

The Impact of Parcel Characteristics on the Cost of Development Rights to Farmland

Dennis Wichelns and Jeffrey D. Kline

This paper examines the economic impact of selected farmland characteristics on the appraised value of development rights. Price elasticities are estimated for the size and location of farmland parcels, the amount of road frontage, the existence of panoramic views, and the distance to urban centers. Estimated elasticities suggest that parcel characteristics have a substantial impact on the cost of preserving farmland. For example, the per-acre cost of development rights is estimated to be 53 percent higher on farmland parcels that have a panoramic view of water than on parcels that have no water view. Similarly, the per-acre cost of development rights on a typical 25-acre farm is estimated to be 90 percent higher than on a typical 150-acre farm. Results suggest that the net social benefits obtained through farmland preservation programs may be enhanced by considering the impact of farmland characteristics on the marginal costs of purchasing development rights, when selecting among a set of candidate farms.

Several states have implemented Purchasable Development Rights (PDR) programs to preserve agricultural land before it is converted to other uses. These programs invest public funds to protect social benefits derived through farmland preservation. Because public funds are limited and development rights are often expensive, program administrators and committee members must choose which farmland to preserve from a large number of farms that are offered for consideration. An economically efficient selection process requires that public officials evaluate both the social benefits they expect each farm to generate and the cost of acquiring the development rights. The social benefits and the costs of acquiring development rights will depend on characteristics that include farm size, soil types, location, visibility from public roads, and many others. Information describing the marginal impact of farmland characteristics on social benefits and costs would be helpful to PDR program officials whose goal is to maximize social welfare, subject to budget constraints. This paper addresses one portion of this issue by examining the impact of farmland characteristics on the cost of development rights.

The authors, respectively, are Associate Professor and Research Assistant, Department of Resource Economics, University of Rhode Island.

This paper is Rhode Island Agricultural Experiment Station Contribution Number 2868. The authors gratefully acknowledge the comments and helpful suggestions of three anonymous reviewers.

PDR Programs in the Northeast

Seven northeastern states have implemented PDR programs during the past 15 years. Maryland and Massachusetts began purchasing development rights in 1977, while Connecticut and New Hampshire implemented programs in 1978 and 1979. New Jersey and Rhode Island began their PDR programs in 1983 and 1986 (Derr 1988), and Pennsylvania started a PDR program in 1989. Maine and Vermont have enacted statewide conservation programs that include farmland preservation goals among a set of broader conservation objectives. New York is presently considering legislation that would establish a PDR program to complement its agricultural districts program. In general, public support for PDR programs in the northeast has been steady and referenda to provide funds for beginning or continuing these programs have been approved consistently. To date, the total funding provided for development right purchases in the region includes \$66 million in Connecticut, \$40 million in Maryland, \$80 million in Massachusetts, \$5 million in New Hampshire, \$150 million in New Jersey, \$100 million in Pennsylvania, and \$14 million in Rhode Island.

PDR programs are usually administered by committees whose members represent various government and citizen interests. These committees select the farms to be included in PDR programs from all

of the farms that are offered during a given period of time. The selection task is particularly difficult when the total development right value of all farms being considered in the program exceeds the funds available. This is likely to occur more often in the future, as program funds are reduced due to public agency budget reductions and the costs of development rights continue to rise. In many states, rising real estate prices caused the costs of PDR programs to increase significantly during the 1980s. In Rhode Island the average real appraised value of development rights was \$4,257 per acre during 1984 through 1987, before increasing by 77 percent to \$7,538 per acre during 1988 through 1991.

The criteria used to select farmland for inclusion in PDR programs are either specified in the enabling legislation or developed through an appropriate public process that begins with the broad program objectives provided in the legislation and generates specific selection criteria. Legislative objectives often include such goals as maintaining agricultural crop production within a given state and preserving open space to protect scenic views, wildlife habitat, and groundwater resources. The criteria developed to pursue these goals often include the evaluation of soil quality for crop production, visibility from public roads, and the presence of wooded areas, streams, or wetlands. In addition, the selection criteria may include an assessment of development pressure in the local area.

In many states, PDR program committees implement the selection criteria through formal scoring mechanisms that require committee members or staff to evaluate a set of characteristics that describe the farmland parcel and the surrounding area. Candidate parcels are then ranked according to the total score received in this process and this ranking is used to assign funding priorities. The implicit objective of this evaluation and scoring procedure is to maximize the social benefits obtained from farmland preservation, given a limited program budget and the set of objectives stated in the enabling legislation.

