The Price Effects of Urban Growth Boundaries in Metropolitan Portland, Oregon

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Gerrit J. Knaap

INTRODUCTION

The late 1960s and early 1970s brought increasing public concern over environmental issues such as rising population growth, resource depletion, and the overall quality of life. The State of Oregon, nationally recognized as a leader in environmental legislation, expressed its environmental concerns with a bold, innovative approach to land-use planning. The 1973 legislature, which created the Land Conservation and Development Commission (LCDC), conceived a system with local participation yet central control. As the state's central planning authority, LCDC directs the planning process through enforcement of statewide goals and guidelines. The plans themselves, however, are drafted, reviewed, redrafted, and enforced at the local level. Once LCDC coordinates and approves all the city, county, and special district plans, the use of all Oregon lands will be closely regulated.

The cornerstone of the land-use program, the urban growth boundary (UGB), represents a planning tool qualitatively different from traditional land-use regulations. The qualitative difference lies in the addition of a new dimension—the dimension of timing. Whereas traditional land-use regulations specify what, where, and how one can improve land, the UGB specifies when one can improve land. In Oregon, current land usage both inside and outside UGBs is regulated by traditional land-use controls—e.g., zoning, tax incentives, fee simple, and building codes—future land usage is regulated by UGBs. Specifically, only land inside a UGB can be converted to urban use before a specified date; land outside a UGB is preserved for nonurban use until after the same specified date.

Using cross-section data, this study measures the effects of UGBs on vacant single-family land values in metropolitan Portland, Oregon. According to conventional economic theory, land-use policies that influence the allocation of land must affect land values. A test for price effects of UGBs, then, determines if UGBs influence land allocation or whether UGBs are currently redundant instruments to existing land-use controls. The test cannot determine welfare effects. Significant price effects might indicate inefficient market intervention; on the other hand, significant price effects may be necessary to correct existing market, or nonmarket, imperfections. This issue surpasses the scope of this study. But it is clear from the language in the goals and guidelines that LCDC's intent is clearly the latter purpose.

PREVIOUS RESEARCH

Previous studies have examined the price influence of land-use controls that specify density, lot size, or allowable use in the current time period.[1] Peterson (1974*a*, 1974*b*)

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[1]Grieson and White (1981) have shown that the price effects of zoning depend upon the specification of the constraint. Allowable-use zoning, density zoning, and minimum-lot zoning all may reduce the value of restricted lots.

tested for the price effects of zoning in Fairfax County, Virginia, and Boston, Massachusetts. In Fairfax County, Peterson found land values influenced by density zoning and found the effects of density zoning influenced by distance to the urban core. In Boston, Peterson found land values affected by minimum-lot zoning. Jud (1980), in a study of the effects of zoning on land values in Charlotte, North Carolina, also found land values influenced by minimum-lot zoning. In an analysis of allowable-use zoning in Brooklin Park, Minnesota, Gleeson (1979) found land values influenced by a development boundary that separates urban land from agricultural land. The evidence regarding allowable-use zoning, however, is mixed. Maser, Riker, and Rosett (1977) found no price differential between single-family and multiple-family land in Monroe County, New York.

In sum, mixed evidence has surfaced regarding the effects of currently effective land-use controls on land values. This study provides further mixed evidence in this regard. What's more, this study also provides mixed evidence concerning the timing of land-use constraints—that is, boundaries that specify *future* land-use constraints may also affect land values and, hence, land allocation.

