Spatial Hedonic Valuation of a Multi-use Urban Wetland in Southern California

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Most of Southern California's wetlands have disappeared despite being critical ecosystems with many valuable attributes. Many of the wetlands that remain are in relatively urban areas, are severely degraded, and may not function properly. Using hedonic spatial error models, we measure the economic value of living near an urban multi-use wetland in Long Beach, California. Both sales prices and estimated values are used in the analysis. Results show that proximity to wetlands increases residential property values in the focus area. This analysis provides important information for policymakers to justify ongoing restoration projects and prevent further degradation of urbanized natural resources.

Key Words: economic valuation, hedonic pricing, wetlands

In the economics literature, there is a general consensus that coastal ecological resources such as wetlands are valuable (Boyer and Polasky 2004). The economic value of a wetland is thought to vary by the location of the resource as well as its specific ecological attributes, but the results are not consistent across studies (Brander, Florax, and Vermaat 2006). These inconsistencies stem partly from the diversity of types of wetlands, each with a wide range of functions and differing interactions with surrounding residents (U.S. Fish and Wildlife Service 1979, Mitsch and Gosselink 2007). Comparisons across studies and valuation methodologies may also be problematic because there is no generally accepted definition of a wetland.

In California, more than 90 percent of coastal wetlands have been lost to commercial and residential development (Dahl 1990). In addition, because wetlands are a public good, policymakers have often underestimated their overall value to society. One strategy for addressing wetland loss and degradation is habitat restoration. However, restoration efforts often require understanding of how humans can benefit from ecosystems and how ecosystem management can be influenced using policy tools (Heal 2000, Kramer 2007). Accurate and comprehensive valuations of such resources improve our understanding of

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the benefits provided by ecosystems and thus can guide policy decisions about them.

This study focuses on Colorado Lagoon, a tidal salt marsh lagoon located in Long Beach, California, approximately 30 miles south of Los Angeles on the Pacific coastline. It provides important ecosystem functions, such as habitat provision for many plant and animal species, flood protection, storm buffering, and carbon sequestration. The surrounding area is highly urbanized and densely populated. Colorado Lagoon not only provides ecosystem functions but also supports many types of recreational activities by the surrounding population. The majority of previously conducted wetland valuation studies focused on relatively rural wetland areas.[1] In addition, valuation studies have tended to feature freshwater wetlands rather than saltwater or brackish wetlands. Our study site is thus unique in terms of its urban setting, wetland type, and multi-use function. We have been unable to identify any previously published valuation studies on wetlands in Southern California.[2]

We use a hedonic pricing model to determine if Long Beach residents value living close to Colorado Lagoon, historically part of the largest saltwater wetland ecosystem in the city. Like other applications of traditional hedonic models, our analysis uses data on prior home sales to assess the value of proximity to the lagoon. We then extend the analysis to include estimated housing values for each home from Zillow.com, a publicly accessible real estate website. Similar to assessed values from property assessors, which use formulas with home characteristics and comparable sales as inputs, these estimated values are computed using Zillow's proprietary algorithm and do not represent market transactions. Since comparable sales (which reflect local environmental attributes) factor into the formula, we compute hedonic regressions using these estimated values to see how they compare to results from sale price models. There are times when sales data are not available, are prohibited from being released by state or county law, or are incomplete. It would be useful if these Zillow estimated values could provide an approximation of environmental impact in cases where sales data cannot be used.

We estimate both spatial and traditional hedonic pricing models. Our results show that residents value living closer to the lagoon. Since there is currently a multi-million dollar restoration effort ongoing at the lagoon to improve its quality and functionality, these results shed light on some of the potential benefits of that project. We also find evidence that estimated property values can serve as a rough gauge of the impact of environmental amenities.

Colorado Lagoon

Colorado Lagoon is an interesting multi-use study site for several reasons. First, it is open to the public for numerous recreational activities that include swimming and fishing. As illustrated by frequent large crowds there on weekends, the lagoon is a popular recreational location for local and nonlocal visitors whose activities generate a large volume of trash and degrade the lagoon's environmental quality. In addition, until August 2012, the lagoon suffered from very poor water and

[1] See Boyer and Polasky (2004) for an overview of the literature. There have been relatively few studies in recent years focusing specifically on the valuation of urban wetlands (see, for example, Tapsuwan et al. (2009) and Lantz et al. (2013)).

[2] Other studies, such as Hall, Hall, and Murray (2002), used valuation methods to assess other coastal resources in the region but not wetlands.

sediment quality. The main cause of poor water quality was reductions in tidal flows generated by physical alterations to the surrounding region and unfiltered and untreated storm drain water emptying into the lagoon. Consequently, Colorado Lagoon has been closed to the public on several occasions in response to dangerous levels of bacteria and sewage.

