RESEARCH ARTICLE

Public purchases and private preferences: A hedonic model of open space acquisitions

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Abstract

The traditional hedonic model uses market purchases to estimate implicit prices. Hedonic models composed of only public land purchases violate key assumptions of hedonic model theory. The resulting implicit prices cannot be interpreted as the purchasing agency's maximum willingness to pay. The problems are illustrated using a hedonic model of public land purchases. The model reveals negative implicit prices for attributes for which the agency has stated positive preferences. The results confirm that implicit prices derived from open space hedonic models should be interpreted in the context of the broader market for land, not as the agency's willingness to pay.

Keywords: hedonic model; open space; implicit price; wetlands; Long Island

1. Introduction

Open space properties are becoming increasingly scarce in rapidly developing metropolitan areas (Alig *et al*. 2004). Fee simple land purchases and the purchase of development rights have become attractive, though not the only, policy tools for protecting open space (Harper and Crow 2006). Public agencies must decide which properties and what locations will best meet the public's need for open space. Hedonic models have been used for decades to estimate and analyze residential and commercial property values. Very recently several studies have been published in which the hedonic technique was used to analyze public land purchases. We expect that more applications of hedonic models in public land purchases will appear as more communities adopt open space preservation policies. Therefore it is critical to understand how such models can be applied and how their results should be interpreted. In this paper we provide guidance to economists and policy researchers on how to apply and interpret hedonic models of public purchases in order to avoid costly policy mistakes. We analyze the techniques used to estimate property values of preserved open space and apply this analysis to a case study in the Town of Brookhaven, on New York State's Long Island.

In Section 2 we present the conventional hedonic model, as developed by Rosen (1974), and use it to analyze economic models of public land purchases. In Section 3 we review the small but growing body of literature regarding economic models of public open space preservation. We critique these analyses with respect to the theory of hedonic pricing described in Section 2. Finally in Section 4, we propose a refined interpretation of how environmental attributes explain variation in open space acquisition costs through a case study in the Town of Brookhaven, NY ("Brookhaven").

2. Theory

2.1 Rosen's hedonic model

Rosen (1974) formalized the theory supporting the hedonic model and laid the foundation upon which current hedonic models are built. Rosen's hedonic theory states that the market price of a differentiated consumer good is a function of its utility-bearing characteristics. A hedonic model is essentially a regression model that links a good's price, the dependent variable, with its various attributes, the independent variables. To describe it more formally, let *C* be vector of characteristics of good *X*, such that *X* can be described by its characteristics $x_i = x_i(c_{i1},...,c_{ij},...,c_{in})$ where c_{ij} is the j^{th} quality of model *i* of good *X*. The hedonic price function then is

$$(1) \qquad p_x = p_x(c_{i1},...,c_{ij},...,c_{in}).$$

The partial derivative of the hedonic regression equation with respect to any characteristic in the model reveals that characteristic's implicit price (Freeman 2003). That is, the resulting regression model coefficients describe how a small change in one of the attributes affects the good's price, all else being equal. The hedonic price function is identical to the market price. As the title of Rosen's article suggests, pure competition is a key assumption. For only under the condition of pure competition will the model produce the desired results: the buyer's willingness to pay for the good's characteristics (Rosen 1974).

Pure competition leads to the following conditions. One, buyers are price takers, that is, they add zero weight to the market. Two, buyers and sellers make decisions that maximize their utility and their perfect matching leads to equilibrium prices. Third, the distributions of buyer preferences and seller costs determine the market clearing price (Rosen 1974). In addition to these conditions, buyers are assumed to purchase only one unit of the consumer good. However, this assumption may be relaxed if the multiple units are purchased to satisfy different needs (for example, a primary residence and vacation home) (Palmquist 2005).

Rosen (1974) describes the market as a series of bids and offers from buyers and sellers, respectively. Under the pure competition assumption, the buyer's maximum bid curve (θ_i), or willingness to pay, is tangent to the market price curve $p(C_i)$. Likewise, the seller's minimum offer curve (ϕ_i), or willingness to accept, is also tangent to the market price curve $p(C_i)$. The bid and offer curves have equal slopes and "kiss" at quantity C_i* (Figure 1). In thick markets with many buyers and sellers, any consumer or producer surplus is eliminated (Harding *et al*. 2003). The implicit price for characteristic C_i can be interpreted as a maximum willingness to pay for that characteristic.

2.2 Imperfect competition

A number of factors can lead to imperfect competition and market disequilibrium, such as buyer and seller characteristics (Cotteleer *et al*. 2008), differences in bargaining power (Harding *et al*. 2003), and thin markets (Cotteleer *et al*. 2008). New entrants with eclectic tastes may also temporarily disrupt the market equilibrium. Imperfect competition can lead to problems interpreting an implicit price as a maximum willingness to pay.

