Factors Determining Differences in Local Hunting Lease Rates: Insights from Blinder-Oaxaca Decomposition

Ian A. Munn and Anwar Hussain

ABSTRACT. *Factors determining local hunting lease rates, and differences between rates across Mississippi regions, were analyzed using Blinder-Oaxaca decomposition procedures. Per acre rates were 26% greater in west versus east Mississippi. Depending on the decomposition procedure employed, differences in resource endowments accounted for 43% to 69% of the gap. Differences in habitat quality were primarily responsible. Lessors in east Mississippi can improve their rates by reducing lease sizes and shortening contract lengths. Information about differences in local lease rates and the sources of those differences is critically needed by landowners, outfitters, hunters, financial institutions, and natural resource managers.* (JEL Q23, Q26)

I. INTRODUCTION

Information on hunting lease rates is becoming increasingly vital to many stakeholders (e.g., landowners, hunters, outfitters, financial institutions) as fee-access hunting becomes common across the United States (Mozumder et al. 2007; Henderson and Moore 2005; Baen 1997). Natural resource and university extension officials also need this information in designing natural resource conservation programs and local rural development projects (Torrell et al. 2005; Shrestha and Alavalapati 2004). The significance of lease rate information to various stakeholders mainly arises due to the capitalization of lease rates into land values and subsequent implications for alternative land uses and associated economic policy issues.

Currently, lease rates on various bases (e.g., per acre, per gun, per hunter) are available at the state or broad regional level for many areas of the United States. Due to the local nature of hunting lease markets, however, stakeholders need lease rate information at more local levels to make appropriate decisions in their specific domain of management activities. An analysis of the determinants of differences in local lease rates is important because a better understanding of local lease rate differences allows stakeholders to optimize outcomes in light of local conditions. For instance, if the main cause of the gap in lease revenues is differences in wildlife habitat quality, then the appropriate response for landowners would be investing in wildlife food plots or manipulating forest cover types accordingly. Alternatively, if the gap is due to differences in local economic demand and supply conditions, then effective marketing might likely be an appropriate management response. Extension officials need this information to better guide their clientele and efficiently allocate their outreach efforts. Financial institutions (e.g., corporations, timber investment management organizations [TIMOs], real estate investment trusts [REITs]) are increasingly interested in how lease rates are capitalized into local property values and how lease rates impact their financial portfolios. Specific research objectives were to estimate hunting lease rates for two regional markets, using data from leases sold by sealed-bid auction; identify resource and economic factors that underlie differences in these lease rates; and

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highlight insights implied by these differences.

II. METHODS

Theoretical Framework

Hunting lease markets operate following the same economic principles as markets for other commodities and factors. Hunting lease rates are determined as a result of the interaction of demand for and supply of hunting sites. Demand for a hunting site is essentially a derived demand because hunters are primarily interested in quality game and hunting experiences, which in turn are determined by habitat quality and other site characteristics (e.g., access, amenities on site). From the hunter's perspective, hunting sites with better quality habitat are in greater demand because, all else being equal, such sites likely have better quality game, or at least the potential to produce it. Earlier research on hunting lease markets (Shrestha and Alavalapati 2004; Messonnier and Luzar 1990; Loomis and Fitzhugh 1989; Livengood 1983) documented that game quality and hunting experiences correlated with specific cover types (e.g., bottomland hardwoods, mixed pine-hardwoods, open spaces), year-round supply of water for game species, and access (e.g., location, on-site trails, roads). Thus, such site characteristics influence demand. Lease package characteristics also mediate hunter demand for hunting sites and include lease rate, lease type (lease duration), tract or lease size, and the nature of restrictions imposed by landowners (e.g., contribution to management practices, liability insurance requirements).

On the supply side, lease rates were a primary determinant of landowner willingness to supply hunting rights. Landowners likely assessed lease rates in light of opportunity costs of alternative land uses, which frequently included personal hunting. Additional mediating factors on the supply side include ability to provide services and amenities (e.g., guide services, hunting blinds, lodging) and landowner management expertise in operating a lease enterprise (Hussain et al. 2007).

The foregoing identification of demand and supply factors, however, was adequate only in the context of a single lease market. An analysis of differences in lease rates across lease markets entails incorporating adjustments for differences in land quality, an exercise that can be challenging due to regional differences in geology, physiography, vegetation, subregional climate, soils, land use, wildlife, and hydrology. According to Peterson (1986), land quality adjustments can be made only in the context of particular land uses. For instance, agricultural use, soil fertility, topography, precipitation, and irrigation have important bearing on land quality. With regard to hunting-related land uses, habitat quality is a primary concern. Although habitat quality is largely a function of the mix of various cover types and water sources present, the relative mix alone cannot fully account for local habitat quality. Two parcels of land with a similar mix of cover types, but in two different regions, may have substantially different habitat quality due to underlying soil fertility characteristics (Strickland and Demarais 2008). Adjustments are necessary to approximate equivalent acres in different localities to correctly assess the influence of habitat attributes on lease rates.

