Valuing House and Landscape Attributes: Application of the Hedonic Pricing Technique Investigating Effects of Lawn Area on House Selling Price

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ABSTRACT

Hedonic pricing is used to determine the effect of a landscape element such as the lawn area on the home selling price of single-family homes in Athens, Georgia. Results show that lawn area and the use of zoysiagrass as the dominant species positively and significantly influenced the selling price.

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Introduction

The purpose of this study is to determine the economic value of potential lawn area type, and quality on the selling price of a home. By quantifying the effect of potential lawn area on a home's selling price, a landscaper may use the results as a method of soliciting new business or by changing the lawn services that are offered. The results of the study will also help real estate agents and homeowners to place the proper emphasis on lawn and landscape appearance and quality in preparation of the house sale.

The homes in this study are single family homes that were sold from 1998 through 2000 in Athens-Clarke County, Georgia. Each was located on a lot less than 3 acres in size and had a courthouse transaction indicating that the house was sold at "arm's length." Information about housing and landscaping attributes were collected for each home.

The application of the hedonic pricing technique is suitable because this study focused on determining factors affecting the house selling price, where a number of attributes differentiate one house from another. Goodman (1998) traces the development of the hedonic price analysis to Andrew Court's work for the automobile industry. In a 1939 article, Court used weighted characteristics, hedonics, to develop, "an idea of usefulness and desirability," for automobiles. However, Court's work on hedonic price analysis resulted in little response from other economists. Hedonic prices and price analysis remained unnoticed until the much cited article by Rosen (1974). In this article, Rosen states, "Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them" (p. 34). Rosen also develops the hedonic price function. He proposes that the price is a function of a **z** vector, which is a vector of attributes and characteristics, each making a meaningful contribution to the price, the price can be decomposed into a series of a product attribute valuations. The use of the hedonic method implies that a product can be accurately described by a set of its own characteristics. Among the most frequent applications of the hedonic method are studies involving the real estate industry. The ordinary least squares (OLS) method is used to estimate and determine the effect of the lawn quality and area and other features on the selling price of a home.

Landscape and Turfgrass Value in Hedonic Price Studies

There have been numerous studies measuring the effect of trees on the selling price of a home. Payne (1973) introduced the idea that excessive tree cover had a negative effect on residential property value. He estimated that more than thirty trees to a half-acre lot led to a reduction in the total property value (Payne, p. 75). However, it appears that homeowners' preferences have changed over time. Anderson and Cordell (1988) examined the effects of trees on residential property values in Athens, Georgia. Their study encompassed a sample of 844 single family homes sold between 1978 and 1980, and concluded that the presence of trees on the lot increased the value of a home by 3.5 to 4.5 percent. Recently, Sydor (2005) conducted a similar study in Athens, Georgia, and concluded that a 10 percent increase in relative tree cover could result in a premium of up to $3,240 of the residence's value.

Rosiers *et al*. (2002) used the hedonic approach to measure landscaping effects on house values. Their study found that a one percent increase in ground cover resulted in a 0.2 percent increase in selling price. However, the study also found that as the density of visible vegetation on the property increases, there is a 2.2 percent drop in the price of the house. Earlier evidence that various landscape features are valued differently by house buyers was provided by Luttik (2000) in an attempt to determine the effect of environmental factors on house prices in the Netherlands. He concluded that a house in Leiden that had a water view had a 10 percent premium on its price, and that there was a seven percent premium on houses with attractive landscape and water features.

Although effects of tree cover or other landscape features on residential property value have been established, turfgrass effects have received little attention. One limitation in the turfgrass value assessment is the calculation of the turfgrass area. Robbins and Birkenholtz (2003) introduced a method for calculating the potential lawn area (PLA). The method defines the PLA as the overall lot size in square feet less the house square footage divided by the number of floors in the house. The method is flexible and can be applied to any residential property. To get the final PLA, the authors multiplied the PLA by a multiplier (equal to 0.816) to account for impervious space and other non-lawn space of each lot. Impervious space is any part of a lot that is resistant to surface water percolation. Robbins and Birkenholtz (2003) use this method to calculate lawn coverage because the satellite images and aerial photos available were not at high enough resolutions to adequately measure lawn cover.

