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The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space

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I. INTRODUCTION

Implicit in the concept of greenbelts are two complementary purposes: the preservation of land in a natural, garden-like, or agrarian state, and the shaping and limitation of urban spread. F. J. Osborn traces the greenbelt concept back to roughly the 13th century B. C., when

> The Lord said to Moses . . . . "Command the people of Israel, that they give to the Levites . . . cities to dwell in; and pasture lands round about the cities. The cities shall be theirs to dwell in, and their pasture lands shall be for their cattle and for their livestock and for all their beasts. The pasture lands of the cities . . . shall reach from the wall of the city outward a thousand cubits all around" [*Numbers* 35: 1–4].

Preservation was clearly a purpose: ". . . the fields of common land belonging to their (the Levites') cities may not be sold; for that is their perpetual possession" [*Leviticus* 25:34].

Osborn develops strains of the greenbelt concept from the Old Testament through Plato, Aristotle, Roman city-planning, Thomas More's *Utopia* and Robert Owen, but credits Ebenezer Howard's *Garden Cities of Tomorrow* for uniting the complementary purposes of limiting urban spread by preserved open space [Osborn 1946, pp. 167–80]. These ideas led to the Green Belt Act of 1938 for London and its neighboring counties, as well as the founding of such towns as Greenbelt, Maryland; Greendale, Wisconsin; and Greenhills, Ohio, during the 1930s [Mayer 1967].

In the last decade the greenbelt concept has acquired new importance, particularly at the suburban level, where many communities have become acutely aware of the twin phenomena of sprawl and a decimated stock of open space. The subject of this study, Boulder, Colorado (located in the Denver-Boulder SMSA), found in the 1960s that its policies to control development, particularly of its mountain backdrop, were inadequate [Schulman 1972]. In 1967 Boulder voters approved a proposal to establish a fund for purchasing and managing green-

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belts, financed by a 0.4% city sales tax, which generates over one million dollars per year in revenue.[1] To date, the Boulder Open Space Program has purchased some 8,000 acres in and around the city.

Policy debates in Boulder as well as in other communities have stressed the local public good benefits of controlling growth and preserving open space [City of Boulder 1974]. For the most part this emphasis has overlooked the quasi-public good benefit which is associated with the increased property values adjacent to greenbelts and which could provide additional tax revenue to support such purchases.

In this paper we examine the quasi-public good effect of greenbelts in Boulder, Colorado. In the following section we briefly present the theoretical model employed in the analysis, which suggests that under certain circumstances price differentials may be used to evaluate this quasi-public good. Data from three separate greenbelt areas in the city are then used in a multiple regression analysis to empirically evaluate the effect of greenbelt proximity on property price. The final section of the paper presents some of the policy implications of these findings, which we argue also apply to the problem of greenbelt provision in other suburban communities in the United States.

2. THE MODEL AND DATA BASE

The classic models of urban rent determination have focused mainly on the transportation-saving aspect associated with alternative locations [Muth 1969, Möhring 1961]. In the last few years, however, urban experts have begun to focus on the ways in which amenities and disamenities affect urban residential property values. In this context the effects upon property values of neighborhood parks, lakes and reservoirs, air pollution, aircraft noise and the location of power plants have been examined [Weicher and Zerbst 1973; Hammer, Coughlin and Horn 1974; Darling 1973; Ridker and Henning 1967; Gautrin 1975; Blomquist 1974; Knetsch 1964].

In these models the commodity "housing" is taken to represent the bundle of services offered by the land and the structure, which can usefully be classified into three categories: locational advantage, space and structural services, and amenities [Gautrin 1975]. These models either assume that purely or workably competitive markets exist or utilize some assignment-type model which allows theoretical interpretation of price differentials for urban property. In particular, when some project is carried out which affects the level of amenities in some part of the urban area, if the structural services and the locational advantage of each housing unit are held constant, then price differentials which exist can be attributed to the amenity. Economic theory implies that these price differentials will be equal to the capitalized value of the externality generated by this amenity.[2]

[1] We believe Boulder was the first city to approve a tax earmarked for greenbelts, but a large number of cities throughout the United States and Europe have city-financed greenbelt programs.

