Property Tax Policy and Land-Use Change

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ABSTRACT. *In this study, we analyze the effect of property taxes on changes between agricultural, forestry, Conservation Reserve Program, and developed land uses in Louisiana. We estimate a random parameters logit model of land-use conversion from the National Resources Inventory plot data. Our results indicate that land-use changes are inelastic with respect to property taxes. Simulation shows that current use valuation policy, while slowing down development of rural lands, also affects changes between rural land uses.* (JEL Q15, H23)

I. INTRODUCTION

Land-use changes, while driven by maximization of economic benefits to landowners, sometimes produce negative externalities such as air and water pollution, loss of biodiversity, wildlife habitat fragmentation, and increased flooding. There are a number of public policies that seek to mitigate these negative externalities by slowing conversion of rural lands to more intensive uses, or encouraging reforestation and sustainable forest management. Examples of such policies are tax incentives, cost sharing, easements, and certification programs (York, Janssen, and Ostrom 2005). When the majority of land base is privately owned, like in the U.S. South, it is important to understand how these public policies influence private landowners' decisions concerning land-use change.

A number of studies have examined the effects and effectiveness of government programs such as Conservation Reserve Program (Schatzki 2003), flood control projects (Stavins and Jaffe 1990), programs for wetlands conservation (Parks and Kramer 1995), zoning and urban control policies (Carrion-Flores and Irwin 2004). However, there has been very little research to quantify the effect of taxation policies, in particular, preferential valuation, on the land-use changes, and especially with the focus on forest lands.

Property taxes have an important influence on the management of private forest and farm lands (Hibbard, Kilgore, and Ellefson 2003). Traditionally, the value of real property for the tax purposes is being assessed based on its fair market value. Because of economic pressures created by development, market value of rural lands often exceeds capitalized income-producing capability of rural land uses (Hickman 1982). While such appreciation benefits landowners, it does not improve their ability to pay taxes and often forces land development. In order to restore balance between taxable value of rural properties and their income-producing potential, every state has developed programs that allow or require preferential property tax treatment of farmland and sometimes other rural lands (Morris 1998). The most common policy is assessment of rural land according to its current use. Use-value laws are seen as providing tax relief to rural landowners and allowing them to retain land in traditional uses, which are considered socially desirable (Hickman 1982).

During the second half of the twentieth century, land-use dynamics in the U.S. South have been shaped by several main trends: conversion of forestry and agricultural lands to developed use due to population growth and urban sprawl, conversion of marginal agricultural lands to forestry

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use, and expansion of intensive agriculture on best quality lands in the Mississippi Delta (Wear 2002; Rudel 2001). All of these trends have a significant contribution to the land-use dynamics in Louisiana.

In this article, we use panel data of USDA Natural Resource Inventory (NRI) sample plots to evaluate effectiveness of the use-value program in Louisiana by estimating effects of property taxes on the Markov transition probabilities between four major use categories of private lands (agricultural, forestry, developed, and Conservation Reserve Program) using a random parameters logit (RPL) model. The estimated model is used in simulation to quantify the effect of current use valuation program on land-use change.

In the following section we introduce the use-value programs and review the literature on their effectiveness. Then we lay out a discrete choice model of land-use change followed by description of data. The later section provides results of RPL estimation of land-use change in Louisiana and a simulation assuming no preferential assessment. The concluding section focuses on the policy implications of our empirical findings.

II. USE-VALUE PROGRAMS

The basic types of use-value programs are pure preferential assessment, preferential assessment with deferred taxation, and restrictive agreements (Hickman 1982). Under pure preferential assessment, eligible lands are taxed on the base of current use value. If land is converted to a use ineligible for preferential taxation, it is reassessed on the base of a market value. Under deferred taxation, when converted to ineligible use, the land is not only reassessed, but a penalty is imposed, which is based on tax savings during the period property was assessed according to current use. Under restrictive agreements, the owner of eligible property signs with the government a contract, which restricts the use of property for certain time period. According to Morris (1998), pure preferential assessment programs is used by 19 states, preferential assessment with deferred taxation is used by 26 states, and five states practice preferential assessment with restrictive agreements and deferred tax.