Cotteleer *et al*. (2008), for example, described local farmland markets in the Netherlands. Farmers looking to purchase additional farmland generally look for available properties within about 20 km of the currently owned farm. This extremely local market lacks enough entry and exit to support a competitive market equilibrium. In such thin markets, the lack of competition prevents the bid and offer curves from coming together at the hedonic price function. As Harding *et al*. (2003) note, the bid curve floats above the hedonic price function and the offer curves hang below (Figure 2). The difference between the two curves at the point at which their slopes are equal is the excess surplus. This excess surplus is divided between the buyer and seller (Harding *et al*. 2003). In such cases the implicit price defined by the market will not be equal to the buyer's willingness to pay, that is, the maximum bid. The buyer's willingness to pay would be greater than the observed implicit price, which would represent a floor price for that attribute.

3. Public land purchases

As open space in metropolitan areas becomes scarcer, public agencies have sought ways to preserve the remaining open space properties and the ecosystem services they provide. A number of economists have used hedonic models to estimate implicit prices for land attributes based on public purchases of land or development rights. This application of hedonic modeling presents some challenges.

A public agency is just one of many buyers of vacant land within a market, most of whom are interested in development. That the agency purchases multiple properties does not pose problems with the hedonic theory because each property is assumed to meet a different need and be in a different location, for example, improving water quality or providing unique recreation opportunities. However, the focus on public land likely violates the pure competition and market equilibrium assumptions.

First the public agency may be a relatively new entrant into the vacant land market. The agency probably has eclectic tastes that differ from the private buyers that dominate the market. If the market has not yet adjusted to the eclectic tastes of the new buyer, then the market may not be in equilibrium. This is true even if the agency maintains its status as a price taker. In fact, many municipalities are required by law to purchase land at fair market value, as is the case in Brookhaven (D. Cole, Town of Brookhaven, personal communication). The agency may not use its bargaining power to "low ball" sellers, yet the market may not realize that wetland properties, for example, are more valuable to the agency than they would be to private developers. This could lead to the situation described in Figure 2, in which the bid and offer curves are not tangent to one another.

Second, the market may not be in equilibrium because of thin local markets for open space properties. The public agency may be targeting those properties, such as wetlands, that few private buyers are interested in purchasing. Cotteleer *et al*. (2008) describe just such a thin-market situation in local farmland markets. These authors show that the bid and offer curves are not tangent to one another in thin markets.

Another problem, not related to market equilibrium, is one of sampling and statistical inference. Hedonic models use market prices to estimate the maximum willingness to pay for a characteristic of buyers across that market. The market price is determined by both private and public buyers. A hedonic model that includes only public purchases amounts to a non-random sample of all purchases in the market. For this and the market equilibrium problems, implicit prices derived from hedonic models of public purchases cannot be interpreted as the agency's maximum willingness to pay for a land attribute.

These challenges do not mean that hedonic methods cannot be applied to public land purchases. Rather, it demands that the expected coefficient signs and resulting implicit prices be carefully considered and interpreted. A hedonic model can be used effectively to explain variation in acquisition cost based on land attributes, as several studies have done (Wichelns and Kline 1993, Lynch and Lovell 2002, Loomis *et al*. 2004, Larkin *et al*. 2005, Mashour *et al*. 2005). The implicit prices can reveal the floor price of an agency's willingness to pay for an attribute. However the expected sign using the public agency's preferences may not be the same as the expected sign using the broader market's preferences. This can lead to unexpected results, but which are consistent with the theoretical treatment above.

A number of researchers have estimated implicit prices for land attributes for public land purchases. In several of these studies the sign of the regression coefficient was opposite of expectations. From the purchasing agency's perspective, any variable that brings conservation benefit would be expected to have a positive sign. In other words, the agency would be willing to pay a substantial amount of money to ensure that wetlands, endangered species, or unique geological features are preserved. However, these same attributes may be valued differently by private buyers who dominate the vacant land market. The presence of wetlands or endangered species restricts building which would lower the demand for such parcels and in turn, the implicit prices for these attributes.

Mashour *et al*. (2005) studied conservation easements in Florida. Their hedonic model incorporated nine explanatory variables, including percent of land in wetlands. The State of Florida, the purchasing entity, has a clear preference for protecting wetlands and presumably would be willing to pay a premium for wetland properties. The authors however, use private market preferences for their expected signs, namely a negative sign for wetlands. The resulting coefficient does have a negative sign.

The authors point out the benefit of this information for bargaining with the state over easement prices. Mashour *et al*. (2005, p. 779-780) state

> Also, a value for wetlands may be initiated by incentives from agencies. If agencies are interested in having landowners preserve their wetlands, a value must be placed on them. Until there is a stated incentive for asking landowners to protect their wetlands, much less a disincentive as illustrated in this study, wetlands will continue to be lost.