In the context of hunting lease markets, demand and supply factors underlying hunting lease rates and the need to account for regional differences in habitat quality imply the following reduced form specification of the hedonic lease function:[1]

$$Y^i = f(S, LP, HQA), \tag{1}$$

where Y^i is lease rate per unit in locality i; S

[1] The hedonic pricing method (Rosen 1974) has been used by many in forestry (e.g., Le Goffe 2000; Munn and Rucker 1994) to analyze implicit prices for various composite commodities. Systematic variation in lease rates per acre can be used to impute implicit prices (or willingness to pay) for hunting site attributes. Underlying assumptions include the existence of an integrated hunting lease market in equilibrium, and hunting leases that have any number of levels of available characteristics from which hunters can choose.

refers to site characteristics; LP summarizes lease package attributes; and HQA is the habitat quality adjustment factor to account for omitted physiographic variables whose influences on habitat quality are not captured by the mix of forest types on a hunting site.

Decomposition Techniques

To decompose differences in local lease rates, a decomposition technique introduced independently by Blinder (1973) and Oaxaca (1973) and three of its variants formulated by Reimers (1983), Cotton (1988), and Neumark (1988) were employed. The technique was commonly used in labor market analyses of wage gaps between groups of economic agents (e.g., men and women, blacks and whites, union and nonunion members). In a forestry-related application, Munn and Rucker (1995) analyzed gaps in timber sale revenues between public and private sellers. This technique offered a way of partitioning the gap in performance outcomes between two groups into a part attributable to the amount of endowments, and a part attributable to valuation of the endowments.

Outlining essentials of the technique, let $i = E$ for east Mississippi, $i = W$ for west Mississippi, and the hunting lease rate (Y^i) in each region i be given by

$$Y^i = \mathbf{B}'\mathbf{X} + \varepsilon \quad E(\varepsilon) = 0 \quad i \in \{E, W\}, \qquad [2]$$

where $\mathbf{X}$ represents a vector of variables determining lease rate, and $\mathbf{B}$ a vector of associated parameters to be estimated. Assumptions underlying the technique included statistically significant differences between variable means, corresponding coefficients, and properly specified regression models. To test for statistically significant differences in variable means, a paired t-test was used. To test for differences in corresponding coefficients, the following regression equation was estimated:

$$Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k + \gamma_0 D_0 + \gamma_1 D_1 X_1 + \ldots + \gamma_k D_k X_k + \mu. \qquad [3]$$

Coefficients on dummy interactions were differences between coefficients of the two groups (west and east Mississippi), that is, $\gamma_j = (\beta_j^W - \beta_j^E), j = 0,1,2,3,\ldots,k$. The hypothesis that the coefficients were the same for the two groups was equivalent to the null hypothesis, $H_0: \gamma_0 = \gamma_1 = \ldots = \gamma_k = 0$. The alternative hypothesis (H_a) was that at least one of the coefficients on the dummy interactions was not equal to zero.

According to Oaxaca (1973), the raw differential in lease rates between the two regions can be represented by any of the following alternatives (O'Donnell et al. 2008, 149):

$$Y^W - Y^E = \Delta\mathbf{X}\beta^E + \Delta\beta\mathbf{X}^W, \qquad [4]$$

where $\Delta\mathbf{X} = \mathbf{X}^W - \mathbf{X}^E$ and $\Delta\beta = \beta^W - \beta^E$, or as

$$Y^W - Y^E = \Delta\mathbf{X}\beta^W + \Delta\beta\mathbf{X}^E. \qquad [5]$$

According to equation [4], differences in the X's were weighted by coefficients of east Mississippi, and differences in the coefficients were weighted by the X's of west Mississippi. In equation [5], differences in the X's were weighted by coefficients of west Mississippi and differences in the coefficients were weighted by the X's of east Mississippi. The left-hand side of either of these equations is the raw differential. The first part of either of these equations on the right-hand side measured differences due to endowments (i.e., explained variation), whereas the second part measured differences due to effects or valuation of endowments (i.e., unexplained variation).

