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Living on the Edge: Residential Property Values in the Urban–Rural Interface

Molly Espey, Fahmida Fakhruddin, Lawrence R. Gering, and Huiyan Lin

This study estimates the contribution of both urban–rural fringe location and lake proximity on residential property values in three upstate counties of South Carolina through estimation of spatial hedonic housing price models. Location in the urban fringe and the urban–rural interface are found to have a positive impact on residential housing values relative to either urban or more rural locations. Lakes in the upstate contribute positively to housing values to the extent that the house has a view of a lake, lake access, or lake frontage.

Key Words: environmental valuation, hedonic analysis, lake proximity, rural development, urban–rural interface, urban sprawl

JEL Classifications: O18, R14, R21

While still a relatively rural state, South Carolina is currently among the more rapidly growing states in the country in terms of both population and land development. With the fifteenth fastest population growth during the last decade (U.S. Census) and the tenth fastest rate of land development (USDA), South Carolina is experiencing rapid transformation in and expansion of the urban–rural fringe. As this growth continues, urbanized areas stretch beyond city limits, transforming small communities and formerly rural places.

Rural areas provide many amenities such as outdoor recreational opportunities and quiet, scenic landscapes. Urban areas, on the other hand, offer a greater diversity of job opportunities as well as convenient services and products. However, urban areas also provide disamenities such as traffic congestion, noise, and pollution. A mixture of these two, found in fringe or interface areas, may offer the best of both worlds for individuals and families looking for a place to live. This study compares housing values in urban, rural, and interface areas through the integration of geographical information systems (GIS) and hedonic housing price analysis to estimate the value of living in the fringe.

From 1980 to 2000, the population of the United States increased by 22% and over 30 million acres of land were developed (USDA). Proportionately, both metro and nonmetropolitan growth in the South (32.3% and 10.6%, respectively) has been second only

Molly Espey is professor, Department of Applied Economics and Statistics, Clemson University, Clemson, SC. Fahmida Fakhruddin is a former graduate student, Department of Applied Economics and Statistics, Clemson University, Clemson, SC. Lawrence R. Gering is associate professor, Department of Forestry and Natural Resources, Clemson University, Clemson, SC. Huiyan Lin is a senior analyst with Capital One.

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to the West (36.2% and 27.2%, respectively). In South Carolina, the Piedmont region, located between the metropolitan areas of Atlanta, GA and Charlotte, NC and encompassing the I-85 corridor, is second only to two coastal counties in terms of its rate of growth (Dobson, Oldendick, and Prince). With its proximity to Atlanta and Charlotte and an influx of residents and changing demographics, the area is experiencing the pressure of growth from both external and internal forces.

This study focuses on the three most rural, yet fastest-growing counties of the Piedmont region: Anderson, Pickens, and Oconee counties. While the impact of general location in urban, interface, and rural areas is the primary focus, the contribution of lake amenities on residential housing values is also estimated in this analysis. The next section reviews the literature of hedonic studies of open space amenities as well as relevant analyses of development in the urban–rural fringe. This study expands upon this literature by considering lake view, lake access, and lake frontage, along with specific urban, rural, and fringe location variables. The estimated values of location and lake proximity are found to be robust across four regression models, ordinary least squares and three models that account for spatial correlation in different ways.

Background

The hedonic pricing technique, as applied to housing, is based on the idea that the value of a house is a function of the value of the bundle of "utility bearing" attributes that comprise the house (Rosen). These attributes include structural characteristics such as square footage, the number of bedrooms, and lot size. Other less easily quantifiable attributes include characteristics of the surrounding neighborhood, the presence of amenities such as a nice view, or the presence of disamenities such as noise. Thus the price of a house (P_h) can be written as

$$(1) \quad P = f(S, N, A),$$

where S, N, and A indicate vectors of structural, neighborhood, and other amenity variables respectively. This equation is the hedonic, or implicit price, function for housing and is often referred to as the "first-stage" hedonic function (Palmquist). The implicit price of any particular characteristic, for example A_m, an amenity variable, can be estimated as

$$(2) \quad \delta P_h / \delta A_m = P_{Am}(A_m).$$

This partial derivative gives the change in expenditures on housing that is required to obtain a house with one more unit of A_m, all else constant. If the value of the partial derivative is positive, the attribute is an amenity. If the value is negative, the attribute is a disamenity.