The Robbins and Birkenholtz (2003) formula accounting for the potential lawn area is:

(1) $PLA = LSQ - (SQ/FLR) * 0.816$

LSQ is lot size in square feet, SQ is the house square footage, FLR is the number of floors, and 0.816 is the multiplier used to account for impervious and other non-lawn space.

Methods and Data

The data used in this study can be separated into two subsets, housing data and landscape data. The bulk of housing data was obtained from a previous study by Sydor (2005). Data referred to house attributes, such as selling price, year of sale, heated square footage of the house and other relevant information. Property specific characteristics like lot size, tree cover, and bare land value were also included. Some of these variables were listed among data provided by Sydor (2005), e.g., the lot size or the bare land value.

Other measures such as the PLA and the amount of impervious space were developed specifically for this study. The PLA was calculated using the method introduced by Robbins and Birkenholtz (2003). The amount of impervious space was collected from a data set provided by the Athens-Clarke County Transportation and Public Works Department. Such space includes paved driveways and walkways. Because some families may own and use more than one or two vehicles, the driveway size varies. The landscape data subset included measures pertaining to turf surrounding the house. Landscape attributes, for example, the turfgrass species, turfgrass color, and the turfgrass quality for each of the surveyed residential properties were included in the landscape data subset and measured using index procedures developed for this study. Information about turfgrass was obtained from curbside assessment of each property.

The final dataset used for this study contained 271 observations and 29 variables. Table 1 provides a description of the variables used in this study.

Turfgrass description

Because all assessments were conducted from the curb or sidewalk, the dominant turfgrass species was identified in the front yard of the homes. These observations were taken five to seven years after the house was sold, therefore, it was assumed that the turfgrass species did not change during that time.

The turfgrass assessments were conducted from the middle of May through the end of June, 2005. This period was chosen because the warm-season turfgrasses had ample time to enter their vegetative stage after their winter dormancy. The period was also suitable for the evaluation of the only cool-season turfgrass, tall fescue, considered in the study. The different turfgrass species assessed were bermudagrass, centipedegrass, zoysiagrass, tall fescue, and St. Augustine. The category "Other" on the turfgrass check sheet classified turfgrass that was unidentifiable and yards that did not have any turfgrass.

Turf quality (TQ) and turf color (TC) scores were also assessed for each residence. The National Turfgrass Evaluation Program (NTEP) measures TQ and TC on a scale from one to nine. These scores are based on visual observations of the turfgrass. A score of nine implied the highest quality or color score, respectively, and the score of one being the worst according to the industry standard set forth by the NTEP for evaluating turfgrass quality and genetic color. A turfgrass index score was also developed based on summing the TQ and TC scores.

The PLA

In this study a modified method of calculating the PLA is proposed. The method takes into account the Robbins and Birkenholtz (2003) method. However, the proposed method also accounts for house amenities that present an extension of the house, for example a porch. The specific formula used in this study to calculate the PLA is:

(2) PLA = (LSQ – ((HSQ-BASEM)/FLR) – GSQ – DSQ – PCSQ – OPSQ – SPSQ) * 0.816

where the PLA is potential lawn area, LSQ is lot size in square feet, HSQ is heated square footage, BASEM is basement square footage, FLR is number of floors at or above grade, GSQ is garage square footage, DSQ is deck square footage, PCSQ is porch square footage, OPSQ is open porch square footage, SPSQ is screened-porch square footage, and 0.816 is the multiplier to account for impervious and other non-lawn space.

Estimation and Results

Functional form selection

Since the development of the hedonic pricing method, there has been much debate on the choice of a proper functional form of the regression model. There is no guidance in economic theory that would support the best possible functional. Instead, researchers base their choice on the goodness-of-fit measures and the signs and significance of estimated coefficients. In their 1998 study, Craig, Palmquist, and Weiss (1998) obtained the "best fit" for their data with the semi-log functional form. There have also been studies that used more than one functional form for estimation in a simple hedonic study. Sydor (2005), for example, used the linear functional form, the linear-log functional form, and the Box-Cox transformation functional form. It appears that a frequent approach is to test alternative functional forms and to use the functional form that best fits the data.