In theory, the evaluation and scoring mechanisms used by PDR program committees are consistent with the objective of protecting social benefits efficiently. In practice, the probability of achieving this objective would be enhanced if two sets of information were made available to all program committees: 1) data describing the marginal cost of acquiring development rights to farmland, as a function of parcel characteristics, and 2) data that describe the marginal social benefits of farmland protection, as a function of those same characteristics. In the absence of these data, PDR pro-

gram committees cannot select with certainty the truly optimal mix of farmland parcels for inclusion in PDR programs. However, they may be able to reduce or minimize the cost of achieving specific objectives regarding farmland characteristics, provided that the appropriate marginal cost information is available.

The goal of this paper is to examine the marginal cost implications of farmland characteristics. The data and analysis presented in the paper should be useful in reducing the public expenditure required to obtain a selected mix of farmland characteristics. In the future, as studies are conducted to determine the marginal benefits associated with specific farmland characteristics, the results of those studies can be combined with the information presented in this paper to evaluate more completely the marginal social costs and benefits that are generated in PDR programs.

Previous Studies

Much of the existing literature regarding purchasable development rights for farmland examines supply-side issues such as landowner compensation (Field and Conrad 1975, Small and Derr 1976, and Wolfram 1981) and landowner participation (Conrad and LeBlanc 1979, Phipps 1983, and Pitt, Phipps, and Lessley 1987). In other studies, Duncan (1984) and Lessley (1988) discuss the integration of PDR programs with other farmland preservation programs, and Morris (1988) evaluates PDR program efficiency. Demand-side issues such as determining what the public truly desires from PDR programs have received less attention. Halstead (1984), Bergstrom, Dillman, and Stoll (1985), and Beasley, Workman, and Williams (1986) study the public's willingness-to-pay to protect environmental amenity benefits provided by farmland, and Waddington (1990) studies the public's willingness-to-pay for a farmland preservation program. Molnar and Smith (1984), Furueth (1987), and Lembeck, Willits, and Crider (1991) explore public attitudes toward farmland preservation. None of these studies examines the impact of farmland parcel characteristics on the price that is paid for development rights.

Conceptual Framework

Many of the benefits derived through farmland preservation can be classified as public goods and it is appropriate for state agencies to expend public

funds to secure these benefits for the future. One plausible strategy for a PDR program committee would be to maximize the net social benefits derived over time through farmland preservation. This would require evaluating the costs of preserving candidate farmland parcels and estimating the social benefits that each parcel is expected to generate, over time.

The costs of obtaining development rights will vary among states, and among areas within states, according to farmland parcel characteristics including location, size, road frontage, and slope. For example, farms located near urban areas where development pressure is strong will be described by rather high prices for development rights, while the development rights on farms located further from urban areas will be relatively cheap. Road frontage, good drainage, and gentle slope are usually viewed positively by developers and parcels with these characteristics bring higher development right costs.

The social benefits of farmland preservation can also be described as a function of parcel characteristics. Farmland located near major roads or highways may generate significant visual amenity benefits while a farm that is located far from a population center may not be viewed by many state residents. However, the likelihood that remote farmland will remain in agriculture may be higher because farming near the population center may eventually become inconsistent with suburban land uses over time. The sum of discounted benefits received from farmland preservation depends on the number of residents who derive individual benefits and the length of time during which these benefits are available.

Information describing the marginal impacts of parcel characteristics on both the costs and benefits of farmland preservation is required to determine which farmland parcels to preserve and how to preserve them at minimum cost. This paper examines the marginal cost implications of selected farmland parcel characteristics. The results motivate measurement of the marginal benefits derived from these same characteristics so that socially optimal farmland preservation strategies can be identified.

Empirical Analysis

Chicoine (1981) and Shonkwiler and Reynolds (1986) present a model of farmland values and land values that includes land characteristics as key independent variables. Their model is based on the theoretical relationship between value and urban

proximity suggested by Mills (1972) and Muth (1961). The general form of the land value model can be used to describe development right values in terms of parcel characteristics as in:

$$(1) \quad V_i = \beta_0 X_{i1}^{\beta_1} \exp \left[\sum_{j=2}^n \beta_j X_{ij} \right]$$

where V_i is the appraised value of development rights, in dollars per acre, for the i^{th} parcel, X_{i1} is parcel size in acres, and the X_{ij} are measures of the j^{th} characteristics describing the i^{th} parcel, for $j = 2$ to n . An empirical version of the model in Equation 1 is presented below and is used to estimate development right price elasticities for a set of parcel characteristics including location, size, road frontage, and panoramic view. Estimated coefficients are used to calculate development right values for hypothetical parcels that differ according to specific characteristics, to illustrate the marginal impact of parcel characteristics on the value of development rights.

