, served by basic utilities and subject to no unusual development restrictions or neighborhood conditions" and are based on surveys of real estate experts in each of the areas.

Data for N and Y are collected from various editions of the *County and City Data Book*, a publication of the Bureau of the Census. Both variables are expected to have positive coefficients.

The measurement of urban land supply constraints for each of the areas under study is of two types: (1) man-made land-use controls; and (2) natural restrictions. Land-use controls are measured by the staff at ULI (see Black and Hoben 1984) by separating various cities into those rated most restrictive and least restrictive based on a multitude of economic growth and local governmental policy characteristics. ULI reports that lot prices (and changes in lot prices) are more strongly correlated with the measure of regulatory restrictions than with the traditional demand variables (population, income, etc.). Natural restrictions on the supply of urban land are quantified through the use of the supply indices developed by Rose (1989a).[4] A description of these indices is provided earlier in this paper. The indices were originally calculated using 1980 data. We reason that we can apply the indices with confidence to our entire data set since not much variation occurred between these years with respect to natural restrictions.

It is possible to segregate the sample of cities into four groups based on their natural restrictions and land-use controls. The sample is first divided into most- and least-restrictive areas based on the ULI rating of regulatory restrictiveness. Each of the two groups is then broken into two more groups—those above and those below the mean of each group's natural supply index. Table 1 presents the list of cities by land-use restrictions.

TABLE 1

List of Cities by Land-Use Restrictions

Panel A
Most Restrictive

	Land Value				
City Name	1975	1980	1985	1990	Rose Index
Boston	$18,176	$23,750	$45,000	$90,000	0.795
Hartford	12,000	20,000	25,000	35,000	0.986
Lexington	10,000	14,000	25,000	31,000	0.997
Miami	11,750	25,000	30,000	37,500	0.726
Minneapolis	9,500	20,000	22,000	25,000	0.903
Pittsburgh	10,000	16,900	20,000	29,500	0.974
Portland	10,000	22,000	22,000	31,250	0.949
Salt Lake City	8,375	16,625	19,750	25,500	0.955
San Diego	15,000	40,000	50,000	150,000	0.778
Seattle	8,000	20,000	31,000	77,500	0.707
St. Louis	10,500	15,000	20,000	25,000	0.964

Panel B
Least Restrictive

	Land Value				
City Name	1975	1980	1985	1990	Rose Index
Albuquerque	$11,650	21,250	28,500	37,500	0.998
Atlanta	8,000	13,250	16,000	18,000	1.000
Charlotte	6,000	9,500	14,250	16,000	0.988
Chattanooga	4,500	7,500	8,750	10,150	0.996
Cincinnati	8,700	15,000	17,500	18,000	0.978
Dallas	9,500	16,000	30,000	32,500	0.992
Houston	7,850	12,000	20,000	18,000	0.996
Indianapolis	7,000	12,000	16,500	21,000	0.995
Jacksonville	8,500	12,000	17,250	30,000	0.846
Kansas City	10,000	14,000	15,000	26,500	0.972
Louisville	9,900	15,125	25,000	23,000	0.970
New Orleans	13,500	21,000	35,000	32,000	0.737
Oklahoma City	7,300	13,000	15,000	15,000	0.991
Phoenix	10,000	20,000	30,000	30,000	1.000
Raleigh	8,580	14,500	25,000	30,000	0.989

The next independent variable used in our estimation is a measure of growth. During each five-year period, cities that have experienced a change in civilian employment greater than or equal to 25% and a change in population

[4]Through correspondence with Rose, we obtained supply indices for several cities that did not appear in the 1989a paper (i.e., Albuquerque, Chattanooga, Jacksonville, Lexington, and Raleigh).

greater than or equal to 7% are deemed high-growth areas; otherwise, they are low-growth areas. This information has been collected from the *County and City Data Book* and the *Survey of Current Business.*

Therefore, the basic equation is:

(3) $$\ln PRICE = b_0 + b_1 \ln POP + b_2 \ln INC + b_3 LDCNTL + b_4 NAT + b_5 GROWTH,$$

where:

PRICE = the price of urban residential land;

POP = population;

INC = per capita income;

LDCNTL = 1 if city is classified as having a high degree of land-use controls, 0 otherwise;

NAT = 1 if city is classified as having a high degree of natural restrictions, 0 otherwise; and

GROWTH = 1 if city is classified as a high-growth area, 0 otherwise.

The natural restrictions and land-use controls can also be modeled using three dummy variables to represent the four groups. The resulting equation is then:

(4) $$\ln PRICE = b_0 + b_1 \ln POP + b_2 \ln INC + b_3 HIGH + b_4 MEDI + b_5 MED2 + b_6 GROWTH,$$

where:

HIGH = 1 if a high degree of natural restrictions and a high degree of land-use controls, 0 otherwise;

MED1 = 1 if a low degree of natural restrictions and a high degree of land-use controls, 0 otherwise; and

MED2 = 1 if a high degree of natural restrictions and a low degree of land-use controls, 0 otherwise.