A general formulation that accommodated the above variants as special cases was

$$Y^W - Y^E = \Delta\mathbf{X}[\mathbf{W}\beta^W + (\mathbf{I} - \mathbf{W})\beta^E] + \Delta\beta[\mathbf{X}^W(\mathbf{I} - \mathbf{W}) + \mathbf{X}^E\mathbf{W}], \qquad [6]$$

where $\mathbf{I}$ is the identity matrix and $\mathbf{W}$ is a matrix of weights. When $\mathbf{W} = 0$, equation [4] was implied, whereas $\mathbf{W} = \mathbf{I}$ yields equation [5]. The Reimers (1983) formulation followed when diag($\mathbf{W}$) = 0.5, whereas the Cotton (1988) formulation was obtained when diag(**W**) = *fw*, with *fw* denoting the proportion of observations belonging to one of the regions (e.g., west Mississippi). The Neumark formulation took a different route (O'Donnell et al. 2008, 151) by using coefficients (β^p) obtained from pooled data regression in the following equation:

$$Y^W - Y^E = \Delta \mathbf{X}\beta^p + [\mathbf{X}^W(\beta^W - \beta^p). + \mathbf{X}^p(\beta^p - \beta^E]. \qquad [7]$$

In general, different estimates of the explained and unexplained shares of the raw differential were obtained, depending on the choice of weights in the matrix **W**. To determine how sensitive the relative explained and unexplained shares were to the choice of weights, an empirical approach was taken by using Stata code written by Jann (2005) that incorporated all the above alternative formulations. The code also estimated standard errors corresponding to the explained and unexplained components of the raw differential via bootstrapping (Efron and Tibshirani 1993).

The choice of weights has been a contentious issue in decomposition analyses and has generated a vast body of literature. According to Reimers (1983, 571), the choice amounts to an assumption about what the reward function would be in the absence of endowments effects. Cotton (1988) argued that for weights to make sense, they needed to be based on underlying economic theory, in contrast to previous research, which treated the issue as an index number problem. Finding weights that were consistent with theory continued to be an issue. Cotton proposed that the relative proportions of the two groups in the sample best approximated theoretical requirements.

Data Sources and Description of Variables

Data for this research were compiled from various sources. Information on hunting lease rate per acre (the dependent variable for each locality), lease duration (in years), and lease size (in acres) were obtained from the 2005 hunting lease records of the Public Lands Division of the Mississippi Secretary of State's Office. The sixteenth section of every township, ±640 acres, was set aside to benefit public education in the Land Ordinance of 1785.[2] In Mississippi, the board of directors of each school district decides how these lands in its jurisdiction are managed. Revenue is generated through the sale of timber and from leasing various land rights for oil, gas, minerals, farming, and hunting. Hunting leases are allowed only on forested land, and leases are awarded to the highest bidder in a sealed bid auction. School districts advertise lease sales in local newspapers for two consecutive weeks prior to the lease auction. Hunting leases may include all or part of the forested portion of a section, and multiple leases on a particular section are common. In 2005, there were 876 hunting leases on sixteenth-section lands, which generated over $2.5 million in total revenue (Mississippi Secretary of State 2005).

Information on forest cover type was provided by the Mississippi Institute of Forest Inventory (MIFI) (Parker et al. 2005). For each sixteenth section, this consisted of number of acres in pines, hardwoods, mixed pine-hardwoods, water, recently regenerated sites, and open spaces. Acreages by cover type were converted to percentages of each section, and it was assumed that the cover type information for each section was representative of the habitat quality for each hunting lease on that section. Percentage hardwoods served as the base case (i.e., omitted category) for regression purposes.

Cover type information, however, cannot account for differences in overall habitat quality. Given that soil fertility data as it relates to habitat quality was unavailable, an alternate adjustment factor was needed.

[2] Fifteen counties in northern Mississippi do not have sixteenth-section lands. When Mississippi became a state in 1817, a large portion of northern Mississippi was still owned and inhabited by the Chickasaw Tribe and was not subject to the Land Ordinance of 1785. The U.S. government subsequently sold this land occupied by the Chickasaw and failed to set aside sixteenth-section lands.

In the context of hunting-related land uses, Strickland and Demarais (2000, 2008) analyzed characteristics bearing on habitat quality. They documented that, holding cover type constant, deer antler size was strongly correlated with soil fertility, which suggested antler measurements may provide a reasonable adjustment factor. Average Boone and Crocket scores for 3.5-year-old male white-tailed deer (*Odocoileus virginianus*) for each county were, thus, used as the habitat quality adjustment factor. Boone and Crocket scores are a measure of antler size. Data were obtained from Strickland and Demarais (2000), who estimated average countywide Boone and Crocket scores based on antler measurements collected by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) through the Deer Management Assistance Program (DMAP). DMAP monitors the deer population in Mississippi by taking biological samples from harvested game on wildlife management areas and from participating landowners and hunters.