Real Estate Appraisal Data

The Rhode Island PDR program requires real estate appraisals for all candidate farms to determine the agricultural and full-use values. The complete appraisals, performed by realtors and commercial appraisal companies, provide a data base of parcel characteristics that contribute to the appraised value of development rights. Real estate appraisals have been conducted on 34 candidate parcels in the Rhode Island PDR program since its inception in 1986.

The Rhode Island PDR program requires that the development right value of candidate parcels be calculated by subtracting the estimated value of the most profitable agricultural land use in the state (turfgrass production) from the appraised fair market value of the land at its highest and best use. This method maintains a constant agricultural value assessment for all farms while the full market value varies among parcels. The value of turfgrass production in Rhode Island was estimated to be \$2,500 per acre in 1985 and has not been revised since then. One disadvantage of this fixed agricultural value method is that any increase in land value automatically becomes reflected in the value of development rights. In addition, this method does not permit land of different productive quality to be evaluated accordingly. However, any variation in the appraised value of development rights among farmland parcels will reflect

variation in the characteristics that determine the potential net returns from developing each parcel.

Regression Analysis

The conceptual model in Equation (1) describing the per-acre appraised development right value as a function of parcel characteristics is converted to an estimable form by taking the natural logarithm of both sides and adding a random error term. The econometric model estimated in this study includes pertinent variables for which real estate appraisal data have been collected from the Agricultural Land Preservation Commission that administers the Rhode Island PDR program. The empirical version of the model is the following:

$$(2) \ln(\text{COST}) = \ln\beta_0 + \beta_1\ln(\text{SIZE}) + \beta_2(\text{DISTANCE}) + \beta_3(\text{FRONTAGE}) + \beta_4(\text{LOCATION}) + \beta_5(\text{VIEW}) + \beta_6(\text{TIME}) + \epsilon$$

where COST is the real appraised development right value in dollars per acre, SIZE is the parcel size in acres, DISTANCE is the distance in miles from the town in which the farm is located to the state capital of Providence, and FRONTAGE is the ratio of linear road frontage in feet, to parcel size in acres. LOCATION is the distance in miles from the farmland parcel to the nearest local town center or beach. This variable is included to capture the positive impact on development right value of proximity to regional centers. VIEW is a dummy variable that equals one if a panoramic view of water is present from the parcel, and is equal to zero if there is no such view. TIME is a monthly index of time which equals one during January 1979 and increases by one for each month thereafter. The value of TIME for each observation is the month in which the real estate appraisal was performed for that parcel. The terms β_0 through β_6 are regression coefficients to be estimated and ϵ is a random error term.

The estimated model explains 69 percent of the observed variation in real appraised development right values. The signs and magnitudes of estimated coefficients are consistent with expectations and are shown in Table 1. The estimated coefficients for the dummy variables, VIEW and TIME, can be interpreted directly. The estimated coefficients for the continuous variables are used to calculate estimated price elasticities that describe the proportional change in the appraised value of development rights, given a one-percent change in value of the explanatory variable.

The estimated coefficient for VIEW is positive and significant, suggesting that development right values are 53% higher ($e^{0.427}$) on parcels with panoramic views than on parcels without views. The estimated coefficient for TIME is also positive and significant, suggesting that real appraised development right values have increased at the rate of 1.6 percent per month during the period for which data are available.

Development right price elasticities are computed for each variable by evaluating the first derivative of Equation (1) with respect to each variable. Estimated elasticities for parcel size, distance, and location are negative, while those for road frontage and panoramic views are positive. The elasticity for SIZE suggests that the per-acre appraised value of development rights declines by 0.357 percent as parcel size increases by one percent. The elasticity for DISTANCE suggests that the appraised value of development rights decreases by 0.273 percent as the distance of a parcel from Providence increases by one percent. Similarly, the elasticity for distance to the nearest town center or beach LOCATION implies that a 0.338 percent reduction in the appraised value of development rights would result from a one percent increase in distance to the nearest town center or beach. The elasticity for FRONTAGE suggests that development right value increases by 0.197 percent given a one percent increase in linear road frontage, per acre.

Table 1. Ordinary Least Squares Estimates of the Development Right Price Elasticity Model^a

Variable	Parameter	Estimated Coefficient	t-Statistic	Elasticity at the Mean
Intercept	β_0	8.465	11.304	—
ln(SIZE)	β_1	-0.357	-2.909	-0.357
DISTANCE	β_2	-0.013	-1.578	-0.273
FRONTAGE	β_3	0.006	1.774	0.197
LOCATION	β_4	-0.125	-3.190	-0.338
VIEW	β_5	0.427	2.675	—
TIME	β_6	0.016	4.509	—

^aThe price elasticity model is presented in Equation 2. There are 34 observations in the data set and the adjusted R-Squared for the model is 0.69.