Many prior studies have estimated the effects of various types of open space on a house's sales price or assessed value. Among the earlier studies, Weicher and Zerbst studied parks in Columbus, OH; Correll, Lillydahl, and Singell analyzed greenbelts in Boulder, CO; Frech and Lafferty estimated the impact of the California Coastal Commission's efforts to preserve open space; and Do and Grudnitski estimated the value of proximity to golf courses. Mahan, Polasky, and Adams estimated a positive value of proximity to urban wetlands and Tyrvainen and Miettinen estimated the value of proximity to urban forests. Espey and Owusu–Edusei examined the value of proximity to urban parks, while Netusil and Bolitzer and Lutzenheiser and Netusil examined the impact of proximity to a variety of open space types on urban property values. All of these studies, however, focus on proximity as distance to a specific urban amenity.

Anselin, Parks, and Bockstael were among the first economists to focus on spatial characteristics in the modeling of land use. Anselin was at the fore of development of spatial econometrics while Parks integrated economic analysis into models of forest and agricultural landscapes. Bockstael used landscape data in both a predictive model of land conversion to a developed use and in a hedonic model of residential land values, with a focus

on the Patuxent Watershed near Washington, DC. Geoghegan, Wainger, and Bockstael expanded on some of this work by estimating the relationship between various spatial landscape indices and residential housing values in the same area. Their study produced a much richer model of open space values by taking into account development densities and landscape patterns. Hardie, Narayan, and Gardner estimated the impact of both farm and nonfarm factors, including spatial variability in development, on farmland values. Isakson and Ecker examined the influence of location in the market for undeveloped urban fringe land in Denver, CO.

Several more recent studies have measured open space as a percentage of land within a certain radius around each house. Acharya and Bennett incorporated open space, land-use diversity, and other environmental variables to capture spatial characteristics around houses. Irwin and Irwin and Bockstael compare differential impacts of public and private open space and permanent and nonpermanent open space. Geoghegan, Lynch, and Bucholtz focus on open space purchased for agricultural preservation.

Even after accounting for spatial characteristics explicitly, spatial dependence may still exist, resulting in inefficient coefficient estimates. Development of econometric procedures to account for spatial dependence and produce efficient and consistent estimators has been an important part of the spatial econometric literature (Anselin; Dubin 1988, 1992; Can 1990, 1992; McMillen 1992, 1995). Leggett and Bockstael and Bockstael and Bell use a spatial error model in their studies of open space, while Theebe and Brasington and Hite use a more general spatial Durban model that can capture spatial dependence in both the X-characteristics of nearby properties as well as spatial dependence in the residuals in their studies of environmental disamenities.

In this study, several spatial econometric models are estimated while focusing on landscape values in terms of general degrees of development ranging from urban to rural locations with three gradations of interface in between. Three types of amenity values associated with major lakes that might be reflected in housing values are also considered: lake view, lake access, and frontage on a lake.

Empirical Models

The hedonic price of houses in the study area is estimated as

$$(3) \quad P_i = f(S_i, N_i, A_i),$$

where P_i is the log of the sales price of a given house, S_i is a vector of structural housing characteristics, N_i is a vector of county location variables and average travel time to work, and A_i is a vector of lake proximity variables and urban–rural fringe location variables.

Spatial dependence is formalized in terms of contiguity where the dependent variable or error term at each location is correlated with observations for the dependent variable or error term at other locations. Spatial correlation among the dependent variables is defined as a spatial lag situation which is specified by the spatial autoregressive model (SAR):

$$(4) \quad y = \rho W y + X\beta + \varepsilon,$$
$$\varepsilon \sim N(0, \sigma^2 I_n),$$

where y is a vector of dependent variables, X is the matrix of independent variables and W is the spatial contiguity matrix, which is used to account for the influence of the price of the nearest neighboring houses on the price of any given house. This spatial weight matrix is constructed using the Thiessen polygon scheme to specify neighbors and standardized so each row sums to unity, creating a row–stochastic matrix for estimation of the parameter ρ, the spatial autoregression coefficient.