A PARTIAL EQUILIBRIUM MODEL

Suppose there exist two types of residential land, urban and nonurban, where the difference is enforced by zoning regulations and defined by housing density, minimum-lot size, or some other allowable-use criteria. Suppose further that as a result of zoning, urban rents, R_u, are higher valued than nonurban rents, R_n, for some radial distance from the urban core. For ease of graphical exposition, urban rents are assumed to decline linearly with distance, *t,* and nonurban rents are assumed spatially invariant under permanent zoning. The market values of urban and nonurban land equal the present value of their respective rental streams. That is,

$$P_n = R_n + R_n/(1+r)^1 + R_n/(1+r)^2 + \cdots R_n/(1+r)^\infty \quad [1a]$$

$$P_u(t) = R_u(t) + R_u(t)/(1+r)^1 + \cdots R_u(t)/(1+r)^\infty \quad [1b]$$

Figure 1 illustrates the behavior of urban and nonurban land values with distance to the urban core under the above assumptions and under the assumption that zoning designations are permanent. Urban land is higher valued to distance t'. Beyond distance t', all land commands nonurban land values. This occurs because zoning regulations typically prohibit nonurban land from urban use but not urban land from nonurban use.

When zoning designations are not permanent, and nonurban land may become urban land sometime in the future, the values of urban and nonurban land remain the present value of the expected rental streams but with certain modifications:

$$P_n(t) = R_n + R_n/(1+r)^1 + \cdots R_n/(1+r)^{x-1} + R_u(t)/(1+r)^x \cdots R_u(t)/(1+r)^\infty \quad [2a]$$

where x = expected date of up-zoning;

$$P_u(t) = R_u(t) + R_u(t)/(1+r)^1 + \cdots R_u(t)/(1+r)^\infty \quad [2b]$$

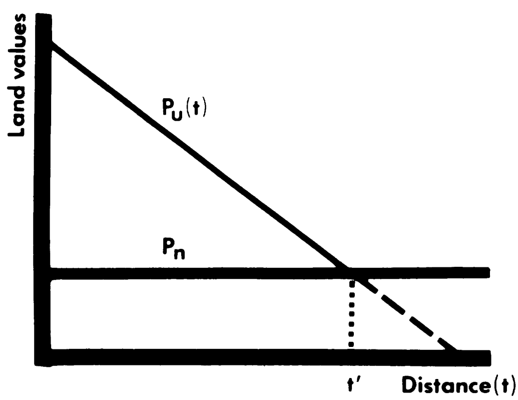

FIGURE 1
LAND VALUES WITH DISTANCE UNDER PERMANENT ZONING

Figure 2 illustrates the behavior of urban and nonurban land values with distance to the urban core under these assumptions. The value of nonurban land increases by the present value of the incremental rent received following up-zoning to urban land and incidentally becomes spatially variant. That is, nonurban land values at $t < t''$ reflect expectations of future urban rents, and urban rents vary with distance to the urban core.

UGBs, in specifying when nonurban land can convert to urban land, affect land values in this simple model as follows:

$$P_n^i(t) = R_n + R_n/(1+r)^1 + \cdots R_n/(1+r)^{x-1} + R_u(t)/(1+r)^x \cdots R_u(t)/(1+r)^\infty \quad [3a]$$

where, e.g.,

P_n^i = price of nonurban land inside the boundary, and x is the expected date of up-zoning inside the boundary;

$$P_n^0(t) = R_n + R_n/(1+r)^1 + \cdots + R_n/(1+r)^x + \cdots + R_n/(1+r)^{y-1} + R_u(t)/(1+r)^y \ldots R_u(t)/(1+r)^\infty$$

where, e.g.,

P_n^o = price of nonurban land outside the boundary, and y is the expected date of up-zoning outside the boundary, and $y > x$;

$$P_u^i(t) = R_u(t) + R_u(t)/(1+r)^1 + \ldots R_u(t)/(1+r)^\infty \quad [3b]$$

$$P_u^0(t) = R_u(t) + R_u(t)/(1+r)^1 + \ldots R_u(t)/(1+r)^\infty$$

Figure 3 illustrates the effects of an UGB on urban and nonurban land values. Land

