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Supply of Private Acreage for Recreational Deer Hunting in Georgia

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Supply of Private Acreage for Recreational Deer Hunting in Georgia

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Understanding factors that influence the supply of private acreage for lease hunting has become increasingly important to sustaining hunting. Improving on existing studies that mostly utilized landowners' responses from contingent surveys, we adopted a different approach to this question by analyzing 2009 market data from Georgia counties. Results from multivariate regression indicate that supply of private lease hunting acres was influenced by: (a) site characteristics such as the relative proportion of certain habitat types; (b) market forces and access factors such as rural road networks and proximity to population centers; and (c) spillover effects of conservation programs such as wildlife management areas (WMAs), and government payments to landowners through a variety of habitat enhancement programs. The findings provide support for policies that increase public investment in habitat conservation on private and public lands or assist landowners with developing innovative marketing strategies to benefit from the recreational potential of their lands.

Keywords counties, Georgia, deer hunting, private land, supply

Introduction

Hunting participation in the United States has been gradually declining since the 1980s (Walls, Darley, & Siikamaki, 2009). Among the possible reasons for this decline are structural changes in population, urbanization of rural culture, land use change, and other factors (Poudyal, Cho, & Bowker, 2008), as well as a reduction in access to suitable hunting land (Mehmood, Zhang, & Armstrong, 2003; Miller & Vaske, 2003; Mozumder, Starbuck, Berrens, & Alexender, 2007). A number of states offer hunting opportunities on public lands such as Wildlife Management Areas (WMAs). The WMAs are public lands set aside by state agencies primarily for conservation of wildlife habitat and provision of outdoor recreation opportunities to the public. However, these resources are limited in both scope and size and are often in high demand by hunters leading to overuse and issues of conflict (Liu, Pagoulatos, Hu, & Fleming, 2010). Further, existing public lands are under increasing pressure to meet public demand for other types of outdoor recreation including bird

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watching, hiking, and backcountry camping thereby further limiting their potential to serve as primary hunting grounds.

The most important resource for recreational hunting is private land (individual/family and commercial) of all use types (i.e., forests, grasslands, rangelands, marshes). The majority of hunters use private lands only. A recent survey by the U.S. Fish and Wildlife Service, for example, indicated that in 2006 about three-quarters of total hunting days occurred on private lands (U.S. Fish & Wildlife Service, 2006). However, despite studies that have consistently showed hunters' higher preference and willingness-to-pay for access to private lands (Anderson & Hill, 2005; Hussain, Zhang, & Armstrong, 2004), ensuring public access to private lands continues to be an issue in several geographic regions (Bihrle, 2003). Slow growth in the supply of private hunting acreage, as well as an increasing number of *No Hunting* posted areas (Bihrle 2003; Duda et al., 2004; Jagnow, Stedman, Luloff, San Jullian & Finley, 2006) have further constrained hunting opportunities in many areas including the southern United States (Cordell & Super, 2000). This situation is further complicated by the fact that almost 80% of wildlife habitats in the United States occur on private lands (Benson, 2001, p. 359; Benson, Shelton, & Steinbach, 1999). Hence, garnering private landowners' cooperation and willingness to allow hunting on their land is crucial for ensuring the future of recreational hunting and the ensuing economic benefits.

There are many ways in which government agencies can assist private landowners in developing the recreational potential of their private lands. For example, providing conservation payments to landowners for habitat conservation and enhancement could help improve the quality of hunting grounds and potentially increase the supply of private hunting acres. Programs such as the Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP) are already in place across the nation. These programs pay private landowners to retire their land from farming or to conduct a variety of conservation and best management practices to enhance the environmental quality of their land. Although such programs have been shown to improve both the quality and quantity of game habitat on private lands (Ribaudo & Hellerstein, 2008), the extent to which such programs have led to an increase in recreational hunting has not been well documented. In particular, it is not clear whether communities receiving such public funding for habitat conservation have actually opened their land to the public for recreation (Liu et al., 2010).

