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Marginal Effects of Land Characteristics and Purchase Factors on Rural Land Values

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ABSTRACT

Hedonic models estimate the marginal effect of land characteristics and factors that contribute to a purchase decision on rural land values in submarkets of north Louisiana. While size of tract and mix of land use have expected impacts on rural land values, forces that motivate the buyer also affect price.

KEYWORDS

Agricultural Finance, Land Value, Land Ownership

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ABSTRACT

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INTRODUCTION

Previous research has found that nine distinct rural land submarkets exist in Louisiana. These submarkets are somewhat geographically homogeneous and have similar soil, topography, and socioeconomic characteristics. The northern portion of the state is divided into three submarket areas: Red River, North Central, and North Delta and includes 23 of the 64 parishes in the state. The population of the three submarkets is approximately 1,000,000 as of 2000, according to the U.S. Census information. This comprises about 22 percent of the state population. Average per capita income for the three submarkets is $14,000 with the highest per capita income in the Red River submarket ($15,386) and the lowest in the North Delta submarket ($12,665). The highest percentage of persons below the poverty level exists in the North Delta submarket at 29 percent, whereas both the Red River and the North Central submarkets have levels at 22 percent.

The North Delta submarket is predominantly row crop agriculture, featuring cotton, rice, wheat, soybeans and corn production. According to the LSU AgCenter's *2002 Louisiana Summary*, the total valuation of these crops in the North Delta submarket is $288,718,806, followed by timber valued at about $62,220,408 and total cattle value of $24,407,474. The Red

River submarket is comprised of both row crop production and timber production. The valuation of timber is greater at a value of $134,730,744, followed by total cattle value of $43,838,963 and row crop valuation of $36,223,457. Geographically, the North Central submarket separates the other two submarkets and has a much higher proportion of timber production. The total timber valuation is estimated to be about $330,035,872 followed by total cattle value of $18,207,041 and row crop production valued at $521,794. These submarkets consist primarily of rural agricultural land. Major Metropolitan Statistical Areas (MSAs) are located on the fringe of these submarkets and have potential for influencing the land market as they encroach on the rural areas.

Fluctuations in the value of rural real estate have a substantial impact on capital structure and income in Louisiana's agricultural production sector. Factors affecting these values can be identified and estimated, quantifying the contribution of the individual characteristics of property and providing better information on the value of land capital assets. Better market information on the characteristics that affect rural land value will benefit both buyers and sellers in that market.

HEDONIC PRICING MODEL

Hedonic regression provides a means of estimating the effects of the various characteristics of rural land in determining land value. The hedonic approach allows the estimation of individual parcel attributes or characteristics. Historically, rural land market studies have reported that the relationships between rural land prices and various land attributes are nonlinear (Kennedy 1995).

Two equations are estimated. In the first stage, the hedonic model is estimated and the implicit prices of the characteristics are calculated using the partial derivative of the hedonic

equation with respect to each characteristic ($\partial P_t / \partial z_i$). In the second stage, the inverse demand for selected characteristics, income, and other socioeconomic variables hypothesized to explain the demand for the characteristic is estimated. It is assumed that the market-clearing price, P(z), will be determined by the simultaneous interaction of the bid and offer functions, but, since the supply of land is inelastic, bid functions are sufficient to derive equilibrium prices (Freeman 1979).

First Stage Hedonic Model

Rosen's (1974)] two-stage hedonic pricing model was used by Kennedy (1995) to derive coefficients for the characteristics of rural land. The following hedonic model was specified for the Louisiana rural land market by Kennedy:

$$P = \beta_0 Z_1^{\beta_1} \exp\left[\sum_{i=1}^{m} \alpha_i X_i + \sum_{j=1}^{n} \delta_j D_j + \varepsilon\right], \qquad (1)$$

where P is price per acre of land, Z is the size of the tract of land in acres, m is the number of additional continuous variables, X, n is the number of discrete variables, D, and ε is the error term.

Since the price of land is hypothesized to decrease at a decreasing rate as tract size increases (suggesting a nonlinear relationship), we take the natural log of both price and parcel size in the equation, yielding the following:

$$\ln P = \ln \beta_0 + \beta_1 \ln Z_1 + \sum_{i=1}^{m} \alpha_i X_i + \sum_{j=1}^{n} \delta_j D_j + 0. \qquad (2)$$

Marginal Implicit Prices of Characteristics

The implicit marginal price of each characteristic is an estimate of change in per acre land price brought about by a one-unit change in that characteristic. For continuous variables, the partial derivatives, which are the marginal prices, are as follows:

$$MP_t / MZ_{1,t} = IZ_{1,t} = [\ \$_1 / Z_{1,t}\ ] * P_t$$

$$MP_t / MX_i = IX_{I,t} = \ "_i * P_t \qquad (3)$$

where IZ is the implicit price per acre of land and IX is the marginal change in the continuous variable. The t subscript indicates that there are implicit prices associated with each transaction. To estimate the implicit marginal price at the mean price and mean level of the characteristic over all observations, the mean value of each variable must be substituted into the equation (Kennedy 1995).