Many of Colorado Lagoon's visitors are not local residents.[3] However, there is evidence of stewardship among local residents, who formed a grassroots neighborhood group, Friends of Colorado Lagoon (FOCL). FOCL has actively promoted environmental improvement of the wetland and successfully lobbied the City of Long Beach for the multi-million-dollar restoration project currently underway. Progress has been slow, but the restoration efforts provide an opportunity to study how wetlands change in response to such efforts and make our study timely since we focus on the period prior to restoration.[4]

Colorado Lagoon lies within the Los Angeles metropolitan area, one of the most densely populated regions in the United States. The basin's increasing urbanization and associated population pressure threaten the wetlands that remain, making a determination of their value to society critical. Colorado Lagoon is surrounded by dense residential areas comprised primarily of single family homes.[5] It is also near a golf course, two public parks, and Marine Stadium, an engineered and straightened marine channel that is used for water sports and recreation. In addition, the lagoon is situated approximately one mile from the Pacific coastline. The lagoon remains one of the few natural marine habitats left in the area aside from the ocean.

Hedonic Pricing Method

We propose a simple hedonic pricing model to evaluate if and how much residents value living close to Colorado Lagoon. The use of hedonic pricing models is well established in the economics literature.[6] Typically, this technique is used to value changes in environmental quality or housing amenities over time but can also be used to measure the value placed on living close to a wetland. Doss and Taff (1996) found that residents valued living closer to certain types of wetlands (e.g., open-water wetlands) but not others (e.g., forested wetlands). In a meta-analysis of numerous wetland valuation studies, Brander, Florax, and Vermaat (2006) found that the estimated value of a wetland is greater when the wetland is located in an urban area. Tapsuwan et al. (2009) also found a positive premium for living near urban wetlands.

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[3] An informal survey conducted over eleven days (July 24 through September 4, 2010) by Friends of Colorado Lagoon found that 83 percent of lagoon users did not live in the surrounding area, 88 percent identified themselves as Hispanic, and 72 percent were not aware of the environmental quality issues associated with the lagoon (Friends of Colorado Lagoon, Parker, and Zahn 2010). One weakness of the survey was that the term "surrounding area" was not defined, leading to uncertainty regarding the figures.

[4] Phase I of the Colorado Lagoon restoration includes dredging and removal of contaminated sediment. Thus, the site was closed to the public between January and August of 2012. Since restoration occurred after our study period, it does not impact the results of our study.

[5] According to data we have collected, in the area surrounding the lagoon approximately 68.3 percent of the housing units are single family homes.

[6] See, for example, Palmquist (2005) for an overview of the hedonic pricing literature as it applies to valuation of environmental amenities.

Since there are other recreational amenities near Colorado Lagoon, including a park and a golf course, the results of our study may partly reflect the more general value of open space. Numerous studies have examined the value of proximity to open space (see McConnell and Walls (2005) for a review of hedonic studies). For instance, Chamblee et al. (2011) found that nearby land conservation has a positive impact on property prices. Anderson and West (2006) also found a positive impact of nearby open space in urban areas, although the effect varied with demographics. Cho et al. (2009) found that value associated with nearby greenways, parks, and water bodies had increased over time. However, other studies, such as Netusil (2005), showed that proximity to open spaces could reduce values because of impacts of noise or crime. Discrepancies among these studies suggest that the impact of open space on property values can vary according to the specific characteristics of the space and surrounding demographics.

We use the hedonic pricing model as a valuation method because home sales prices and housing attributes are readily available. We believe that valuation methods such as contingent valuation and the travel cost method should be explored in the future to capture values from nonlocal residents. However, surveying was not monetarily feasible for this project and, in the absence of market prices for goods and services provided by wetlands, the hedonic model is appropriate. Although the hedonic pricing method does not allow us to capture the entire value of the lagoon, it illustrates some of the value to local residents. Future research plans include using another valuation method to supplement our current findings.

Hedonic models rely on an assumption that the housing market is in equilibrium. The large number of mortgage defaults and foreclosures in recent years has led economists to question the validity of that assumption. A main implication of current disequilibrium in the housing market is that the model coefficients may not reflect actual marginal willingness to pay (WTP), which is the common interpretation following Rosen (1974). So although we use year variables to control for unobserved influences that change over time (such as the boom and bust of the housing market), deflate prices with a local housing price index, and recognize that the sample area we study contains few if any vacant houses, caution is urged in interpreting coefficient estimates as direct measures of WTP.