Improving recreation access to rural areas influences hunting participation (Brown & Connolly, 1994). In the South, substantial acres of hunting grounds are located in rural landscapes containing transportation infrastructure, such as major interstate corridors and rural road networks that likely influence the marketability of these rural private hunting lands. Provision of WMAs could also improve the recreational potential of adjacent lands because of the possible spillover effects.

A few studies have examined the supply side of enabling public access to private hunting grounds. For example, Liu et al. (2010) found that the likelihood of private landowners in the Southern Appalachians offering public access to their land for recreation was positively related to the total supply of acres available. Zhang, Hussain, and Armstrong (2006) and Hussain et al. (2007) surveyed non-industrial private forest land owners in Alabama and Mississippi, respectively, to investigate the factors influencing landowners' participation in lease hunting and their expected lease rates. Zhang and colleagues (2006) found that land ownership type, tract size, landowner place of residence, and employment status affected landowners' likelihood of leasing land for hunting in Alabama while Hussain et al. (2007) found that the likelihood of leasing land for hunting was influenced by a multitude of factors including characteristics of the land and the landowners themselves, along with perceived accidental liability, land use conflict, and loss of privacy.

Ribaudo and Hellerstein (2008) analyzed county level data to gauge the feasibility of using CRP projects to increase opportunities for fee hunting under various scenarios. They found that implementing such projects increases the quality of wildlife habitat, which could potentially lead to increases in supply of private hunting land. However, their study covered only CRP projects and did not consider public investment in other types of conservation programs such as WRP, the Farmable Wetlands Program (FWP), and the Conservation Reserve Enhancement Programs (CREP). These other programs may provide significant contributions to habitat improvement and therefore help supply more land for hunting. From a biophysical standpoint, it is reasonable to expect that implementing these conservation programs may increase game availability and/or quality on private land. However, other socioeconomic considerations and market factors may influence a landowner's decision to make private acreage available for hunting.

To date, existing studies of the supply of private hunting lands have focused on the stated preference approach, which uses self-reported surveys to examine landowner willingness to participate in lease hunting typically in hypothetical scenarios of contingent valuation questions. Since many of these questions are binary in nature (e.g., asking whether or not landowners would participate or have participated in lease hunting), the supply dimensions (i.e., total land actually leased) are rarely explored. While data on leased acres are usually not readily available, adopting a market approach using lease data may better explain the market clearing supply (i.e., equilibrium) and can be used to develop a statistical model to explain factors that affect supply. Unlike other natural resource goods (timber) and services (park entrance), the market has not been institutionalized for lease hunting and published data are rarely available to the public. To date, there is an absence of studies that have actually used market data to analyze the supply of and factors influencing hunting leases.

Purpose of Study

This study sought to develop an aggregate supply model to explain the total acres leased for deer hunting in Georgia counties. Several factors likely to influence the supply of private acreage for leasing hunting were explored including lease price, availability of substitute or complement sites, site characteristics, access, location and market forces, as well as several government policies (notably the provision of wildlife management areas and government payments to landowners for habitat improvement) in increasing public access to private hunting grounds.

Sustaining the supply of sufficient hunting grounds in Georgia is important because of its economic significance. Total annual expenditures by hunters in Georgia is estimated to be nearly $419 million (U.S. DOI, Fish & Wildlife Service, & U.S. DOC, U.S. Census Bureau, 2006), an amount that is even higher than the total farm gate value generated from some of the major row crops in the state such as soybeans or tobacco (Boatright & McKissik, 2010).

Methods

Model

We modeled the total supply of private hunting acreage at the county level. Previous studies have adopted similar models to characterize county or regional level aggregate demand for hunting (Anderson & Hill, 1985; Brown & Connelly, 1994; Sun, Van Kooten, & Voss,

2005). Economic theory suggests that supply of a good or service is affected by a variety of factors including the price of the good or service itself, price or availability of related goods, technology, price or availability of input, government policies, socioeconomic, and other factors. Based on these factors, the following conceptual model was formulated (see also Table 1).

$$\begin{aligned} &\textit{Total private hunting land leased in county} \\ &= f\ \textit{(lease rate, substitutes/complements, site characteristics,} \\ &\quad \textit{location and market forces, government policy and regulations,} \\ &\quad \textit{sociodemographic factors)} \end{aligned} \tag{1}$$

We posit that the average county lease rate per acre captures price effect on supply. We expected lease rate per acre to positively affect the supply since more landowners may open their land for higher lease rates.

