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The Capitalization of Wildlife Recreation Income into Farmland Values

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Wildlife recreation—hunting, fishing, and wildlife watching—appears to be an increasingly important pastime for many Americans. From 1991 to 2001, U.S. wildlife recreation expenditures surged from $77 billion to $108 billion in 2001 dollars. Land lease and ownership expenditures by wildlife recreation participants are also rising and appear to be capitalized into farmland values. This paper analyzes the impact of hunting lease rates on farmland values in Texas. The results indicate that counties with higher wildlife recreation income streams have higher land values.

Key Words: farmland values, wildlife recreation

JEL Classification: Q15

Wildlife recreation—hunting, fishing, and wildlife watching—has garnered increasing attention as an engine of economic activity in rural areas. The expansion and success of rural outfitter businesses, such as Cabella's and Bass Pro Shop, are clear examples of the economic possibilities of wildlife recreation activity. Other examples are the emerging businesses engaged in hunting and trapping industries. From 1998 to 2003, the hunting and trapping industry grew 25% in the number of firms, employment, and payroll.[1]

More recently, wildlife recreation has emerged as an increasing influence affecting U.S. farmland as farmers capture additional income streams from wildlife recreation. According to the 2002 U.S. Department of Agriculture Census of Agriculture, more than 2,800 farms averaged $7,217 from recreation services, where recreation service income was characterized as hunting and fishing. Surveys of land values indicate that recreation activity is fueling a surge in land values. In Texas, 68% of land market professionals indicated that hunting and fishing was a dominant motive for land buyers in 2003 (Gilliland, Robertson, and Cover). In a survey of agricultural bankers in the Kansas City Federal Reserve District, 66.3% reported that recreation demand was a contributing factor in farmland value gains in December 2005, up from 44.4% in December 2002 (Novack).[2] According to the U.S. Fish and Wildlife Service (1991, 2001), the average expenditure for leasing hunting land in real terms in the United States rose from $1.66 in 1991 to $2.77 in 2001.

Wildlife recreation creates additional demand for land and opens up opportunities for additional farm revenue streams. Since farmland values are capitalized values of expected earnings, increased revenues from wildlife recreation should fuel farmland value gains.

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[1] Calculations were based on 1998 and 2004 County Business Patterns data for the hunting and trapping industry (NAICS code 1142; http://www.census.gov/epcd/cbp/view/cbpview.html). Payroll growth rates were calculated in 2004 dollars.

[2] The Kansas City Federal Reserve District covers that states of Nebraska, Kansas, Oklahoma, Colorado, Wyoming, northern New Mexico, and western Missouri.

While research has focused on the impact of recreation and scenic amenities on land values, the impact of wildlife recreation on farmland values might be unique for various reasons. First, unlike other recreation activities, wildlife recreation does not necessarily lead to the conversion of farmland to nonfarm activities. Second, wildlife recreation uses a public good, wildlife, to provide private benefits. Some types of wildlife recreation—hunting and fishing—are consumptive activities. By controlling hunting and fishing access to private land, landowners control access to wildlife and create a rivalrous and excludable good that can be used to capture a private benefit. Recreation service income for farmers is an example of this private benefit. The presence of wildlife can also present costs to farmers. For example, high densities of wildlife can lead to severe crop damage or increased probability of automobile accidents.

Past literature suggests that land values are higher in regions with more abundant wildlife. Yet, a missing feature of the literature is whether land values are higher in regions with higher wildlife recreation income. While places with abundant wildlife were found to have higher land values, these studies were unable to determine if higher land values were coming from the amenity value wildlife provides or the additional income generated from wildlife recreation. Given the use of farmland in an expanding wildlife recreation industry, this paper analyzes the impacts of wildlife recreation income on farmland values. Specifically, this paper tests the hypothesis that counties with larger revenues from wildlife recreation have higher farmland values. After reviewing previous literature, a hedonic price model of farmland values is used to identify the impact of hunting lease rates and recreational income on farmland values in Texas. The results indicate that farmland values in Texas are higher in counties with higher hunting lease rates and recreational service income for farmers, *ceteris paribus.*

Literature Review

Farmland is a resource used in a variety of activities, including wildlife recreation, and its value is derived from the capitalized value of its expected future returns. Thus, the present value of farmland is the sum of all future income streams, appropriately discounted to reflect the difference between present and future values of the dollar. In practice, predictions of future returns are uncertain, and the present value of farmland is based on expectations of future income streams. As a result, in its simplestform, with income expected to remain constant for the infinite future, the present value of farmland can be determined by the following formula:

$$(1) \quad PV(t) = \frac{Y^e}{r},$$

where t is time, Y^e is the expectation of future income, and r is the discount rate. If future income is expected to grow at a constant rate, g, the formula for the present value of farmland becomes:

$$(2) \quad PV(t) = \frac{Y^e}{r - g}.$$

Present value models are the foundation from which researchers analyze the capitalization of income into farmland values. Given that agricultural income, including farm program payments, is the primary revenue stream for farmland, it is not surprising that a large number of studies have analyzed the capitalization of agricultural income streams into farmland values (Barnard et al; Burt; Castle and Hoch; Chavas and Shumway; Featherstone and Baker; Herriges, Barickman, and Shogren; Just and Miranowski; Miranowski and Hammes; Moss; Phipps). Most of these studies have used time-series data, while a few have used cross-sectional data. Recent studies have focused on the capitalization of government payment programs in farmland values. Barnard et al. estimated that government payments account for between 12% and 69% of farmland values, depending on the region of the country. Goodwin, Mishra, and Ortalo-Magné indicated that one additional dollar in government payments would yield a $4.69 rise in land values. Moreover, a single dollar increase in net agricultural revenues would add roughly

$4 to $6 per acre in land values; however, this estimate did not account for the estimated premium for land with higher yield potential.