The basic hedonic regression assumes that all of the components of a property's value are known. The property is a function of the individual characteristics of the house, the neighborhood, and the geographic location. The fundamental hedonic equation, therefore, is $V = f(\mathbf{C}, \mathbf{L}, \mathbf{T})$ where V represents the property value, $\mathbf{C}$ is a vector of housing characteristics, $\mathbf{L}$ captures elements of the housing location, and $\mathbf{T}$ represents time effects. The model estimated is given by equation (1).

$$\ln V_i = \beta_0 + \beta_1 \mathbf{C}_i + \beta_2 \mathbf{L}_i + \beta_3 \mathbf{T} + \varepsilon_i \tag{1}$$

Here, $i = 1, \ldots, n$ indexes each single family housing unit and ε_i is the error term, which we assume to be independent and identically distributed. V_i represents the home's sale price, which appears in natural log form. Vectors $\mathbf{C}_i$, $\mathbf{L}_i$, and $\mathbf{T}$ capture information on housing characteristics, location effects, and time, respectively. Results from both the semi-log and the dual-log functional forms are estimated. The coefficient estimates have a convenient elasticity interpretation in the dual-log model. Semi-log coefficient estimates represent a percentage change in the home's price resulting from a one-unit change in the independent variable.

A concern with property data is spatial dependence between observations. Home sales can exhibit spatial dependence because of local geographic characteristics, similarities in home builders and designs, the appraisal practice of using comparable sales to value properties, and other unobservable influences. Traditional methods of controlling for spatial influences, such as local fixed effects, may not sufficiently tackle the problems induced by spatial dependence (Anselin 1999, 2001, Brasington and Hite 2005), such as biased and inconsistent coefficients in the presence of spatial lag dependence or inefficient estimators and biased standard errors in the presence of spatial error dependence.

To account for spatial dependence, we use the following spatial error model.

$$\ln V_i = \beta_0 + \beta_1 \mathbf{C}_i + \beta_2 \mathbf{L}_i + \beta_3 \mathbf{T}_i + \varepsilon_i \tag{2}$$

$$\varepsilon_i = \lambda \mathbf{W} \varepsilon_i + \mathbf{u}_i \tag{3}$$

In this specification, the main regression (equation (2)) is identical to the model presented in equation (1). However, a nonspherical error term, shown in (3), is used. In that error term, **u** is a vector of independent and identically distributed error terms. **W** is a spatial weight matrix (SWM) and λ is a spatial error parameter to be estimated. The SWM specifies a set of neighbors for each observation. Following theory, the structure of the SWM is exogenous to the model (LeSage and Pace 2009). An inverse-distance SWM is used here: $w_{ij} = (1 / d_{ij})$ when the distance between two houses (d_{ij}) is less than 200 feet and $w_{ij} = 0$ otherwise.[7] Robust Lagrange multiplier tests favor the presence of spatial error dependence over spatial lag dependence. Likelihood-ratio tests also confirm the existence of spatial error dependence.

Assessed and Estimated Values in Hedonic Models

Although no past studies have used Zillow's estimates, hereafter called "Zestimates," in hedonic regressions, several have examined the reliability of assessed values (for tax assessors) in computing implicit prices of home attributes with mixed results. For instance, Ma and Swinton (2012) found that assessed values are a poor substitute for sales prices in determining the value of land attributes. On the other hand, Kim and Goldsmith (2009) reported that assessed values could capture the value of environmental effects on home prices effectively. Finally, Clapp and Giaccotto (1992) found that assessed values could be used to compute price indices accurately with some minor corrections.

Several nonhedonic studies have examined Zestimates. A 2007 analysis by *The Wall Street Journal* (Hagerty 2007) found that the median difference between Zestimates and the actual price was 7.8 percent; there were larger differences around outliers such as larger, more expensive homes that had unique features. Hollas, Rutherford, and Thomson (2010) compared Zestimates

[7] Several other SWM specifications were explored, including nearest neighbor, inverse-distance squared, and inverse-distance SWMs with different distance radii. In each case, the qualitative impact on the results was limited. All SWMs are row-standardized.

to self-reported home values, such as the ones used in the U.S. Census Bureau's American Housing Survey. They found that self-reported estimates generally were closer to actual values with a median overestimation of 7.92 percent. Finally, according to Zillow, Zestimates from dense metropolitan statistical areas like Los Angeles perform better than Zestimates from rural areas; 68.2 percent of all Zestimates are within 10 percent of the sale price.