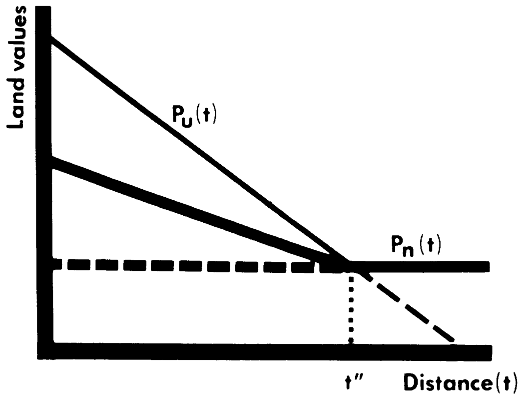

FIGURE 2
LAND VALUES WITH DISTANCE UNDER NONPERMANENT ZONING

values in urban zones will not vary across the UGB. UGBs indicate when nonurban land may become urban land and receive urban rents; and since land in urban zones already receives urban rents, urban land values will not vary across the UGB. Land values in nonurban zones, however, will vary across the UGB. The price differential equals the difference between the present value of the expected rental stream inside the boundary and the present value of the expected rental stream outside the boundary due to the difference in timing of allowable urban development. That is,

$$P_n^i(t) - P_n^0(t) = [R_u(t) - R_n]/(1+r)^x + [R_u(t) - R_n]/(1+r)^{x+1} \ldots \times [R_u(t) - R_n]/(1+r)^{y-1} > 0 \quad [4a]$$

$$P_u^i(t) - P_u^0(t) = 0 \quad [4b]$$

In sum, the model above describes the effects of an UGB—a demarcation of where zoning changes and future urban development may take place—on urban and nonurban land values. As the model is specified, urban land may exist outside the UGB; urban development may have been allowed in the past where additional urban development is

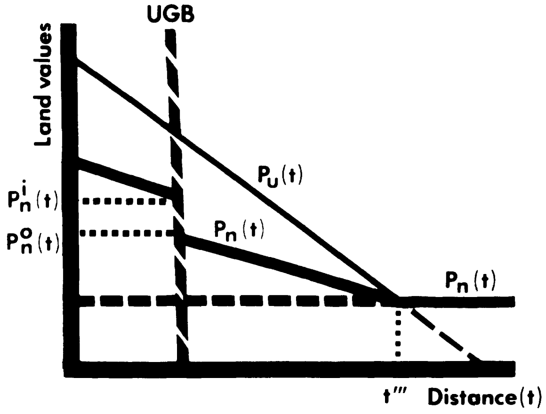

FIGURE 3
LAND VALUES WITH DISTANCE AND AN UGB

not currently permitted. The value of urban land outside the boundary, if it exists, will not diverge from the value of urban land inside the boundary except due to non-UGB differences. That is, the value of land currently designated for urban use will not be affected by a boundary that identifies land that may become urban in the future.[2] Nonurban land values, however, will diverge at the UGB. Zoning changes to urban use are expected sooner inside the UGB than outside the UGB; hence, since urban land values are assumed higher than nonurban land values, nonurban land values inside the UGB will be higher than nonurban land values outside the UGB.

METHODOLOGY

Hedonic price estimation is used to test the model above. The hedonic equation may be expressed as follows:

$$P_L = B_o + E\beta_{1j}E_j + \beta_2\text{URBAN} + \beta_3(\text{NONURBAN} * \text{UGB}) + \beta_4(\text{URBAN} * \text{UGB}) + w;$$

where,
P_L = the market price per acre of the homesite;
E_j = a vector of extraneous variables;
URBAN = a dummy variable indicating zoning (urban = 1);
NONURBAN = a dummy variable indicating zoning (nonurban = 1);
UGB = a dummy variable indicating location with respect to the UGB (outside = 1); and,
w = a stochastic disturbance.

Similar specifications have been employed by Peterson (1974*b*) and Diamond (1980) and permit measurement of the effects of land-use controls on subsets of observations—in this case, the effect of the UGB is measured on urban and nonurban land values.

Three implications of the suggested model can be tested using the above hedonic equation. First, the effects of zoning can be tested by estimating β_2; if $\beta_2 > 0$, then urban land is higher valued than nonurban land. Second, β_3 provides a measure of the price effects of UGBs on nonurban land values; if $\beta \leq 0$, then nonurban land values are higher inside the UGB than outside the UGB (e.g., equation [4a]). Third, β_4 provides a measure of the price effects of UGBs on urban land values; if $\beta_4 = 0$, then urban land values do not diverge at the UGB (e.g., equation [4b]).