The derivative for discrete variables is given in semilogarithmic equations using the variance of the discrete variable (Kennedy 1981):

$$ID_j = (\exp [\ c_j - ½\ V(c_j)\ ] - 1\ ) * \text{mean price}, \qquad (4)$$

where ID_j is the implicit price of the discrete variable, c_j is its estimated coefficient, $V(c_j)$ is the variance of the c_j, and mean price is the mean price per acre over all of the observations used in the model. Using the variance of the estimated coefficient can lead to less bias in the estimate when $V(c_j)$ is substantial.

THE DATA

Data for this study were reported using mail survey techniques. The Louisiana Rural Land Market Survey is sent to a statewide listing of knowledgeable individuals of rural land markets. The survey has been conducted annually since 1994. The 2002 survey, for example, included over 1,000 individuals who were state certified appraisers, officers in commercial

banks, personnel of the Farm Service Agency, Federal Land Bank and Production Credit Association, and members of the Louisiana Chapter of the American Society of Farm Managers and Rural Appraisers, and the Louisiana Realtors Land Institute.

The survey was constructed to facilitate the reporting of detailed information on actual sales of rural real estate in Louisiana and to record subjective information based on the respondent's knowledge of the local land market. For the purposes of the survey, rural real estate was defined as all land outside the city limits of the major metropolitan areas in Louisiana, 10 acres or more in size, and included attachments to the surface, such as buildings and other improvements.

Statewide, 3,806 sales have been reported during the January 1, 1993 to June 30, 2002 period. The data were spatially plotted based on the legal description of each tract using the GIS software package ARC/View.

The data for this study, a subset of the statewide data set, has 1090 observations that were reported from actual sales transactions that occurred from January 1, 1993 through June 30, 2002 in the three selected submarkets being studied. The data are both cross-sectional and time series data.

THE VARIABLES

Sale price per acre is the dependent variable in this study. Table 1 lists the variables considered in stage one of the hedonic model analysis. The table includes both continuous and discrete variables. Continuous variables are quantitative in nature while discrete variables are qualitative, representing the presence or absence of a condition or characteristic. Each variable is discussed below.

Continuous Variables

Survey Data Variables

Tract size (LNACRES) is expected to have the largest significant effect in the models. Because the larger tracts have a higher overall value and a smaller number of potential buyers, the effect of tract size is expected to be negative, reflecting an inverse relationship. Previous research suggests that this effect is nonlinear. The percentage of land in a tract devoted to row crops (PERCROP) is expected to have a positive influence on the dependent variable. Cultivated land may be priced at a premium because it represents intensive use that is expected to generate an income stream in the future. Because pastureland also represents an intensive use of land, percent of pastureland (PERPAST) in the tract may also add to the value of rural land, depending on the extent of the improvements.

The presence of timberland in this model is also expected to have a positive influence on per acre price similar to that of row crops. One would expect that the presence of a stand of trees available for harvest increases the value of the land by the worth of the trees.

Percentage of cropland devoted to the primary crop (PRIACRES) is also expected to have a positive relationship to price per acre. Logically, farmers will plant the most profitable crop on the best suited soils. The more land devoted to a primary crop, the higher the expected future income stream.

The sum of the value of the existing house, any barn on the land, and improvements (VAL) made to or on the land (such as growing crops) is expected to have a direct relationship to the price per acre of land. Planted cropland is expected to have a positive relationship because of the income it is expected to produce; the house and other buildings and improvements because of the capital investment they add to the land.

Table 1. Hedonic Pricing Model and Bid Function Variables, North Central, North Delta, and Red River Submarkets, Louisiana.