Data Description

We obtained housing data from the Los Angeles County Office of the Assessor. The data included information on all past home sales in Los Angeles County and were our source of information on structural variables, such as square footage, the number of bedrooms and bathrooms, the sale date and price, and the age of the home.[8] Since the structural attributes available from the Office of the Assessor were limited, we gathered additional data on homes' heating and cooling systems and existence of a garage from Zillow.com.[9] GIS maps obtained from the Office of the Assessor were used to calculate proximities and the latitude and longitude coordinates used in the spatial econometrics. We included sales for 2000 through 2011 in the model.

Previous studies have suggested that urban housing markets are composed of submarkets and that each submarket should have a different hedonic price function (Straszheim 1974, Schnare and Struyk 1976, Harrison and Rubinfeld 1978, Goodman 1978, Michaels and Smith 1990). If housing market segmentation exists and the hedonic price function is estimated for the urban market as a whole, the implicit price estimates will be incorrect for residents located in the submarkets (Freeman 2003). In our study, we identified two neighborhoods as representative of the relevant housing market surrounding Colorado Lagoon: Alamitos Heights and Belmont Heights. Although they cover a relatively small area, these neighborhoods are closest to the lagoon and have similar characteristics so could be seen by potential buyers as close substitutes. The focus area is also recognized as a distinct market by local realtors.[10] The public school districts within these neighborhoods are highly desirable, particularly at the elementary level, which leads many buyers to concentrate on the area. Therefore, we believe that these two neighborhoods offer a reasonable and geographically delineated market for analysis given their characteristics and proximity to the lagoon.

We adjust sales prices for inflation using the Federal Housing Finance Agency's quarterly housing price index (HPI) for the Los Angeles metropolitan statistical area and express the prices in 2011 dollars. As for most studies in the hedonic literature, we restrict the sample to single family homes. After omitting observations with missing or erroneous information, we are left with 651 property sales.

[8] The "Local Roll" and "Sales List" are the source of these data.

[9] Zillow.com is a relatively popular housing website in the United States and is used by real estate professionals and home buyers. Although there have been previously reported instances of inaccuracies, we cross-checked the data with other sources and found the information to be consistent.

[10] Conversations with a local realtor confirmed that these neighborhoods are seen as substitutes by buyers. Many buyers target these neighborhoods in Long Beach for their amenities and desirable school districts, characteristics that are not generally associated with adjacent neighborhoods. Also, the Pacific West Association of Realtors' Greater Long Beach Area Map recognizes our study area as a distinct market.

For location variables, we include an indicator variable for homes on Ximeno Avenue, which has a high volume of traffic. Proximity to the lagoon is captured by the linear distance from the house to the lagoon. Although we could have used road distance to the lagoon, there are multiple access points and it was not clear how most locals travel to the site.[11] Previous hedonic studies of proximity to environmental externalities have similarly used linear distance (Boyle and Kiel 2001, Palmquist 2005, Walsh, Milon, and Scrogin 2011). We also control for homes directly adjacent to the lagoon with an indicator variable. A potential complication in the analysis is that there is a golf course directly north of the lagoon and a park to the southeast. It could be difficult to disentangle the effect of proximity to those amenities from proximity to the lagoon. We use indicator variables to account for houses directly adjacent to the park and golf course.[12] Furthermore, most homes in the two neighborhoods in the sample lie east and west of the lagoon and are not in direct proximity to the golf course and park. Nonetheless, the impact of the lagoon may partially represent these other amenities.

Descriptive statistics for the sample appear in Table 1. The average sale price in the sample is $578,608, which exceeds the 2006–2010 U.S. Census median value of owner-occupied housing units in Long Beach and Los Angeles County ($478,400 and $421,600). The summary statistics reflect what is visually observable in the study area—housing characteristics are highly heterogeneous in many aspects. Home size ranges from 400 to 4,546 square feet, the number of bedrooms from 1 to 7, and the number of bathrooms from 1 to 6.5. The oldest houses tend to be small Craftsman bungalows with fewer bedrooms and bathrooms than more modern homes. As those modest homes were gradually replaced over time, they gave way to large custom homes.[13] Only 11 percent of the houses in the sample have central heating and 26 percent have central air conditioning.[14]

Zestimates are calculated in a proprietary program by Zillow that produces an approximation of a house's value based on comparable sales, structural attributes, past sales history, and tax assessment data (if available).[15] To ensure consistency, the same parcels from the sales data set are used; however, since there is only one value per house, the sample is smaller. Additionally, since the estimates are not linked to sale dates, we do not use the year dummies. The mean Zestimate in the sample of 453 observations is $593,878 with a standard deviation of 183,547. The Zestimate average is only about 2 percent different from the mean of the sales data.

[11] We explored an alternative model with concentric distance "buffers." The results were similar to the model with a linear specification.