We used the availability of public hunting grounds such as WMAs to control for any substitute or complementary effect for two reasons. First, the WMAs provide prime habitat for game species, and second, some of the hunters who regularly hunt in WMAs may lease additional lands nearby because they are more familiar with the territory. Even though it is reasonable to expect that the availability of public hunting land would have a negative impact on supply of private acres nearby (i.e., as a substitute), it is possible that thousands of private acres located adjacent to these WMAs may in fact benefit from any spillover effect and become equally or more suitable for lease hunting. Hence, we expect a positive effect of this variable on supply of private acreage.

Previous work suggests that habitat characteristics influence wildlife abundance, diversity and quality of hunting ground (Baen, 1997; Hussain et al., 2007). This occurs because the quantity and quality of habitat components (food, water, cover) for a game species and associated prey largely depend on the land cover and land use characteristics of the site. For example, some species thrive better in upland savannas whereas others find better food, cover and water along bottomland hardwood areas and swamps. Thus the productivity and carrying capacity of these different sites to support a game population largely depends on land cover characteristics. Hence, in order to explain the differences in habitat suitability and capacity to support species population, we used the proportion of county lands in general land use including forest, farmland, and water areas. We considered land cover types and proportion of land in different forest habitat types to characterize the inputs needed to produce the hunting habitat. Other inputs such as provision of food plots, habitat management, controlled burns, and county-specific or club specific harvest restrictions in the production process can affect habitat, but they were not included due to lack of available county-level data.

Realizing that the general land use types alone may not capture the specific habitat types required for wildlife, we included additional variables that represent the specific habitat characteristics of forestland in counties. Since considerable hunting occurs on forestlands and a number of habitat types have been shown to have varying impacts on hunting potential (Hussain et al., 2007; Zhang et al., 2006), we used different types of forest habitat including hardwood and pines as a proportion of county forestlands. We expected that the total acres leased would be positively affected by availability of some forest types; in particular those that are related to major game species like deer. We also considered

Table 1
Definition of variables and mean values

Variable	Definition	Mean (standard deviation)
Price variable		
Lease Rate ($/acre)	Average per acre lease rate for deer hunting in the county	12.048 (0.725)
Substitute/Complement		
WMA units (numbers)	Number of wildlife management areas (WMA) units in the county	0.955 (1.121)
Site characteristics variables		
Forest (%)	Forest as a percentage of county area	60.199 (17.718)
Agriculture (%)	Agriculture land as a percentage of county area	27.257 (16.864)
Water (%)	Water as a percentage of county area	2.888 (3.782)
Oak-Gummy-Cypress Forest (%)	Oak-Gummy-Cypress habitat type as a percentage of county forest area	7.581 (7.537)
Loblolly Shortleaf habitat (%)	Loblolly Shortleaf Pine habitat as a percentage of county forest area	19.434 (13.428)
Longleaf Slash Pine habitat (%)	Longleaf Slash Pine habitat as a percentage of county forest area	7.991 (11.997)
Road Mileage (‘1000 mileage)	Road networks as a total mileage (in thousands) of interstate, state and local roads in the county	0.645 (0.372)
Location and market force variables		
Distance to major cities (‘1000 mileage)	Distance (in thousand miles) to the closest big city (>100,000 population) from the county	0.049 (0.024)
Population density (People/Sq. mile)	Estimated county population in 2009 divided by the total county area	195.057 (396.729)
Government policy		
Conservation Payment (‘1000 $)	Total payment received by the private landowners in the county for the habitat conservation and improvement under CRP, WRP, FWP, and CREP programs in 2007.	84.830 (119.629)
Other socioeconomic variables		
Per capita income (‘1000 $)	Average per capita income of county residents	26.299 (5.397)
African-American (%)	Population of African-American as a percentage of county population	28.097 (16.895)
Age 35 to 64 (%)	Population of 35–64 years age cohort as a percentage of county population	39.225 (3.318)
Age below 18 (%)	Population of below 18 years age cohort as a percentage of county population	25.138 (2.827)

transportation or access to rural hunting sites as equally important factors in representing site characteristics. Total road mileage in the county was added as an explanatory variable and expected to have a positive effect on total lease acres.