Symbol	Variable	Expected Sign
Continuous Variables		
LNPRICE	Natural log of per acre sale price of land	
LNACRES	Natural log of size of tract in acres	(-)
PERCROP	Percentage of cropland in tract	(+)
PERPAST	Percentage of pastureland in tract	(+)
PERTIMB	Percentage of timberland in tract	(+)
PRIACRES	Number of acres use in production of primary crop	(+)
VAL	Value of house, barn and improvements ($)	(+)
ROADFEET	Road frontage in feet	(+)
TIME	Measured by month, beginning with January 1993	(+)
Discrete Variables		
ROADTYPE	Paved Access Road	(+)
RPEXPN	Reason for Purchase: Expansion	(+)
RPRESI	Reason for Purchase: Residence	(+)
RPRECR	Reason for Purchase: Recreation	(+)
RPINVEST	Reason for Purchase: Investment	(+)
RPCOMM	Reason for Purchase: Commercial development	(+)
RPFARM	Reason for Purchase: Establish farm	(+)
INFLCOMM	Significant influence on land value: Commercial	(+)
INFLRESI	Significant influence on land value: Residential	(+)
INFLPOND	Significant influence on land value: Pond	(+)
INFLFLOOD	Significant influence on land value: Flooding	(-)
INFLRECR	Significant influence on land value: Recreational	(+)
INFLURBAN	Significant influence on land value: Urban fringe	(+)
INFLHWY	Significant influence on land value: Highway	(+)
SHRBOSMSA	Sale located within Shreveport-Bossier MSA	(+)
MONROEMSA	Sale located within Monroe MSA	(+)
ALEXMSA	Sale located within Alexandria MSA	(+)
CORNBASE	Sale includes corn base acreage	(+)
COTTONBASE	Sale includes cotton base acreage	(+)
MILOBASE	Sale includes milo base acreage	(+)
OATBASE	Sale includes oat base acreage	(+)
RICEBASE	Sale includes rice base acreage	(+)
WHEATBASE	Sale includes wheat base acreage	(+)

Road frontage (ROADFEET) is also expected to have a direct relationship to the price per acre of land. Road frontage is measured in number of feet that border a road, and represents ease of access and enhances development potential for the future. Time (TIME) as measured by month, beginning with January 1993 is expected to have a positive impact on land price during the study period, due to the impact of appreciation of land value over time.

Discrete Variables

Survey Data Variables

The discrete survey data variables are all expected to have a positive effect on the value of rural land with the exception of influence of flooding. Paved access (RT) represents ease of access and enhances development potential for the future similar to that of road frontage.

Reason for purchase variables include: Expansion, Residence, Recreation, Investment, Commercial Development, Establish Farm. Expansion (RPEXPN), recreation (RPRECR), establish farm (RPFARM), and investment (RPINVEST) as the primary reasons for purchase are expected to have income generating benefits and/or increase the demand for land. Residence (RPRESI) and commercial development (RPCOMM) as the primary reasons for purchase are also expected to have a positive effect, because the purchase of a residence or business is both a consumptive and investment action.

Variables identified as having a significant influence on land value include: commercial, residential, pond, flooding, recreational, urban fringe, and highway. Commercial (INFLCOMM), residential (INFLRESI), and recreational (INFLRECR) are expected to have a positive impact on land values similar to that of the reason for purchase variables. Influence of highway (INFLHWY) is expected to be positive because of ease of access for means of transportation. Influence of urban fringe is expected to have a positive affect as land

encroaching on major cities tends to have a greater value. Influence of flooding, however, is expected to have a negative impact on land value as logically, land that is prone to flooding prohibits many other influences from having a positive effect.

Within the three submarkets being evaluated there exist three metropolitan areas. These are Monroe (MONROEMSA), Shreveport (SHRBOSMSA), and Alexandria (ALEXMSA). There is an expected positive impact on land values for sales located within the metropolitan statistical area of these cities.

Accordingly, a positive impact on land values should also be associated with acreage that is included in a government base program. For this study, base programs considered included those for corn (CORNBASE), cotton (COTTONBASE), milo (MILOBASE), oats (OATBASE), rice (RICEBASE), and wheat (WHEATBASE).

RESULTS

In order to interpret the hedonic pricing model used in this research, implicit prices were estimated for rural real estate as a function of its characteristics. Implicit prices of each of the characteristics were determined by calculating the partial derivatives of the equation with respect to each characteristic and evaluating the regression equation for each reported observation.

Hedonic Pricing Model Results

The surveys reported 229 sales in the North Central submarket January 1, 1993 through June 30, 2002. Per acre values of these sales ranged from $50 to $15,000 per acre, with a mean price of $933.67 per acre. Tract size varied from ten acres to 842 acres, with a mean of 93 acres. In the North Delta submarket, 519 sales were reported for the same time frame. Per acre values of these sales ranged from $186 to $5,000 per acre, with a mean price of $781.25 per acre. Tract size varied from ten to 4,758 acres, with a mean of 276 acres. There were 342 sales reported for

the Red River submarket during this time. Per acre values of these sales ranged from $87 to $9,351 per acre, with a mean price of $1,025 per acre. Tract size varied from ten to 5,400 acres, with a mean of 196 acres. The estimated coefficients for the model are given in Table 2. All variables in the models are statistically significant at the .15 level or higher.