Site accessibility was measured as the straight-line distance from each lease to the closest urban area (in miles) using ArcGIS. According to the 2000 U.S. Census (U.S. Department of Commerce 2002), five Mississippi cities in the study area were classified as urban areas (i.e., population $\geq$ 50,000): Biloxi, Pascagoula, Hattiesburg, Jackson, and Olive Branch (a Memphis suburb).

Previous research on nonindustrial private forestland hunting leases in Mississippi has suggested that distinct lease markets exist (Hussain et al. 2007; Munn et al. 2005). Mississippi was therefore divided into two markets based on underlying geographic regions (Pettry 1977). Counties lying primarily in the Mississippi Alluvial Valley (MAV) and the adjacent Upper and Lower Thick Loess regions were designated as west Mississippi. Counties primarily in the Upper and Lower Coastal Plain, Upper and Lower Thin Loess, Interior and Gulf Coast Flatwoods, and Black Prairie regions were designated as east Mississippi (Figure 1). A band of counties across the state's northern tier either did not have sixteenth-section lands set aside for education (e.g., northeast Mississippi) or had no hunting leases on the available sixteenth-section lands. In addition, four counties in southeast Mississippi had no hunting leases on their sixteenth-section lands. Although information on 876 hunting leases was available from the Public Lands Division of the Mississippi Secretary of State's Office, only 715 leases had complete data on variables of interest. Additional details about the variables described above are presented in Table 1.

III. EMPIRICAL RESULTS

Descriptive statistics of variables used in the analysis are presented in Table 2. Clearly lease revenue per acre and endowments as represented by the independent variables differed between regions. Mean values of the dependent variable (i.e., average lease rate per acre) for east (N = 497) and west Mississippi (N = 218) were, respectively, \$6.98 and \$12.74, which were statistically different from each other ($p < 0.0001$). Regional means for the independent variables were statistically different among the two Mississippi regions except for percentage share of mixed pine-hardwoods, regeneration, and open land. The null hypothesis of equal resource endowments across the two regions was, thus, rejected ($p < 0.05$), which was an important requirement of Blinder-Oaxaca decomposition. West Mississippi leases were endowed with larger proportions of bottomland hardwoods and water (e.g., streams, rivers, lakes), greater Boone and Crocket scores, and better site access. East Mississippi leases, in contrast, were larger (acres leased), longer (lease duration in years), and had larger proportions of pine land. The null hypothesis of coefficient homogeneity across the two regions was also rejected (p = 0.10). Consistent with equation [3], testing of this hypothesis involved running a regression of log lease revenue per acre on the independent variables including a constant, a regional dummy variable, and its interaction with the independent variables.