The location of potential lease lands in relation to existing markets is another important determinant of supply because large proportions of hunters come from urban centers (Hussain et al., 2007). We used the proximity of the county to major cities in the state including Atlanta, Augusta, Chattanooga, Columbus, Macon, and Savannah and the population density of the county to capture any market effect coming from inside and outside the county. The total government payment to county landowners through a number of habitat conservation programs was included to gauge the potential impact of such programs on lease hunting. We hypothesized that counties with a higher level of government payments to landowners would have a higher number of private acres available for lease hunting. Our analysis only considered the conservation payment made through federal programs and does not include payment from other state-funded programs partly because the federal programs constitute the larger portion of such funding in the state, and are in place since long. While a number of state governments funded tax credit programs were already in place, more specific programs of direct payments are relatively new. For example, the Georgia Conservation Tax Credit program was signed into law in 2006 only (http://www.georgiawildlife.com/node/961).

Socioeconomic variables such as age, race, and income were included to control for other factors that may influence leasing decisions of landowners in the county (Messonnier & Luzar, 1990; Raedeke, Rikkon, & Bradley, 1996) or indirectly shape the market clearing quantity of lease acres by influencing the demand. For example, the population age cohort 35 to 64 was included as it represents the likely age distribution of the hunting population (Poudyal et al., 2008), which could affect the equilibrium acreage in leases. The population of age cohort below 18 years was also included because the time commitment and resources of likely hunters and the need for source of income for landowners could be influenced by the presence of children (Mehmood et al., 2003). Detailed definitions and descriptive statistics of variables included in the model are explained in Table 1.

Equation 2 shows the econometric specification of the supply model.

$$Y = \beta_0 + \sum\nolimits_k \beta_k X + \varepsilon \tag{2}$$

where Y is an $Nx1$ vector representing the dependent variable, that is, total acres of private land (in thousands) leased for hunting in the county, and X is an NxK matrix representing the county level observations on K explanatory variables as discussed in the previous paragraphs. Similarly, β_0 is the intercept and β_k represents the vector of coefficients to be estimated for K explanatory variables. The last term ε is an $Nx1$ vector of random errors.

We began by estimating Equation 2 using an ordinary least square (OLS) estimator. However, as our analysis used cross-sectional data (i.e., observation over multiple areal units) the model could be impacted by spatial dependence, which occurs when OLS residuals are correlated across observations (i.e., spatial error dependence) or when the observations are not independent (i.e., spatial lag dependence). Depending on the type of dependence present, it may violate the OLS assumption of uncorrelated error terms and independence of observation units. We used a robust Lagrange Multiplier (LM) Test to check for the presence of spatial dependence (Anselin & Bera, 1998). Multicollinearity, which occurs when covariates are correlated to each other, was checked using the variance

inflation factor (VIF). Variables that did not exceed the suggested threshold VIF of ten (Freund & Wilson, 1998) were kept in the final model.

Study Area and Data Sources

This study was conducted using county level data in Georgia. Georgia has 159 counties located in a variety of physiographic zones. These zones range from Appalachian Plateau and Blue Ridge and Valley in the north, Piedmont and Upper Coastal Plain in the central and southwestern region, to the Lower Coastal Plain in the southeastern region. The diversity in vegetation and landforms across the state support a variety of game habitats and offer a varied level of recreational hunting opportunities on private lands. There is also a substantial variation across the state in population density, transportation networks, and accessibility to rural landscapes.

It should also be noted that a few counties across the state had missing data on average lease rates. Average lease rate calculated from rates of all other counties was used as proxy rates for missing counties. Doing so increased the degrees of freedom. We also estimated a separate model excluding those counties, but no change was noticed in overall results.