THE DATA

The data consist of every vacant single-family homesite sold during fiscal year 1980 in Washington and Clackamas counties.[3] According to the county assessors' offices, each of the observations represents an "arm's length" transaction, which suggests a sale at true market value. All 455 transactions were recorded between September 1979 and August 1980, approximately four years after the UGB was originally drawn.

[2]In a general equilibrium model, the value of urban land may be affected by a UGB. The magnitude of the effect depends on the elasticities of demand for urban and nonurban land and the cross-price elasticity of demand between the two markets. See, e.g., Ohls, Wiesberg, and White (1974).

[3]Observations were also gathered from Multnomah County but were excluded for a lack of observations outside the growth boundaries. Further, Chow tests, which showed instability of coefficients across county submarkets, precluded any pairwise pooling of observations.

The relevant zoning designation for each parcel was obtained from the local zoning authority and classified as urban or nonurban. A parcel is classified as nonurban if zoning restricts development to less than 4.4 units per acre; a parcel is classified as urban if zoning permits development greater than 4.4 units per acre. Thus in this classification system, the difference between urban and nonurban land is defined in terms of density zoning—and this is the classification system used to enforce the UGB.

A dummy variable captures the relationship of the parcel of land to the UGB: a value of zero for the UGB dummy variable indicates location inside the boundary; a value of one indicates location outside the boundary. Parcels inside the UGB can be developed at urban densities before the year 2000, parcels outside the UGB cannot. The UGB coefficient should be interpreted as the decrease in price per acre of a parcel located outside the UGB compared to a parcel inside the UGB.

One additional variable should be explained. The Intermediate Growth Boundary (IGB) identifies properties lying in areas designated as future urban or specially regulated. These designations exist as a political compromise over the placement of the UGB and are locally enforced. Properties outside the IGB cannot currently be developed at urban densities, but will presumably convert to urban use before properties outside the UGB. The IGB, then, can be perceived as a UGB within a UGB, the IGB having an earlier expiration date. The two variables are mutually exclusive; a value of one for either precludes the same for the other.[4]

RESULTS

Table 1 presents ordinary-least-squares estimates of the hedonic valuations. The model of the price effects of the UGB suggests that the impact of the UGB should be proportional to the value of land, hence the regression is specified in the log form.[5] Further, the equation is specified in double-log form to overcome multicollinearity problems between the noncategorical independent variables.

Washington County

The results in Washington County were robust. Out of eleven variables used to capture extraneous determinants of land value, seven were significant with expected signs. In brief, land values were higher for parcels located within 300 feet of a sewer line; land values are higher for parcels located in incorporated municipalities; and land values are higher for parcels located in recorded plats. Land values increase with the median income of the census tract and increase slightly over the fiscal year. Land values decrease with distance to the urban core and decrease (in per acre terms) with the size of the parcel.

The Oregon land-use program affected land values in Washington County as suggested by the model above. Holding other things constant, urban land is higher valued than nonurban land, as measured by the variable URBAN. Further, nonurban land values are higher inside the UGB than outside the UGB, as measured by the variable NONURBAN*UGB. Urban land, however, does not exist outside the UGB, hence, the effect of the UGB on urban land values cannot be measured.

Nonurban land values inside the IGB are also higher than nonurban land values outside the IGB, as measured by the variable NONURBAN*IGB. But urban land values inside the IGB are not higher than urban land values outside the IGB, as measured by the variable URBAN*IGB. Further, the effect of the IGB on urban and nonurban land values is not the same; that is, the coefficient on the variable NONURBAN*IGB is significantly different

[4]The IGB was created to correct what LCDC perceived as an excess amount of land inside the Portland metropolitan UGB. To preserve rich agricultural farmland for as long as possible from urban encroachment, a "line within a line" approach was adopted. All land within the UGB is designated for urban use before the year 2000; but land within the IGB must be developed first—preserving for a time those lands best suited for agricultural use. The concept of the IGB was drawn from the UGB; hence its effect on land values should be similar, but with a different time dimension. A map showing the IGB and UGB is provided in Appendix B.