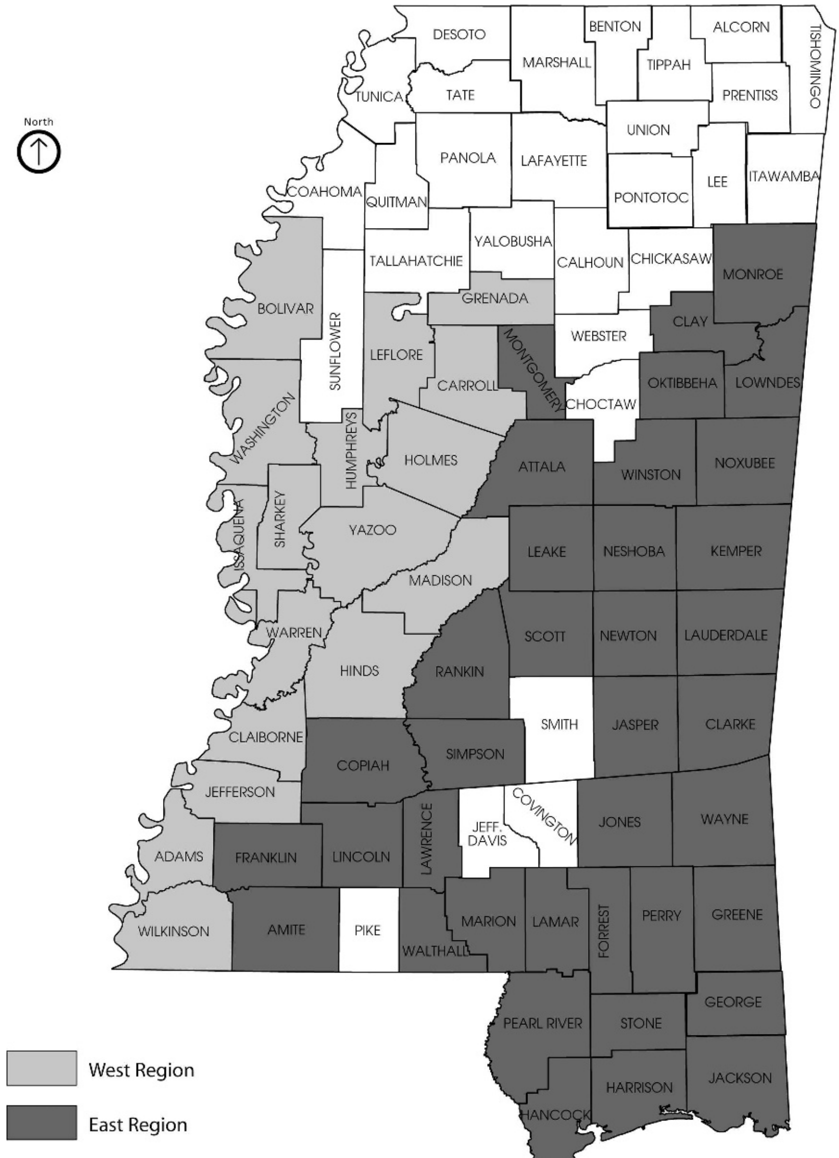

FIGURE 1
Regions Used in Blinder-Oaxaca Decomposition Analysis of Hunting Lease Rates on Sixteenth-Section Lands in Mississippi

Ordinary least-squares regression results of the hedonic lease functions are reported in Table 3. The highly significant *F*-statistics for both regional regressions suggested the importance of the independent variables included in the specified models. The adjusted *R*-squared statistics were low, but this could be a consequence of a number of issues: omitted variables due to lack of data, for example, the game species present (the presence or absence of waterfowl has a major impact on lease prices); measurement issues (e.g., forest cover data for each section were assumed to be representative

TABLE 1

DEFINITION AND DESCRIPTION OF VARIABLES USED IN THE ANALYSIS OF HUNTING LEASE RATES ON SIXTEENTH-SECTION LANDS IN MISSISSIPPI

Variable	Description	Hypothesized Sign
Dependent		
Log revenue per acre	Logarithm of lease revenue per acre per year	
Independent		
Lease characteristics		
Log lease size	Logarithm of acres leased	?
Lease duration	Lease duration specified in years	?
Site characteristics		
%Pine land	Percentage of section in pine timber	–
%Mix pine-hardwoods	Percentage of section in mixed pine-hardwood timber	+
%Water	Percentage of section covered by water (e.g., sloughs, streams)	?
%Regeneration	Percentage of section in recently regenerated timber	?
%Open land	Percentage of section in open space (e.g., recently harvested, clearings)	?
%Bottomland hardwoods	Percentage of section in bottomland hardwood timber	+
Habitat quality adjustor	Approximated by projected Boone and Crocket score	+
Site access	Distance (miles) of lease land to closest urban area[a]	+
Site access^2	Site access squared (Site access × Site access)	–

[a] Biloxi, Pascagoula, Hattiesburg, Jackson, and Olive Branch (a suburb of Memphis), Mississippi.

of the habitat quality for each hunting lease on that section); and the cross-sectional nature of the data. Percentage of pine land and the habitat quality adjustment were statistically significant in both regions. In addition, lease duration was significant in west Mississippi, whereas lease size and percentage regeneration were significant in east Mississippi. Last, lease duration was only marginally significant in east Mississippi.

Overall, two empirical patterns were suggested regardless of region. First, certain

TABLE 2

DESCRIPTIVE STATISTICS OF VARIABLES USED IN THE ANALYSIS OF HUNTING LEASE RATES ON SIXTEENTH-SECTION LANDS IN MISSISSIPPI

	Mississippi		West Mississippi		East Mississippi		Significance between Group Means
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Dependent							
Revenue per acre ($)	8.74	6.97	12.75	8.50	6.98	5.31	
Log revenue per acre	0.84	0.28	1.02	0.27	0.76	0.25	*
Independent							
Lease characteristics							
Log lease size	5.45	1.08	5.80	0.78	5.30	1.16	*
Lease duration	5.46	3.16	5.09	1.99	5.62	3.54	*
Site characteristics							
%Pine land	0.35	0.25	0.20	0.22	0.42	0.23	*
%Mix pine-hardwoods	0.11	0.08	0.09	0.08	0.11	0.07	
%Water	0.01	0.04	0.02	0.04	0.01	0.04	***
%Regeneration	0.09	0.10	0.08	0.07	0.09	0.11	
%Open land	0.15	0.16	0.16	0.19	0.15	0.15	
%Bottomland hardwoods	0.29	0.22	0.46	0.25	0.22	0.16	*
Habitat quality adjustor	113.77	11.62	123.14	8.06	109.66	10.50	*
Site access	54.45	29.82	61.77	29.18	51.25	29.56	*
Site access^2	3,853.11	4,710.60	4,662.97	5,139.69	3,497.88	4,468.85	*

* Significant at 0.01; *** significant at 0.10.