When spatial dependence exists in the error term, a spatial autoregressive error model (SEM) is employed. The SEM model takes the form

$$(5) \quad y = X\beta + u,$$
$$u = \lambda W u + \varepsilon,$$
$$\varepsilon \sim N(0, \sigma^2 I_n),$$

where y is a vector of dependent variables, X is the matrix of independent variables, W is the spatial weight matrix accounting for correlation in the error terms across space, and λ is the error correlation coefficient, analogous to the serial correlation coefficient in time-series models. A Lagrange Multiplier test based on the least squares residuals and the spatial weight matrix indicated the presence of spatial correlation in the error term.

The spatial Durbin model (SDM) can be used to account for dependence across observations in both the dependent and independent variables (Anselin). The SDM model takes the form

$$(6) \quad y = \rho Wy + X\beta_1 + WX\beta_2 + \varepsilon, \quad \varepsilon \sim N(0, \sigma^2 I_n),$$

where W is the spatial weight matrix and the parameter ρ is a coefficient on the spatial lag of the dependent variable. Wy captures the extent to which housing prices are affected by neighboring housing prices. A spatial lag of the explanatory variables is constructed using the matrix product WX as an additional set of independent variables. This additional set of variables represents independent variables constructed as averages from the nearest neighboring observations and captures the impact of characteristics of neighboring houses on the price of a given house.

Data

Topographically, the study area ranges from sloping to moderately hilly uplands of the Piedmont Plateau to the steep uplands of the Blue Ridge Mountains. Forested lands comprise a majority of the total area. The area is bordered by Georgia on the southwest and North Carolina to the north. Interstate 85 runs through the south-central part of the study area, connecting the city of Anderson and Anderson County with Atlanta, to the southwest, and Greenville, SC to the northeast. The study area includes part of the Sumter National Forest and various public lands managed by the state. Three major man-made lakes, Jocassee, Keowee, and Hartwell, form the boundary between Oconee County on the west and Pickens County on the east. The Tugaloo River branch of Lake Hartwell forms the border between South Carolina and Georgia from about the middle of western Oconee County to the middle of western Anderson County. The city of Anderson is the most populous community in the study area with just over 25,000 people. See Figure 1.

Research by Marek and Marek and Gering has resulted in categorization of area into urban, rural, and three degrees of interface (urban fringe, urban–rural fringe, and rural fringe), based on housing density and land use as shown in Figure 2. The classification categories were based on Anderson Level II Classification System (Anderson et al.). The houses were geocoded and merged with the land classification map to determine the location and categorize each house in an urban, urban fringe, urban–rural fringe, rural fringe, or rural area.

This study includes data for 3,438 private arms-length sales of single-family homes conducted between 1999 and 2001 as recorded by the Multiple Listing Service (MLS). Omission of observations with missing data resulted in 3,052 observations used. Structural variables include the number of bedrooms, the number of bathrooms, house square footage, house age, lot acreage for lots one acre or larger, whether or not the house has air conditioning, whether or not the house has a garage or carport, whether or not the house has a swimming pool, whether or not the house is a mobile home, and a measure of house quality (above average, average, and below average condition). The MLS also indicated whether each house was located on one of the three major lakes, was not located directly on the lake but had private access rights to the lake, or simply had a lake view but no frontage or private access.

As a measure of proximity to work opportunities, each household's average travel time to work was approximated using the U.S. Census estimate of the average travel time for the block group within which the house is located. County-specific effects were estimated