[5]I am indebted to an anonymous reviewer for pointing this out.

TABLE 1
SINGLE-FAMILY VACANT LAND, FY-1980

	Washington County	Clackamas County
URBAN	.267 (1.80)*	−.407 (1.74)
NONURBAN*UGB	−.980 (4.10)**	−.645 (2.50)**
NONURBAN*IGB	−.944 (5.57)**	−.258 (.78)
URBAN*IGB	−.005 (.03)	−.064 (.28)
ACCESS	−.404 (2.36)**	−.019 (.12)
ACRES	−.186 (2.85)**	−.665 (10.12)**
SEWER	.148 (1.71)*	.470 (2.79)**
PLAT	.506 (4.23)**	.084 (.44)
NOCITY	−.374 (3.61)**	−.140 (1.11)
PORTLAND	.255 (.48)	
TAX	.414 (.95)	−1.442 (3.35)**
INCOME	1.055 (2.31)**	.311 (1.11)
RACE	−1.048 (.39)	6.278 (1.34)
SLOPE	−.108 (.50)	.087 (.89)
DATE	.085 (1.73)*	.057 (1.16)
Constant	11.061	−5.751
R^2	.812	.787
N	267	188
F	72.38	45.75

*Significant at the 95% level; one-tail test.
**Significant at the 99% level; one-tail test.

than the coefficient on the variable URBAN*IGB.[6]

In sum, and as the model suggested, urban land is higher valued than nonurban land; nonurban land inside a growth boundary is higher valued than nonurban land outside a growth boundary; and urban land, when it exists on both sides of a growth boundary, is not higher valued inside the boundary than outside the boundary.

Clackamas County

The results in Clackamas County were mixed. Of ten variables used to capture extraneous determinants of land value, only three were significant. In brief, land values are higher for parcels located within 300 feet of a sewer line, and land values decrease with property-taxation levels and decrease (in per acre terms) with parcel size.

The model of the Oregon land-use program is supported only in part by the results in Clackamas County. Urban land values could not be shown higher valued than nonurban land values. In fact, the variable URBAN is nearly significant in the opposite direction. However, nonurban land values inside the UGB are higher than nonurban land values outside the UGB, as measured by the variable NONURBAN*UGB. The effect of the UGB on urban land values, again, cannot be measured.

The IGB could not be shown to affect either urban or nonurban land values. Both the variables NONURBAN*IGB and URBAN*IGB are insignificant; and the effect of the IGB on urban and nonurban land values cannot be shown significantly different.[7]

In sum, two of the variables used to capture the effects of the Oregon land-use program support the model above. Nonurban land values are higher inside the UGB than outside the UGB, and urban land values are not higher inside the IGB than outside the IGB. But two of the land-use variables do not support the model above. Urban land values are not higher than nonurban land values, and nonurban land values inside the IGB are not higher than nonurban land values outside the IGB.

Explaining The Mixed Results

The results confirm a significant UGB effect on land values in both Washington and

[6]A test using linear restrictions rejects the hypothesis $\beta_3 = \beta_4$ (for the IGB) at the 99% level. $F_{test} = 20.027$.

[7]A test using linear restrictions could not reject the hypothesis $\beta_3 = \beta_4$ (for the IGB) at the 90% level. $F_{test} = .067$.

Clackamas counties, but the difference in the measured effects of the variables URBAN and IGB between the two counties warrants further comment. As the principal instrument of the statewide land-use program, the UGB is enforced ubiquitously throughout the metropolitan area; the enforcement of land-use constraints inside the UGB, however, remains the responsibility of local planning agencies. What's more, the Metropolitan Service District, the metropolitan-wide planning agency for Portland, Oregon, "has acted to insure a degree of latitude that local jurisdictions may exercise in adopting growth management strategies [inside the UGB]."[8] Thus the difference in the measured effects of the variables URBAN and IGB is likely the result of a difference in the enforcement of the constraints these variables represent.