Use-value programs could be mandatory or optional in scope. In the case of optional programs, eligibility for the use-value assessment could be restricted by minimum tract size, minimum annual production, minimum period of continuous forest cover, ownership, and zoning.

The use-value program in Louisiana was established in 1976. This is an optional pure preferential assessment program with few eligibility restrictions, similarly to the use-value programs in most states of the South Central United States. Bona fide agricultural, horticultural, marsh, and timber lands, as defined by general law, are assessed for the tax purposes at 10% of use value. All other lands are assessed at 10% of fair market value.

Use value is determined uniformly throughout the state by dividing net return (gross return net of production costs) by capitalization (discount) rate. The Louisiana Tax Commission determines the capitalization rate, as well as prepares a table of the range of production costs and gross returns by land classes. In order to be assessed at its use value, agricultural, horticultural, marsh, or timber land must be (1) at least three acres in size, or have produced an average gross annual income of at least 2,000 dollars in one or more of the designated classifications for the four preceding years, and (2) a landowner must file an application for a use-value assessment with the assessor in the parish or district in which the property is located and sign an agreement that the land will be devoted to one or more of the designated uses. Because of few restrictions, easy enrollment process, and no back penalties for the withdrawal, virtually all eligible property is assessed at current use value. In 1992, about 86% of total land area in the state was assessed at current use.

There is a general agreement that the current use valuation provides substantial tax relief to participating owners. However, most theoretical studies conclude that this relief by itself, at best, delays but does not prevent conversion of land from traditional to developed land uses because property owners may be unable to resist the large capital gains associated with development (Anderson 1993, 2005). Land development may be driven by other factors: population and migration changes, socioeconomic characteristics of landowners, and transitional factors (Granskog et al. 2002).

Few empirical studies attempt to analyze the effectiveness of use-value programs to prevent conversion of rural lands to urban uses, most of these studies are focused on farm lands. Parks and Quimio (1996), who study impact of use-value program on farmland conversion in New Jersey, have found that preferential taxation has a very small impact on preservation of farmlands. Ferguson and Spinelli (1998) perform time series analysis of the rates of conversion of farmland in four Virginia jurisdictions. They have found that the adoption of use-value taxation does not impact the rates of farmland loss. Morris (1998) studies the effect of existence and duration of use-value programs on the proportion of farmland in 3,000 counties during the period 1957–1987 and concludes that preferential assessment delays conversion of farmland.

There are only few empirical studies that examine effect of current use valuation on conversion of forest lands. Brockett, Gottfried, and Evans (2003) compare attitudes of non-industrial private forest owners of Franklin County, Tennessee, that participate in Tennessee Greenbelt Program with attitudes of those not participating in the program. They have found that while providing tax relief to forest landowners, the program does not influence their decisions concerning preservation of forest lands. Williams et al. (2004) evaluate effectiveness Tennessee Greenbelt Program. They have found that the program is ineffective in preserving forest lands at several levels, including failure to affect landowner's decision concerning conversion of land to developed use.

While playing an important role in changing the relative profitability of land uses and possibly delaying land development, current use valuation may at the same time cause unintended changes between rural land uses. As to our knowledge, there are no empirical studies that examine effect of property taxes on the land transition between rural uses such as agricultural and forestry. In this study we not only quantify the effects of property taxes and use-value program on transition of agricultural and forestry lands to developed use, but also evaluate their influence on transition between agricultural and forestry uses.