[2] Lind models this process and demonstrates that the theoretical result given here requires either that greenbelt purchases affect only a relatively small amount of land so that only land around the greenbelt will change in price, or that all profits and consumer surpluses have been eliminated by the market [Lind 1973]. In this analysis it seems appropriate to assume that the purchase of greenbelt property by the city has been small enough so as to leave the rental value of properties removed from the greenbelt largely unchanged. Substantial expansion of greenbelt purchases could make estimation of these quasi-collective benefits more difficult.

In the case of greenbelts some further clarification of this externality is desirable. Specifically, there are two public good aspects. First, Boulder's open space is a public good which benefits everyone in the Boulder area. The most compelling argument may be made for the view of the mountain backdrop, which is consumed collectively and virtually without exclusion; thus, the view approaches pure public good status. It may also be argued that there is considerable option demand elsewhere for Boulder open space; a number of people may be willing to pay something to maintain open space in Boulder even if they have no present plans to utilize it. Second, specific parcels of greenbelt benefit those living nearby. In this sense specific parcels are quasi-public goods, because there is some exclusion from benefit due primarily to distance. Given that city open space is supplied to consumers at a zero price, an "excess demand" results for the private assets associated with access to this public good [Margolis 1968, pp. 545–46].[3] Therefore, if greenbelts are a quasi-public good conferring a benefit, one would expect that the price of nearby land, the consumption of which is rival, would include a rent reflecting the value of the greenbelt externality. It is the value of this quasi-public good that we propose to evaluate, and we proceed by testing the hypothesis that, holding all other variables constant, residential property values decline with distance from a greenbelt in its neighborhood.

We assume that housing markets are at least workably competitive so that in the long run properties become assigned in accordance with maximum profit and utility conditions. To examine the effect of greenbelts on property values we selected three different areas of Boulder where a total of 1,382 acres of greenbelt property had been purchased adjacent to residential developments over the last ten years. In each of these areas we collected data for a sample of single-family residential properties which sold in 1975 and which were located within 3,200 feet of the greenbelt. Some major neighborhood characteristics and the size and cost of greenbelt purchases for each of these three samples are given in Table 1.

Drawing on the literature [Brigham 1965; Downing 1970; Hammer et al. 1974; Ridker and Henning 1967] we constructed a model relating price to property characteristics. The variable definitions and sources are as follows:

P	=	Sales price of single-family residential property in 1975, from County Tax Assessor.
DGB	=	Walking distance in feet, using most direct public access to greenbelt, estimated from City and County Planning Department maps.[4]
AGE	=	Age of the house in 1975, from Assessor.
RMS	=	Number of rooms as counted by Assessor.
FSF	=	Finished square footage of house, measured by Assessor.
AL	=	Dummy variable for average lot size, 1 if average, 0 otherwise, estimated from Planning maps. "Average" is defined by the aggregate sample of 85 properties.
ABL	=	Dummy variable for above-average lot size, 1 if above average, 0 otherwise.

[3] Individuals in the city, of course, pay additional sales tax to support the greenbelt program, but this payment is invariant with proximity.

[4] Hammer, Coughlin, and Horn [1974, p. 275] found that public-access distance was superior to straight-line distance in explaining variations in sales price.

TABLE I
CHARACTERISTICS OF PROPERTY SAMPLES AND GREENBELT PARCELS IN THREE NEIGHBORHOODS

Neighborhood Sampled	Number of Observations	Average Property Value	Average Age of House (years in 1975)	Distance from Downtown (miles)	Year of Greenbelt Purchase	Size of Greenbelt (acres)	Cost of Greenbelt Purchase
Sample One	36	$67,700	4	4	1968–71	924	$1,477,000
Sample Two	31	39,000	5	9	1974	74	283,000
Sample Three	18	30,000	39	1.5	1970–74	384	901,000
Totals	85	$49,172				1,382	$2,661,000

D = Urban distance, estimated from county map; this variable was calculated as follows:[5] (2/3) (average distance from neighborhood to center of city) + (1/3) (average distance from neighborhood to nearest major shopping center).