An alternative version of the equation uses the continuous index for the Rose natural supply index (rather than segregating the sample into most and least restrictive) as well as a crime variable. The crime variable represents quality-of-life variation between cities.[5] Areas with a high degree of crime will experience depressed land prices. A size variable should account for spatial differences between cities. Smaller areas (measured in square miles) should exhibit higher land prices. Information on the number of serious crimes reported to the police and size of each area has also been collected from the *County and City Data Book.*

[5] See Roback (1982), Blomquist, Berger, and Hoehn (1988), and Evans (1990) for a review concerning quality-of-life factors.

Therefore, the basic equation becomes:

$$\ln PRICE = b_0 + b_1 \ln POP + b_2 \ln INC + b_3 LDCNTL + b_4 \ln ROSE + b_5 GROWTH + b_6 \ln CRIME + b_7 \ln SIZE, \quad (5)$$

where:

PRICE = the price of urban residential land;

POP = population;

INC = per capita income;

LDCNTL = 1 if city is classified as having a high degree of land-use controls, 0 otherwise;

ROSE = Rose natural supply index;

GROWTH = 1 if city is classified as a high-growth area, 0 otherwise;

CRIME = number of serious crimes reported to police; and

SIZE = size of area measured in square miles.

We expect the results for all of the regressions to indicate that land prices are significantly higher as the land supply decreases, both as a result of natural and man-made restrictions. The summary statistics for the data set are presented in Table 2.

TABLE 2

Summary Statistics

Variable	mean	s	max	min	N
PRICE	$21,558	$18,071	$150,000	$4,500	104
INC	$9072	$3619	$17,870	$3,781	104
POP	773,081	767,031	3,766,000	134,231	104
ROSE	0.930	0.000	1.00	0	104
LDCNTL	0.580	0.500	1.00	0	104
GROWTH	0.115	0.321	1.00	0	104
CRIME	47,296	31,843	180,308	9041	104
SIZE	203.965	192.586	758.7	17.3	104

IV. EMPIRICAL RESULTS

The empirical results are presented in Table 3. The F-statistics for all of the equations lead us to conclude that urban residential land prices are related to income, population, and supply restrictions. The R^2 values for the first two cases are very high, at approximately 73%. The coefficient of multiple determination for Equation (5) is approximately 50%.

All forms of the model show that natural restrictions and land-use controls have a positive and significant effect on land prices. In our estimation of equation (3), land value is increased an average of 30% due to natural restrictions and an average of 37% due to land-use controls.

TABLE 3
Summary of Empirical Results-Log Case
(t-statistics in parentheses)

Panel A - Equation 3	
Independent Variables	Dependent Variable ln(PRICE)
Constant	0.239 (0.359)
ln(POP)	0.070 (1.575)
ln(INC)	0.921 (10.648)*
LDCNTL	0.372 (5.008)*
NAT	0.300 (4.720)*
GROWTH	0.293 (3.029)*
adjusted R^2	73.23%
F	56.61*
Panel B - Equation 4	
Constant	0.148 (0.217)
ln(POP)	0.077 (1.673)*
ln(INC)	0.920 (10.597)*
GROWTH	0.307 (3.084)*
HIGH	0.661 (7.682)*
MED1	0.408 (4.791)*
MED2	0.337 (3.875)*
adjusted R^2	73.34%
F	44.46*
Panel C - Equation 5	
Independent Variables	Dependent Variable ln(PRICE)
Constant	3.381 (4.538)*
ln(POP)	0.338 (2.923)*
ln(INC)	0.381 (4.105)*
LDCNTL	0.168 (1.997)*
ROSE	0.327 (4.232)*
GROWTH	0.126 (1.747)*
CRIME	-0.193 (-1.937)*
SIZE	0.031 (0.362)
adjusted R^2	50.4%
F	15.97*

*Significant at the 10% level.

Estimation of Equation (4) shows that the coefficients on all three of the dummy variables are positive and significant. The results indicate that (1) a high degree of natural restrictions in an area with a high degree of land-use controls increases land value by an average of 66%; (2) a low degree of restrictions in an area with a high degree of land-use controls increases land value by an average of 41%; and (3) a high degree of natural restrictions in an area with a low degree of land-use controls increases land values by an average of 34%.