Another group of studies analyzed the impact of urbanization on farmland values (Chicoine; Clonts; Dunford, Marti, and Mittelkammer; Folland and Hough; Reynolds and Tower; Shi, Phipps, and Colyer; Shonkwiler and Reynolds). In general, these studies tested the hypothesis that the potential for future urban expansion and the conversion of farmland into residential or commercial use was being capitalized into farmland values. These studies found that the potential for urban development was being capitalized into farmland values and that regions closer to large and growing urban centers experienced higher land values. Most of these studies used cross-sectional data and focused on the spatial variation of farmland values.

Research has found that scenic amenities influence property values. In a hedonic price model using sales data on residential properties in suburban and exurban Maryland, Irwin and Bockstael found that residential prices were higher in areas with more open space, and Irwin found that residential property values in central Maryland were higher near places of open space. The study also found that property near open space had a premium over agricultural or forested land that could be developed for residential use, suggesting that open space is valued for the absence of development. Yet, this study did not analyze the impact of scenic amenities or, more specifically, wildlife amenities on farmland values.

Another body of research has focused on the influence of land attributes on wildlife recreation leases. Many of these studies analyzed Texas hunting leases because Texas has a well-developed hunting lease market and limited free public access to wildlife (Pope, Adams, and Thomas).[3] Based on a 1979 survey of hunters in Texas, Livengood analyzed the value of hunting leases and the marginal willingness of hunters to pay for hunting white-tailed deer. The study analyzed the individual lease data using a hedonic price model and estimated that hunters were willing to pay $25 for a deer in 1978–1979 dollars. When the lease rates were converted to a per acre basis, the study reported that rates ranged from 25 cents to $10 per acre annually.[4] Pope and Stoll reported that the rights to hunt were much more valuable than the guarantee of a deer harvest, and the right to hunt added $152 to $393 per acre to the value of land in Texas.[5] Baen analyzed Texas hunting leases using a 1996 survey of Texas landowners and calculated an annual average hunting lease rate. The information from this study was used to develop a hunting lease index that was based on the deer densities, trophy quality deer, and metropolitan proximity of rural lands. Based on the 1996 survey, Baen calculated that hunting leases accounted for 25% of the market value of land in Texas and over 80% of the land values in some counties.[6]

Analysis of hunting lease arrangements in other areas of the United States reveals that land attributes influence the hunting lease rates. Messonier and Luzar used a hedonic price model to analyze hunting leases in Louisiana. Using data collected from a 1989 survey of Louisiana hunting clubs, hunting lease rates were discovered to be dependent on the number of acres available at the hunting club. Shrestha and Alavalapati analyzed the impact of various ranchland attributes on Florida hunting leases and found that vegetation cover had a positive impact on hunting revenues. Ranches with 22% tree or other vegetation cover received $16.15 per acre per year from hunting leases, and when coverage was doubled, leases rose 20%.

A few studies have analyzed the impact of

[3] Baen reported that 98% of Texas land was privately owned. The U.S. Fish and Wildlife Service (1996) reported that over 80% of the big game hunters hunted only on private land in the United States.

[4] When converted to constant 2002 dollars, the average lease rates per acre range from roughly 70 cents to $29 per acre.

[5] The land value impacts per acre range from $435 to $1,125 in 2002 dollars.

[6] Baen calculated hunting lease impacts by capitalizing the average county lease rates at a 3% capitalization rate and then dividing the capitalized value by the average county land value.

wildlife amenities on land values. Using survey data of hunting leases from Texas hunters and land values from school district tax information, Pope, Adams, and Thomas analyzed the relationship between deer harvests, hunting lease rates, and land values. Hunting lease rates and land values in Texas were higher in regions with greater deer harvest densities. The contribution of white-tailed deer to Texas land values was estimated to be $55 per acre of deer range in 1982 dollars. Using school district tax information, Pope analyzed the impact of wildlife attributes on average land values at the school district level. Using a hedonic price model to analyze the relationship between the deer population and average land values, the value of owning the ingress rights to land for hunting contributed approximately $180 per acre to land prices in the Texas Hill Country in 1981 dollars. More recently, Bastian et al. analyzed the relationship between agricultural land values in Wyoming and various wildlife amenities. Based on data from the Wyoming Farm and Ranch Land Market survey, agricultural land values were higher if there was access to scenic views, elk habitat, and sport fishery.