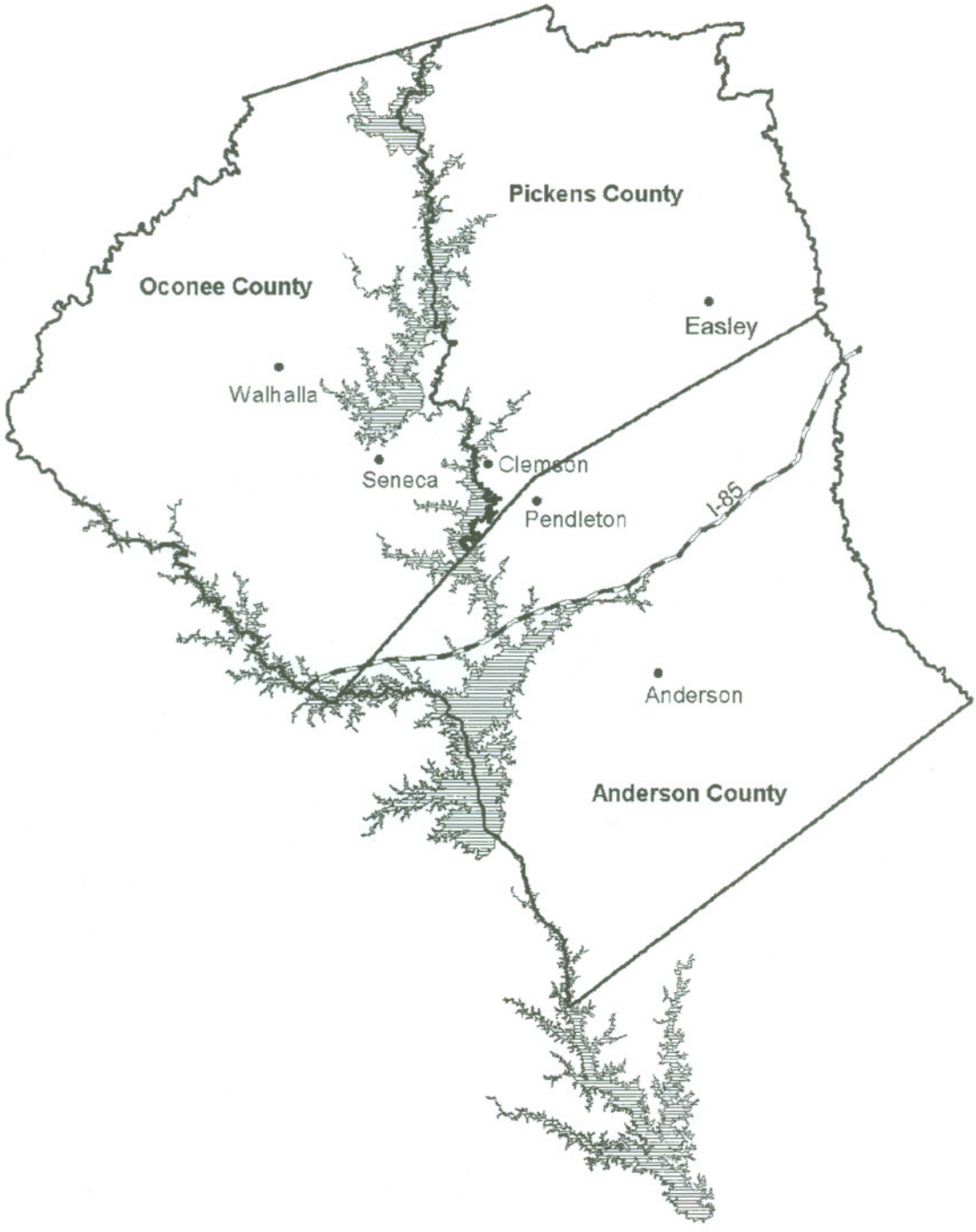

Figure 1. Study Area of Upstate South Carolina

using property tax rates and county dummy variables.

Summary statistics for the structural housing characteristics, travel time, and location characteristics are included in Table 1. The average house in the sample is an 18-year-old, 1800-square-foot, three-bedroom, two-bathroom house. Forty-two percent are in above average condition while 3% are in below average condition. Ninety-one percent of the