Neighborhood characteristics, such as Downing's use of deterioration, race, education and income, or Ridker and Henning's use of housing density, occupational distribution and income, were not readily available and were not used. This was assumed not to be restrictive to our analysis because in socioeconomic conditions Boulder is a relatively homogeneous community, and because we believed that the age and lot size variables would tend to capture deterioration and density. A zoning variable might have been a good proxy for some neighborhood effects, but zoning did not vary significantly among the three neighborhoods sampled. Property tax rates also did not vary sufficiently, and hence were not included in the model.

We originally included additional housing characteristic variables in our model, e.g., number of bedrooms, number of bathrooms, dummy variables for presence of a basement and a garage, and structural design and construction dummy variables. These variables did not add to the explanatory power of our model and led to problems of multicollinearity.

A reviewer suggested that we include a variable that would capture the differences of view over the valley that exist because of varying degrees in elevation. We experimented with this variable in the one relevant neighborhood but discovered it did not enter as statistically significant. Some discussion of these efforts is included later in the paper, but after consideration of these factors we settled on the above model.

3. EMPIRICAL RESULTS

We first used ordinary least squares procedures to estimate the relationship between greenbelt proximity and property values for the aggregate sample of 85 observations. Second, we estimated the relationship within each neighborhood independently. Finally, we focused

[5] We assumed that urban distance has no effect on prices within a neighborhood, but is significant for price comparisons among different neighborhoods.

on one particular neighborhood to explore further the potential implications of neighborhood open space. The regression results for the aggregate sample are as follows (standard errors are shown in parentheses):

$$\hat{P} = 004 - 4.2DGB^{*} - 169AGE - 2618RMS^{*}$$
$$(1.0) \quad (124) \quad (619)$$
$$+ 14.2FSF^{*} - 4726.4L^{*} + 4806.4BL$$
$$(1.8) \quad (1723) \quad (2668)$$
$$+ 10833D^{*} - 1599D^{2*}$$
$$(5044) \quad (613)$$

$n = 85$; Adjusted $R^2 = .91$, $F = 105$
* significant at the .05 level

These results are generally consistent with our a priori expectations. Each of the coefficients of the explanatory variables has the expected sign and, with the exception of age of house, all are statistically significant at conventionally acceptable test levels. We dismissed heteroskedasticity as a potential problem because theoretically it did not seem that the variance of price would be related to the location of properties. No serious multicollinearity persisted in this or the other models presented in this paper.

According to our regression results, distance from the greenbelt has a statistically significant negative impact on the price of residential property. Specifically, other things being equal, there is a $4.20 decrease in the price of a residential property for every foot one moves away from the greenbelt. The hypothesize that near the open space, individuals with a high demand for proximity bid up prices for residential space, the consumption of which is rival. At greater distances, not only is there more space, but also the benefit conferred becomes less and less, so that eventually there is no effect from the specific greenbelt as a neighborhood quasi-public good; however, all properties are still affected by the area-wide public good.[5]

TABLE 2
VALUE OF THE AVERAGE HOUSE AND GREENBELT PROXIMITY*

Walking Distance from Greenbelt	Average Value of House
30 feet	$54,379
1,000	50,348
1,283	49,172
2,000	46,192
3,200	41,206

* These results are calculated using the partial regression coefficient on *DGB* and by assuming that the sample's average value property is located at the average distance for the sample

Some feeling for the impact of proximity is reflected in the finding estimated from the above results that if other variables are held constant, the average value of properties adjacent to the greenbelt would be 32% higher than those 3,200 walking feet away. This relationship is illustrated in Table 2.

Other variables are also significant. As expected, both finished square footage and the number of rooms have strong positive effects on price. Specifically, each additional finished square foot raises the price of the property by $14.20, and each additional room raises the price of the property by $2,618, *ceteris paribus*.

[5] This line of analysis suggests, *ceteris paribus*, a negatively sloped curvilinear relationship between price and distance from greenbelt; this negative slope would approach zero at some distance where the neighborhood greenbelt effect was negligible. Quite to the contrary, we found for all the equations estimated in this paper that a linear form provided a better fit than log, semi-log, reciprocal, or quadratic forms. Confronted with this linearity, we arbitrarily assumed that the neighborhood effect ends at 3,200 feet. Darling [1973] and Blomquist [1974] also chose linear forms.