In sum, past literature has analyzed the relationship between land values and the presence of wildlife. The literature found that land values were higher when wildlife was in more abundant supply. However, research analyzing the relationship between wildlife attributes and land values is unable to distinguish between the impacts derived from amenity values associated with wildlife and the impacts derived from potential recreation income. To date, analysis regarding the capitalization of wildlife recreation income into farmland values is limited. Studies by Pope, Adams, and Thomas, and Pope have combined recreation income with other agricultural income in their models. As a result, these studies were unable to separate the impacts of recreation income from other agricultural income streams. This paper extends the literature by explicitly testing the relationship between recreation income and farmland values.

Texas Wildlife Recreation Income

The primary challenge in analyzing the capitalization of wildlife recreation income in farmland values is to obtain measures of wildlife recreation income. Fortunately, Baen published average per acre hunting lease rates for 115 Texas counties for 1996. These averages were obtained from the 1996 Texas Farm and Ranch Hunting Survey from the office of the Texas Comptroller of Public Accounts. Landowners were randomly selected in each of the Texas counties from landowner tax rolls. The response rate was 16% and responses covered 142 out of the 254 counties (Figure 1). More detailed information on the Texas Farm and Ranch Survey is contained in Baen.

Baen's survey revealed that Texas hunting leases span a variety of lease arrangements, covering many different species.[7] In 1996, a third of the land was leased under an annual lease, and roughly 60% of leases were for a specific hunting season. While leases for deer were the most common type of seasonal lease, seasonal leases were also made for the hunting of exotics, predators, quail, turkey, and wild hogs. Given that 80% of the lease arrangements covered deer hunting, it is not surprising that the geographic coverage of the hunting lease rates (Figure 1) overlapped with the deer densities in Texas, as shown in Figure 2.

While Baen's data series limits analysis to the state of Texas, Texas appears to be a viable state to analyze the impact of wildlife recreation on farmland values. Various studies suggest that the hunting market for wildlife on

[7] Pope, Adams, and Thomas identified four general types of lease arrangements in Texas. The first and most common type was the annual or seasonal lease, where the hunter was granted access to hunt for a full year or a season. Annual leases typically allow hunters to hunt multiple species, while seasonal leases allow for the hunting of a limited number of species during the hunting season. The second type of lease was the day hunt, which allows hunters access to land for hunting on a per day basis. The third type of lease arrangement charged hunters for the animal killed instead of access to land. The fourth type of lease involved the landowner leasing the hunting rights to an outfitter, recreation/sportsman club, or other organization that coordinated hunting on the land.

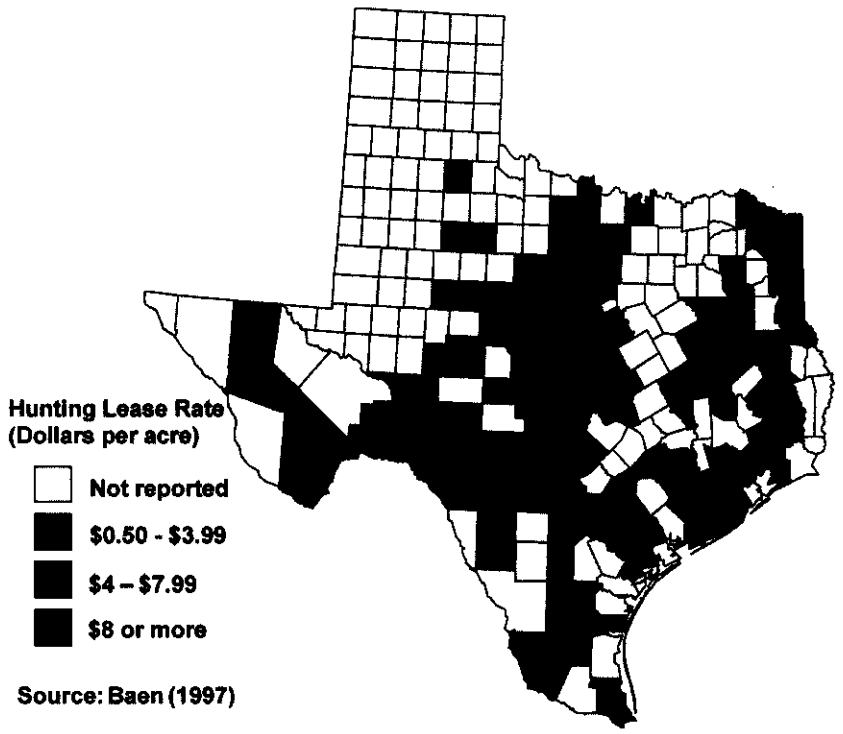

Figure 1. Texas Hunting Lease Rates, 1996

private land was highly developed in Texas during the 1980s and 1990s (Baen; Pope, Adams, and Thomas). The amount of Texas land under hunting leases jumped 19.6% to 36.6 million acres during the 1980s (Baen). Lease arrangements were highly diverse, ranging from annual, seasonal, and day leases to the selling of lease rights to outfitters (Pope, Adams, and Thomas). A majority of the lease arrangements were informal and transacted through family, friends, and associates.[8]

[8] Since informal and formal contracts are both binding contracts, it is assumed that revenues from both types of leases are capitalized at the same rate. However, the informal nature of hunting lease rates may limit the impact of recreation income on land values since informal contracts may not be viewed as transferable contracts with a change in land ownership. Moreover, informal leases may have a lower lease rate due to lower transaction costs associated with finding suitable hunting lease arrangements for both the landowner and renter. While research has not analyzed the differential impacts of informal and formal lease arrangements on land values, Tsoodle, Golden, and Featherstone have estimated that Kansas farmland buyers received a discount on the purchase price when buying from a related seller.