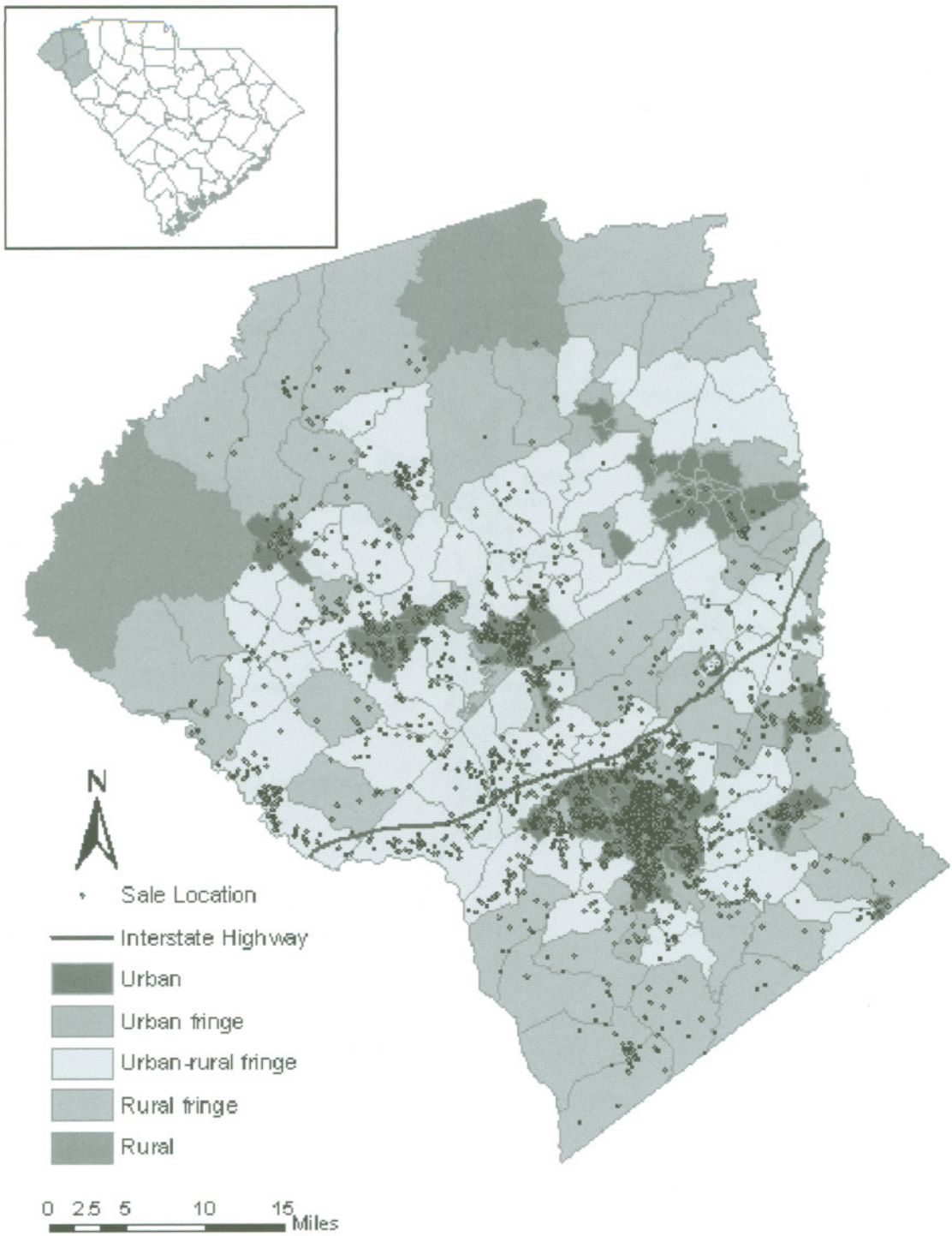

Figure 2. Location Classification and Location of the Houses

homes have air conditioning, 59% have a garage, 11% have a carport, 5% have swimming pools, and 8% are mobile homes. Fifty-five percent of the houses are on lots one acre or smaller while fewer than 2% are on lots 10 acres or larger.