"Washington County, with large areas having sewer and water service has existing and strictly enforced immediate urban and future urban areas."[9] Because of this longstanding resolve to enforce current and future land-use controls, the land-use program in Washington County operates precisely as suggested by the general model and affects land values accordingly.

Unlike Washington County, however, Clackamas County has not resolved to enforce the existing land-use controls inside the UGB. "Clackamas County, without the luxury of broad sewer coverage, has opted in their Comprehensive Plan for a growth management strategy of a flexible line-within-a-line approach."[10] That is, Clackamas County has not resolved to enforce existing zoning restrictions and the IGB to control development inside the UGB. Instead, the county has chosen to keep its land-use controls inside the UGB flexible and conditional upon the availability of sewer service. Hence, land values in Clackamas County are less influenced by zoning and the IGB and are more influenced by the availability of sewer service.

In sum, the mixed results reflect in part the resolve of the planning agencies to enforce existing land-use controls. The effect of the UGB is significant in both counties because the UGB must be enforced by order of the state land-use authority, LCDC. The effects of zoning and the IGB are significant in Washington County where the county has chosen to enforce its zoning restrictions and to use the IGB as a growth boundary within a growth boundary. The effects of zoning and the IGB are insignificant in Clackamas County where the county has chosen to use flexible short-term land-use controls inside the UGB.

CONCLUSION

This analysis of the residential land market in metropolitan Portland, Oregon, sought to identify the price effects of urban growth boundaries. A model of the effects of UGBs was presented where it was suggested that UGBs affect land values via the timing of traditional land-use constraints. Observations of land values in the market place were then used to test the suggested model.

The results were mixed but explicable. The UGB was found a significant influence on land values in both counties; the effects of zoning and the IGB varied between Washington and Clackamas Counties. In Washington County, where the instruments to control growth were fixed and strictly enforced, the results strongly support the general model. Urban land values were higher than nonurban land values, nonurban land values were shown divergent at growth boundaries, and urban land values could not be shown divergent at a growth boundary. Thus, land-use restrictions on both current and future urban development were found to affect land values as expected.

In Clackamas County, where the instruments to control growth inside the UGB were flexible and weakly enforced, the results support the general model only in part. Nonurban land values were shown divergent at the UGB, and urban land values were not shown divergent at the IGB. Contrary to the model, urban land values were not higher than nonurban land values, and nonurban land values could not be shown divergent at the IGB. Thus, only one of the land-use restrictions—

[8]The Metropolitan Service District (1979), p. 46.
[9]*Ibid.*, p. 46.
[10]*Ibid.*, p. 46.

one on future urban development—was found to affect land values as expected. But then only one of the land-use restrictions is effectively binding in this county.

Although the UGB was found a significant influence on nonurban land values in both Washington and Clackamas counties, only the IGB provided evidence regarding the effects of growth boundaries on urban land values. This was not surprising. By design, UGBs in Oregon encompass all urban areas in the state; therefore, the effects of the UGB on urban land values cannot be measured using cross-section data. Time series data, then, must be used to uncover further information on the price effects of UGBs on urban land values. This is left for future research.

Turning now to allocative impacts, the observed price differentials in nonurban land values suggest that UGBs are not redundant instruments. If growth boundaries specify timing—as they appear to do, especially in Washington County—their allocative impacts are not as obvious as they first seem. Urban growth boundaries, as they are used in Oregon, do not currently constrain urban land supplies—traditional zoning regulations do. If the land area inside the Portland metropolitan UGB doubled, *urban* land supplies would not increase. Only when additional land is zoned for urban use will the supply of urban land increase. Therefore, the *currently* effective urban growth boundary is the outline of all land currently in urban zones.