III. MODEL

Most of existing studies of land use in the United States are based on the classic land-use theory developed by David Ricardo and Johann von Thünen. This theory explains land-use patterns in terms of relative rent to alternative land uses, which depends on land quality and location. Due to data limitations, the majority of econometric land-use studies utilize aggregate data describing areas or proportions of certain land-use categories within well defined geographic areas such as counties as a function of socioeconomic variables and land characteristics aggregated at the level of geographic unit of observation (Alig and Healy 1987; Plantinga, Buongiorno, and Alig 1990; Stavins and Jaffe 1990). Some of the studies, employing aggregate data, model shares of exhaustive set of land use within specified land base using binomial or multinomial logit model of shares, which allows restricting shares to unity (Parks and Murray 1994; Hardie and Parks 1997; Ahn, Plantinga, and Alig 2000; Nagubadi and Zhang 2005; Zhang and Nagubadi 2005).

Comparing pooled, fixed-effects, and random-effects specifications of the cross-sectional–time series land use shares model, Ahn, Plantinga, and Alig (2000) conclude that pooled specification does not adequately control for cross-sectional variation in dependent variables. As a result, the model's parameters measure a combination of spatial and temporal effects and cannot be used for the inferences regarding land-use change or land-use change predictions.

They suggest that specification with cross-sectional fixed effects provides a better measure of temporal relationship. However, the use of cross-sectional fixed effects requires relatively long time series and prevents the use of explanatory variables that do not have temporal variation (like land quality). These obstacles were overcome in some recent studies that use plot-based observation of land characteristics in order to directly measure land use transitions and model these transition either within discrete choice (Bockstael 1996; Kline, Moses, and Alig 2001; Lubowski, Plantinga, and Stavins 2006) or survival analysis (Irwin and Bockstael 2002) frameworks. In this study we model land-use transitions derived from the plot-based NRI data, similarly to Lubowski, Plantinga, and Stavins (2006). We use an RPL approach, which allows us to model complex substitution patterns among land uses, overcomes independence of irrelevant alternatives (IIA) property of multinomial discrete choice models, and which permits correlation of unobserved components of utility for individual plots over time.

Consider a risk-neutral landowner seeking to maximize her or his utility, which is a present value of the future streams of return to a plot of land. The landowner has an option to allocate this plot to one of several possible uses. Let W_{ntj} be the present value of the future stream of returns to plot n in land use j and time t, and $C_{ntj|i}$ be the present value of the cost of converting plot n from use i to alternative use j (it is equal to 0 if $i = j$). Following Bockstael (1996), the parcel, that currently is in land use i, would be converted to a new land use j if $W_{ntj} - C_{ntj|i} \geq W_{ntm} - C_{ntm|i}$ for all possible uses m, including current use i. This approach allows modeling the choice of new land use separately for each of possible initial land uses, because it compares utilities of possible new land uses conditional on initial land use. In order to be able to compare land-use choices across different initial land uses, we define utility of converting plot n from land use i to land use j as $U_{nt+1j|i} = W_{ntj} - W_{nti} - C_{ntj|i}$. Utility of land-use conversion is not observable directly, but it can be expressed as a sum of systematic part, or representative utility $V_{nt+1j|i}$, and random part ε_{ntj} that captures the factors affecting utility, but not included into representative utility. Representative utility of land-use conversion for individual plot n is a function of vectors of observable attributes of initial and final land uses $\mathbf{x}_{nti}$ and $\mathbf{x}_{ntj}$, and vector of observable attributes of plots $\mathbf{s}_{nt}$, that are related to either returns or conversion costs: $V_{nt+1j|i} = V(\mathbf{x}_{ntj}, \mathbf{x}_{nti}, \mathbf{s}_{nt})$. The probability of converting plot n from land use i to land use j is

$$\begin{aligned} P_{nt+1j|i} &= \text{Prob}\left(V_{nt+1j|i} + \varepsilon_{ntj} > V_{nt+1k|i} + \varepsilon_{ntk}\right) \\ &= \text{Prob}\left(\varepsilon_{ntj} - \varepsilon_{ntk} > V_{nt+1k|i} - V_{nt+1k|i}\right) \end{aligned}$$

