AN ANALYSIS OF THE IMPACT OF LOCAL DROUGHT CONDITIONS ON GROSS SALES IN THE LAKE HARTWELL REGIONS

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Abstract. Lake Keowee is a reservoir created by the Keowee Dam and the Little River Dam and is located in Oconee County, South Carolina. Figure 1 illustrates the location of the lake in the state. The Lake was constructed by Duke Energy for use as cooling water by the Oconee Nuclear Generating Station's three reactors. While the primary function of the lake has been as an input into the power generation process, the past thirty years have seen a dramatic expansion in the lake's economic role in the region. As the economic activity directly and indirectly related to Lake Keowee has evolved, so too have the number of stakeholders associated with the lake. The economic concerns of regional stakeholders peaked over the period 2007-2009 as record drought plagued the region and brought to light questions regarding the economic impact that falling lake levels have on surrounding communities. Figure 2 illustrates Lake Keowee's water level changes from 1998-2010.

This paper will begin to evaluate the importance of lake level as a lakefront amenity. This research begins with a review of hedonic literature studying lake and lake related features. This is followed by a discussion of the hedonic models used for the counties bordering Lake Keowee over the twelve year period from 1998-2009. This period includes two major droughts, which should provide sufficient data to clarify the capitalized value of lake level on lakefront property. This analysis is a portion of a larger study funded by Duke Energy to understand the economic impact of Lake Keowee and declining lake levels on the regional economy.

Figure 1. Lake Keowee

HEDONIC PRICING MODELS

Hedonic modeling is one tool that has become a popular method for assessing the value of environmental attributes, both positive and negative. Hedonic models are used to assign a quantifiable value to goods that are not directly exchanged in the marketplace. For example, if two lakefront homes are identical in every way except one area of the lake has more shoreline exposure due to declining lake levels, the price differential between these two homes reflects the marginal value associated with lake level, or effectively the value of "full pool." Thus, property on or near the lake, or with lake access, is bought and sold regularly and should reflect the intrinsic value of lake activity and amenities. These models are able to utilize housing markets as proxies for a wide range of environmental qualities or amenity values (Palmquist et al., 1997).

Hedonic modeling has been used to measure the impact of water quality on housing values (Brashares, 1985; David, 1968; Feenberg and Mills, 1980; Michael et al., 2000; and Young and Teti, 1984). Much of this research indicates that water quality variables which are

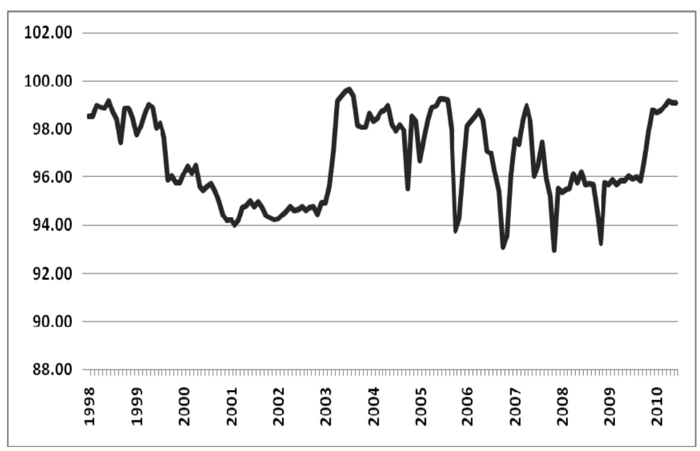

Figure 2 - Keowee Lake Level, 1998-2010 (Full pool normalized to 100 feet)

physically observable to residents yield the strongest correlations with property values. Brashares (1985) concludes that when water quality characteristics are not physically observable they are less likely to be capitalized into property values.

Michael et al. (2000) discuss the importance of individual perceptions of water quality events and their impact on implicit housing prices. Historical water quality conditions may create stickiness in housing prices that may not be observed from characteristics at the time of sale. Additionally, events that are perceived as temporary may not be capitalized into property values when compared against events that are longer term or permanent.

A number of hedonic studies have evaluated the impact of water's aesthetic and recreational properties on local property values (Brown and Pollakowski, 1977; D'Arge and Shogren, 1989; Darling, 1973; David, 1968; Feather et al., 1992; Knetsch, 1964; Lansford and Jones, 1995). A common finding among these studies is that proximity to the water source and the size of lake (water) frontage increase property values. Lansford and Jones (1995) confirm that scenic view, waterfront location and water level are all statistically significant contributors to enhanced property values. While proximity to the lake makes the most substantial impact on housing prices, consumers do appear to exhibit a positive preference for higher water levels as capitalized in the value of homes.

THEORETICAL CONTEXT

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 individual attributes that comprise the house, such as square footage, number of bedrooms, number of bathrooms, and proximity to such amenities as schools or parks. The price of a house (P_h) can be written as:

(1) $P_h = f(S_j, N_k, L_m)$

Where S_j, N_k, and L_m indicate vectors of structural, neighborhood, and lake related variables respectively. This equation represents the hedonic, or implicit price, function for housing. The implicit price of any characteristic, for example L_m, a lake attribute variable, can be estimated as:

(2) $\delta P_h / \delta L_m = P_{Nk} (L_m)$

This partial derivative gives the change in expenditures on housing that is required to obtain a house with one more unit of L_m, ceteris paribus. If the value of the partial derivative is positive, then the attribute is an amenity; if the value is negative then the attribute is a disamenity such as air pollution or possibly, declining lake levels.