TABLE 3
REGRESSION RESULTS FOR THREE SEPARATE RESIDENTIAL NEIGHBORHOODS WITH ADJACENT GREENBELTS

	Neighborhood		
Variable	One	Two	Three
Constant	34,730	20,549	11,567
DGB	−10.2* (1.8)	3.4* (1.6)	−3.0 (2.7)
AGE	938* (433)	302 (758)	−448* (174)
RMS	2,307* (772)	2,206* (950)	6,427 (3034)
FSF	8.3* (2.8)	0.2 (2.3)	3.2 (5.0)
AL	5,745 (2994)	714 (1183)	8,763 (4234)
ABL	9,479* (3992)	−969 (1908)	11,000 (7650)
n	36	31	18
Adjusted R^2	.92	.71	.67
F	66.5	13.5	6.7

Note: Standard errors are shown in parentheses.
* Significant at the .05 level.

The lot size dummy variables are jointly significant. As expected, lot size and price relate positively. A house with an average lot size costs $4,726 more than a house with a below-average lot size, holding all other factors constant. Likewise, relative to a house with a below-average lot size, a house with an above-average lot size is $4,806 more expensive, *ceteris paribus*.

Holding other factors constant, we expected older houses to have lower prices relative to newer ones. Although age of house enters with the expected sign, it is not statistically significant at the .05 level. An explanation for this is offered later in the paper.

Finally, urban distance relates to price as a quadratic curve, concave downward. As one moves away from the city center, there is initially an increase in property prices. With additional distance, however, the urban distance function becomes negatively sloped.

In addition to the aggregate sample, individual equations were estimated for each of the three greenbelt neighborhoods. This was considered desirable due to major differences among the three neighborhoods. These results are summarized in Table 3.

While these results are generally consistent with our expectations and the results of the aggregate model, the coefficient on *DGB* is not well behaved in these equations. We believe that the explanation of this lies in the timing and planning of these greenbelt purchases in relationship to residential construction. In neighborhood 1 greenbelt purchases were made from four to seven years before our sample was taken, and most of the residential construction not only occurred after these greenbelt purchases, but neighborhood design also maximized the advantage of this amenity in its planning. In the remaining two neighborhoods greenbelt purchases were

made only one to five years before our sample of property values. At least equally important were the facts that in neighborhood 2 the purchase was of a relatively small parcel of agricultural land adjacent to a development which is currently surrounded by agricultural property, and that in the planning of this development a major access road was placed between the housing sites and the greenbelt parcel. Hence, in this case it is not surprising that the direction of this effect is reversed. We expect that as further development occurs in the area there will be greater capitalization of the amenity of open space. For neighborhood 3 the *DGB* coefficient is significant only at the 25% level, which is an unacceptable probability of type I error. In this case not only was the greenbelt purchase relatively recent, but in addition, the neighborhood is older (housing age varied from 21 to 55 years) and more settled, with relatively little turnover. We believe that property values will adjust in time to internalize more fully the value of this purchase.

From a policy point of view an important implication of the above finding is that the neighborhood value of open space as reflected by an increase in nearby property values depends critically on the ability of private developers and urban planners to integrate neighborhood development and access to open space. Since the greenbelt amenity has been capitalized in neighborhood 1, we focus on this neighborhood in the remainder of the paper to explore further the public policy of open space provision.

Distance from the greenbelt has a very strong depressing impact on the price of residential property in neighborhood 1. In particular, price decreases $10.20 for every foot one moves away from the greenbelt.* In addition to the planning and timing of open space and neighborhood development, another reason for the strength of this effect may relate to the nature of the greenbelt abutting this particular neighborhood. The neighborhood sits at the base of a group of partially wooded mesas which ascend toward the front range of the Rocky Mountains. There are many rock outcrops in this area, and to the east there are views of the greater Boulder Valley.