[12] Given the proximity of these amenities and the location of the sample, efforts to control for proximity to the golf course and lagoon would result in collinear variables.

[13] Spatially, there is no pattern apparent in the location of newer houses. We controlled for additional noteworthy streets in the study area in our model, but only Ximeno Avenue influenced the results.

[14] The proportion of houses with central air conditioning and heating is low compared to most parts of the country, undoubtedly because there are so many older homes and because of the temperate weather near the ocean.

[15] See www.zillow.com/help/what-is-a-zestimate.

Table 1. Summary Statistics

	Mean	Std. Dev.	Min.	Max.
Sale price (dollars)	578,607.70	244,751.10	30,000	1,800,000
Bedrooms	2.74	0.90	1.0	7.0
Bathrooms	1.90	0.92	1.0	6.5
Square footage of house	1,602.31	758.36	400.00	4,546.00
Pool	0.07	0.25	0	1
Heating	0.11	0.31	0	1
Cooling	0.26	0.44	0	1
Garage	0.26	0.44	0	1
Age	75.27	23.51	3	107
Distance to lagoon (feet)	2,912.59	1,431.54	610.36	5,583.89
Lagoon-front	0.02	0.13	0	1
Park-front	0.00	0.04	0	1
Ximeno Avenue	0.02	0.14	0	1
Year 2000	0.10	0.30	0	1
Year 2001	0.12	0.32	0	1
Year 2002	0.12	0.32	0	1
Year 2003	0.10	0.31	0	1
Year 2004	0.12	0.32	0	1
Year 2005	0.09	0.29	0	1
Year 2006	0.09	0.28	0	1
Year 2007	0.05	0.21	0	1
Year 2008	0.04	0.21	0	1
Year 2009	0.07	0.25	0	1
Year 2010	0.06	0.24	0	1
Year 2011	0.04	0.19	0	1
Number of observations: 651				

Results

We provide empirical results from the hedonic pricing models in Tables 2 and 3. Table 2 shows estimates for the models using the natural log of the *sale price* as the dependent variable; Table 3 provides estimates for the models using the natural log of the *Zestimates* as the dependent variable. In both tables, the first two columns show results from the semi-log and dual-log models (models 1 and 2) and the next two columns list results for semi-log and dual-log models that control for spatial dependence (models 3 and 4) using an inverse distance SWM.

The coefficients can be interpreted as elasticities for dual-log models or as semi-elasticities for semi-log models. For example, the coefficient for the age variable in model 1 in Table 2 is 0.001, indicating that a one-year increase in age increases the sale price by 0.1 percent. For the corresponding dual-log model (model 2 in Table 2), the coefficient is 0.044, indicating that a 1 percent increase in age increases the sale price by 0.044 percent. Coefficients on

Table 2. Regression Results Using the Natural Log of Sale Price as the Dependent Variable

	Semi-Log (1)	Dual-Log (2)	Spatial Semi-Log (3)	Spatial Dual-Log (4)
Bedrooms	0.00741 (0.021)	–0.01744 (0.062)	0.00547 (0.016)	–0.02367 (0.055)
Square footage of house	0.00028*** (0.000)	0.52749*** (0.056)	0.00028*** (0.000)	0.52476*** (0.036)
Pool	0.14141*** (0.040)	0.15115*** (0.038)	0.13382*** (0.051)	0.1463*** (0.049)
Heating	–0.03888 (0.032)	–0.02876 (0.031)	–0.02181 (0.043)	–0.01626 (0.042)
Cooling	0.02030 (0.024)	0.01675 (0.024)	0.01510 (0.029)	0.01179 (0.029)
Garage	0.04826* (0.028)	0.03696 (0.028)	0.04406 (0.031)	0.03427 (0.031)
Age	0.00123 (0.001)	0.04362 (0.028)	0.00120* (0.001)	0.04031** (0.020)
Distance to lagoon (feet)	–0.00002*** (0.000)	–0.06856*** (0.017)	–0.00002*** (0.000)	–0.07156*** (0.020)
Lagoon-front	0.17406** (0.083)	0.14150* (0.078)	0.16070* (0.099)	0.12727 (0.097)
Golf-front	–0.01376 (0.064)	–0.01406 (0.050)	0.00015 (0.102)	–0.00302 (0.098)
Park-front	0.18926*** (0.028)	0.13868*** (0.026)	0.16587 (0.283)	0.12953 (0.279)
Ximeno Avenue	–0.28732 (0.214)	–0.28577 (0.214)	–0.32090*** (0.088)	–0.31586*** (0.086)
Year 2001	0.14392*** (0.047)	0.13930*** (0.045)	0.14002*** (0.046)	0.13585*** (0.047)
Year 2002	0.23407*** (0.041)	0.23762*** (0.040)	0.23631*** (0.046)	0.23909*** (0.046)
Year 2003	0.47384*** (0.038)	0.46651*** (0.037)	0.48136*** (0.047)	0.47472*** (0.047)
Year 2004	0.59822*** (0.052)	0.60606*** (0.052)	0.60796*** (0.046)	0.61375*** (0.046)
Year 2005	0.77966*** (0.045)	0.79143*** (0.043)	0.78367*** (0.049)	0.79404*** (0.049)
Year 2006	0.85414*** (0.040)	0.85228*** (0.039)	0.88218*** (0.050)	0.87555*** (0.051)