The total number of private acreage leased for hunting and the average hunting lease rates were obtained from the Georgia Farm Gate Value Report developed by the Center for Agriculture and Economic Development at the University of Georgia (Boatright & McKissik, 2010). This Report included data on the quantity and price information of several agriculture based product and services including deer hunting leases for each county in Georgia for the year of 2009. We used deer hunting acreage as the best measure of lease acreage because it represents the dominant game species in the state, although in most cases a lessee can still hunt several other game species on the land. Data on government expenditures for habitat conservation programs on private lands came from county reports of the National Agriculture Census Report of 2007 (NASS, 2007). These data represented the total amount paid by the government to county landowners for implementing a variety of habitat improvement programs (e.g., CRP, WRP, FWP, CREP), or retiring land from intensive farming. We used county level total payment data from the 2007 Census, because this was the most recent data available on conservation payments to landowners to match with 2009 lease data. This approach is justifiable from a production process standpoint because it takes at least a couple of growing seasons for such investments to bring some environmental benefit, habitat improvement, and increased game sightings in the area.

The number of WMAs in each county was obtained from a map generated by the Georgia DNR (http://www.georgiawildlife.com). Data on a variety of broad land use categories including forest, farmland, and water areas were obtained from the NORSIS Dataset of the USDA Forest Service (Cordell & Betz, 1997). The proportion of forestland in different types of forest habitat was obtained from the USDA Forest Service's Forest Inventory and Analysis (FIA) dataset. The FIA data included acres of various types of forest habitat (e.g., oak-gum-cyprus, Loblolly Shortleaf pine, Longleaf Slash pine) as a percentage of total forest in each county. Highway road mileage by county in 2009 was obtained from the Georgia Department of Transportation (http://www.dot.state.ga.us) and included all the interstate, state, and local rural roads. Sociodemographic variables such as population density, percentage of people in the age cohort representing likely hunters' and children' age cohorts, percentage of African-American population, and per capita income for the same year were obtained from Georgia Statistics Database (http://www.georgiastats.uga.edu). The African-American group was chosen because they constitute the largest minority

demographic group in the state. Distance between the county and the major cities were calculated in ArcGIS 9.2 using the Environment and Scientific Research Institute (ESRI) Database.

Results and Discussion

Table 2 presents results from the multivariate OLS regression estimation of Equation 2 along with the coefficients, standard errors, and conventional R^2. The computed VIF are shown in the last column of the table and are less than the suggested threshold of ten (Freund & Wilson 1998, pp. 194) indicating that multicollinearity was not an issue. However, a spatial diagnostic test using robust Lagrange Multiplier (LM) tests (Anselin & Bera, 1998) indicated that residuals were spatially correlated (Moran's I $= -0.018$, $p = .01$). Further, a series of robust LM tests revealed a stronger evidence of the presence of spatial lag dependence (robust LM Statistic for lag $= 5.49$, $p = .01$), than the spatial error dependence (robust LM Statistic for error $= 4.74$, $p = .03$). Following Anselin (2005, p. 199), we estimated a spatial lag model to address the issue of spatial autocorrelation in OLS residuals. Equation 3 presents the algebraic expression for the spatial lag model (SLM) (Anselin & Bera 1998).

$$y = \rho Wy + X\beta_k + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n) \tag{3}$$

where y represents an $Nx1$ vector of the dependent variable, Wy is a spatial lag of the dependent variable, and the scalar ρ represents the spatial lag autoregressive coefficient. Similarly, β_k is a $Kx1$ vector of parameters to be estimated, X is an NxK matrix of independent variables, and ε refers to error terms assumed $N(0,\sigma^2 I)$. A first order queen-contiguity matrix (W) was used to define the neighbors. In such a weight matrix, adjacent counties that share a vertex along the boundaries of the ith county are considered neighbors of the ith county, but others are not (Anselin, 2005).

While the results from both the OLS and spatial autoregressive model are presented in Table 2 for comparison purposes, findings and conclusion will be discussed for the SLM model only. The SLM model showed an improved R^2 value indicating a relatively better fit of the model to the data. Out of 16 variables, 10 were statistically significant in the OLS model at ($p = .01$) or better level and had coefficients with expected signs in OLS model, while the SLM model had nine significant variables with expected signs.