This study follows the method of Craig, Palmquist, and Weiss (1998) in applying the semi-log functional form to estimate the specified empirical model. Sirmans, Macpherson, and Zietz (2005) state, "…the hedonic pricing model is often estimated in semi-log form with the natural log of price used as the dependent variable" (p. 4). The semi-log functional form was chosen because results show the rate of change in the independent variables cause in the dependent variable.

Empirical Specification

The dependent variable chosen for this study was the selling price of the home commonly applied in the literature involving hedonic property value analysis (for example, Anderson and Cordell 1988; Kim and Wells 2005; Sydor 2005). The effects of the variables used in the model are easy to interpret in terms of their contribution to the house selling price.

Following Rosen (1974) the hedonic price function can be expressed as:

(3) $P_h(\mathbf{Z}) = \mathbf{G}^h(\mathbf{Z}_1, \mathbf{Z}_2, \ldots, \mathbf{Z}_n)$

where P_h is the selling price of a house and $\mathbf{Z}_1, \mathbf{Z}_2, \ldots, \mathbf{Z}_n$ are house and landscape attributes.

In this study, the selected independent variables can be classified into two different categories. The first category consists of features of a house. These variables not only included the basics of a house, but also included certain amenities that help differentiate one house from another. The basic house features included the total number of rooms, heated square footage, and the age of the house. The age was calculated by subtracting the year of construction from 2000. Dummy variables were used to indicate the presence of a deck and the presence of an open porch. Additional dummy variables depicting the features of the house included a dummy variable for more than one bathroom and two dummies accounting for each of the first two years in the three-year time window. The base year was set at 2000 because more than 60 percent of the transactions occurred in that year. All of the house features, except for the year of sale and open porch square footage, are listed by Sirmans, Macpherson, and Zietz (2005), as the twenty most common characteristics used in hedonic pricing equations.

The second group of variables includes the landscape features attributed to the house and its lot. Included among these variables were the amount of impervious space and the leaf coverage area. The impervious space variable was included to show the effect that non-lawn area has on the selling price of homes. Leaf coverage and the ratio of leaf cover to the PLA were both included to depict the relationship of other landscape features on the selling price of a home and effects of the trade-off between trees in the landscape and lawn area. Also included in this category were dummy variables for the turfgrass species - centipedegrass, zoysiagrass, tall fescue, and St. Augustinegrass. The “Other” category referred to residential properties without a lawn or properties, where the turfgrass species could not be determined. Bermuda grass was used as the baseline for the turfgrass dummies because it was the most prevalent turfgrass species in the sample. An index score, which was the summation of TQ and TC from each assessment, was also included in the empirical model to see the effects of a combination of turfgrass quality and turfgrass color on the selling price of homes in Athens-Clarke County.

Dummy variables for the amount of PLA for each home were used in this study. The PLA dummy variables represented a range of different lawn areas. The base case was set to include homes that had a PLA of 10,000 square feet or less. This PLA category accounted for almost 37 percent of all observations. The other PLA dummy variables were set to include the observation where the PLA was between 10,001 and 15,000 square feet, 15,001 and 25,000 square feet, and greater than 25,001 square feet, respectively.

The final empirical model used for the estimation included the following variables:

$$(4)\ \log(P_h) = a + \beta_1 PLAM2 + \beta_2 PLAM3 + \beta_3 PLAM4 + \beta_4 IMPSP + \beta_5 LCPLA + \beta_6 RMS + \beta_7 LC2 + \beta_8 LC + \beta_9 OPSQ1 + \beta_{10} DSQ1 + \beta_{11} BRS1 + \beta_{12} CENT + \beta_{13} ZOYS + \beta_{14} STAUG + \beta_{15} OTH + \beta_{16} INDEX + \beta_{17} DATE1 + \beta_{18} DATE2 + \beta_{19} HSQ + \beta_{20} AGE.$$

Table 1 provides the names and full definitions for each variable.