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Table 2. (continued)

	Semi-Log (1)	Dual-Log (2)	Spatial Semi-Log (3)	Spatial Dual-Log (4)
Year 2007	0.62668*** (0.135)	0.61227*** (0.135)	0.64526*** (0.061)	0.62897*** (0.061)
Year 2008	0.72798*** (0.044)	0.70992*** (0.043)	0.73481*** (0.062)	0.71996*** (0.062)
Year 2009	0.57716*** (0.043)	0.58355*** (0.041)	0.58132*** (0.053)	0.58758*** (0.053)
Year 2010	0.51994*** (0.048)	0.54218*** (0.046)	0.54080*** (0.055)	0.55594*** (0.055)
Year 2011	0.50144*** (0.054)	0.49473*** (0.053)	0.51029*** (0.065)	0.50442*** (0.065)
Constant	12.19046*** (0.089)	9.22203*** (0.427)	12.20174*** (0.075)	9.27886*** (0.100)
Lambda	—	—	0.15095*** (0.018)	0.12697*** (0.022)
R-square	0.613	0.625	0.625	0.633
Adjusted R-square	0.599	0.611	0.611	0.620
Number of observations: 651				

Notes: Robust standard errors appear in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

dummy variables are interpreted similarly for all models once corrected for their form (i.e., using Halvorsen and Palmquist (1980)). For example, the coefficient for the dummy for presence of a swimming pool in model 1 in Table 2 is 0.141. The corrected value of 0.152 indicates that houses that have swimming pools have a 15.2 percent higher estimated value than those without pools.

Sale Price Results

The results of our sale price estimates, shown in Table 2, are fairly consistent across all models in terms of coefficient signs and magnitude. For housing characteristics, square footage of the home and the indicator variable for swimming pools are positive and statistically significant at the 99 percent confidence level in all models. The coefficient on the indicator variable for having a garage is statistically significant and positive in model 1 but insignificant in all other models. The coefficient on the age of the house is positive and statistically significant only in the spatial models, indicating that there is likely some spatial clustering associated with home age. According to model 4, a 1 percent increase in the age of the house increases the sale price by 0.04 percent. Although the direction of that effect was not expected, it may capture information about the likelihood that the oldest houses were built in the most desirable places or that they have been significantly remodeled. The variables in our model may not sufficiently capture these more subtle effects. The number of bedrooms and presence of heating and cooling systems do not significantly impact sales prices in any of the models, although square footage is positive and significant in all models.

Table 3. Regression Results Using the Natural Log of Estimated Value (Zestimate) as the Dependent Variable

	Semi-Log (1)	Dual-Log (2)	Spatial Semi-Log (3)	Spatial Dual-Log (4)
Bedrooms	0.03552***	0.05919***	0.03511***	0.05840***
	(0.011)	(0.022)	(0.009)	(0.021)
Square footage of house	0.00029***	0.54203***	0.00028***	0.53843***
	(0.000)	(0.019)	(0.000)	(0.018)
Pool	0.01800	0.03552*	0.01263	0.03135*
	(0.026)	(0.020)	(0.021)	(0.017)
Heating	–0.01565	–0.00501	–0.00471	0.00310
	(0.021)	(0.018)	(0.018)	(0.015)
Cooling	0.00817	–0.00359	0.00726	–0.00323
	(0.013)	(0.010)	(0.012)	(0.010)
Garage	0.02132	0.01410	0.02080*	0.01386
	(0.014)	(0.011)	(0.013)	(0.011)
Age	–0.00034	–0.02332**	–0.00040	–0.02270***
	(0.000)	(0.010)	(0.000)	(0.009)
Distance to lagoon (feet)	–0.00002***	–0.06114***	–0.00002***	–0.06179***
	(0.000)	(0.008)	(0.000)	(0.010)
Lagoon-front	0.14468	0.11541	0.14254***	0.111167***
	(0.093)	(0.073)	(0.041)	(0.035)
Golf-front	0.01166	0.00360	0.01561	0.01585
	(0.033)	(0.023)	(0.043)	(0.036)
Park-front	0.08925***	0.04095***	0.06952	0.03638
	(0.009)	(0.007)	(0.106)	(0.090)
Ximeno Avenue	0.01091	0.00741	0.01735	0.00870
	(0.025)	(0.019)	(0.037)	(0.031)
Constant	12.75477***	9.80787***	12.77126***	9.83634***
	(0.048)	(0.147)	(0.033)	(0.153)
Lambda	—	—	0.17298***	0.16200***
			(0.051)	(0.051)
R-square	0.858	0.899	0.862	0.902
Adjusted R-square	0.854	0.896	0.858	0.899
Number of observations: 453				