In terms of location, almost three quarters of the houses are in Anderson County, 18% in

Table 1. Summary Statistics (n = 3,052)

Variable	Mean	Minimum	Maximum
Price	$130,644	$7,500	$959,000
Structural			
Bedrooms	3.09	1	6
Bathrooms	2.14	1	5
Square footage	1,805	400	6,500
Age	18	0	51
Air conditioning	0.91	0	1
Garage or carport	0.7	0	1
Swimming pool	0.05	0	1
Mobile home	0.08	0	1
Acreage	1.12	0	362
Above average condition	0.42	0	1
Below average condition	0.03	0	1
Neighborhood			
Average travel time to work (minutes)	24	8.2	38.2
Pickens County	0.08	0	1
Oconee County	0.18	0	1
Lake proximity			
Lake frontage	0.04	0	1
Lake access	0.08	0	1
Lake view	0.03	0	1
Fringe location			
Urban fringe	0.13	0	1
Urban–rural interface	0.32	0	1
Rural fringe	0.08	0	1
Rural	0.0003	0	1

Pickens County, and just over 8% in Oconee County. About 46% are in urban environments, 13% in the urban fringe, 32% in the urban–rural interface, a little over 8% in the rural fringe, and less than 1% in rural environments. About 4% of the houses are situated on a lake front, another 8% have lake access, and an additional 3% have a lake view.

Empirical Results

Results for all four models are shown in Table 2, with a semilog specification used for all. Coefficient estimates for continuous variables in a semilog model indicate the percentage change in the dependent variable housing price. For dummy variables, the percentage change in the dependent variable is equal to $e^{\beta} - 1$, where β is the coefficient estimate for that dummy variable. The autoregression correlation coefficient for the SAR model, ρ, is not statistically significant, hence the SAR model results are insignificantly different from OLS. In contrast, the error correlation coefficient for the SEM, λ, is statistically significant, and in the SDM, several of the coefficients for the lagged independent variables as well as the coefficient on the lagged dependent variable are significant.

Structural coefficient estimates are of the expected sign and generally consistent across the four models. Thus, bathrooms, square footage, air conditioning, presence of a garage or carport, swimming pool, more acreage, and better general condition of the house all contribute positively to housing value while mobile homes, older houses, and houses in poorer condition have lower values, all else constant.

Table 2. Empirical Estimation Results (n = 3,052)

Variable	OLS	SAR	SEM	SDM
Intercept	10.18***	10.14***	10.26***	9.80***
Structural				
Bedrooms	0.03**	0.03***	0.03***	0.03***
Bathrooms	0.11***	0.11***	0.09***	0.090***
Square footage	0.0004***	0.0004***	0.0004***	0.0004***
Age	−0.008***	−0.008***	−0.008***	−0.006***
Air conditioning	0.37***	0.37***	0.30***	0.32***
Garage or carport	0.20***	0.20***	0.19***	0.17***
Swimming pool	0.07***	0.07***	0.08***	0.07***
Mobile home	−0.48***	−0.47***	−0.49***	−0.46***
Acreage	0.003***	0.003***	0.004***	0.003***
Above average condition	0.05***	0.05***	0.06***	0.07***
Below average condition	−0.26***	−0.26***	−0.25***	−0.24***
Neighborhood				
Average travel time to work (minutes)	−0.002	−0.003	−0.002	−0.002
Pickens County	0.10***0.009	0.10***	0.09	0.14
Oconee County	0.009	0.007	0.02	0.02
Lake proximity				
Lake frontage	0.52***	0.52***	0.48***	0.42***
Lake access	0.36***	0.36***	0.33***	0.29***
Lake view	0.33***	0.33***	0.31***	0.23***
Fringe location				
Urban fringe	0.09***	0.09***	0.11***	0.11**
Urban–rural interface	0.11***	0.11***	0.13***	0.07**
Rural fringe	0.03	0.03	0.05	0.03
Rural	−0.18	−0.17	−0.1	−0.17
Spatial lags				
W-Bedrooms				−0.05***
W-Bathrooms				0.02
W-Square footage				0.0001***
W-Age				−0.004***
W-Air conditioning				0.21***
W-Garage				0.02
W-Swimming pool				−0.02
W-Mobile home				0.07**
W-Acreage				−0.002***
W-Above average condition				−0.04**
W-Below average condition				−0.08
W-Average travel to work				−0.02***
W-Pickens County				−0.06
W-Oconee County				−0.02
W-Lake front				0.14***
W-Lake access				0.11***
W-Lake view				0.04
W-Urban fringe				−0.05
W-Urban–rural interface				−0.001
W-Rural fringe				−0.004
W-Rural				−0.63

Table 2. (Continued)