Despite the traditional informality of the Texas hunting market, Texas ranked first in various formal measures of hunting and wildlife recreation activities in the late 1990s. In 1996 and 2001, Texas ranked first in hunting expenditures, with $1.5 billion spent on hunting (Table 1). Texas also ranked first with 1.2 million hunting participants. According to the 2002 Census of Agriculture, Texas ranked first in the number of farms receiving income from recreation services (8,230) and in the total value of income they received ($77.6 million).

Empirical Model

Given that farmland values are derived from the capitalization of the expected future income streams derived from multiple and sometimes competing uses, the hunting lease data are used here in a hedonic price model to analyze their impact on Texas farmland values. In hedonic models, prices of heterogeneous goods are determined by the goods' characteristics. Hedonic price models have been used extensively to compute the value of

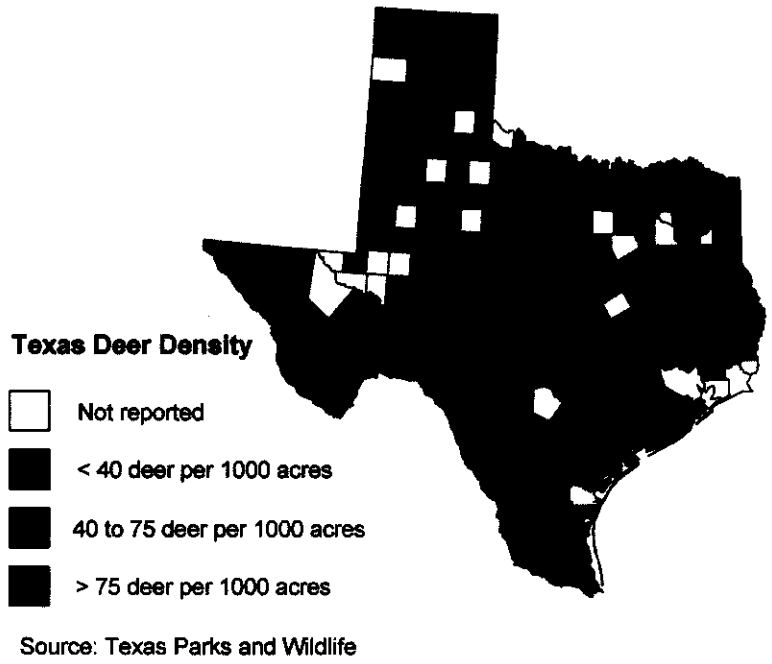

Figure 2. Texas Deer Densities, 1999 to 2003 (average)

agricultural land attributes in farmland prices (Herriges, Barickman, and Shogren; Miranowski and Hammes). Hedonic models have also been used to analyze residential property values (Irwin).

One assumption in the cross-sectional analysis of the capitalization of hunting lease income is that a single year's observation perfectly reflects the expected long-term income from hunting. This assumption may not necessarily hold true if revenues fluctuate from year to year, or in the case of hunting leases, season to season. In analyzing the capitalization of government program payments, Goodwin, Mishra, and Ortalo-Magné critiqued the literature for its failure to recognize this implicit assumption embodied in the empirical analysis. They indicate that the failure to adequately measure expectations of future income streams biases the estimates toward zero, effectively making the resulting coefficients lower bounds. Thus, estimates of the capitalization of various income streams, including wildlife recreation income, into farmland values in the literature and in this paper are conservative estimates.

Strong demand for Texas hunting land may limit the uncertainty regarding the assumption that current lease rates reflect expected future hunting lease income. At least, strong demand would mitigate the risk that hunting lease rates would fall. For example, in Texas, the number of state resident hunters hunting in Texas rose 33% from 1996 to 2001, while the number of nonresident hunters rose 22%. Based on U.S. Fish and Wildlife Service data (1991, 2001), the average per acre hunting lease expenditures rose 66% in real terms from 1991 to 2001. If strong demand is expected to fuel continued gains in hunting lease rates that outpace gains in other income streams, the capitalization rate for hunting lease would be higher than for other income streams.[9] Conversely, if hunting lease income is expected to grow slower than other income streams, the capitalization rate would be lower.

Assuming that observed incomes adequately proxy expected income streams in the future, the hedonic price model is specified as:

[9] If returns from two income streams, I^1 and I^2, are expected to grow at different but constant rates, g^1 and g^2, where $g^1 > g^2$, the present value of land equals $PV = [I^1/(r - g^1)] + [I^2/(r - g^2)]$. In this case, the capitalization rate for I^1, $1/(r - g^1)$ is greater than the capitalization rate for I^2, $1/(r - g^2)$.