For the North Central submarket, size of tract (LNACRES), percentage of land in crops (PERCROP), pasture (PERPAST) and timber (PERTIMB), value of the house, barn and improvements (VAL), time (TIME), road type (RT), and commercial influence on land value (INFLCOMM) were significant at the 0.01 level. Recreation as the primary reason for purchase (RPRECR) and residence as the primary reason for purchase (RPRESI) were significant at the .05 and .15 levels respectively.

For the North Delta submarket, size of tract (LNACRES), percentage of land in crops (PERCROP), time (TIME), commercial influence on land value (INFLCOMM), sales located within the Monroe Metropolitan Statistical area (MONROEMSA), and cotton base acreage (COTTONBASE) were significant at the 0.01 level. Value of the house, barn and improvements (VAL) and residence as the primary reason for purchase (RPRESI) were significant at the .05 level. Road frontage in feet (ROADFEET) and rice base acreage (RICEBASE) were significant at the .10 and .15 levels respectively.

For the North Delta submarket, size of tract (LNACRES), percentage of land in crops (PERCROP), value of the house, barn and improvements (VAL), time (TIME), road type (RT), residence as the primary reason for purchase (RPRESI), recreation as the primary reason for purchase (RPRECR), flooding influence on land value (INFLFLOOD), and urban influence on land value (INFLURBAN) were significant at the 0.01 level. Commercial influence on land

Table 2. Model Coefficients, by Submarket.			
Variables	**North Central**	**North Delta**	**Red River**
Intercept	6.8122* (0.1657)	6.1487* (0.0373)	7.0683* (0.1224)
LNACRES	-0.2632* (0.0367)		-0.2314* (0.0275)
PERCROP		0.001734* (0.000446)	0.002072* (0.000823)
PERPAST	0.006336* (0.001048)		
PERTIMB	0.002608* (0.000850)		
VAL	0.0000062653* (0.00000078208)	0.0000012955** (0.00000062092)	0.0000081733* (0.00000088126)
ROADFEET		0.0000207*** (0.0000111)	
TIME	0.008548* (0.001106)	0.004668* (0.000507)	0.007357* (0.000752)
RT	0.2520* (0.0682)		0.2769* (0.0594)
RPRESI	0.1809**** (0.1184)	0.2885** (0.1200)	0.2909* (0.0903)
RPRECR	-.2563** (0.1244)		-.3967* (0.1202)
RPFARM			-0.2330*** (0.1256)
INFLFLOOD			-0.3351* (0.0849)
INFLCOMM	0.7649* (0.1747)	1.0388* (.2111)	0.7097** (0.2881)
INFLHWY			0.2374**** (0.1491)
INFLURBAN			0.5063* (0.1213)
MONROEMSA		0.7759* (0.1075)	
COTTONBASE		0.1221* (0.0379)	
RICEBASE		0.0943**** (0.0589)	0..6090** (0.2950)
R-Square	0.5593	0.3105	0.5699

Note: Standard errors reported in parentheses.
*denotes significance at the 0.01 level, **denotes significance at the 0.05 level, ***denotes significance at the 0.10 level, **** denotes significance at the 0.15 level.

value (INFLCOMM) and rice base acreage (RICEBASE) were significant at the .05 level. Farming as the primary reason for purchase (RPFARM) and highway influence on land value (INFLHWY) are significant at the .10 and .15 levels respectively.

Marginal Implicit Prices of Characteristics

The first-stage of the hedonic model yields only point estimates of the marginal prices based on the quantity of the characteristic and the price per acre paid in the reported transaction. These values are relevant only for these transactions and therefore no direct implications can be drawn from them (Kennedy 1995). The direction and magnitude of influence of the characteristics is observable by examination of the implicit prices at the mean values of the rural land price and characteristic quantity. A positive coefficient and implicit price indicate that an increase in the characteristic results in an increase in the price of rural land, and a negative coefficient and implicit price indicate a decrease in the characteristic results in a decrease in the price of rural land. Using the estimated coefficients from the first stage of the hedonic model and mean levels of the prices and characteristics, the mean marginal implicit prices for rural land characteristics are estimated. These marginal implicit prices for characteristics at the mean price and characteristic level are presented in Table 3.