Expected effects of the independent variables

The effect of the PLA is directly linked to the objective of this study which is to examine the effect of the lawn area on the selling price. The PLA variables used in the model are dummy variables and represent four categories of lawn sizes. Although homeowners generally seem to prefer to have a lawn, a particularly large lawn may be a disadvantage. The larger the lawn, the more time, effort and money it takes to maintain it, but a very small lawn may not be eye-appealing while still requiring maintenance. The effects of the lawn sizes are measured against the smallest size, i.e., 10,000 square feet. It is expected that the second and, perhaps, the third size category may have the positive effect on selling price. The second category includes lawns that were centered around the mean lawn area calculated from the sample.

The impervious space variable is expected to have a negative effect on price. Not only could a turfgrass be more aesthetically pleasing but homeowners pay less for every square foot of impervious space because such a space increases runoff.

Anderson and Cordell (1988) and Sydor (2005) found that the presence of trees, which can translate into leaf coverage, had a positive effect on the selling price of a house. The positive effect of the leaf coverage area should lead to an increase in the selling price of the home. Other landscape-related features were described by additional variables, including the dummy variables for some of the turfgrass species. The turfgrass quality and color index score is also expected to have a positive effect. When compared to the base turfgrass species, i.e., bermudagrass, zoysiagrass is expected to have the positive effect on the home selling price. The positive influence is expected because zoysiagrass has good appearance, creates a thick turf and requires relatively little maintenance. Considered a “luxury” turfgrass suggests that zoysiagrass may be present in the affluent areas of a town or county. The tall fescue dummy variable is expected to have a negative effect. Tall fescue does not have the high costs associated with the laying of sod (i.e., it is sown), but, considered a cool season turfgrass, it does poorly during Georgia’s summer. The turfgrass quality and color index variables for each home should also have a positive effect because it is assumed that homeowners would like a lawn that had a high turfgrass quality and color score.

For the house specific characteristics based on previous literature (e.g., Sydor, 2005), it is expected that variables including the number of rooms, the presence of a deck or open porch, the heated square footage should exert a positive influence on the house price. The number of rooms and the bathroom dummy should have a positive influence on the selling price because a house with many rooms and bathrooms indicates a house design, which is likely to be highly priced. The open porch and deck variables are expected to have a positive influence because these amenities add to the value of the house. The age of the house is expected to have a negative effect on the dependent variable because newer homes were likely more expensive to build and their value has depreciated less.

Results

The empirical model was estimated in SAS using the ordinary least squares (OLS). The specified empirical model used a log-linear functional. Models estimated with cross-sectional data tend to have a smaller overall explanatory power than similar models estimated using time series data. The adjusted R-squared in the case of this study was 0.62 and is within the range reported in the literature for property value studies. The F-value of 21.97 indicated that a number of the explanatory variables significantly influenced the dependent variable.

Because of the objective of this study the result regarding the significance and the sign of the coefficients on the PLA dummy variables was important. The PLAM2 variable, which was the benchmark dummy variable, for homes with the PLA between 10,001 and 15,000 square feet had, as expected, a positive and statistically significant effect on the home selling price when compared to the base PLA variable. For example, a home priced at $100,000 with the PLA between 10,001 square feet and 15,000 square feet can be expected to have a selling price premium of about $12,939, holding all variables equal. However, the PLAM4 variable, which indicated homes with more than 25,001 square feet of the PLA, had a negative effect on the dependent variable. The selling price of a home would be heavily discounted. The results from the PLA dummies are consistent with expectations that as lawn size increases, the positive change in price results from an increase only to a certain size. Although homeowners like to have a lawn, an excessively large lawn appears to be a disamenity for most potential buyers. This finding is consistent with that of Rosiers *et al*. (2002) who reported that an increase in the density of vegetation decreased the selling price of a house.