To test the effect of differences in view on the price of property, we constructed a set of dummy variables classifying properties as having an excellent, moderate, or no view of the valley. This assessment of view was determined by on-site inspection. We experimented by entering these variables into the equation in numerous ways, and consistently found that the coefficient associated with this variable was statistically insignificant and the coefficients on other variables in the equation remained unchanged. Although this finding was unexpected, it may be accounted for by several factors. First, the unique geographical features of the area make the view somewhat random. For example, some properties at lower elevations have extremely good views because they are raised just enough to afford a view over existing properties. Perhaps more surprising, a substantial number of homes

* It has been argued that the benefit of a park, as perceived in the market, is understated by such measurement because, to the extent that property tax assessments are related to market value, assessments will also reflect the value of proximity [McMillan 1975]. The resultant tax differential will be capitalized into prices. Therefore, McMillan argues that the appropriate measure of proximity benefits should include not only a property's price but also the change in taxes.

However, since our primary concern was the neighborhood effect of the greenbelt on property value and the public policy implications of this effect, we felt that price was a more appropriate dependent variable.

were constructed on the site in a way which did not take advantage of the view possibilities, and for many the view was cut off completely. Some of this may have been due to inadequate foresight. Many of the older homes originally had good views in all directions. Planners may have been casual in designing the site to account for long-run development which eventually restricted or cut off the view of the valley completely. (The correlation coefficient between excellent view of the valley and age of house was −.59). Second, the properties at higher elevations are subjected to more severe winds, which may have prohibited design features and locations that maximized view possibilities. Thus, while one would expect a priori that view would be an important variable in explaining property price, it does not appear significant in this case.

As hypothesized, the number of rooms and finished square footage both add significantly to the price of the house. In neighborhood I each additional room, for example, increases price by $2,307, *ceteris paribus*.

There is a statistically significant difference in the average price of property for houses with below-average and above-average lot sizes. A house on an above-average lot has a price $9,479 greater than a house on a below-average lot, *ceteris paribus*.

Age of house (ranging from less than one to eight years) has a significant positive impact on price. This price appreciation results from additions of landscaping and other necessary and "normal" improvements that take place in new housing developments. The positive effect of age on price in this neighborhood accounts for the insignificant relationship for this variable in the aggregate equation.

Some of the housing units in neighborhood I appear to be more luxurious, individually designed and of higher quality as proximity to the greenbelt increases. This, of course, is not completely captured in any of the above variables, and to the extent it exists would result in an overstatement of the value of greenbelt proximity. While we are convinced that this phenomenon exists to some extent, our attempts to capture it by the inclusion of structural design and construction dummy variables failed to show any statistically significant effect. Nevertheless, the reader should be cautioned that the values associated with the proximity of greenbelt might be somewhat overstated.

4. POLICY IMPLICATIONS

The above analysis suggests that the existence of greenbelts may have a significant impact on adjacent property values. Thus, while the value of the purely public good may be difficult or impossible to estimate, this quasi-collective value can be conceptually defined and empirically evaluated in at least approximate terms.[5] A number of policy questions arise with respect to this increase in property values. For example, how should this increase in tax base affect greenbelt purchases? Should some alteration in tax policy be made because of this benefit? What is the appropriate unit of local government to internalize this quasi-public good? As a framework for considering these issues we have esti-

[5] We recognize that broader issues remain beyond these quasi-public good effects, in particular the community's collective benefit from open space, the net incidence of a public good financed by a sales tax, and the potential regressivity of a program which may in effect limit local population growth.

mated the quasi-public good effect of the greenbelt in neighborhood 1. Because of this effect, in 1975 the aggregate property value for the neighborhood was approximately $5.4 million greater than it would have been in the absence of greenbelt. This increment resulted in an annual addition of approximately $500,000 to the potential neighborhood property tax revenue.[9] The purchase price of this greenbelt parcel for the city was approximately $1.5 million, and thus, the potential property tax revenue alone would allow a recovery of initial costs in only three years.[10] Table 4 presents estimates of the present discounted value of this tax revenue at discount rates of 5 and 10 percent. Thus, for all units of local government the potential property tax revenue exceeds the cost of this purchase by from 3 to 5 times,[11] and the internal rate of return exceeds 30 percent.