Table 1. Wildlife Recreation Expenditures and Farm Level Recreation Service Income by State

	State	Wildlife Recreation[A]		Farm Recreation Services[B]	
		Expenditures (millions)	Participant (thousands)	Income (1000s)	Farms (number)
1	Texas	1,513.9	1,201.0	77,616	8,230
2	Pennsylvania	941.0	1,000.0	2,209	303
3	New York	822.2	714.0	1,420	419
4	Wisconsin	801.0	660.0	1,876	628
5	Alabama	663.6	423.0	5,216	839
6	Ohio	636.5	490.0	2,198	299
7	Tennessee	588.7	359.0	2,416	637
8	Arkansas	517.2	431.0	3,119	478
9	Georgia	503.7	417.0	6,117	1,059
10	Michigan	490.3	754.0	3,295	615
11	Minnesota	482.6	597.0	1,843	400
12	Illinois	450.9	310.0	3,668	606
13	Louisiana	446.2	333.0	2,346	307
14	North Carolina	438.1	295.0	1,870	622
15	Missouri	424.8	489.0	3,222	773
16	Florida	394.2	226.0	2,844	278
17	Colorado	382.6	281.0	12,042	867
18	Kentucky	373.2	323.0	1,153	421
19	Oregon	364.9	248.0	3,000	350
20	Mississippi	360.3	357.0	3,475	608

[A] Source: U.S. Fish and Wildlife Service. (2001)
[B] Source: 2002 Department of Agriculture Census of Agriculture.

$$(3) \quad P = f(\boldsymbol{A}, \boldsymbol{U}, \boldsymbol{S}, H),$$

where the dependent variable P is the county level per acre farmland values in Texas counties in 2002 (data were obtained from the 2002 Census of Agriculture at http://www.nass.usda.gov/Census_of_Agriculture/index.asp), $\boldsymbol{A}$ is a vector of agricultural attributes, $\boldsymbol{U}$ is a vector of nonagricultural attributes, $\boldsymbol{S}$ is a vector of scenic, environmental, or recreation attributes, and H is the hunting lease rate variable. Table 2 provides descriptive statistics on the data.

Control Variables

Several variables are used to control the nonrecreational attributes influencing farmland values. Three variables control the impacts of the county's agricultural economy on farmland values. The average annual county level per acre crop receipts from 1997 to 2000, *CROP,* is included as a measure of the economic returns to crop farming. The average county level per acre livestock receipts from 1997 to 2002, *LSTK,* is included as a measure of the economic return to livestock farming. Counties with larger crop or livestock returns are assumed to have higher capitalized farmland values.

Farm incomes have also been supported by government payments. *GOV,* the average annual per acre value of government payments received in the county between 1998 and 2000, is used as a measure of the farm income stream derived from federal subsidies. Counties with higher levels of government payments are expected to have higher demand for farmland and higher land values. A positive relationship between *GOV* and farmland values is expected.

Multiple variables are used to control the urban impacts on farmland values. A dummy variable, *METRO,* identifies counties that are classified as a metropolitan area. Another

Table 2. Descriptive Statistics

Variable	Description	Source	Mean	St. Dev.	Min	Max	*N*
Dependent Variable							
County farmland value	Dollars per acre	Calculations based on 2002 USDA Census of Agriculture data	1099.16	633.99	83.00	2877.00	114
	Log of dollars per acre	Calculations based on 2002 USDA Census of Agriculture data	6.79	0.72	4.42	7.96	114
Independent Variable							
HUNTING	Hunting lease rates (dollars per acre)	Baen (1997)	4.20	2.29	0.50	12.50	114
POPDEN	Population per square mile, 1990 (thousands)	Calculations based on US Counties 1998 data	0.06	0.18	0.00	1.64	114
POPGROW	Population growth, 1990–2000 (annualized rate)	Calculations based on REIS data	1.38	1.50	−2.59	6.14	114
ADJACENT	Nonmetropolitan counties adjacent to metropolitan area (dummy = 1)	Identification based on USDA rural-urban continuum codes	0.43	0.50	0.00	1.00	114
METRO	Metropolitan counties, 1990 (dummy = 1)	Identification based on USDA rural-urban continuum codes	0.22	0.42	0.00	1.00	114
CROP	County crop receipts, average 1997 to 2000 (thousand dollars per farm acre)	Calculations based on REIS and 1997 Census of Agriculture data	0.03	0.07	0.00	0.46	114
LST K	County livestock receipts, 1997 to 2000 (thousand dollars per farm acre)	Calculations based on REIS and 1997 USDA Census of Agriculture data	0.07	0.11	0.00	0.87	114
GOV	County government payment receipts, 1997 to 2000 (thousand dollars per farm acre)	Calculations based on REIS and 1997 USDA Census of Agriculture data	0.01	0.01	0.00	0.06	114
GEOG	Natural amenity geography index	Calculations based on USDA natural amenity index	−0.52	0.98	−3.09	1.97	114
FARMS	Farms receiving recreation service income	2002 USDA Census of Agriculture	51.94	46.52	1.00	295.00	114
RECACRE	Average county recreation service income per average farm acre	Calculations based on 2002 USDA Census of Agriculture	14.19	10.80	0.60	77.82	107
DEERDEN	Deer per 1000 acres	Texas Parks and Wildlife	54.15	42.99	0.00	211.29	111