DATA AND RESULTS

Structural characteristics of homes were chosen in an effort to avoid omitted variable bias and in reference to relevant literature. In this model, a variable representing proximity to the nearest city, average neighborhood value, and local tax area were used to capture potential neighborhood effects.

Measuring the importance of water level, and specifically the impact of declining water levels, on these communities is the variable of interest in this analysis. Several specifications of this variable were tested to determine the best fit for the overall model:

- Keowee level,
- Below full pool,
- Level-Keowee minimum,
- Level-Keowee mean.

Ultimately, the below full pool (BFP) measurement was used to capture the importance of declining water levels on housing values.

Model results for each county are provided in Tables 1 and 2. Individual models were chosen because the data across counties was too inconsistent to create a pooled sample. Overall model results indicate that this analysis contributes to our understanding of the variables that influence housing prices in Oconee and Pickens County. The Adjusted r-squared for Pickens county is .51 and Oconee county is .22. Structural characteristic results exhibit similar trends across the counties. For both counties there is a positive relationship between housing sales price and acreage. In Oconee County, the number of bedrooms, built square feet, and the number of floors all have a positive impact on sales price. In Pickens County, bathrooms and square feet squared have a positive statistically significant relationship with sales price.

Neighborhood characteristics in both models are important for further clarifying indicators of housing sales price. In Pickens County the three tax areas have strong negative statistically significant impacts on home price compared against tax area four and average neighborhood value has a small but positive impact on housing value. In both counties the distance to Seneca, the nearest city, is positive and significant. Year dummies and the MSA per capita income variables all confirm the importance of regional, state and national economic conditions on housing values. The signs of the estimated coefficient on the year dummies for Oconee County provide evidence of the housing bust and the recessionary activity that began in 2006.

Table 1. Hedonic Model for Lake Keowee (Pickens County)

Variable	Coefficient	Std Error	Prob>|t|
Water and Temperature Variables			
Below Full Pool	-0.0509	0.091175	0.5768
Below Full Pool* Temperature	0.000862	0.000957	0.3676
Avg temperature	-0.00114	0.003067	0.7108
Below Full Pool Squared	0.002875	0.007544	0.7032
Structural Characteristics			
Acres	0.013092	0.001784	<.0001
Bedrooms	-0.11666	0.060066	0.0525
Baths	0.113979	0.05588	0.0417
Built square feet	-0.00023	0.000145	0.112
Square feet^2	6.87E-08	2.63E-08	0.0091
Neighborhood Characteristics			
Seneca Travel Time	0.010721	0.001623	<.0001
Average Neighborhood Value	2.44E-06	3.38E-07	<.0001
Year Variables	--	--	--
Observations		**843**	
Adjusted R^2		**0.5045**	
Model F		**34.7434**	

Table 2. Hedonic Model for Lake Keowee (Oconee County)

Variable	Coefficient	Std Error	Prob>|t|
Water and Temperature Variables			
Below Full Pool	-0.223798	0.124811	<.0001
Below Full Pool* Temperature	0.0039427	0.001861	0.0731
Avg temperature	-0.000501	0.002579	0.0342
Below Full Pool Squared	0.0417216	0.017891	0.8461
Below Full Pool Squared *Temperature	-0.000713	0.000275	0.0198
Structural Characteristics			
Acres	0.0177008	0.005968	0.003
Bedrooms	0.0152215	0.006549	0.0202
Baths	-0.012769	0.008825	0.148
Built square feet	9.87E-06	4.06E-06	0.015
Floors	0.0283267	0.016468	0.015
Neighborhood Characteristics			
Seneca Travel Time	0.0002088	0.003015	0.0856
Year Variables	--	--	--
MSA_PCI	7.88E-06	1.93E-06	<.0001
Observations		**2407**	
Adjusted R^2		**0.22471**	
Model F		**31.3199**	

A polynomial fit of the water level measure, below full pool, and relevant interaction terms suggest a more accurate fit than a linear relationship against housing price. BFP and related terms suggest an overall negative and statistically significant relationship in Oconee County. There is not a statistically significant relationship in Pickens County. This provides evidence that as water levels fall, there is a slight decrease in housing sales price in Oconee County. This confirms evidence from earlier research that there is a small but statistically significant relationship between water level and housing values.

SUMMARY AND CONCLUSIONS

A hedonic model is used in this analysis to estimate the relationship between water level and housing sales price. The estimated housing price equation yields statistically significant results for structural and neighborhood characteristics as well as water level. This confirms earlier research that water level is a significant characteristic but results in small changes in sales price.
Droughts, by their very nature, are temporary events. However, research on negative environmental characteristics indicates that consumer's physical view of the lake and their perceptions of current and future events also influence the capitalization of these different characteristics. As a result, understanding how buyers and sellers conceptualize these conditions is an important area for additional research. Survey research, in addition to a hedonic model, could provide additional insight into consumer perceptions. In conclusion, as the number of lake related stakeholders continues to grow and the economic role of lake and lake related expands these are questions that will remain important for consumers, businesses and policymakers.

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