Table 2. Summary Statistics for Parcel Characteristics Used to Evaluate the Impact of Selected Characteristics on Development Right Prices^a

Variable	Units	Mean	Standard Deviation	Minimum	Maximum
COST	\$/Acre	6,188	3,924	915	13,573
SIZE	Acres	81.2	49.4	16.0	222.0
DISTANCE	Miles	20.7	9.5	4.0	32.0
FRONTAGE	Feet/Acre	31.9	23.7	0.0	95.8
LOCATION	Miles	2.7	2.1	0.0	9.0

^aThere are 34 observations in the data set.

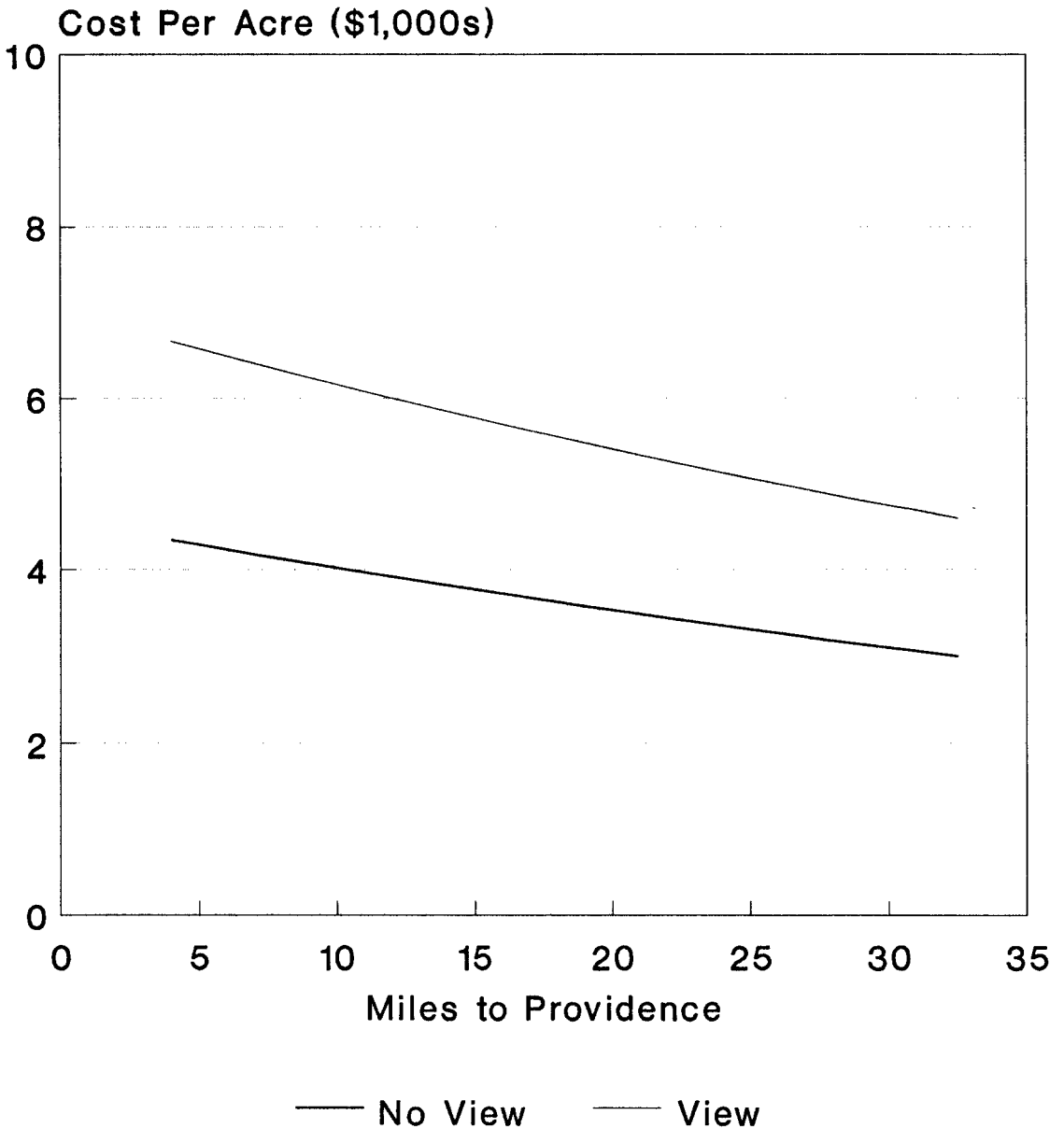


Figure 1. The Cost of Development Rights as a Function of the Proximity to Providence, RI

Parcel Characteristics and Development Right Cost

The appraised value of development rights represents the direct and immediate cost to the state of preserving each farmland parcel. The estimated coefficients are used to calculate this cost for hypothetical parcels with selected characteristics. In each comparison, all but one characteristic are held constant at their mean values (Table 2) and the characteristic being examined is varied within the actual range of values present in the data set. Differences in the calculated costs of purchasing the development rights for these parcels illustrate the degree to which each characteristic can impact the cost of obtaining development rights on individual parcels. These impacts have important economic implications when the social objectives of PDR programs are considered.