* REIS is Regional Economic Information System.

dummy variable, *ADJACENT,* identifies nonmetropolitan counties that are adjacent to metropolitan areas. Both variables are included as a measure of the impacts of urban sprawl on farmland demand as metropolitan areas grow in size and spread into neighboring nonmetropolitan counties. The population density of the county in 1990, *POPDEN,* and the average annual population growth from 1990 to 2000, *POPGROW,* are used to measure the impacts of a large and growing population on the demand for farmland for residential use in larger nonmetropolitan counties. In fact, much of the recent economic growth in the United States has emerged from newly classified micropolitan counties, which are defined as nonmetropolitan counties with a city between 10,000 and 50,000 in population (Henderson and Weiler). Farmland values are hypothesized to be positively related to *METRO, ADJACENT, POPDEN,* and *POPGROW* because of higher demand for land near large and growing populations with more abundant urban amenities.

Natural amenity data are used to control the impact of scenic and environmental amenities on farmland values. McGranahan described the development of the natural amenity index based on various weather and geographic variables. Due to the expected high correlation between crop productivity and weather conditions, we only include a geographic index based on topography and water surface area in our model.[10] Standardized land surface from topography codes and water surface area data for all U.S. counties were obtained from USDA Measuring Rurality Briefing Room (http://www.ers.usda.gov/Briefing/Rurality/). The standardized data were then summed and indexed to 100.

Wildlife Recreation Variables

The initial variable used to measure recreation income is the average hunting lease rate in 1996 provided by Baen. The lease rate is based on a twelve month annual access. The hunting lease variable, *HUNTING,* is expected to be positively related to farmland values. One drawback of the hunting lease variable is that it is derived from a relatively small sample. A total of 414 surveys were obtained in the 1996 survey for an average of roughly three per county.[11]

To check for the robustness of the results, alternative models are estimated that replace the hunting lease variable with other proxy measures of recreation income. Given the availability of total county recreation service income and farms receiving recreation service income in the 2002 Census of Agriculture, the average recreation service income per farm is also calculated. The survey form only identified hunting and fishing as recreation service. However, a preferred method would identify income on a per acre basis, because farm sizes can be highly variable. Thus, an alternative measure, *RECACRE,* approximates the average income per acre by dividing average recreation service income per farm by the average farm size in the county. *RECACRE* is expected to be positively related to farmland values.

For a further check for robustness, we include the number of deer per acre for Texas counties. The deer density measure, *DEERDEN,* will not analyze the capitalization of wildlife recreation income, but the capitalization of wildlife attributes in Texas farmland values. Deer density measures are not able to distinguish between land value gains arising

[10] Additional analysis used McGranahan's natural amenity index and found a high correlation between this index and weather measures. Models including these measures found the amenity and weather indexes to be highly significant, but led to insignificant results for the crop receipts per acre (*CROP*) variable.

[11] According to the 2002 Census, 8,230 Texas farms received income from recreation services. Assuming no change in the number of farms receiving recreation services income from 1996 to 2002, the lease rates obtained from Baen would be derived from approximately 5% of the population. The small sample raises some concern that the lease rates and the estimated impacts may not reflect a larger number of farms engaging in wildlife recreation activity, but could be derived from a small number of farms generating extremely large wildlife recreation incomes, which could be driving hunting lease rates. The variable, *FARMS,* the number of farms earning recreation service income, was included to help control for the market size impact.

from amenity effects and those arising from potential recreation income. *DEERDEN* is expected to be positively related to Texas farmland values.

While average lease rates may influence farmland values, land values may also be influenced by the total size of the wildlife recreation market. For example, a hunting lease rate may be high, but if only a single hunting lease transaction occurs in the county, it would have limited impacts on farmland values. The size of the wildlife recreation market is measured by the number of farms receiving income from recreation services (hunting, fishing, etc.) in 2002 as reported by the Census of Agriculture. Counties with larger recreation service markets are expected to have greater impacts on farmland values.[12]

Empirical Results

Regression results for the estimated farmland price models are presented in Table 3. The model was applied to 114 Texas counties for which hunting lease rates were reported in Baen.[13] The initial model included only the hunting lease rate. To check for robustness of results, alternative models replaced the hunting lease rate with recreation income measures and wildlife recreation attributes as described previously. Both linear and log-linear forms of the model were estimated, and the log-linear form is used here because it minimizes Akaike's Information Criterion (AIC).[14] The model appears to have good fit according to the adjusted R^2 measures. The potential for spatial autocorrelation was addressed following Rappaport.[15]

In model 1, the control variables are statistically significant at the 0.10 level with the hypothesized sign, except *GOV*. The insignificance of *GOV* may be due to collinearity with *CROPS* because the variance inflation factors for *GOV* and *CROPS* are greater than two (Judge et al.).[16] The high degree of collinearity is not surprising given that government payments are primarily received by crop producers and are based on productivity of the land. Variables controlling the agricultural attributes of the county are significant with the hypothesized signs and consistent with other research results. Counties that have higher crop and livestock cash receipts per acre have higher land values. Farmland that offers a higher expected return from agricultural production has a higher capitalized value, *ceteris paribus*.