The authors misinterpret the market-based implicit price for the agency's willingness to pay for wetlands. This is a clear, but entirely understandable, example of the confusion generated by using public purchases to estimate market implicit prices. The implicit prices do not accurately reflect the agency's willingness to pay.

Larkin *et al*. (2005) analyzed public purchases within Florida's Conservation and Recreation Lands (CARL) program. The hedonic model included a number of land attributes, such as the number of elements designated as Florida Natural Areas Inventory (FNAI) features within a project area and priority criteria for inclusion in the CARL program. The agency has a clear and documented preference for purchasing properties that have FNAI elements and meet the CARL criteria. Yet the hedonic model of CARL purchases showed that variables for FNAI elements and two of the priority criteria actually had negative coefficients. The results are inconsistent with the interpretation of implicit price as a maximum willingness to pay.

Like Mashour *et al*. (2005), Larkin *et al*. (2005) understandably interpret the results from the perspective of a typical hedonic model, but this leads to confusion between agency and private market preferences. They correctly note that "…the resulting implicit prices should be considered lower-bound estimates of the total public or social value of these lands" (Larkin *et al*. 2005 p.128). However, they state

> Moreover, the estimated implicit prices of natural land attributes and pressures to convert the open-space lands will reflect the shadow value of preservation as opposed to the value inferred from nearly residential or agricultural uses (Larkin *et al*. 2005, p. 116).

As demonstrated above, the estimated implicit prices do not reflect the shadow value of preservation. The implicit prices are products of the market as a whole, including buyers with preservation, residential, and agricultural motives. Larkin *et al*. (2005) also imply that the state places a higher priority on natural elements than on historical elements because of their respective implicit prices. The broader land market actually determines the implicit prices for natural and historical elements, not the agency. The implicit prices based solely on public purchases are unreliable indicators of the agency's relative priorities and using them as such could lead to inefficient conservation policies.

4. A Long Island Case Study

4.1 Background

In this section, we present a hedonic analysis of public land purchases in the Town of Brookhaven, on New York State's Long Island. The objective was to highlight the challenges of interpreting the hedonic model coefficients in light of the theoretical limitations. We estimated a hedonic model of public open space purchases. The null hypothesis was that market equilibrium conditions for the hedonic model are met and the implicit prices can be interpreted as Brookhaven's maximum willingness to pay for that attribute. The alternative hypothesis is that the market equilibrium conditions are not met and therefore the implicit prices cannot be interpreted as a willingness to pay. To test these hypotheses, we compared the implicit prices for each attribute against the agency's property evaluation checklist (Parcel Ranking Sheet (PRS)) for that attribute. If the null hypothesis is correct, the signs of the implicit prices should match the scores in the PRS: they should be positive. Negative implicit prices for attributes that contribute positively to the PRS score would indicate that the market is not in equilibrium, that excess surpluses exist (Figure 2), and that the implicit prices should not be interpreted as the agency's willingness to pay.

4.2 Study Area

The Town of Brookhaven in Suffolk County, New York, lies roughly 60 miles east of Manhattan on eastern Long Island (Figure 3). Brookhaven's population grew from less than 50,000 in 1950 to more than 450,000 in 2000. This tremendous growth has changed Brookhaven's character from a largely agricultural region to one of sprawling residential and commercial development. Full build-out of all available open space is expected by 2025 (Regional Plan Association 2004). Town officials feared that the growing population would strain the area's environmental resources, in particular the drinking water aquifer below the town. Town officials, with voter approval, implemented a land acquisition program to preserve what open space remains (Town of Brookhaven 2004) (Figure 3 and Figure 4). The Central Pine Barrens ecosystem occupies much of the remaining undeveloped land.

Modeling a single, large town such as Brookhaven has benefits and limitations. Investigating the behavior of one open space program allows for more control to tease apart the contributions of the various environmental attributes. Subtle differences may be lost in an analysis of multiple jurisdictions. On the other hand, the data and practical significance may be limited. However, Brookhaven is a town of more than 400,000 people and covers more than 250 square miles of land. While the level of government may be that of a town, Brookhaven's population and physical size are more similar to cities, counties and metropolitan areas.

4.3 Property Cost (Cost)

The purchase cost for each project was the hedonic model's dependent variable. A project refers to one or more parcels that were purchased together. Most projects consisted of only a single parcel; others contained multiple parcels, as in a subdivision. It was not possible to assign purchase costs to individual parcels in a project. Parcels within a project were usually contiguous, though in rare cases they were not. Cost data were supplied by Brookhaven.