Assuming random components of utility functions are independent, identically distributed, and follow type I extreme value distribution, the probabilities could be appropriately estimated using a conditional logit (CL) model (McFadden 1973). Based on our representative utility of land use conversion, the probability of converting plot n from land use i to land use j according to CL model is

$$\begin{aligned} P_{nt+1j|i} = &\exp\left(\alpha_{ij} + \tau_{tj} + \boldsymbol{\beta}' x_{ntj} - \boldsymbol{\beta}' x_{nti} + \boldsymbol{\gamma}_j' \mathbf{s}_{nt} - \boldsymbol{\gamma}_i' \mathbf{s}_{nt}\right) \\ &\div \sum_{k=1}^{J} \exp(\alpha_{ik} + \tau_{tk} + \boldsymbol{\beta}' \mathbf{x}_{ntk} - \boldsymbol{\beta}' \mathbf{x}_{nti} \\ &+ \boldsymbol{\gamma}_k' \mathbf{s}_{nt} - \boldsymbol{\gamma}_i' \mathbf{s}_{nt}) \end{aligned}$$

where α_{ij} is the conversion-specific constant ($\alpha_{ij} = 0, \forall i = j$), τ_{tj} are fixed year effects ($\tau_{Tj} = 0, \tau_{tJ} = 0$), $\boldsymbol{\beta}$ is a vector of coefficients of the attributes characterizing alternative land uses, and $\boldsymbol{\gamma}_j$ is a vector of coefficients of the plot-specific attributes for land use j ($\boldsymbol{\gamma}_{Jn} = 0$ to remove an indeterminacy in the model). Components of representative utility specific to initial land use ($\boldsymbol{\beta}' \mathbf{x}_{nti}$ and $\boldsymbol{\gamma}_i' \mathbf{s}_{nt}$) cancel out due to appearance in numerator and denominator:

$$P_{nt+1j|i} = \frac{\exp\left(\alpha_{ij} + \tau_{tj} + \boldsymbol{\beta}' \mathbf{x}_{ntj} + \boldsymbol{\gamma}_j' \mathbf{s}_{nt}\right)}{\sum_{k=1}^{J} \exp\left(\alpha_{ik} + \tau_{tk} + \boldsymbol{\beta}' \mathbf{x}_{ntk} + \boldsymbol{\gamma}_k' \mathbf{s}_{nt}\right)}, \quad [1]$$

Because CL model [1] does not contain components specific to initial land use, we can simultaneously estimate the full set of Markov probabilities, as opposed to estimating these probabilities separately for each initial land use.

The CL model exhibits the IIA property, which implies that removal of one of the outcomes from the choice set does not change the ratio of probabilities of remaining outcomes. This property is unlikely to represent the actual structure of choices in many real situations. In application to modeling land-use change, the undeveloped or rural land uses (agricultural or forestry) are likely to be substitutes in the land development decisions. Another limitation of the CL model in application to panel data is the assumption that errors are independent in choices repeated for each sample plot over time. This is not a realistic assumption because unobserved factors influencing land-use decision at each sample plot would likely to persist over time. Furthermore, coefficients of variables such as returns or property taxes are assumed to be same for all landowners. In reality, there could be a variation in landowners' marginal utility of return or marginal disutility of property tax. It is especially true if the values of these variables are not available for the individual plots and aggregated data such as county or parish averages are used instead.

Assuming that the parameters of outcome specific explanatory variables can vary across sample plots, we obtain an RPL[1] version of CL model [1]:

$$P_{nt+1j|i}(\boldsymbol{\beta}_n) = \frac{\exp\left(\alpha_{ij} + \tau_{tj} + \boldsymbol{\beta}_n'\mathbf{x}_{ntj} + \boldsymbol{\gamma}_j'\mathbf{s}_{nt}\right)}{\sum_{k=1}^{J}\exp\left(\alpha_{ij} + \tau_{tk} + \boldsymbol{\beta}_n'\mathbf{x}_{ntk} + \boldsymbol{\gamma}_k'\mathbf{s}_{nt}\right)}, \quad [2]$$