Variables controlling the impacts of urban attributes of the county are significant with the hypothesized sign. Demand for land for urban use and thus land values are higher in places with larger concentrations of people. Farmland values are higher in counties with higher population density. Moreover, farmland in metropolitan counties and in counties adjacent to metropolitan areas has a higher value because of a higher potential to be converted to urban use due to sprawl. Texas counties that enjoyed

[12] The total county farm recreation service income in 2002 was also used to measure the size of the wildlife recreation market in the county. The number of farms receiving recreation income (*FARMS*) was used because it provides a better approximation of the number of recreation lease transactions in the county. Moreover, Akaike's Information Criterion (AIC) was minimized when the *FARMS* measure was used.

[13] Disclosure problems associated with the government payments variable limited the observations to 114 counties.

[14] Theory provides little guidance in the choice of the model's functional form. The common approach is to select the functional form that minimizes goodness of fit criterion for the model (Irwin).

[15] Rappaport used a generalization of the Huber-White heteroskedastic-consistent estimator to report standard errors to account for spatial autocorrelation among disturbance terms. The following declining weighting function for estimating the covariance between disturbances is imposed on counties with a Euclidean distance less than 100 kilometers between county centers, where s_{ij} is the estimate of σ_{ij} and u_i is the regression residual. $S = g(distance_{i,j})u_iu_j$, where $g(distance_{i,j}) = 1$ for $distance_{i,j} = 0$; $g(distance_{i,j}) = 1 - (distance_{i,j}/100)^2$ for $0 < distance_{i,j} \leq 100$ km; and $g(distance_{i,j}) = 0$ for $distance_{i,j} > 100$ km.

[16] Variance inflation factors on all other independent variables are less than 2 and do not indicate that multicollinearity severely impacts other coefficient estimates. Dropping the government payments variable does not significantly alter the coefficient on the crop receipts data. However, dropping the crops receipts variable does lead to a positive and significant coefficient on the government payments variable.

stronger population growth in the 1990s also had higher farmland values.

Most importantly, variables associated with wildlife recreation were found to be positive and significantly related to farmland values in Texas counties. In model 1, hunting lease rates were found to be positive and significantly related to farmland values in Texas counties. The elasticity associated with the hunting lease rate is 0.25, higher than the 0.14 elasticity associated with gross livestock receipts.[17] This result is consistent with Livengood, who found revenues from hunting leases in deer ranges to be greater than the revenues from a cow-calf grazing operations. The higher capitalization rate may indicate that landowners expect stronger income growth in hunting leases than livestock revenues. In dollar terms, if a county's hunting lease rate was one dollar higher then average, the county's farmland value was 6% higher on average or \$65.51 (\$65.51 = 0.060 × 1099.16).[18] This result appears to be consistent with estimates in the literature. Pope, Adams, and Thomas computed that white-tailed deer added \$55 per acre to Texas land values, while Pope estimated an added value of \$180 per acre in Texas Hill Country land values. It appears that hunting lease income has been capitalized into farmland values.

Texas farmland values also appear to be higher in counties with more formal recreation income. The number of farms receiving wildlife recreation income was positively associated with land values. This result suggests that farmland values are higher in locations with more developed markets for wildlife recreation activity.

Variables used to check for the robustness of the results were also found to be significant and positively related to Texas farmland values. Farm income from recreation services appears to be capitalized into Texas farmland values. Texas farmland values were found to be higher in counties with higher average recreation income per farm acre (model 2). The elasticity associated with average recreation service income variable was 0.18, again higher than the elasticity of the gross livestock receipts variable.. However, the elasticity was found to be lower than the elasticity associated with the hunting lease rate variable. This difference may emerge from the fact that recreation service income includes fishing and other recreation income in addition to hunting lease income.

In model 3, counties with more deer per acre were found to have higher land values. Consistent with previous literature, farmland values were higher in regions with a greater abundance of deer.

In sum, wildlife recreation has emerged as another income stream for farmers who rent land to hunters, anglers, and other outdoor enthusiasts. The results suggest that various types of wildlife recreation income have been capitalized in farmland values. Texas farmland values in 2002 were higher in counties that had higher hunting lease rates in 1996, *ceteris paribus*. Moreover, farmland values were higher in counties with higher farm recreation income. Wildlife attributes also appear to be capitalized into farmland values as counties with greater deer densities had higher farmland values.

Conclusion

Wildlife recreation is clearly a large and expanding industry. U.S. residents spend several billion dollars each year to hunt, fish, and

[17] The elasticity for a log-linear model, $\ln y = \beta_0 + \beta_1 x$, is βx and results in a 0.25 elasticity measure (0.060 × 4.197).