Thirty-seven project purchases were recorded from 1999 through 2005 for which complete information was available. Acquisition costs were adjusted to 2005 dollars using the Consumer Price Index for housing (all U.S. city average, Series ID: CUUR0000SAH). The real estate market on Long Island was especially strong, even "frothy," during this time and raised concerns about the validity of using multiple years' sales in a single data set. A Chow test was performed in SPSS (2004) to test whether the regression parameters (expressed as 2005 dollars) were equal across years. With the full data set (1999-2005), the Chow test rejected the null hypothesis that regression parameters were equal across years ($F = 15.84$, $p < 0.00$, $N = 37$). Brookhaven completed only 2 transactions during 1999 and 2000, so these sales were deleted from the data set and the Chow test was performed again. The Chow test failed to reject the null hypothesis with this trimmed data set ($F = 0.474$, $p = 0.75$, $N = 35$). Using purchases from 2001 to 2005 was deemed appropriate, even though this reduced the already limited data set. The mean cost for an open space property in the data set was $1,112,483 with a mean cost per acre of $89,034. For comparison, a recent analysis of residential development in Brookhaven assumed a vacant land cost of $150,000 per acre (Long Island Builders Institute, Inc. 2004).

4.4 Explanatory Variables

Brookhaven's Division of Land Management evaluated each nominated property using a checklist, called the Parcel Ranking Sheet (PRS). In some cases, such as proposed subdivision, a group of properties were evaluated together as a project. The number of parcels within a project ranged from 1 to 47, with a mean of 5.2 parcels per project. Most parcels in a project were adjacent to one another, but in three cases the parcels were more than a mile (1.6 km) apart. There was no method of teasing apart either the prices or the environmental attributes for individual parcels. The authors recognize this limitation of the data set. All the information in the PRSs and used in the hedonic model were completed by the same individual at the Division of Land Management (D. Cole, personal communication). This ensured consistency across site visits.

The data on environmental attributes were collected directly from Brookhaven's PRSs. No interpretation or aggregation was performed at this stage. The 55 PRS variables were clearly too many to include in the regression model given the small number of observations. The following procedure was used to select variables for inclusion in the regression analysis. Attributes having an unweighted PRS score of 15 or greater were identified for inclusion in the model. A cutoff score of 15 enabled the inclusion of variables from all six categories, yet was exclusive enough to limit the variables to a practical number. This list of 27 variables was further trimmed by eliminating variables that were significantly ($p = 0.05$) and highly ($r^2 > 0.40$) correlated with other variables. When problem correlations were identified, the lower scoring variable was dropped. When the scores were equal, the variable with the lower weight was dropped. The wetland variables included both wetland type (e.g. freshwater or intertidal marsh) and wetland size as a proportion of the property (e.g. between 25 % and 50% of property size). Wetland size variables were included in the regression model because the relative size is likely to constrain development more than wetland type and therefore affect the acquisition cost. Wetland type variables were not included in the model. Twelve variables were selected, converted to dummy (presence/absence) variables, and included in the regression model. In addition, one continuous variable for property size was included. While the Parcel Ranking Sheets did include a property size, we used the actual property size as ultimately purchased by Brookhaven. Table 1 defines the variables and lists the summary statistics and expected signs. Most of the model coefficients are expected to have positive signs because these attributes contribute positively toward the PRS score. Because of the positive PRS score, we can assume that Brookhaven has a preference for these attributes and would be willing to pay a premium to secure them. As part of the exploratory data analysis, total property acquisition cost (*Cost*) was tested for correlation with PRS total score (*Score*).

4.5 Hedonic Model Specification

The model was specified using linear, linear-log, log-linear and log-log forms, but only the linear form is presented here (Equation 2):

$$(2) \qquad \mathbf{C} = \mathbf{E}\boldsymbol{\beta}_{\mathbf{E}} + \boldsymbol{\varepsilon},$$

where **C** is the $(n \times 1)$ vector of acquisition costs (*Cost*) and *n* is the number of observations (35); **E** is an $[n \times (k+1)]$ matrix of observations on *k* on-site environmental attribute variables derived from the Parcel Ranking Sheets; $\boldsymbol{\beta}_{\mathbf{E}}$ is the $[(k+1) \times 1]$ vector of parameter estimates for the on-site environmental attributes (E); and $\boldsymbol{\varepsilon}$ is an $(n \times 1)$ vector of error terms which are assumed to be independent and identically distributed. The R^2_{adj} was calculated for the specified model to determine how the attributes contribute to variation in acquisition cost.

The dependent variable in hedonic models often exhibits spatial autocorrelation, which can result in unbiased but inefficient OLS estimators and biased variance estimates. If left uncorrected spatial autocorrelation in the dependent variable can affect both the precision of the parameter estimates and the reliability of hypothesis tests (Dubin 1998). The Moran's *I* Index was calculated in the Spatial Statistics module of ArcGIS 9.1 for *Cost* using two conceptualizations of spatial relationships: inverse distance and inverse distance squared. The Moran's *I* Index ranges from -1.0 to 1.0, reflecting dispersed and clustered patterns, respectively. Random spatial distributions have a Moran's *I* index around zero (ESRI 2005).We calculated a Moran's $I = 0.02$ for both spatial relationship conceptualizations. Neither score was statistically significant. We concluded that spatial autocorrelation of *Cost* was not a problem in this case.