As expected, the coefficient on the lease rate variable had a positive coefficient but the effect was not statistically significant, probably because there was no remarkable variation in fee rates among Georgia counties. For example, although fees varied from \$8/acre to \$18/acre among counties with the mean of \$12/acre, the standard deviation was only \$0.72/acre. Recent studies have also found the supply of private acreage to be inelastic in price (Lieu et al., 2010), suggesting that the fee variable may not in fact be an important determinant of landowners' lease hunting participation, as has been previously suggested (Hussain et al., 2007; Zhang et al., 2006).

Consistent with our expectation, the coefficient of the number of WMAs in the county was statistically positive and significant ($p = .01$), suggesting that landowners in counties with higher numbers of WMAs may be able to open more hunting acres for lease to the public. This observed correlation provides empirical evidence for spillover effects of such protected areas. Even though WMAs protect and manage wildlife habitat inside

Table 2
Estimates from the multivariate regression model

	Coefficients (standard errors)		
Variables	OLS	SLM	VIF
Constant	94.224	89.104	—
	(84.303)	(79.561)	
Price variable			
Lease Rate ($/acre)	1.244	1.232	1.120
	(1.508)	(1.420)	
Substitute/complement variables			
WMA units (numbers)	10.502**	10.336**	
	(4.545)	(4.283)	
Site characteristics variables			
Forest (%)	−0.245	−0.226	4.160
	(0.495)	(0.467)	
Agriculture (%)	−0.934**	−0.908**	2.490
	(0.421)	(0.396)	
Water (%)	−1.321	−1.407	1.220
	(1.336)	(1.258)	
Oak-Gummy-Cypress Forest (%)	1.914**	1.683**	1.930
	(0.680)	(0.828)	
Loblolly Shortleaf habitat (%)	1.360**	1.258**	3.400
	(0.597)	(0.573)	
Longleaf Slash Pine habitat (%)	(0.600)	(0.579)	2.700
	(0.600)	(0.579)	
Road Mileage (‘1000 mileage)	68.697***	67.079***	1.690
	(20.240)	(19.059)	
Location and market force variables			
Distance to major cities(‘1000 mileage)	−599.733**	−566.473**	2.050
	(259.150)	(245.414)	
Population density (People/Sq. mile)	−0.076***	−0.072***	3.020
	(0.024)	(0.023)	
Government payment			
Conservation Payment (‘1000$)	0.140**	0.142**	2.180
	(0.055)	(0.052)	
Other socioeconomic variables			
Per capita income (‘1000 $)	−0.091	−0.066	2.110
	(1.267)	(1.193)	
African-American (%)	0.644*	0.580	1.980
	(0.392)	(0.373)	
Age 35 to 64 (%)	−1.340	−1.308	1.260

(*Continued*)

Table 2
(Continued)

Variables	Coefficients (standard errors) OLS	SLM	VIF
	(1.526)	(1.439)	
Age below 18 (%)	−1.799	−1.765	1.290
	(1.877)	(1.768)	
R^2	0.43	0.44	
N	159	159	
ρ	—	0.096	

***, **, and * indicate the significance of t-scores in OLS model and z-scores in SLM model at 1%, 5%, and 10%, respectively.

the boundary, private forests and farmlands around WMAs may see increased recreation potential from the increased movement and sighting of game.