where $\boldsymbol{\beta}_n$ is a vector of coefficients that is unobserved for each n and randomly varies over sample plots representing variation in owners' marginal utility of observed attributes of alternative land uses and unobserved plot specific factors affecting the choice. In particular, random coefficients can capture effects of unobserved factors that persist over time, similarly to random effects in random effect models of panel data. Furthermore, by allowing the coefficients of observed variables to vary randomly over sample plots, the model can represent any pattern of substitution between alternative choices (Train 1998; McFadden and Train 2000), and thus relax IIA property of CL model.

In our model of land-use change, the observable attributes of land uses ($\mathbf{x}_{nti}$) are returns and property taxes per acre of land under alternative land uses. We hypothesize that higher return to a particular land use increases the probability of land being retained in or converting to this land use. Similarly, higher property tax to a particular land use decreases the probability of land being retained in or converted to this land use. The observable attributes of plots ($\mathbf{s}_{nt}$) in our model are land quality and population influence index. Our expectation is that land of higher quality is more likely to be converted to agricultural use and that proximity to populated places increases the probability of land development.

IV. DATA

Land-use data for Louisiana are derived from the National Resources Inventory (NRI) obtained from USDA National Resources Conservation Service (NRCS 2000). The NRI is a longitudinal panel survey of the Nation's soil, water, and related resources designed to assess conditions and trends every five years. For each NRI sample point, data has been collected on land cover, land use, irrigation, soil potential and erosion, conservation practices, resource concerns, and land ownership type. Due to variable sampling intensity,

[1] RPL was applied to model land use by Nelson et al. (2005). They modeled land-use allocations using cross-sectional data. RPL in their study performed worse than conditional logit (CL) or nested logit (NL) models. In particular, the log-likelihood statistics had shown worse goodness-of-fit of RPL model than of CL model, which suggests a different specification of RPL model (RPL, as well as NL, cannot worsen goodness-of-fit of base CL model).

TABLE 1

Transitions Between Major Land-Use Categories in Louisiana (thousand acres)

		Final Land Use					
Initial Land Use	Period	Agriculture	Forestry	CRP	Developed	Other	Total
Agriculture	1982–87	8,356.4	170.9	39.0	81.5	58.9	8,706.7
	1987–92	8,210.5	136.5	98.5	47.9	88.7	8,582.1
	1992–97	7,969.6	167.1	3.0	61.6	72.3	8,273.6
Forestry	1982–87	202.0	13,043.7	3.4	64.4	107.5	13,421.0
	1987–92	48.3	13,015.4	0.8	53.9	115.3	13,233.7
	1992–97	29.8	13,034.9	–	57.6	50.4	13,172.7
CRP	1987–92	–	–	42.4	–	–	42.4
	1992–97	3.0	1.4	137.3	–	–	141.7
Developed	1982–87	0.2	–	–	930.5	–	930.7
	1987–92	–	0.1	–	1,080.5	–	1,080.6
	1992–97	–	–	–	1,183.4	–	1,183.4
Other	1982–87	23.5	19.1	–	4.2	8,271.6	8,318.4
	1987–92	14.8	20.7	–	1.1	8,401.4	8,438.0
	1992–97	42.1	23.0	–	3.2	8,537.1	8,605.4
Total	1982–87	8,582.1	13,233.7	42.4	1,080.6	8,438.0	3,1376.8
	1987–92	8,273.6	13,172.7	141.7	1,183.4	8,605.4	3,1376.8
	1992–97	8,044.5	13,226.4	140.3	1,305.8	8,659.8	3,1376.8

sample points represent different number of acres of land indicated by expansion factors, which are used as weights to aggregate over the sample points. The details of NRI sampling design, data collection, and estimation procedures are discussed by Nusser and Goebel (1997). The 1997 NRI dataset provides data that are nationally consistent for all nonfederal lands for four points in time: 1982, 1987, 1992, and 1997.