4.6 Estimation Results

Parcel Ranking Sheet total score (*Score*) and acquisition cost (*Cost*) were not significantly correlated with one another (r^2 = -0.10, p = 0.55, N = 35). The hedonic model estimation results are presented in Table 2. The linear regression model explained more than 90% of the variation in cost (R^2_{adj} = 0.94), which is far better than the performance of several previous hedonic models of open space (Wichelns and Kline 1993, Lynch and Lovell 2002, Loomis *et al*. 2004, Mashour *et al*. 2005). Four of the thirteen explanatory variables were statistically significant ($p < 0.10$). None of the three wetland variables in the model had a statistically significant influence on acquisition cost. Seven of the variables had unexpected negative signs, though only one of them (*Species*) was statistically significant.

The "leave one out" bootstrapping method was used to validate the model's out of sample predictive ability (Devore 2004). Estimated costs for out of sample observations were significantly and highly correlated with actual costs (Pearson's r^2 = 0.94, p<0.01).

5. Discussion

All of the variables contribute positively to PRS scores. Therefore we expected all variables to show positive regression coefficients as long as the market equilibrium assumptions hold. The unexpectedly negative regression coefficient for *Species* appears contradictory to Brookhaven's preferences, as stated in the PRS, and indicates a lack of market equilibrium. The results indicate that the market situation is similar to the diagram in Figure 2, where Brookhaven's maximum bid is above the hedonic price function. The resulting implicit price estimates cannot be interpreted as a measure of Brookhaven's willingness to pay for the land attributes. The negative coefficient for *Species* in this study is consistent with the findings of Larkin *et al*. 2005, who found a negative coefficient for threatened or endangered species elements on publicly purchased properties. Larkin *et al.*'s (2005) data set included 65 properties, so our findings are not likely the result of the relatively small sample size.

The *Species* variable highlights the problem. In the PRS, the presence of a Federal or State endangered or threatened species or a species of special concern earns the property 25 points. Brookhaven clearly has a preference for such properties, yet the *Species* coefficient is not positive. Interpreting the coefficients under the assumption of market equilibrium would lead to incorrect conclusions about Brookhaven's preference for endangered and threatened species.

The positive regression coefficients resulted when Brookhaven's preferences for open space properties aligned with those of private buyers. Properties that are adjacent to public land, or have a scenic vista would be desirable to the broader vacant land market. Attributes with negative coefficients are those that are not desirable to most private buyers, especially residential developers, namely, endangered or threatened species habitat. Variables for wetlands, location in a FEMA "V" flood zone, and view of a major road also had negative coefficients, but were not significantly different from zero. The hedonic model estimates how the market, not a subset of buyers, values a good's characteristics.

In spite of these challenges, hedonic models of public open space or easement purchases can provide valuable information to the purchasing agency. Many agencies, including Brookhaven, collect land attribute data before making a purchase offer. The agency can use a hedonic model with land attribute and price data from previous sales to estimate the purchase cost of newly evaluated candidate properties. Estimated costs could be use to screen out properties that are obviously too expensive, or could be combined with real estate appraisals to improve purchase negotiations.

Perhaps most importantly, the differences between the estimated implicit prices and PRS or similar scores may help identify the most cost effective properties (Wichelns and Kline 1993, Larkin *et al*. 2005, Mashour *et al*. 2005). For example, our model shows that *Species* had negative affect on purchase cost, while *Adjacent* and *Vista* had positive effects on cost. Both sets of attributes provide similar benefit scores, yet Brookhaven could achieve those benefits at less cost by preferentially focusing on properties with endangered or threatened species habitat. High scoring attributes with negative implicit prices would be most desirable from this perspective.

6. Conclusions

Economists have published a number of hedonic models of public land or easement purchases, but the results are vulnerable to misinterpretation. This body of literature is very young and therefore limited. However we expect to see more publications on public land purchases as more communities adopt open space preservation programs. Our intention was to provide policy researchers with guidance on how to avoid misinterpreting the results of hedonic models of public purchases. We presented the theoretical basis of the hedonic model as developed by Rosen (1974) and elaborated on by Harding *et al*. (2003) and Cotteleer *et al*. (2008). A lack of market equilibrium, such as in thin markets, can lead to excess surpluses and misleading implicit price estimates. Several recent hedonic models of public open space purchases have misinterpreted the resulting implicit price estimates as the public agency's willingness to pay. The case study of the Town of Brookhaven on Long Island demonstrated the discrepancy between the implicit price estimates and the agency's own stated preferences for open space attributes. An implicit price estimate from a hedonic model of public land purchases cannot be interpreted as the purchasing agency's willingness to pay. It can, however, be narrowly interpreted as that attribute's effect on the purchase cost. If interpreted properly, the hedonic model can be used to improve the cost effectiveness of open space preservation programs.