Results were mixed in terms of the effect of input characteristics. General land use categories, including forestland and water areas as a percentage of county area, were insignificant. The percentage of county land under agriculture was significant ($p = .02$) and was negatively related with the supply of lease hunting acres. This result was not consistent with our *a priori* belief, but there are many counties with intensive farming of row crops in the lower central and southwestern part of the state. These lands are perhaps less suitable for deer habitat, and hence lease hunting may not have been developed. It is also possible that not many landowners in the area want hunters on the commercial part of the farm. Another possible explanation is that the effect of broader and general land use categories faded as the model also included some specific variables capturing the percentage of different types of habitats that may influence the availability of game species and quality of deer hunting grounds. Results from a reduced model (without these specific forest type variables) confirm our speculation. The percentage of county forests under oak-gum-cypress, loblolly shortleaf pine, and longleaf slash pine were significantly ($p < .05$) and positively related with the supply of lease acres at the county level. However, speculation of the marginal effects among these forest habitat types reveals that oak-gum-cypress forest had a substantially larger effect on the total land leased compared to loblolly and longleaf pine types. This result was consistent with propositions by Harris, Sullivan, and Badger (1984) and Hussain et al. (2007) that the productivity of hardwood forest supports higher richness of wildlife habitat and game quality. As expected, total road mileage was significant ($p < .01$) and positively related with the total supply of lease hunting acres in the county.

Among the location and market force variables, the distance to major city factor was significant ($p = .02$) and negatively related with the total lease hunting acres in the county, suggesting that the counties located near bigger metropolitan areas are likely to have more acres of land leased for hunting than those located farther away. This observation may be explained by the fact that hunters living in big urban areas lease hunting grounds in nearby counties. There could also be an effect of the opportunity cost of travel time and transportation costs, which may be going up of late. Hussain, Munn, Hudson, and West (2010) found that hunters placed a significant value on lease locations that are close to their residences. Population density of the county, which was posited to control for a number

of urbanization and market force related factors was also significant ($p < .01$) and had a negative effect on the total lease acres in the county. This result may be due to the associated opportunity cost of land in urban counties with high population density. In such counties, land is usually in higher demand for residential development and other commercial uses as they bring higher rents to the landowners compared to hunting leases.

As the study area section illustrated that there is a significant variation in biophysical and socioeconomic conditions between the northern and southern Georgia, an attempt was made to control for this difference and some other market variation by using a North–South (of Interstate Highway 20) dummy. However, the dummy itself was insignificant and did not alter the size, sign, and significance of other variables, and hence was excluded from the final model.

As expected, government payment provided to landowners for habitat conservation had a significant ($p < .01$) and positive effect on total land leased for hunting. Since the payment directly helps landowners to either retire land from intensive farming or install conservation and habitat enhancement programs, it probably helps in increasing game abundance and quality of hunting ground (Ribaudo & Hellerstein, 2008). As a result, the total supply of hunting land in the county increases. Marginal effect indicated that a thousand dollar investment in habitat conservation programs in the county may increase the supply of total lease acres by 142 acres. However, this should be taken cautiously because the effect as observed here might have been inflated by the compounded spillover effect of such investment. As game species are mobile, many of the adjacent forestlands currently not enrolled in such programs could also benefit from these adjacent habitat improvements. Wilson and Thilmany (2005) also concluded that public investment in such conservation programs results in spillover effects that bring significant economic benefit to local communities through agritourism.

Among the socioeconomic variables included to control for the characteristics of the landowners and potential hunters in the county, only the percentage of African Americans was marginally significant in the OLS model but insignificant in the SLM model. Other sociodemographic variables including percentage of the county population in likely hunters' age cohort and children's age cohort, and per capita income were not statistically significant. The insignificance of these variables may hint that site characteristics, market forces, and government programs for wildlife habitat management perhaps are better predictors of supply than the general characteristics of landowners and the hunters in an aggregated supply model.

Nevertheless, our results should not be taken to underrate the importance of these variables in a random utility based supply model of individual landowners. As the aggregated supply model in this study used those variables as proxies to control for the characteristics of forest landowners in counties, these are population averages and may not well represent the typical characteristics of landowners in the county. The bottom line is that there is a fundamental difference between survey sample approaches which examine the behavior of individual land owners and the more macro county level approaches which use available county aggregate data. The former is best used when the research question is to examine how policies might induce landowners to modify behavior. The county-level approach is much cheaper to implement and takes advantage of existing data sources. Moreover, it avoids sampling issues like selection, and response biases. The county level approach is best used to assess larger demographic changes, and so on. We used those proxies because landowner demographic data are not available at the county level. Future studies may refine our model with variables that represent the characteristics of landowners instead of the general population in the study area.