Parcel Proximity to Urban Centers

The estimated per-acre development right cost for a typical farm participating in the Rhode Island PDR program decreases as the distance to Providence increases (Figure 1). For example, the development right cost for a typical farm with mean size, road frontage, and other characteristics, and located 10 miles from Providence is estimated to be \$4,021 per acre. The development right cost for the same farm, but located 30 miles from Providence is estimated to be \$3,100 per acre, or \$921 per acre less (Table 3).

If one objective of farmland preservation is to preserve agricultural resources and maintain agricultural viability, program administrators may want to preserve less expensive parcels located further from Providence. In these remote areas, farm activities might also be less likely to conflict with residential land uses. However, if the public enjoys the scenic amenities associated with farmland, these benefits might be enhanced by preserving more expensive parcels closer to Providence where the public is more likely to see them. Program administrators need more information regarding the marginal social benefits pertaining to agricultural viability and scenic views to determine the optimal mix of farmland parcels to be preserved.

A similar result is obtained regarding the location of parcels relative to local town centers or beaches. For example, the development right cost for a parcel with mean characteristic values and located one mile from a local town center is estimated to be \$4,327 per acre or a total of \$351,343 (Table 3). The development right cost for a similar parcel located six miles from a town center is es-

Table 3. Comparing the Price of Development Rights to Farmland at Different Values of Selected Parcel Characteristics^a

Characteristic	Measure	Price of Development Rights (\$/Acre)	Total Parcel Cost (\$)
Proximity to Providence	10 Miles	4,021	326,478
	30 miles	3,100	251,731
		921	74,747
Proximity to Urban Centers or Beaches	1 Mile	4,327	351,343
	6 Miles	2,316	188,060
		2,011	163,282
View of Water	View	5,362	435,399
	No View	3,498	284,082
		1,864	151,317
Size of Parcel	25 Acres	5,328	133,191
	150 Acres	2,810	421,527
		2,518	-288,336
Road Frontage	65 Ft./Ac.	4,267	346,493
	10 Ft./Ac.	3,068	249,102
		1,199	97,391

^aAll parcel characteristics other than the one that is varied intentionally are evaluated at the mean values presented in Table 2.

timated to be \$2,316 per acre or a total of \$188,060. The difference is \$2,011 per acre or a total of \$163,282.

Panoramic Views

Farmland parcels with a panoramic view of water generate higher development right costs in Rhode Island than do parcels without such a view. Given mean values for all characteristics, the per-acre development right cost for a parcel without a panoramic view is \$3,498, while the per-acre cost for a parcel with a view is estimated to be \$5,362 (Table 3). The difference of \$1,864 per acre yields a total development right cost difference of \$151,317 for a parcel with mean characteristics. A panoramic view on the parcel increases the cost by 53 percent. However, there is no evidence that the presence of a panoramic view on a candidate parcel yields any greater benefits than those obtained from a parcel without such a view. In most PDR programs, the public does not gain access to the preserved parcel and, therefore, they do not gain access to the view. The additional cost associated with preserving farmland parcels that have panoramic views may exceed the marginal social benefit.