Our findings have significance beyond open space preservation. Economists engaged in biodiversity conservation often use hedonic models, and these models could encounter challenges similar to the one we have presented here. Economists, such as those reviewed in Naidoo *et al*. (2006), have long advocated for cost effective approaches to biodiversity conservation. However disciplinary barriers still thwart the adoption of such approaches. Future work should focus on not only refining methods for identifying cost effective environmental conservation, but also overcoming the disciplinary or institutional barriers to such methods.

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Table 1: Explanatory variables for the hedonic model of Brookhaven's open space purchases.

Category	Variable	Description	Mean (S.D.)	Hypothesized Sign
	Cost	Acquisition cost (2005 $) (Dependent variable)	$1,112,483 (1,681,942)	n/a
I. Physical	*Wetland>25*	Total property area in wetlands greater than 25% but less then 50%; 1 if present, 0 otherwise	0.11 (0.32)	Positive
	Wetland>50%	Total property area in wetlands greater than 50% but less then 75%; 1 if present, 0 otherwise	0.14 (0.36)	Positive
	Wetland>75	Total property area in wetlands greater than 75%; 1 if present, 0 otherwise	0.17 (0.38)	Positive
	Natural_Buffer	Acquisition will create a natural buffer or corridor along a stream or river; 1 if present, 0 otherwise	0.49 (0.51)	Positive
	Species	Contains an endangered or threatened species; 1 if present; 0 otherwise	0.23 (0.43)	Positive
	Historical	Has historical or archaeological significance; 1 if present zero otherwise	0.69 (0.47)	Positive
II. Size	*Size_Purch*	Purchased property size (ha)	11.97 (25.51)	Positive
III. Location	*Adjacent*	Adjacent to other publicly held lands; 1 if present, 0 otherwise	0.69 (0.47)	Positive
	FEMA_V	Property located in a Federal Emergency Management Agency (FEMA) "V" flood zone; 1 if present, 0 otherwise	0.06 (0.24)	Positive
IV. Community Values	*Drainage*	Provides an area for natural drainage; 1 if present, 0 otherwise	0.77 (0.43)	Positive
V. Aesthetic Values	*Vista*	Site contains significant scenic vistas; 1 if present, 0 otherwise	0.49 (0.51)	Positive
	RoadView	Property contains important views along expressway or major road corridors; 1 if present, 0 otherwise	0.20 (0.41)	Positive

VI. Farmland	*FarmSoil*	Property contains soil types suitable for high agricultural production; 1 if present, 0 otherwise	0.23 (0.43)	Positive

Table 2: Hedonic model parameter estimates, linear form with *Cost* as the dependent variable.

Category	Variable	β	SE	*p*-value
	Constant	267,055	258,003	0.31
I. Physical	*Wetland>25*	-194,723	274,000	0.49
	Wetland>50	89,306	291,565	0.76
	Wetland>75	-157,788	260,122	0.55
	Natural_Buffer	199,709	185,424	0.29
	Species	-391,600	204,123	0.07*
	Historical	-262,825	178,177	0.16
II. Size	*Size_Purch*	23,576	1,699	0.00**
III. Location	*Adjacent*	362,021	196,696	0.08*
	FEMA_V	-534,815	404,798	0.20
IV. Community Values	*Drainage*	-152,168	271,922	0.58
V. Aesthetic	*Vista*	371,567	172,587	0.04**
	RoadView	-52,567	216,528	0.81
VI. Farmland	*FarmSoil*	381,172	278,406	0.19

$R^2 = 0.96$, $R^2_{adj} = 0.94$, SE = 411,436, $F = 42.09$, $p < 0.01$, $N = 35$
**significant at α = 0.05
*significant at α = 0.10