Conclusion

Sustaining hunting as a recreational and economic activity may require more facilities and hunting grounds outside of existing public lands. Even though hunters may place a higher preference on private lands than public lands for its habitat quality and low-crowding appeal, decreasing access to private hunting lands in some areas has been considered partly responsible for the recent decline in hunting. Improving upon previous studies that have used survey responses of landowners to gauge the factors that influence their willingness to supply hunting lands, our work used lease data to develop an aggregated supply model and identify factors that may influence the aggregate supply of private acreage for lease hunting.

The findings from this study further our understanding of the economics and management of lease hunting, and offer some useful implications in promoting lease hunting on private lands. First, specific site characteristics such as the relative percentage of different forest habitat types and access to the lease sites are more important than broader land use categories in explaining the leasing potential of private lands for major game species like deer. For example, abundance of certain types of habitats within the forest land use were more important than the percentage of forest itself, and hardwood habitats were more important than softwood or pine dominant habitats.

Similarly, millions of forest areas in the rural South are located away from current transportation networks and are somewhat inaccessible. As our results highlight the importance of access, rural communities located in comparatively remote areas may benefit from the expansion of rural road networks by making more rural acres accessible to leases. While increasing transportation access to rural roads may increase the market potential of rural forest acres for lease hunting, enough attention should be paid to minimize the environmental and habitat fragmentation impacts of transportation corridors in pristine landscapes. Further, as the recent economic recession has seen a substantial decline in timber price and timber harvesting in rural Georgia, opening up markets for lease hunting could serve as a supplemental source of income for landowners in the area. Due to the economic recession and increasing gasoline prices, many outdoor recreationists might have been substituting their long distance vacations and out of state hunting trips with shorter trips to more local areas. Increasing supply of private acreage for hunting and other outdoor activities such as bird watching and nature study will help meet demand for recreation.

Second, public programs and investment in wildlife management on both public and private lands are effective in increasing the availability of private hunting acres to the public. Specially, our study confirms a positive contribution and spillover effect of WMAs and public investment in habitat conservation programs on the supply of private hunting acres. These observations may also hold important policy implications as they provide additional justification for increased investment in programs like CRP and WRP as they benefit hunters and local communities by opening-up recreational opportunities. State wildlife management agencies may see some benefit in establishing new management units, which will not only protect more habitats but also help increase the hunting opportunities in nearby private lands.

On the other hand, private lands adjacent to WMA units also serve as part of the home range or refuge for many WMA species. This symbiotic relationship could be highlighted in public education and outreach materials to enhance public understanding and acceptance of such protected areas. Further, many of the state natural resource agencies including the Georgia Department of Natural Resources are facing budget shortfalls and are considering

the closure of some recreational areas. However, as the economic contributions from the spillover effect of WMAs are likely to extend beyond WMA boundaries, this observation provides a valid explanation to continue managing these lands for wildlife management and public recreational use. For instance, the spillover effects from WMAs to nearby private lands, in terms of increased wildlife, may allow these lands to become more attractive to existing or prospective hunters. These hunters may then also consider utilizing the nearby WMAs for hunting.

Third, our research suggests that the rural counties located near large metropolitan areas are currently associated with the higher supply of lease hunting acres in Georgia. Forests in these counties provide a comparative advantage to landowners for leasing access to nearby urban hunters and potentially serve as an additional source of income. Therefore, providing extension and education programs that engage landowners in habitat management for hunting and other nature-based recreation activities that help them with innovative marketing approaches may also help ensure the supply of hunting acres to nearby metro areas, while possibly increasing the income of some rural households. These are some of the things that for-profit organizations such as Quality Deer Management (QDM) and some non-profit organizations such as Quail Unlimited are doing. Future studies should investigate the cost effectiveness and efficacy of some of these programs in increasing the supply of private lease hunting acres. For example, comparing the cost of enrolling select acres of private lands under habitat conservation programs or establishing a WMA of certain size with the benefits such programs may bring to an individual landowner and the community. Such a cost-benefit analysis may shed further insight on the net impact of such policies aiming to improve recreational opportunities on private lands.

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