Notes: All Zestimate values used are from July and August 2011. Robust standard errors appear in parentheses. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Variables capturing the specific location of the house are also included to control for street effects and views. Houses on Ximeno Avenue, which is a very busy street, have lower sales prices than other houses in the sample. The effect is statistically significant in the spatial models (models 3 and 4) at a 99 percent confidence level and insignificant in the other two models (models 1 and 2). In the nonspatial models, houses that have a view of a park have higher sales prices. Those coefficients in the nonspatial models are significant at a 99 percent confidence level but are not statistically different from zero in the spatial models, highlighting the importance of spatial controls. Having a view of the golf course, which is adjacent to the lagoon, does not affect sales prices in any of the models. This insignificant effect was initially surprising. However, all of the parcels in the sample that were adjacent to the golf course were separated from it by a road, which mitigated the proximity effect. Conversely, for most homes near the lagoon, there is no similar barrier.

Two variables capture a house's proximity to Colorado Lagoon: distance to the lagoon in feet and an indicator variable for houses that have a view of the lagoon (lagoon-front). The results show that houses farther from the lagoon sell for less than closer ones. For example, increasing the distance from the lagoon by 1 percent decreases the sale price by 0.069 percent in model 2. The effect is statistically significant at the 99 percent level in all models. Similarly, houses with a view of the lagoon have garnered higher sales prices that are statistically significant in all models except the dual-log spatial model (model 4). Houses with a view of the lagoon sell for about 16 percent more than houses lacking a view. We narrowly defined the lagoon-view variable to include only houses with an unobstructed view, restricting this subsample to lagoon-front homes (only 2 percent). Our results show that homeowners place a premium on living close to the natural amenity of the wetland.

Time-indicator variables capturing the year in which the house is sold are also included in the model with the first year of observation (2000) as the omitted category. Without exception, the time coefficients are positive and statistically significant at the 99 percent confidence level. That is, sales prices for 2001 through 2011 are consistently greater than sales prices for 2000.[16] Moreover, the magnitudes of the coefficients show the expected change in prices due to economic and housing market conditions. We find that housing prices generally rose over time from 2001 through 2006 and then decreased in 2008 through 2011 with the largest drops occurring in 2008 and 2009.

We considered other control variables in the model, such as school districts and alternative road indicator variables. However, those variables were highly correlated with other independent variables so they were not used in the final model. Also, given the size of the geographic area involved in the analysis, there was not a great deal of variation among school districts.

The highly significant lambda terms in the spatial models confirm the results of the Lagrange multiplier and likelihood-ratio tests. In addition, the adjusted R-square values range from 0.60 (model 1) to 0.62 (model 4), suggesting that our models are a reasonable fit for the data.

[16] Average sales prices collected from Zillow.com for single family homes in Long Beach follow this same general trend over time.

Estimated Sales Value Results

The results of the models using Zestimates are found in Table 3 and are relatively consistent with the results from the sale price models. The effect of the square footage of the house is positive and statistically significant, presence of a swimming pool has a positive effect on estimated value (although the pool coefficient is statistically significant only for the dual-log models), and a view of a park increases estimated value in the nonspatial models. Having a heating or cooling system, a garage, or a view of the golf course has little to no effect on the estimated price, which is consistent with the sale price models.

The Zestimate models depart from the sale price model in that the number of bedrooms in the home has a statistically significant and positive effect on assessed value; it has no effect on sale price. Being located on Ximeno Avenue does not significantly affect estimated value but has a negative impact on sales prices in the spatial models. The age of the home has a negative impact on estimated value but is statistically significant only for the dual-log models; the same characteristic has a positive effect in the spatial models for sales price. The discrepancies for the age characteristic may be related to how age figures into Zestimates. Perhaps the neighborhoods' mix of small older homes and large newer homes simply does not follow the expected relationship of age to housing value.