Of course, this potential increase in revenue substantially overstates the g from such purchases by the city for two important reasons. First, assessments of property typically do not fully capture increments in property values associated with such amenities. When we estimated the above equation for neighborhood 1 using assessed value rather than sales price, we found a *DGB* regression coefficient of −2.0 (i.e., roughly 20% of the value of the *DGB* coefficient for the sales price regression), rather than −3.1, which would be expected under a 30% assessment rate; therefore, the tax returns from greenbelt purchases would be reduced by roughly one-third. This adjustment, however, still leaves the ratio of property tax revenue to costs for all units of local government considerably greater than one.

The second source of this overstatement is, however, far more serious from

TABLE 4
PRESENT DISCOUNTED VALUE OF GAINS IN PROPERTY TAX REVENUE
(30-year time horizon)

Unit of Government	Discount Rate 5%	10%
City Government	$1,139,950	$ 699,062
School Districts	5,106,282	3,131,348
County Government	1,865,539	1,144,013
Special Districts	242,685	148,823
Total	$8,354,465	$5,123,246

[9] This result was obtained in the following manner: Six concentric bands were drawn around the greenbelt, covering the area to roughly 3,200 feet from the greenbelt edge. The neighborhood effect was assumed to be negligible beyond band 6. The properties in each band were counted and assigned the average property value for the band, which was derived using the partial regression coefficient on *DGB*, the average sample *DGB* (1,318 feet), and the average sample price ($67,700). The potential tax revenue is based on an assessment rate of 30% of value (which is the rate mandated by law, although many counties assess at lower rates) and a property tax rate of 100 mills (approximately equal to the 1975 rate).

[10] The carrying costs of greenbelt are minimal. Maintenance costs for this parcel are roughly $6,000 per year. Since we proceed to discount the value of future tax revenues, inclusion of interest costs would be inappropriate.

[11] The reader might argue that the opportunity cost of this land in terms of tax revenue should be subtracted from these gains to obtain the net gain in tax revenue. Conceptually this is, of course, correct. Because public land is tax exempt, the assessment of opportunity cost requires some assumption with regard to how the greenbelt land might be used in the absence of this purchase, and the cost and revenue implications of this alternative use. Since overall units of local government attempt to balance their budgets, aggregate revenue associated with urban development is generally offset by aggregate costs of services provided. A more detailed evaluation of the net revenue effects of alternative uses would require extensive assumptions about the physical and socioeconomic nature of each use [Muller and Dawson 1972]. Furthermore, since the objective of city officials is simultaneously to control growth and provide open space, the only alternative use commensurate with these objectives is agricultural use. It is likely that tax revenue generated from such use is just adequate to provide local services, and hence, no net gain would be provided by this particular alternative use.

the point of view of obtaining optimal provision of amenities by local governments, and it arises from the fact that in the community studied 86 percent of the additional property tax revenue accrues to units of local government other than the city. Hence, as shown in Table 4, the present discounted value of additional tax revenue from neighborhood 1 to the city is inadequate to cover the costs of this greenbelt purchase by the city.[12]

Clearly, some significant fraction of the tax revenue generated to the county, the school district and other special districts may benefit city and neighborhood 1 residents directly or indirectly. The major policy issue is to what extent the concentration of cost (on the city) and the dispersal of tax benefit to other units of local government will result in non-optimal provision of greenbelts.

Given the current scope of the open space program, it is reasonable to assume that 85 to 95 percent of tax revenue generated by greenbelt accrues to residents of the county. However, as purchases of greenbelts are made by suburban communities in an attempt to shape and limit growth and preserve open space within the region, the benefits and costs will increasingly spill over city and county boundaries to the wider metropolitan area. In the long run more metropolitan area-wide planning and financing of greenbelts may be necessary to allow for optimal provision of open space. As the public good of preserved open space becomes more common in the region, we expect that intra-area property value effects will diminish, but the collective value of greenbelts as an important part of maintaining the quality of urban life will continue. This idea has persisted for over 3,000 years.

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[12] Note, however, that the per capita pure public good value of the neighborhood 1 greenbelt need only be between approximately $4 and $10 to make up the difference under the 5% and 10% rates, respectively. That is, if the people of Boulder would willingly make a onetime per capita payment of $4 to $10, this revenue, together with the property tax revenue specified above, would just cover the purchase price of this greenbelt. Currently, of course, the city relies exclusively on sales tax revenue to cover the cost of greenbelt purchases.

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