Variable	OLS	SAR	SEM	SDM
ρ		0.004		0.04***
λ			0.27***	
Adjusted R^2	0.78	0.78	0.8	0.8
δ^2	0.1052	0.1044	0.0944	0.0934

*** and ** indicate significance at 1% and 5% levels respectively.

One of the drawbacks of more rural locations is the distance from work opportunities. By including travel time to work in the model, this potential difference across the urban to rural landscape is controlled for. In all four models, it is found to have a negative but insignificant impact on housing prices, regardless of location. Neighborhood differences were originally measured by town or community location but were not found to be significant. On the other hand, some county-level differences were found to be significant; in particular, location in Pickens County was estimated to have a positive impact on house price in the SAR and OLS models relative to location in Anderson County.

Lake frontage, lake access, and lake view each contributed positively to housing prices in all four models, raising prices by approximately 61%, 39%, and 36%, respectively in the SEM and about 52%, 34%, and 26%, respectively in the SDM. This translates to a premium of approximately $68,000 to $80,000 for lake frontage relative to the average house, between $44,400 to $66,500 for lake access, and $34,000 to $47,000 for lake view. The lower value for lake proximity in the SDM are likely because of the inclusion of an associative impact from neighbors with lake proximity in addition to one's own proximity, effects that are essentially combined in the SEM. Regardless, lake frontage, access, and view clearly have a significant positive impact on housing values in this area, a fact being capitalized upon in recent years by developers with a spate of new waterfront communities being built.

In addition to lake proximity, the degree of development contributed to significant differences in housing values across the study area as well. Location in the urban fringe was estimated to increase housing prices by just over 11%, or $15,000 for the average house, relative to urban locations, while location in the urban–rural interface increased housing prices somewhere between 7% and 14% ($9,000 to $18,000 for the average house) relative to urban locations. Location in the rural fringe and rural areas, in contrast, did not have a statistically significant impact on housing prices, positively or negatively, in any of the models. This suggests that while some degree of lower density and greater open space has a positive value, more is not necessarily always better or more valued. Many houses in rural and rural fringe areas of the upstate have relatively large distances between neighbors, providing a good degree of privacy, but little opportunity to interact with neighbors. Further, there are generally significantly longer distances to basic services such as grocery stores or gas stations, and fewer choices of available services than in urban and urban–rural fringe areas.

The analysis of finer gradations within the urban–rural fringe allows for a better understanding of the value of different landscapes than models using dummy variables for just urban and rural locations. As others have found using different measures (Acharya and Bennett; Bockstael; Geoghegan, Wainger, and Bockstael), a higher value is placed on more homogeneous landscape patterns as might be found in the urban–rural interface zone in comparison to more diverse urban areas. While open space generally contributes positively to home values, the insignificant difference between location in the rural and rural fringe areas in comparison to urban areas suggest a balance between open space and proximity to urban amenities is most highly valued.

Conclusions

Communities throughout the country are coping with growth at the edge of urban areas. This research reveals the significant added value residents place on living in less urbanized environments in the upstate of South Carolina, as well as the value placed on lake proximity. A better understanding of the interface zone is important in helping managers successfully maintain the values of such lands and the quality of life in rural and formerly rural areas. This will be particularly important as the area continues to develop. Lands currently classified as interface will take on characteristics of urban fringe and the rural fringe will become more like the interface, both possibly becoming even more attractive to new residents. As developers are recognizing, the high value of these areas can be maintained in development by providing a balance of lower-density housing, reasonable proximity to services, and protection of a certain amount of open space.

County and state officials charged with regulating growth can utilize this knowledge to maintain, or even enhance, quality of life in the growing urban fringe. Growth is particularly significant in this study area in terms of lakeside development, as numerous large-scale residential developments have been started or planned in recent years, increasing concern about lake water quality and protection of these valuable resources. Low to moderate density development that does not negatively impact water quality may actually increase adjacent land values with optimal proximity to both neighbors and services.

Finally, this research can also be of value to managers of natural resources interested in assessing the forces of change in the urban–rural fringe (see Cunningham et al.), landowners trying to assess the impact of land use changes on rural land values, and to those interested in targeting private or public land acquisition of open spaces to maximize the social value of such acquisitions.

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