TABLE 3

Estimated Regression Coefficients and Mean Values of Model Variables Used in the Analysis of Hunting Lease Rates on Sixteenth-Section Lands in Mississippi

Variables	Coef.	Std. Err	t	$P>\|t\|$	Mean	Pred.
West Mississippi						
Lease characteristics						
Log lease size	−0.015	0.025	−0.600	0.552	5.799	−0.085
Lease duration	−0.030	0.008	−3.550	0.000	5.092	−0.153
Site characteristics						
%Pine land	−0.330	0.097	−3.400	0.001	0.198	−0.065
%Mix pine-hardwoods	0.371	0.270	1.380	0.170	0.088	0.033
%Water	0.244	0.461	0.530	0.597	0.017	0.004
%Regeneration	−0.332	0.245	−1.360	0.176	0.075	−0.025
%Open land	0.017	0.117	0.150	0.883	0.163	0.003
Habitat quality adjustor	0.006	0.002	2.590	0.010	123.144	0.784
Site access	0.002	0.001	1.270	0.205	61.769	0.116
Site access^2	0.000	0.000	−0.450	0.654	4,662.966	−0.017
Constant	0.430	0.329	1.310	0.193	1.000	0.430
Mean prediction						1.024
$F(10, 207)$	5.650					
Adjusted R^2	0.176					
Prob > F	0.000					
Observations	218					
Revenue per acre	12.745					
East Mississippi						
Lease characteristics						
Log lease size	−0.031	0.011	−2.930	0.004	5.295	−0.165
Lease duration	−0.005	0.003	−1.590	0.113	5.624	−0.028
Site characteristics						
%Pine land	−0.220	0.070	−3.150	0.002	0.422	−0.093
%Mix pine-hardwoods	−0.029	0.178	−0.160	0.871	0.113	−0.003
%Water	−0.179	0.299	−0.600	0.550	0.007	−0.001
%Regeneration	−0.408	0.125	−3.270	0.001	0.092	−0.037
%Open land	−0.108	0.101	−1.070	0.284	0.147	−0.016
Habitat quality adjustor	0.005	0.001	4.550	0.000	109.662	0.539
Site access	0.001	0.001	1.190	0.236	51.245	0.051
Site access^2	0.000	0.000	−0.610	0.540	3,497.882	−0.012
Constant	0.529	0.163	3.250	0.001	1.000	0.529
Mean prediction						0.763
Raw differential						0.260
$F(10, 486)$	8.140					
Adjusted R^2	0.126					
Prob > F	0.000					
Observations	497					
Revenue per acre	6.976					

explanatory variables (i.e., lease size, lease duration, percentage pine land, percentage recently regenerated forestland) were negatively associated with lease revenue per acre. The magnitude of impacts, however, differed between regions. For instance, the effect of percentage pine land was greater in west Mississippi than in the east; the reverse was true with regard to percentage regeneration land, as the effects were relatively harsher in the east compared to the west. Second, two explanatory variables (i.e., site access, habitat quality adjustment factor) were positively associated with lease revenue per acre. Relative impacts in this instance were of the same magnitude in both regions. Other empirical patterns, however, were region specific. Increases in the percentage of open land, percentage of mixed pine-hardwoods, and percentage of

TABLE 4
DECOMPOSITION OF REGIONAL LEASE RATES ACCORDING TO WEIGHTING SCHEMES USED IN THE ANALYSIS OF HUNTING LEASE RATES ON SIXTEENTH-SECTION LANDS IN MISSISSIPPI

	Coef.[a]	Std. Err.	z	$P > \|z\|$
Mean prediction: west Mississippi	1.024			
Mean prediction: east Mississippi	0.763			
Raw differential	0.260	0.022	11.690	0.000
Decomposition by weighting scheme				
*Oaxaca Decomposition [**W** = 0]*				
Differential: explained	0.113 (43.60)	0.022	5.060	0.000
Differential: unexplained	0.147 (56.40)	0.030	4.940	0.000
*Oaxaca Decomposition [**W** = **I**]*				
Differential: explained	0.183 (70.20)	0.037	4.910	0.000
Differential: unexplained	0.077 (29.80)	0.041	1.900	0.057
*Cotton Decomposition [diag(**W**) = 0.31]*				
Differential: explained	0.135 (51.70)	0.020	6.760	0.000
Differential: unexplained	0.125 (48.30)	0.027	4.590	0.000
*Reimers Decomposition [diag(**W**) = 0.50]*				
Differential: explained	0.148 (56.90)	0.022	6.610	0.000
Differential: unexplained	0.112 (43.10)	0.029	3.890	0.000
*Neumark Decomposition [**W** = pooled]*				
Differential: explained	0.185 (71.20)	0.016	11.550	0.000
Differential: unexplained	0.075 (28.80)	0.016	4.760	0.000