Figures

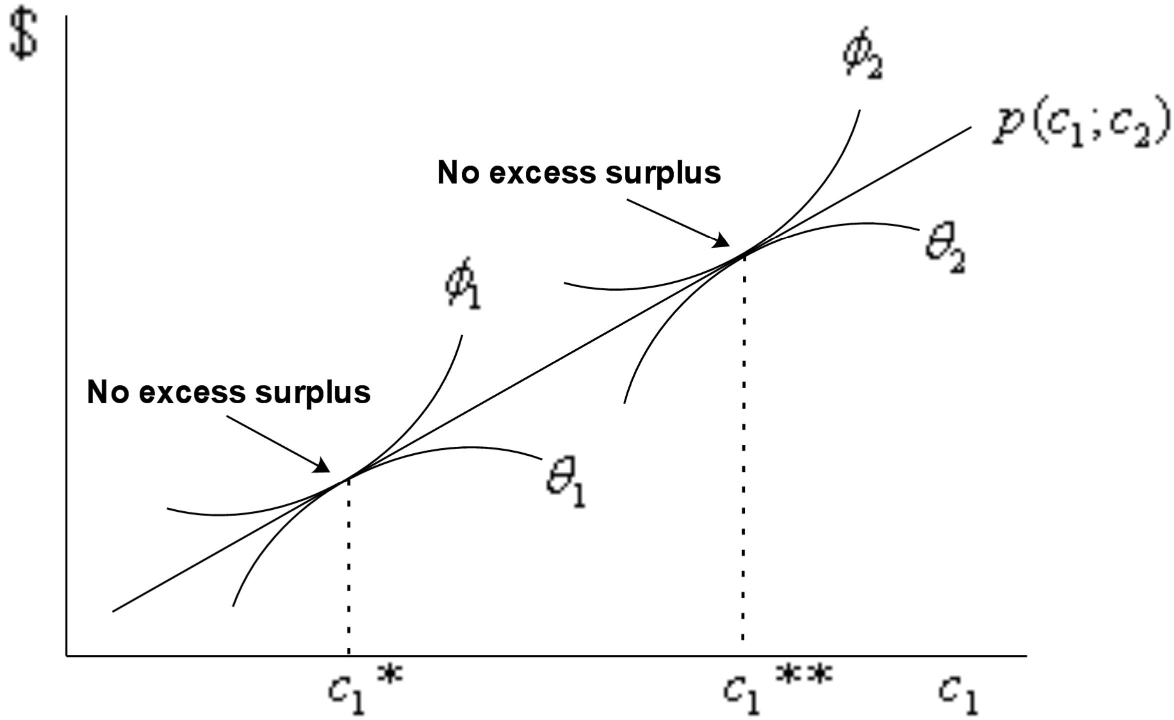

Figure 1: Hedonic prices without excess surplus (Harding *et al*. 2003).

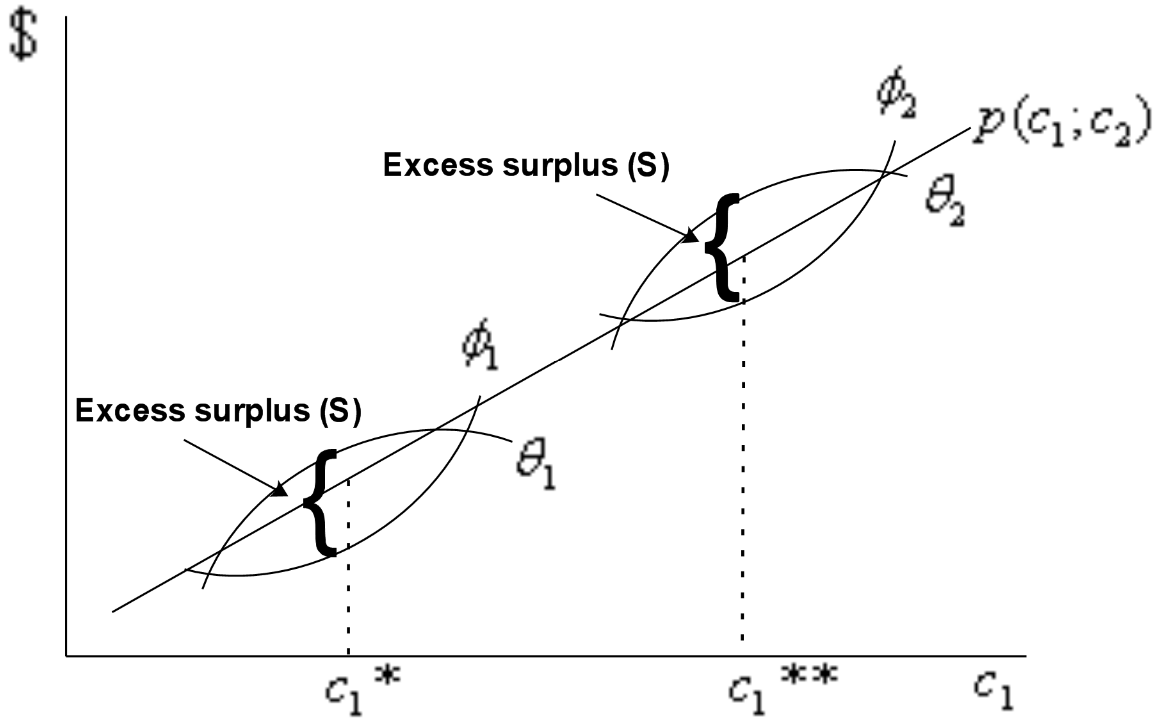

Figure 2: Hedonic prices with excess surplus (Harding *et al*. 2003).