The two variables of interest used in evaluating the value of wetlands are distance to the lagoon and view of the lagoon. As with the sale price models, the effect of distance to the lagoon is negative and statistically significant in all estimated-value models. In addition, the magnitudes of the coefficients are remarkably similar in the spatial and nonspatial models. A view of the lagoon has a positive effect on estimated value though it is statistically significant only in the spatial models. In the sale price models, the impact of a lagoon view is positive and significant in all models except model 4 (dual-log spatial model). The lambda term is statistically significant in the estimated value models, indicating the presence of spatial error dependence. Finally, the adjusted R-square values of the Zestimate models range from 0.85 to 0.90. It is not surprising to find a strong predictive capability in the models that use estimated values since those models may be approximating the ones used by Zillow to make estimates.

Implications

Given the gap in the literature on hedonic pricing models regarding the accuracy of assessed and estimated values, comparisons of models of sales prices and estimated values merit further investigation. Although fully exploring differences between these two models exceeds the scope of this study, the similarities in our results for sales prices and estimated prices potentially could capture the value of environmental amenities. However, the results may be specific to this particular area, and more research will be required to generalize them. In areas that have a higher proportion of unique or high-priced homes, Zestimates are probably less accurate and less likely to capture the influence of environmental attributes. On the other hand, we can conclude that sale price models and estimated value models are not direct substitutes. There are some notable differences in sign, significance, and magnitude between models. We also caution against using results from estimated value models to derive true revealed preferences since there is no established theoretical model (such as Rosen (1974) and its refinements) underpinning them. Nonetheless, when property sales data are not available, estimated values can provide a rough gauge of the impact of environmental amenities with certain caveats.

Overall, the results of our empirical investigation show that houses that are located closer to the lagoon have unambiguously higher sales prices and estimated values. Since this result is robust to several different models and specifications, we conclude that homeowners do value living closer to Colorado Lagoon.

Conclusion

This study uses a hedonic pricing model to determine if there is a premium placed on living in close proximity to Colorado Lagoon, a multi-use saltwater tidal wetland located in Long Beach, California. We use two hedonic pricing models, one that uses sales prices of homes over time and another that uses Zillow.com's estimated housing values at a single point in time. We find that living closer to or having a view of Colorado Lagoon increases both sales prices and estimated home values, an effect that is robust to several specifications. Under our semi-log model (Table 2, model 3), a home 10 percent closer to the lagoon (approximately 300 feet) would have a sale price 0.6 percent higher all else being equal. At the mean home value of $578,608, that change in distance amounts to an expected $3,471 increase in sale price.

The results of the estimated value models should be interpreted with caution since they need to be tested in a broader setting in other areas. However, the similarity in results for the estimated value and sale price models is a promising first step. There are many settings in which sales prices or tax appraisals are difficult or impossible to obtain. Estimated home values can represent an alternative avenue by which to assess the impact of environmental attributes on home values.

Since Colorado Lagoon is near a golf course and several parks, some of the impacts we detect may be attributable to those amenities. In that respect, our results could contribute to the literature on open space. Given the lagoon's long history and plans for its restoration, local residents likely expect the lagoon and surrounding parks to remain open space, and the values generated by the present study are in line with results from similar studies that estimated the value of open space. Future research could use survey methods to disentangle the impact of the lagoon from the influence of nearby parks and the golf course. Once restoration work is complete, we will revisit the impacts of the lagoon on property prices to determine if improving its quality affected home values nearby.

Ecologically, urban wetlands provide many other services to society, including water quality improvements, biodiversity, ground water recharge and discharge, and recreation. Regardless of whether residents recognize those individual characteristics, our results indicate they value proximity to the natural resource, as reflected in higher home values. Given the declining number of wetlands across the United States and the deteriorating quality of the ones that remain, residents' appreciation of these natural resources may support increased protection and restoration of wetlands based not only on ecological concerns but also on economic interests. Due to the large-scale restoration project under way at the lagoon, our results indicate that the ecological benefits of restoration will be augmented by increases in home values after restoration. The results of our spatial model (model 3) indicate that the 37 lagoon-front homes in our study earned a total premium of roughly $2 million,[17] and we expect that restoration of the lagoon will increase that number. If we account for impacts on homes farther from the lagoon and from recreational visits by people residing elsewhere, which would likely increase after restoration, the $6 million to $9 million restoration project may be justified.

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[17] This value was obtained by applying the elasticity from model 4 to the most recent sale value (deflated) for each lagoon-front home. For homes that lacked a recent sale value, we applied the elasticity to the tax appraiser's assessed value for the home.

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