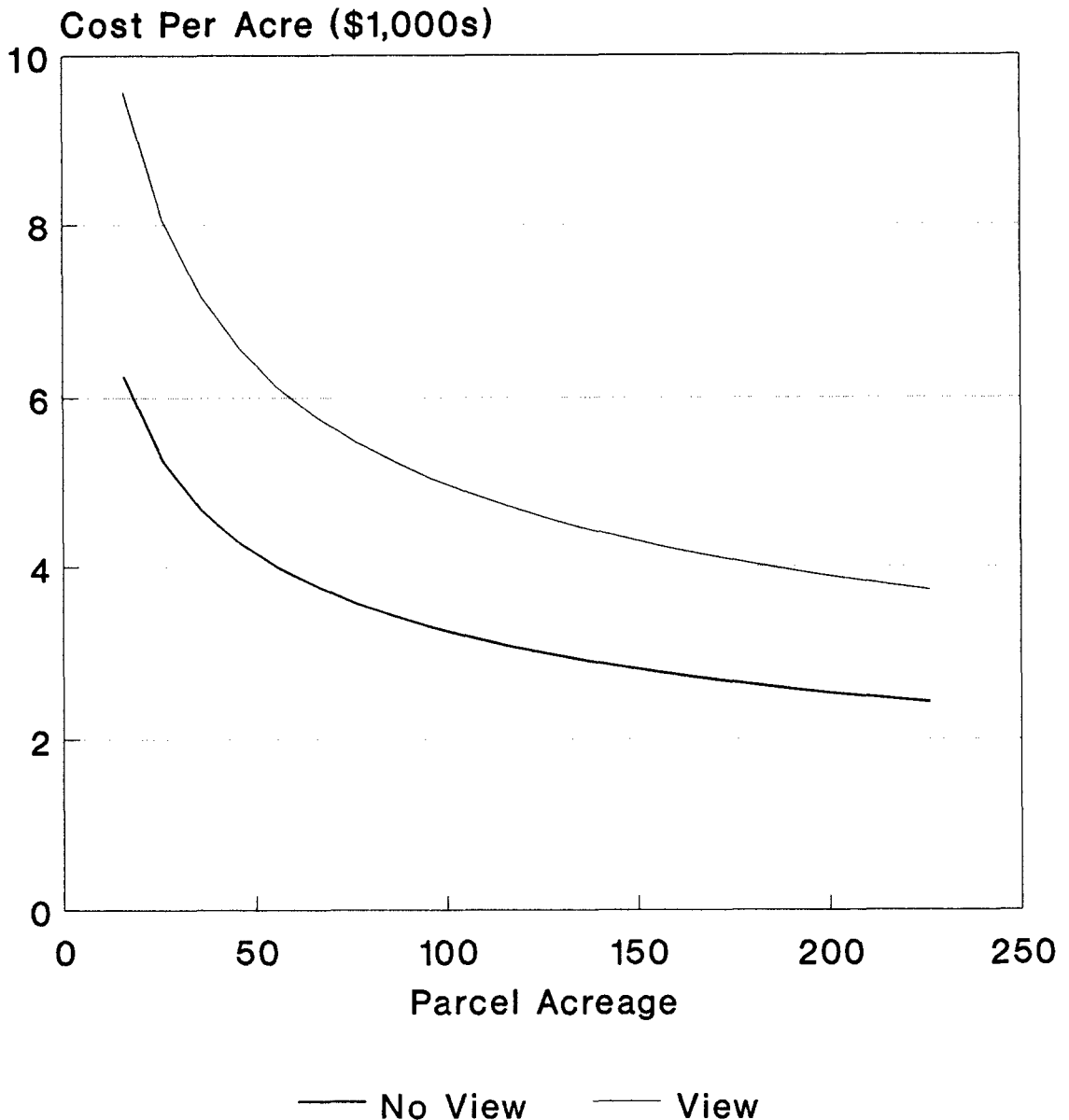


Figure 2. The Cost of Development Rights as a Function of the Parcel Size

Parcel Size

The average per-acre development right cost decreases as parcel size increases (Figure 2). Holding all other parcel characteristics at mean values, the per-acre development right cost for a 25-acre parcel is estimated to be \$5,328, for a total value of \$133,191. The per-acre development right cost for a 150-acre parcel is estimated to be \$2,810, for a total of \$421,527 (Table 3). One way to view this result is that an expenditure of \$421,527 could be

used to obtain development rights on one parcel of 150 acres or on three parcels of just 25 acres each.

Preserving larger parcels at lower per-acre costs may be cheaper than purchasing several small tracts. In fact, many state PDR programs attempt to preserve large contiguous tracts of farmland in an attempt to enhance future agricultural viability. However, many programs also preserve smaller tracts of farmland in several locations to distribute limited PDR funds throughout the state. Because the actual social benefits associated with preserv-