Size of tract (LNACRES) is negative, and its implicit marginal price for the North Central submarket is $-2.64 and $-1.21 for the Red River submarket. This implies that per acre land prices decline by $2.64 and $1.21 per acre, respectively, with every one acre increase in size of tract and holding all other variables constant. The implicit marginal price varies proportionately with per acre price. If a tract sells for a price higher than the mean price per acre, the implicit marginal price suggests that per acre land price declines more than $2.64 or $1.21 per acre with a one acre increase in size of tract. The reverse is also true.

Table 3. Marginal Implicit Prices ($) at Mean Price, by Submarket.			
Variables	**North Central**	**North Delta**	**Red River**
LNACRES	$-2.64*		$-1.21*
PERCROP		$1.35*	2.12*
PERPAST	5.92*		
PERTIMB	2.44*		
VAL	.005849*	.001012**	.008378*
ROADFEET		781.27***	
TIME	7.98*	3.65*	7.54*
RT	1,198.47*		1,349.63*
RPRESI	1,111.00****	1,035.04**	1,365.49*
RPRECR	-1,197.13**		-1,513.11*
RPFARM			-1,283.77***
INFLFLOOD			-1,427.87*
INFLCOMM	1,975.87*	2,159.03*	1,999.49**
INFLHWY			1,285.28****
INFLURBAN			1,688.15*
MONROEMSA		1,687.52*	
COTTONBASE		882.07*	
RICEBASE		857.02****	1,804.31**

*denotes significance at the 0.01 level, **denotes significance at the 0.05 level, ***denotes significance at the 0.10 level, **** denotes significance at the 0.15 level.

If a tract of land sells for a lower price than the mean, the implicit marginal price suggests that per acre land price will decline less than $2.64 or $1.21 per acre.

The marginal implicit price for percentage of cropland in the tract (PERCROP) was calculated at $1.35 for the North Delta submarket and $2.12 for the Red River submarket. An interpretation of this variable is that land in crops has a positive economic impact per acre on land values in these submarkets. However, percentage of pasture (PERPAST) and percentage of timber (PERTIMB) impacted land values significantly in the North Central submarket with marginal implicit prices of $5.92 and $2.44 respectively.

The value of a house, barn and improvements (VAL) has a marginal implicit price of less than $0.009 per acre in any of the three submarkets. This contribution to the overall value of a tract of land is relatively low and can be interpreted based on a $1,000 of improvements as a price increase of $9.00 per acre.

The implicit marginal price of residence as the primary reason for purchase (RPRESI) was calculated at $1,111.00 in the North Central submarket, $1,035.04 in the North Delta submarket, and $1,365.49 in the Red River submarket, meaning that a tract purchased for residence would be valued at over $1,000 dollars more per acre depending on the submarket than tracts purchased for other reasons. Recreation as the primary reason for purchase (RPRECR) had a calculated implicit price of $-1,197.13 per acre in the North Central submarket and $-1,513.11 per acre in the Red River submarket. Interpretation of this implicit price suggests that tracts bought for recreational reasons only are typically valued for less than if the tracts had some higher or better use, such as for residence or commercial development.

The marginal implicit prices of commercial influence on land values for the three submarkets were $1,975.87 for the North Central submarket, $2,159.03 for the North Delta submarket, and $1,999.49 for the Red River submarket. These numbers indicate that land values increase around $2,000 per acre when commercial influences exist. The marginal implicit prices of flooding influence on land price for the Red River submarket was calculated to be $-1,427.87, indicating land values decline by this amount per acre for this submarket when flooding influences the tract of land for sale.

CONCLUSIONS AND IMPLICATIONS

The impacts of purchase and influence variables were shown to be significant in each of the three submarkets. Of particular interest is the impact the reason for purchase variables including residential, recreational, and farm as well as the influence variables including flooding, commercial, highway, and urban had on land value in each of the submarkets. Clearly there are other impacts that affect land value, but these variables are shown to be important in determining land sale prices.

Also of interest is that even in a relatively small area, such diversity can exist in how land is utilized and what affect its use has on the value of land. Generally, it appears that most of the parishes depend largely on agriculture, with little impact of urban influences shown as being significant. Particularly, topography plays a distinguishing role by dividing the submarkets, leaving the North Central submarket especially dependent on forestry and the North Delta submarket dependent on row crop production.

Further study of the submarket characteristics would provide more information regarding what makes each submarket unique, given its attributes, and could further explain why land values vary across Northern Louisiana. Future work could include more analysis of the effects

of socio-economic variables (population, income) on land values. Additional analysis utilizing GIS software may also be useful.

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