In our final estimation, income, population, and growth place upward pressure on the price for urban residential land. On the other hand, areas experiencing a significant amount of crime can expect depressed land values. The model shows that natural restrictions and land-use controls have a positive and significant effect on land prices—land prices are increased an average of 33% due to natural restrictions and an average of 17% due to land-use controls.[6]

V. CONCLUSIONS

This paper examines the impact of both land-use controls and natural restrictions on interurban variations in residential land prices. Using data collected by the Urban Land Institute on the level of supply restrictions by urban areas through land-use controls and the natural supply indexes developed by Rose (1989a), we estimate interurban land price equations. Our results indicate that, as expected, land prices are significantly higher as the land supply decreases both as a result of natural and man-made restrictions.

REFERENCES

Black, T., and J. Hoben. "Effect of Policy Restrictions on Residential Land Prices." *Urban Land* 15 (1984), 3.

Blomquist, G., M. Berger, and J. Hoehn. "New Estimates of Quality of Life in Urban Areas." *American Economic Review* 78 (1988), 89–107.

Brueckner, J. "The Structure of Urban Equilibria: A Unified Treatment of the Muth-Mills Model." In E.S. Mills (ed.) *Handbook of Regional and Urban Economics.* Amsterdam: North Holland, 1987.

________. "Growth Controls and Land Values in an Open City." *Land Economics* 66 (1990), 237–248.

Capozza, D., and R. Helsley. "The Fundamentals of Land Prices and Urban Growth." *Journal of Urban Economics* 26 (1989), 295–306.

Cooley, T., and C. La Civita. "A Theory of Growth Controls." *Journal of Urban Economics* 12 (1982), 129–145.

Evans, A. "The Assumption of Equilibrium in the Analysis of Migration and Interregional Differences: A Review of Some Recent Research." *Journal of Regional Science* 30 (1990), 515–531.

[6]Our equations were also estimated using data collected by the Federal Housing Administration (FHA) on new single-family residential (average and median) land values, as well as raw land values for the same time period. Many observations were missing, thus resulting in a total sample size of only 44. The results obtained using the FHA data set are very similar to that obtained using the ULI data. The authors will be happy to supply these findings to any interested party.

Fischel, W. *Do Growth Controls Matter? A Review of the Empirical Evidence on the Effectiveness and Efficiency of Local Government Land Use Regulation.* Cambridge, MA: Lincoln Institute of Land Policy, 1989.

Frankena, M., and D. Scheffman. "A Theory of Development Controls in a 'Small' City." *Journal of Public Economics* 15 (1981), 203–234.

Hughes, W., and G. Turnbull. "Uncertain Neighborhood Effects and Restrictive Covenants." *Journal of Urban Economics* 39 (1996), 160–172.

Kau, J., and C.F. Sirmans. "The Demand for Urban Residential Land." *Journal of Regional Science* 21 (1981), 519–528.

Muth, R. Cities and Housing. Chicago, IL: University of Chicago Press, 1969.

Ozanne, L. and T. Thibodau. "Explaining Metropolitan Housing Price Differences." *Journal of Urban Economics* 13 (1983), 51–66.

Pollakowski, H., and S. Wachter. "The Effect of Land-Use Constraints on Housing Prices." *Land Economics* 66 (1990), 313–324.

Roback, J. "Wages, Rents and Quality of Life." *Journal of Political Economy* 90 (1982), 1257–1278.

Rose, L. "Topographical Constraints and Urban Land Supply Indexes." *Journal of Urban Economics* 26 (1989a), 335–347.

________. "Urban Land Supply: Natural and Contrived Restrictions." *Journal of Urban Economics* 25 (1989b) 325–345.

Sheppard, S. "The Qualitative Economics of Development Control." *Journal of Urban Economics* 24 (1988), 313–330.

Shilling, J., C.F. Sirmans, and K. Guidry. "The Impact of State Land-Use Controls on Residential Land Values." *Journal of Regional Science* 31 (1991), 83–92.

Speyrer, J. "The Effect of Land-Use Restrictions on Market Values of Single-Family Homes in Houston." *Journal of Real Estate and Economics* 2 (1989), 117–130.

Turnbull, G. "A Comparative Dynamic Analysis of Zoning in a Growing City." *Journal of Urban Economics* 29 (1991), 235–248.

Urban Land Institute. *Market Profiles.* Washington, D.C., various years.

U.S. Department of Commerce, Bureau of the Census. *County and City Data Book.* Washington, D.C., various years.

________. Bureau of Economic Analysis. *Survey of Current Business.* Washington, D.C., various years.

Wheaton, W. "A Comparative Static Analysis of Urban Spatial Structure." *Journal of Economic Theory* 9 (1974), 223–237.

White, M. "Effects of Zoning on the Size of a Metropolitan Area." *Journal of Urban Economics* 2 (1975), 279–290.

Witte, A. "The Determination of Inter-Urban Residential Site Price Differences: A Derived Demand Model with Empirical Testing." *Journal of Regional Science* 15 (1975), 351–364.