The NRI dataset for Louisiana contains 23,679 plots representing 31.4 million acres (Table 1). In this study, we use NRI plots in Louisiana which can be classified as non-federal lands in either agricultural, forest, Conservation Reserve Program (CRP), or developed uses at the beginning and the end of each of the three five-year periods. This constitutes 13,414 plots representing 22.6 million acres. Other land uses, which include rangelands, other rural lands, rural transportation, small and large water bodies, and federal lands are not included in the analysis because of small share (e.g., rangelands) or because changes in these land uses are not driven by market forces (e.g., federal lands).

Land quality is an important characteristic determining potential return from agricultural and forestry uses. There are two variables in NRI database, which are related to the land quality of each sample plot (except federal lands, developed lands and waters): "Land Capability Class" (LCC) and "Prime farmland" (PF). LCC is a categorical variable taking values I to VIII and indicating existence and severity of limitations that reduce the choice of plants or require moderate conservation practices, or preclude cultivation and limit the use of plot mainly to pasture, range, forestland, or wildlife food and cover.[2] PF is a binary variable that indicates whether plot is classified as a prime farmland on which crops can be produced for the least cost and with the least damage to the resource base. For this study we selected "Prime farmland" variable to represent land quality of a sample plot because it more directly reflects the capability of land to produce economic returns.

In order to quantify effect of population and proximity to populated places, we use

[2] Studies that model land use at the county level utilize aggregated NRI land quality characteristics as proportion of certain land capability class (Hardie and Parks 1997; Miller and Plantinga 1999) or as average land capability class (Ahn, Plantinga, and Alig 2002). Lubowski, Plantinga, and Stavins (2006) model land-use change at the plot level and use the land capability class as a set of dummies.

TABLE 2
DESCRIPTIVE STATISTICS OF EXPLANATORY VARIABLES

Variables	*N*	Minimum	Maximum	Mean	Std. Dev.
Parish-level					
Return from agricultural lands, \$/ac	155	4.19	356.36	95.96	77.55
Return from forestry lands, \$/ac	155	0.00	63.87	16.24	12.13
Return from developed lands, \$/ac	155	39.30	1,811.55	607.87	395.04
Property tax for agricultural land, \$/ac	155	−0.43	−6.39	−1.81	0.89
Property tax for forestry land, \$/ac	155	−0.13	−2.52	−0.86	0.43
Property tax for developed land, \$/ac	155	−3.90	−229.67	−52.20	45.59
Tax rate, mills	155	22	152	76.44	26.35
Plot-level					
Population interaction index	30,749	10.58	1,165.98	98.61	91.09
Prime farmland	30,749	0.00	1.00	0.57	0.50

population interaction index (PII) (Breneman 1997), a measure similar to a gravity index. PII is derived from the Census block group population data of 1980, 1990, and 2000.[3] We use linear interpolation to obtain PII for 1982, 1987, and 1992, which are starting years of three five-year transition periods.

Property taxes per acre of agricultural, forest, and developed land for 1981, 1987, and 1992 are calculated using the data available from Biennial Reports of Louisiana Tax Commission (State of Louisiana 1982; Louisiana Tax Commission 1988, 1994). These reports contain data on assessed values and acreages of land and improvements for various land use categories, as well as the millage rates for various local taxes for each parish. Total amount of property tax is obtained by applying millage rates to assessed values of land in each of the land uses. Because of assessed values of agricultural and forestry lands (current use values) are determined uniformly throughout the state, the property taxes for these land uses in a given parish depend on the composition of land classes in this parish and the parish millage rate. Property taxes per acre are presented as negative numbers in our dataset.