Higher nonurban land values inside UGBs reflect expectations of future urban zoning and, hence, future urban rents. These expectations, however, have current allocative impacts. The impacts, once again, are manifest through the timing of the conversion of land from nonurban use to urban use. Land is converted to urban use as soon as zoning permits, since, as a result of zoning, urban rents are higher than nonurban rents. Therefore, nonurban land inside UGBs will be used less intensively than nonurban land outside UGBs. This occurs because all fixed costs in agricultural production must be recovered before the land is converted to urban use. Existing production on nonurban land is unaffected by UGBs, but no new nonurban improvements—e.g., irrigation systems, fencing, and nonresidential structures, etc.—will be made inside UGBs unless the costs of the improvements can be recovered before the expected date of conversion to urban use. As a result, nonurban land inside UGBs will be prepared for conversion to urban use, while nonurban land outside UGBs will remain free of speculative influence. These are the exact effects UGBs were intended to have in Oregon. But additional research is necessary before these or other conclusions can safely be drawn.

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APPENDIX A
Description of Variables

VARIABLES	DEFINITION	SOURCE	EXPECTED SIGN
Dependent Variable:			
1. Price	the sales price divided by the number acres in the sale	the county sales-ratio reports	
Independent Variables:			
1. Access	peak-hour travel time in minutes to downtown Portland	Metro* transportation matrix	negative
2. Acres	the number of acres in the sale	the county assessor's maps and files	negative
3. Sewer	dummy variable; 1 if within 300 feet of a sewer line	Metro overlay maps	positive
4. Slope	dummy variable; 1 if sloped more than 25 percent	Metro overlay maps	negative
5. Income	median income of the census tract	1970 census	positive
6. Race	percentage of the census tract that is white	1970 census	positive
7. URBAN	dummy variable; 1 if zoned for single-family use greater than 4.4 units per acre	Metro generalization of local zoning codes	positive
8. NONURBAN*UGB	dummy variable; 1 if zoned for single-family use less than 4.4 units per acre and located outside the UGB	Metro generalization of local zoning codes and metro maps	negative
9. NONURBAN*IGB	dummy variable; 1 if zoned for single-family use less than 4.4 units per acre and located outside the IGB but inside the UGB	Metro generalization of local zoning codes and metro maps	negative
10. URBAN*IGB	dummy variable; 1 if zoned for single-family use greater than 4.4 units per acre and located outside the IGB but inside the UGB	Metro generalization of local zoning codes and metro maps	zero
11. Tax	property tax rate per $1,000 of assessed value	county assessor's office	negative
12. Date	Discrete index of sales date; 1 = Sept. 1979, 12 = Aug. 1980	sales-ratio reports	positive
13. Portland	dummy variable; 1 if in the City of Portland	county tax codes	negative
14. Nocity	dummy variable; 1 if unincorporated in a local municipality	county tax codes	negative
15. Plat	dummy variable; 1 if located in a recorded plat	county records	positive

*METRO is an abbreviation for the Metropolitan Service District, the metropolitanwide planning agency in Portland, Oregon. Metro coordinates the planning efforts of the local planning agencies and is responsible for enforcing the UGB.

DESCRIPTIVE STATISTICS

	Washington Co.		Clackamas Co.	
	mean	std. dev.	mean	std. dev.
URBAN	.599	.491	.718	.451
NONURBAN*UGB	.082	.275	.228	.421
NONURBAN*IGB	.255	.437	.021	.145
URBAN*IGB	.045	.207	.032	.176
ACCESS	28.899	9.726	29.617	8.017
ACRES	.748	.195	.577	.663
SEWER	.427	.496	.681	.467
PLAT	.790	.408	.773	.449
NOCITY	.618	.487	.394	.490
PORTLAND	.004	.061	.000	.000
TAX	1998.528	156.935	1989.064	221.630
INCOME	11363.974	1616.535	11738.989	2017.018
RACE	95.562	1.422	97.612	.797
SLOPE	.026	.160	.165	.372
DATE	7.281	3.532	6.505	3.387

APPENDIX B