Note: Standard errors computed via bootstrapping. **W** is the assigned weight under each decomposition scheme.
[a] Corresponding percentages in parentheses.

water (e.g., lakes, streams, ponds) at the expense of bottomland hardwoods were associated with positive effects in west Mississippi; however, the reverse was true in east Mississippi, where the magnitudes of these effects were relatively larger. For instance, an increase in percentage of open land at the expense of bottomland hardwoods in west Mississippi resulted in higher lease rates; in east Mississippi this reduced lease rates and by a greater percentage. Likewise, while an increase in percentage of water in west Mississippi induced an increase in lease rates, the opposite impacts followed in east Mississippi.

Mean predicted revenue per acre (expressed in logarithmic form) for east Mississippi was 0.763, whereas for the west it was 1.024, indicating a 26% raw differential in revenue per acre between the two regions (Table 3). Two sets of factors underlie this gap: differences in endowments and effects of endowments, each appropriately weighted. Differences in lease endowments across regions arise when regions have different amounts of factor inputs, given some choice of weights, whereas differences in effects of endowments arise when a region has greater coefficients, given these endowments.

Estimated decomposition results by weighting scheme are presented in Table 4. Regardless of weighting scheme, all estimates of explained and unexplained components are statistically significant at the 95% level or more. A look at the estimated explained and unexplained components also shows that as weight increases from **W** = 0 to **W** = **I**, the share of unexplained component in the raw differential decreases from 57% to 30%. Estimates of explained versus unexplained differences based on pooled weights (i.e., Neumark formulation) are remarkably similar to estimates based on Oaxaca decomposition with **W** = **I**, whereas estimates based on diag(**W**) = 0.31 and diag(**W**) = 0.50 are closely similar to Oaxaca decomposition with **W** = 0. This suggests how sensitive the relative share of

TABLE 5

DECOMPOSITION OF LOCAL LEASE RATE DIFFERENCES ACCORDING TO PREDICTOR VARIABLES USED IN THE ANALYSIS OF HUNTING LEASE RATES ON SIXTEENTH-SECTION LANDS IN MISSISSIPPI

	Explained Differential by Independent Variable				
Variable	**W** = 0	**W** = **I**	**W** = 0.31	**W** = 0.50	**W** = p[a]
Lease characteristics					
Log lease size	−0.016	−0.007	−0.013	−0.012	−0.008
Lease duration	0.003	0.016	0.007	0.009	0.004
Site characteristics					
%Pine land	0.049	0.074	0.057	0.062	0.074
%Mix pine-hardwoods	0.001	−0.009	−0.002	−0.004	0.000
%Water	−0.002	0.002	0.000	0.000	−0.001
%Regeneration	0.007	0.006	0.006	0.006	0.009
%Open land	−0.002	0.000	−0.001	−0.001	−0.002
Habitat quality adjustor	0.066	0.086	0.072	0.076	0.098
Site access	0.010	0.020	0.013	0.015	0.015
Site access^2	−0.004	−0.004	−0.004	−0.004	−0.004
Constant	0.000	0.000	0.000	0.000	0.000
Total explained differential	0.113	0.183	0.135	0.148	0.185

Note: **W** is the assigned weight under each decomposition scheme.
[a] Pooled weights due to Neumark (1988).

explained versus unexplained can be depending on the type of decomposition employed.

Estimated decomposition results by individual predictor are reported in Table 5. Three points are noticeable. First, regardless of weighting scheme, percentage pine land and the habitat quality adjustment factor accounted for the bulk of the explained variation. Of the two, the habitat quality adjustment factor plays the larger role in inducing regional differences in lease rates. Second, regardless of weighting scheme, lease size and site access squared negatively influenced explained variation, whereas lease duration, percentage pine land, percentage regeneration, habitat quality, and site access positively influenced explained variation. This suggests that log lease size and site access squared are favorable in east Mississippi, whereas west Mississippi has advantages that are due to a favorable role played by the latter set of variables. Finally, depending on the weighting scheme employed, the influence of percentage mixed pine-hardwoods, percentage water, and percentage open land varies. These variables may positively or negatively influence the explained variation.