We use market value of agricultural crops divided by acreage of croplands from the Census of Agriculture (Bureau of the Census 1984, 1989; NASS 1992) as a proxy for per acre agricultural returns. Forestry returns are calculated as the value of stumpage sold in a parish averaged over a five-year period preceding conversion period and divided by the acreage of timberlands in a parish. The values of stumpage by parish and by year for Louisiana are derived from the severance tax data by Louisiana Forestry Commission (LDAF 1978–1996). Returns to developed lands are calculated from the assessed values of developed lands, which are defined as 10% of fair market value, and assuming 10% capitalization rate.

Descriptive statistics of the explanatory variables are presented in Table 2. There are 64 parishes in Louisiana. After pooling data for three periods and excluding observations with missing data, we received 155 observations at the parish level. Parish level data were merged with plot level data yielding 30,749 usable observations at the plot level.

V. RESULTS

We model transition between four broad land uses (agriculture, forestry, CRP, and developed) over three five-year intervals (t). Because transition to developed land use is practically irreversible, and transition from CRP is determined by the length of contract, we consider two initial land uses i (agricultural and forestry) and four final land uses or alternatives j (agricultural,

[3] We would like to thank Shawn Bucholtz for providing PII data linked to NRI sample points.

forestry, CRP, and developed). Because the land-use decisions are based on the expectations of landowners from their previous experience, all the explanatory variables are lagged: the choice of land use at the end of each five-year period is a function of explanatory variables at the beginning of this five-year period.

The CL and RPL models of land-use change were estimated using NLOGIT 3.0 (Greene 2002). All observations are weighted using NRI expansion factors scaled so that they sum to the number of observations. In RPL model, we specify the coefficients of returns and property taxes as distributed log-normal in the population and all other coefficients as fixed. The reason these coefficients were selected to be random is that the values of returns and property taxes used in the model are aggregated at the parish level. Returns and taxes at particular sample plots vary over parish averages. This variation is partly controlled for by the plot-level land quality and population influence variables, the remainder could be absorbed by the variation in random parameters. The log-normal distribution of the coefficients was selected to prevent negative values of the coefficient in the part of the population. The CL model was estimated using maximum likelihood method. Since exact maximum likelihood estimation is not possible for the RPL model, the probability is approximated using simulation and simulated log-likelihoods function is maximized. In our estimation we used 2,000 repetitions with Halton sequences which perform better than random draws (Train 1999). The change in the results between 1,000 and 2,000 repetition was negligible.

The estimated parameters and standard errors of CL and RPL models are presented in the Table 3. The likelihood ratio test was carried for the RPL specification against the null hypothesis of CL specification. The value of likelihood ratio statistic is 12.48 with 99% critical value of $\chi^2_2 = 9.21$, which rejects null hypothesis. The coefficients and standard errors of CL and RPL models are similar except for the coefficients for returns and property taxes, which are fixed in CL model and random in RPL model, therefore we discuss transition specific constants and coefficients for the attributes of sample plots without distinguishing between CL and RPL models.

The conversion specific constants determine matrix of transition probabilities: the greater is the value of a particular constant, the higher is the probability of the corresponding transition, ceteris paribus. Since constants corresponding retention land in agricultural and forestry uses, which have the highest probabilities, are restricted to zero for the identification purpose, all other conversion-specific constants are negative, as expected. The lowest is the value of the constant for the conversion from forestry to CRP, which indicates a very low probability of such conversion, possibly due to the specifics of CRP program. The other low probabilities are for the conversion from agricultural and forestry to developed use, as well as for the conversion from forestry to agriculture. The highest are the probabilities of conversion from agriculture to forestry and from agriculture to CRP.

Population size and proximity reflected by the population influence index are factors significantly affecting probability of conversion between land uses. Conversion to agriculture, forestry, and especially to CRP is less likely (in comparison with conversion to developed use) with the increase of population influence index. Higher land quality increases the probability of conversion to or retention in agricultural land use, decreases the probability of conversion to or retention in forestry land use, while not affecting conversion to developed use or CRP.