The leaf coverage effect is consistent with the effect of the leaf coverage results reported by earlier studies. Leaf coverage was positive and statistically significant. The leaf coverage variable being positive and statistically significant supports the findings by Anderson and Cordell (1988) and Sydor (2005). Both studies found a positive relationship between a home's value and the existence of trees for homes in the Athens-Clarke County area. The effect of leaf coverage squared is consistent with the directional effect reported by Payne (1973) who concluded that after a certain threshold value, the increasing number of trees will decrease the value of a property. The ratio of leaf coverage to the PLA was negative and statistically significant with an estimate of -0.05578. This result suggests that there is a trade-off between the leaf coverage and lawn area.

Among binary variables representing turfgrass species, two were statistically significant: zoysiagrass and tall fescue. As expected, the estimate for zoysiagrass, 0.19242, was positive and the estimate for tall fescue, -0.18062, was negative. These results indicate that having zoysiagrass, in the front yard, instead of bermudagrass increases the selling price of the home assuming all other things constant. However, the selling price of homes decreases if tall fescue covers the front yard instead of bermudagrass. For illustrative purposes, a house that is priced at $100,000 and has bermudagrass in its lawn, holding all things equal, would sell for $19,242 more if the home had zoysiagrass. Having tall fescue instead of bermudagrass would decrease the selling price by $18,062. None of the other turfgrass variables were statistically significant, therefore, the effect of their presence on selling price could not be differentiated from a bermudagrass lawn. The calculated premium and discount should be treated with caution because changing a lawn's turfgrass species requires a substantial amount of work, time, and money, e.g., lawn renovation is associated with the replacement or installation of an irrigation system.

Conclusions and Implications

Ordinary least squares regression was applied to estimate the effect of housing and landscape attributes on selling price. Results confirmed the expectation that the PLA, within limits, had a positive and statistically significant effect on the home's selling price. The positive effect on the house selling price was associated with the PLA ranging from 10,001 to 15,000 square feet as compared to the PLA of less than 10,001 square feet. Almost 37 percent of the properties in the sample had lawn area that was less than 10,001 square feet. The results also concluded that when compared to the base PLA, a PLA greater than 25,001 square feet had a negative and statistically significant effect on the selling price.

The results indicated that two of the turfgrass species dummy variables could be statistically differentiated from the bermuda baseline. Having a zoysiagrass lawn would increase the home's selling price, while a lawn seeded with tall fescue would cause the selling price of the home to decrease.

Homeowners, real estate agents, and landscapers should all be able to understand and interpret the results from this study and utilize the knowledge for their respected purposes. Homeowners and real estate agents will be able to weight the affect of a home's lawn area and turfgrass species in preparation of selling the home. For example, a homeowner with a fescue lawn, contemplating selling her property, could evaluate the potential increase in selling price associated with installing a zoysia lawn compared to the cost of installation. Real estate agents could also use the results to inform potential buyers of the value of the landscape attributes, which may increase the probability of a successful sales transaction. Landscape installation and maintenance companies and turfgrass producers can use the results to illustrate of how maintaining and developing a lawn may increase the price homeowners could expect for their house at the time of sale. The value associated with lawn area and turfgrass species could also be used by landscapers and turfgrass companies as a means to solicit new business.

Limitations of the study

The results of this study, although consistent with previous work, should be viewed with some caution because of several limitations. The PLA measurement is an approximation. It is possible that errors were inadvertently made in some of the measurements, because of the constant value of the multiplier applied to each property. It is likely that some properties had flower beds, which would restrict lawn area. Limitations also include the individual turfgrass assessments. The observation of the dominant turfgrass species only took place in the home's front yard. Although unlikely, it is possible that turfgrass species used in the front yard differed from those in the backyard.

Furthermore, the turfgrass assessments were conducted during a single visit. The TQ and TC scores of the warm-season turfgrass species would have been much lower if the assessments were conducted during the months when these turfgrasses are dormant. The season of the year is relevant because the house sales tend to fluctuate. In addition, the turfgrass assessments were five to seven years apart. This difference in timing of the sale and the evaluation of the lawn forced the assumption that the same turfgrass species was still present five to seven years after the house had been sold.