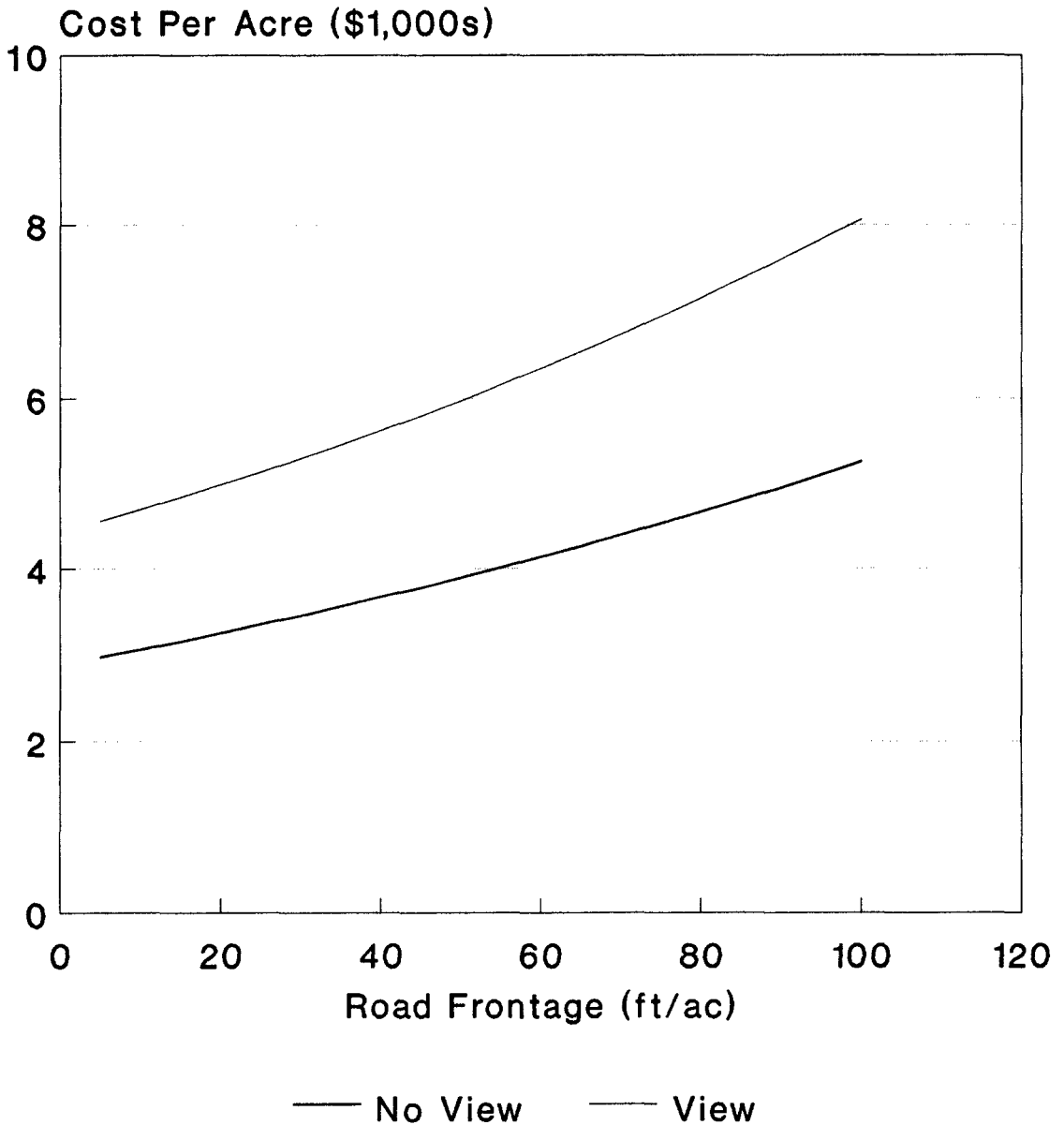


Figure 3. The Cost of Development Rights as a Function of the Parcel Road Frontage

ing large tracts versus smaller ones are not known, it is not possible to determine which preservation strategy is better.

Road Frontage

Linear road frontage is represented in the model as a ratio of total frontage length to total parcel acreage. A parcel with mean characteristic values and total road frontage of 800 feet (ratio of 9.86) has an estimated development right cost of \$3,068 per

acre or \$249,102 total. The per-acre development right value on a similar parcel with 5,280 feet of road frontage (ratio of 65.1) is estimated to be \$4,267 for a total of \$346,493 (Table 3). The difference in per-acre cost between the two parcels is \$1,199 or a total of \$97,391. The average per-acre development right cost rises only gradually as a function of linear road frontage (Figure 3). This suggests that if scenic farmland views are socially desirable, then parcels with a large amount of road frontage per acre may be purchased for a relatively

small additional cost above that for parcels with little road frontage, and net social benefits may be enhanced.

Conclusion

Parcel characteristics for the hypothetical parcels compared in this analysis are well within the range of actual parcels on which development rights have been purchased in Rhode Island. The parcels also are likely to be typical of farmland involved in PDR programs in other states. Results suggest that the marginal cost impacts of several parcel characteristics, including proximity to urban centers, water views, size, and road frontage, are significant. The total costs of obtaining purchasable development rights may be reduced and the net social benefits of PDR programs may be enhanced by considering these characteristics carefully when evaluating candidate parcels for inclusion in PDR programs.