IV. DISCUSSION AND CONCLUSIONS

Estimated coefficients, their predicted contribution to lease rates, and the decomposition of lease rates by variables indicated that habit quality drives lease rates. Only habitat quality–related variables (i.e., percentage pine land, habitat quality adjustment factor) are significant in both regions. Specifically, as the percentage share of pine land relative to bottomland hardwoods increases, lease revenue decreases. This is consistent with work by Harris, Sullivan, and Badger (1984), who argued that bottomland hardwoods provide better habitat and thus better game quality and diversity. Likewise, as the habitat quality adjustment factor increases, lease rates increase. Furthermore, based on predicted values, the habitat quality adjustment factor is the largest contributor to lease rates in both regions. In addition to overall lease rates, the mix of forest cover types and the habitat quality adjustment factor account for over 87% of the explained differential in lease rates, regardless of weighting scheme.

Estimated results in this research imply certain insights regarding the workings of hunting lease markets at a local level. First, the relative mix of a hunting lease's attributes matter. For stakeholders to maximize hunting lease revenue, it is important to strike a balance between attributes under their control, such as land allocation across alternative uses, lease duration, and lease size. The notion that hunting is necessarily compatible with forestry regardless was not tenable. Indeed, trade-offs are involved, and it may be necessary for managers to make conscious resource management decisions with regard to the appropriate allocation of forestland to a particular use. Extension officials aiming to help landowners maximize returns from their lands need to design educational and outreach packages that recognize local natural resource conditions and hunter preferences for specific sites so that landowners make the appropriate decisions.

Second, hunting lease operations could complement other economic activities, but their ability to do so varies with location due to differences in lease endowments and differences in effects of those endowments. Broad state-level information on hunting lease markets and how hunting lease incomes capitalize into land values may not be fully informative. Financial institutions dealing in land transactions need to delineate structurally homogeneous hunting lease regions when managing financial portfolios.

Third, given wide expected ranges in which relative shares of explained and unexplained estimates can lie as weights were varied, it is important to simulate impacts of alternative weights when decomposing raw differentials, and to choose the alternative that makes sense in the context of the issue at hand. In regard to Mississippi hunting lease markets, weights consistent with Neumark's (1988) work are appealing. Weighting scheme $\mathbf{W} = \mathbf{I}$ implied valuations of endowments according to west Mississippi coefficients, and $\mathbf{W} = 0$ implied valuations according to east Mississippi coefficients. But results suggested by both weights are difficult to reconcile with reality because the probability that endowments in east Mississippi would realize west Mississippi lease rates, or returns in west Mississippi could fall to the level of east Mississippi is unlikely. While Cotton's (1988) formulation is theoretically sound, in practice it involves the use of relative proportions of the two regions in the sample. But the proportion of sixteenth-section leases in the east versus the west does not necessarily reflect the hunting lease supply in the broader hunting lease market, and relying on these weights could potentially bias any insights if extrapolated to the broader market.

With regard to the accuracy of the research results reported, it must be pointed out that access to the sixteenth-section hunting lease data was valuable in many ways. First and foremost, data were generated through competitive bidding for hunting sites. Thus, they do not have the same margin of error typically associated with contingent valuation survey data on hunting leases. Second, it was not necessary to make a distinction between gross and net lease rates per unit because school boards that manage sixteenth-section lands do not incur any costs other than opportunity costs associated with granting hunting access. This was an important advantage because cost accounting (to recoup payments due to provision of services and amenities by landowners) could pose many problems when differentiating between gross and net lease rates (Hussain et al. 2007). Third, including essentially all leases in the sample by design eliminated sample selection bias, and bias in estimated coefficients was not a concern. Finally, annual and multiple-year leases on sixteenth-section lands differed from each other only in terms of duration and nothing else. In contrast, annual and multiyear leases on nonindustrial private forestlands not only differ in duration but in other important dimensions, (e.g., many long-term leases allow for installation of semipermanent facilities).

It is, however, important to point out a couple of issues that could potentially compromise the strengths of findings. Note that the validity of estimates based on

Blinder-Oaxaca decomposition is conditional on the assumption that the underlying regression models were properly specified, and all relevant variables were accounted for and properly measured. The use of projected Boone and Crocket scores to adjust habitat quality and approximate equivalent acres may not have fully captured the complexity of site physiographic characteristics. Likewise, the assumption that the section-level cover type distribution accurately reflected habitat available for game on particular leases may not be fully defensible. It seemed a reasonable assumption, however, given that the home range of white-tailed deer, the primary game species in Mississippi, can easily exceed a section. The results of this research are short of being robust, to the extent the projected Boone and Crocket scores failed to capture essential physiographic site attributes, and the observed distribution of forest cover on sixteenth-section lands deviated from the distribution available to game in leases on those sections.

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