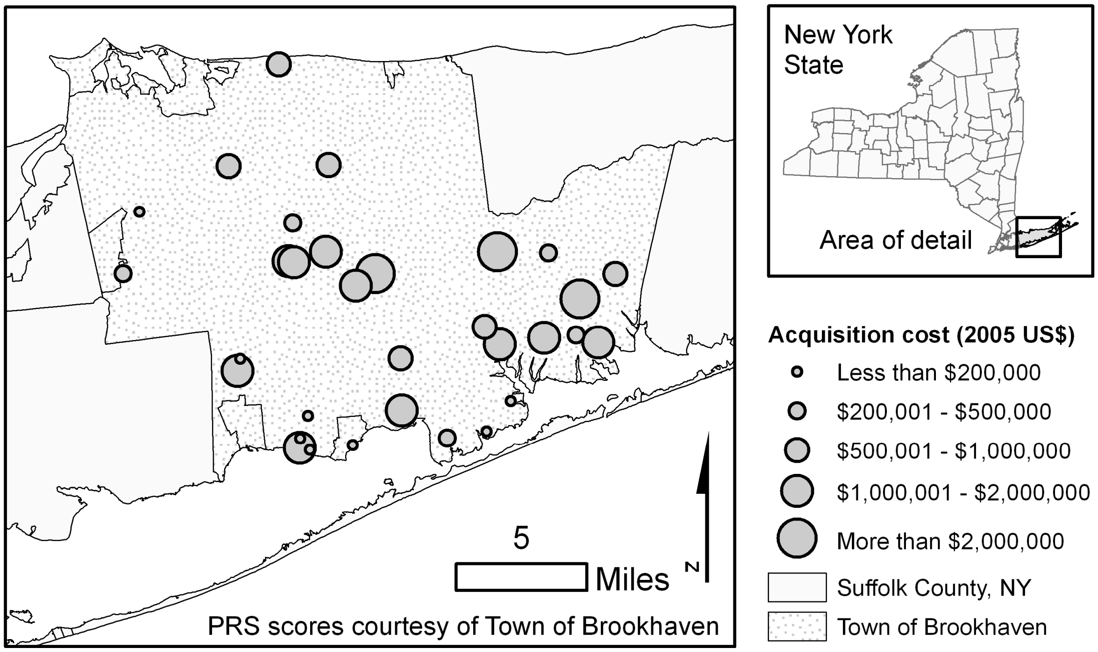

Figure 3: Study area showing open space property acquisition cost (2005 $).

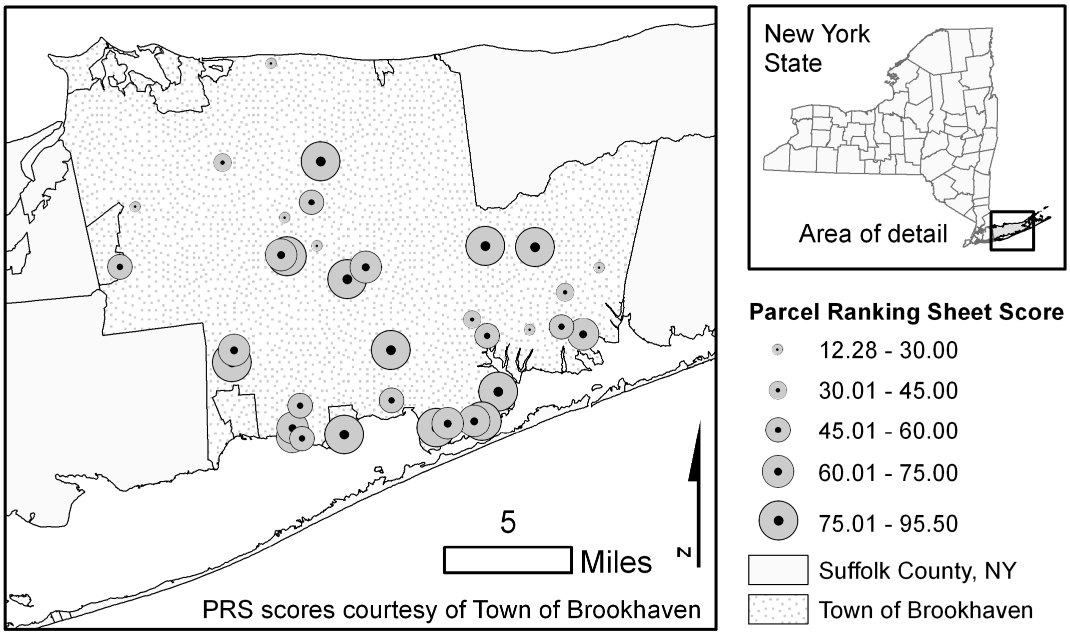

Figure 4: Study area showing open space property Parcel Ranking Sheet (PRS) scores.