[18] Additional analysis incorporated interaction terms between the hunting lease rate variable and the metropolitan and adjacent dummy variable to determine if the capitalization of the hunting lease rate variable varied by distance to metropolitan area. We hypothesized that the capitalization of hunting lease rates would be lower in metropolitan areas or adjacent to metropolitan locations because the future of the hunting lease would be limited as urban expansion encroached on the hunting lands. In other words, the time frame for hunting leases is more finite. An alternative hypothesis would be that that the capitalization of hunting lease rates would be higher because demand for hunting land would be higher near metropolitan locations since a greater number of people would have less access to land for hunting purposes. While the interaction terms were negative in sign, they were insignificant and were dropped from the analysis in order to present a more parsimonious model.

Table 3. Empirical Results

Dependent Variable: Log of County Farmland Value (ln land)	Model 1	Model 2	Model 3
Hunting lease rates *(HUNTING)*	0.060 (0.02) ***		
Recreation service income per acre *(RECACRE)*		0.013 (0.005) ***	
Deer density *(DEERDEN)*			0.004 (0.001) ***
Farms receiving recreation service income *(FARMS)*	0.002 (0.001) *	0.003 (0.001) ***	0.001 (0.001)
Population density *(POPDEN)*	0.553 (0.108) ***	0.350 (0.136) ***	1.996 (1.382) *
Population growth *(POPGROW)*	0.207 (0.037) ***	0.199 (0.036) ***	0.182 (0.038) ***
Rural counties adjacent to metropolitan areas *(ADJACENT)*	0.315 (0.126) ***	0.292 (0.123) ***	0.312 (0.126) ***
Metropolitan counties *(METRO)*	0.388 (0.178) **	0.353 (0.177) **	0.260 (0.207)
Crop receipts *(CROP)*	0.941 (0.344) ***	1.209 (0.449) ***	0.613 (0.388) *
Livestock receipts *(LSTK)*	2.027 (0.451) ***	2.037 (0.413) ***	1.844 (0.411) ***
Government payments *(GOV)*	0.723 (3.807)	1.577 (4.826)	3.827 (3.927)
Geography *(GEOG)*	0.092 (0.061) *	0.060 (0.063)	0.073 (0.062)
Intercept	5.788 (0.208) ***	5.788 (0.18) ***	5.896 (0.174) ***
Observations	114	107	111
Adjusted R^2	0.594	0.603	0.592

Note: Results were corrected for spatial autocorrelation following Rappaport. Standard errors are in parentheses.
* Significant at the 0.10 level.
** Significant at the 0.05 level.
*** Significant at the 0.01 level.

watch wildlife. Farmers are reaping some of the benefits of this burgeoning industry by building revenue streams from recreation services. Income from wildlife recreation and strong demand for land for wildlife recreation are transforming some rural land markets.

Empirical analysis of Texas farmland values finds that hunting leases and recreation income are being capitalized into farmland values. The capitalization of hunting lease incomes and other wildlife recreation revenues into farmland values could have various implications for farmers, bankers, agribusiness owners, and other stakeholders in wildlife recreation areas. The capitalization of wildlife recreation income means that farmers and bankers may need to account for this income stream in their land price appraisal. Land appraised solely on its value from agricultural production may be undervalued. Farmers may need to account for this income stream while bidding on farmland. Bankers may need to include this income stream when approving farm real estate loans or when using farm real estate for collateral.

While the results indicate that wildlife recreation provides a positive net income stream to farmers in Texas, wildlife recreation could

alter the costs of agricultural production costs in a variety of ways. By boosting land values, wildlife recreation may raise the fixed costs of agricultural production. Wildlife recreation may increase the costs associated with crop loss or property destruction by wildlife or wildlife recreation participants. Farmers may also face increased costs associated with liability risk since landowners that allow free public access for recreational use often have some liability protection not afforded to fee-based use.[19] Farmers may also have the burden of managing access to the property.

The capitalization of wildlife recreation income has implications for future research. Researchers may want to analyze the impacts of an expanding wildlife recreation industry on changing farm production patterns if certain crops are more supportive of the wildlife recreation industry. If wildlife recreation is bringing a new nonfarm buyer to farmland markets, researchers may want to explore changes in farm ownership structure in wildlife recreation areas. Researchers may also want to explore the impact of wildlife recreation on nonfarm businesses. In addition to boosting the local leisure and hospitality businesses, wildlife recreation could bring agricultural supply companies a different customer that demands wildlife friendly or safe farm products. Finally, this study analyzed the impacts of wildlife recreation in Texas. Researchers may also want to explore the impacts of wildlife recreation in other geographic areas where hunting lease markets are developing.

Wildlife recreation is a multibillion dollar business that appears to be expanding. The broad impacts of wildlife recreation in rural areas remain uncertain. But wildlife recreation is creating another source of income for farmers and changing the way people explicitly value farmland.

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[19] Baen lists five ways (insurance, lease provisions, release of liability or indemnity agreements, landownership form, and master leases with sublease tenants) farmers can limit their liability risk.

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