Both the appraised value of development rights and the social benefits obtained through farmland preservation are functions of farmland parcel characteristics. This paper has examined the impacts of parcel characteristics on the cost of development rights, but the paper has not examined marginal social benefits. That information, however, in combination with the cost implications presented in this paper, would enable PDR program committees to target the parcel characteristics that society desires, reduce the costs of obtaining the desired mix of those characteristics, and increase the net social benefits generated through PDR programs.

References

- Beasley, Steven D., William G. Workman, Nancy A. Williams. "Estimating Amenity Values of Urban Fringe Farmland: A Contingent Valuation Approach: Note," *Growth and Change*, 17, No. 4(1986).
- Bergstrom, John C., B.L. Dillman, and John R. Stoll. "Public Environmental Amenity Benefits of Private Land: The Case of Prime Agricultural Land," *Southern Journal of Agricultural Economics*, 1985.
- Chicoine, David L. "Farmland Values at the Urban Fringe: An Analysis of Sale Prices," *Land Economics*, 57, No. 3(1981).
- Conrad, Jon M., and David LeBlanc. "The Supply of Development Rights: Results from a Survey in Hadley, Massachusetts," *Land Economics*, 55, No. 2(1979).
- Derr, Donn A. "Historical Overview of Purchase of Development Rights Programs in the Northeast," *Purchase of Development Rights Programs in the Northeast*, Ed. John Mackenzie, Bulletin 474, Delaware Agricultural Experiment Station, Newark, DE, 1988.
- Duncan, Myrl L. "Toward a Theory of Broad-based Planning for the Preservation of Agricultural Land," *Natural Resources Journal*, 24(1984).
- Field, Barry C. and Jon M. Conrad. "Economics of Compensation in Development Rights Programs," *Journal of the Northeastern Agricultural Economics Council*, 4, No. 2(1975).
- Furuseth, Owen J. "Public Attitudes Toward Local Farmland Protection Programs," *Growth and Change*, 18, No. 3(1987).
- Halstead, John M. "Measuring the Nonmarket Value of Massachusetts Agricultural Land: A Case Study," *Journal of the Northeastern Agricultural Economics Council*, 13, No. 1(1984).
- Lembeck, Stanford M., Fern K. Willits, and Donald M. Crider. "Public Attitudes Toward Farmland Preservation in Pennsylvania: Analysis of a Statewide Survey," Report 226, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, University Park, PA, 1991.
- Lessley, Billy V. "Integrating Purchase of Development Rights Programs with Agricultural Districts and Use-Value Assessment," *Purchase of Development Rights Programs in the Northeast*, Ed. John Mackenzie, Bulletin 474, Delaware Agricultural Experiment Station, Newark, DE, 1988.
- Mills, Edwin S. *Urban Economics*, Scott, Foresman and Company, Glenview, Illinois, 1972.
- Molnar, Joseph J., and Steven L. Smith. "Farmland Protection: Attitudes and Preferences of Landowners in Three Alabama Counties," *Rural Sociology Series Number 6*, Alabama Agricultural Experiment Station, Auburn University, Alabama, 1984.
- Morris, Doug E. "A Critical Look at PDR Program Efficiency," *Purchase of Development Rights Programs in the Northeast*, Ed. John Mackenzie, Bulletin 474, Delaware Agricultural Experiment Station, Newark, DE, 1988.
- Muth, Richard F. "Economic Change and Rural-Urban Land Conversions," *Econometrica*, 29, No. 1(1961).
- Phipps, Tim. "Landowner Incentives to Participate in a Purchase of Development Rights Program with Application to Maryland," *Journal of the Northeastern Agricultural Economics Council*, 12, No. 1(1983).
- Pitt, David G., Tim Phipps, and Billy V. Lessley. "Participation in Maryland's Agricultural Land Preservation Program: The Adoption of an Innovative Agricultural Land Policy," *Landscape Journal*, 1987.
- Shonkwiler, J.S., and J.E. Reynolds. "A Note on the Use of Hedonic Price Models in the Analysis of Land Prices at the Urban Fringe," *Land Economics*, 62, No. 1(1986).
- Small, Leslie and Donn A. Derr. "Controlling Development Rights: The Alternatives," *Journal of Soil and Water Conservation*, 31(1976):(Sept./Oct.).
- Waddington, David Gordon. *Willingness to Pay for Farmland Preservation*, Unpublished Masters Thesis, The Pennsylvania State University, University Park, PA, 1990.
- Wolfram, Gary. "The Sale of Development Rights and Zoning in the Preservation of Open Space: Lindahl Equilibrium and a Case Study," *Land Economics*, 57, No. 3(1981).