The model did not include an explicit neighborhood affect which may limit the explanatory power of the results. Athens-Clarke County, like most urban areas, has neighborhoods where the value of land is higher than in other parts of town or county for a number of reasons. Further studies could include some form of a neighborhood affect.

In spite of numerous studies empirical applications of the hedonic pricing method to real estate markets, little research has been conducted with respect to the influence of turfgrass on selling price. This study attempted to explore the effect of lawn area and quality on the house selling price. Further studies on the relationship between the value of potential lawn area and the selling price of residential properties are needed.

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Table 1. Variable names, definitions and measurement units.

Variable	Definition	Units
SP	Home selling price	$
HSQ	Heated square footage	Square feet
OPSQ	Open porch area	Square feet
OPSQ1	Open porch dummy	1 if open porch present; 0 otherwise
DSQ	Deck area	Square feet
DSQ1	Deck dummy	1 if deck present; 0 otherwise
RMS	Total number of rooms in the house	Actual number
BRS	Total number of bathrooms in the house	Actual number
BRS1	Dummy variable for number of bedrooms	1 if BRS>1; 0 otherwise
PLA	Potential lawn area	Square feet
PLAM1	Potential lawn area dummy	1 if PLA<=10000 square feet; 0 otherwise
PLAM2	Potential lawn area dummy	1 if PLA between 10001 and 15000 square feet; 0 otherwise
PLAM3	Potential lawn area dummy	1 if PLA between 15001 and 25000 square feet; 0 otherwise
PLAM4	Potential lawn area dummy	1 if PLA>=25001 square feet; 0 otherwise
IMPSP	Amount of impervious space	Square feet
LC	Leaf coverage	Square feet
LC2	Leaf coverage squared	Square feet
LCPLA	Ratio of leaf cover to potential lawn area	Actual number
BERM	Bermudagrass	1 if bermudagrass; 0 otherwise
CENT	Centipedegrass	1 if centipedegrass; 0 otherwise
ZOYS	Zoysiagrass	1 if zoysiagrass; 0 otherwise
FES	Tall fescue	1 if tall fescue; 0 otherwise
STAUG	St. Augustinegrass	1 if St. Augustinegrass; 0 otherwise
OTH	No turfgrass or unidentifiable species	1 if Other; 0 otherwise
INDEX	Turfgrass quality and color index	Summation of TQ and TC
DATE1	Year of sale dummy	1 if year=1998; 0 otherwise
DATE2	Year of sale dummy	1 if year=1999; 0 otherwise
DATE3	Year of sale dummy	1 if year=2000; 0 otherwise
AGE	Age of the house	Actual number

Table 2. OLS estimates, t-statistics, and means from the semi-log model.

Variable name	Parameter estimate	t-statistic	Mean
Intercept	10.23848*	46.65	--
PLAM2	0.12939***	1.75	0.25
PLAM3	-0.02702	-0.29	0.12
PLAM4	-0.28617*	-2.95	0.26
IMPSP	0.00004*	4.331	3,225.08
LCPLA	-0.05578*	-3.31	2.36
LC	0.00002***	1.75	25,380.59
LC2	-1.27707E-10	-0.690	787759371
RMS	0.07297*	3.26	6.02
OPSQ1	0.00025***	1.867	0.93
DSQ1	0.12538***	1.92	0.21
BRS1	0.16903**	2.56	0.62
CENT	0.07517	1.32	0.31
ZOYS	0.19242***	1.62	0.05
FES	-0.18062***	-1.66	0.06
STAUG	0.03156	0.11	0.01
OTH	0.10418	0.61	0.08
INDEX	-0.00257	-0.23	12.27
DATE1	0.04724	0.67	0.15
DATE2	-0.06330	-1.03	0.21
HSQ	0.00029*	5.76	1,729.82
AGE	-0.00161	-1.216	46.49
F-value	21.967		
Adjusted R^2	0.6199		
Durbin-Watson statistic	1.917		

* Significant at a=0.01.
** Significant at a=0.05.
*** Significant at a=0.10.