Coefficients for the returns and taxes to alternative land uses in CL model are significant and have positive sign. This confirms the basic assumptions of Ricardian land rent theory: the probability of conversion to a particular land use is increasing with higher returns and lower taxes (note that taxes in out data set are negative numbers). Because random coefficients for the returns and taxes are specified as log-normally

TABLE 3
CONDITIONAL LOGIT AND RANDOM PARAMETERS LOGIT MODELS OF LAND-USE CHANGE IN LOUISIANA

		CL	RPL
Transition specific constants (α_{ij}):			
Agriculture to forestry		−2.7096‡ (0.1186)	−2.7731‡ (0.1368)
Forestry to agriculture		−5.8772‡ (0.1363)	−5.8286‡ (0.1595)
Agriculture to developed		−5.7511‡ (0.2662)	−5.1359‡ (0.3387)
Agriculture to CRP		−6.0435‡ (0.8115)	−6.0709‡ (0.8523)
Forestry to developed		−7.1759‡ (0.2542)	−6.5948‡ (0.3022)
Forestry to CRP		−11.3091‡ (1.0293)	−11.2920‡ (1.0612)
Fixed time effects (τ_{tj}):			
Agriculture	1982–1987	−0.0655 (0.2127)	0.1882 (0.2268)
	1987–1992	0.3070 (0.2121)	0.4367* (0.2242)
Forestry	1982–1987	−0.7139‡ (0.2134)	−0.4779† (0.2268)
	1987–1992	0.1172 (0.2148)	0.2355 (0.2223)
CRP	1982–1987	2.5198‡ (0.8166)	2.7419‡ (0.8248)
	1987–1992	3.7521‡ (0.8017)	3.8613‡ (0.8095)
Attributes of land uses ($\boldsymbol{\beta}_n$):			
Return	Mean of coefficient	0.0016‡ (0.0004)	0.0024
	Mean of ln(coefficient		−6.0279‡ (0.1637)
	Std. dev. of ln(coefficient)		0.0008 (12.8935)
Tax	Mean of coefficient	0.0084‡ (0.0031)	0.1121
	Mean of ln(coefficient)		−2.7663‡ (0.2828)
	Std. dev. of ln(coefficient)		1.1550‡ (0.1565)
Attributes of plots ($\boldsymbol{\gamma}_j$):			
Agriculture	Prime farmland	0.5764‡ (0.1842)	0.5275† (0.2112)
	Population influence	−0.0055‡ (0.0005)	−0.0085‡ (0.0008)
Forestry	Prime farmland	−0.5225‡ (0.1786)	−0.5688‡ (0.2043)
	Population influence	−0.0058‡ (0.0005)	−0.0086‡ (0.0009)
CRP	Prime farmland	0.1069 (0.3092)	0.0801 (0.3345)
	Population influence	−0.0259‡ (0.0042)	−0.0295‡ (0.0056)
McFadden R^2		0.8559	0.8562
Log Likelihood		−3,539.7	−3,533.5

Note: standard errors are in parentheses.
* Significant at 10% level; † significant at 5% level; ‡ significant at 1% level.

distributed in RPL model, the results of the estimation are means and standard errors of natural logarithms of the coefficients. The means of the coefficients are calculated as $\beta_i = \exp\left(b_i + s_i^2/2\right)$. For the returns to alternative land uses, the estimated mean of natural logarithm of the coefficient is highly significant while standard deviation is very small and insignificant, suggesting that there is no variation in the coefficient for the returns to alternative land uses. In the same time, standard deviation of the natural logarithm of the coefficient for taxes is large and highly significant, and calculated mean of the coefficient for RPL model is much greater than the coefficient estimated in CL model.

Although property tax is a component of net return, we hypothesized that the influence of property tax is more complex than additive. In order to test this hypothesis we estimate restricted RPL model where the return variable is combined with the property tax variable. Likelihood ratio test indicates that the full model is superior at the 1% significance level, confirming the appropriateness of using return and property tax as separate variables in the model of land use change.

While being significant and consistent with the underlying theory, the coefficients of CL and RPL models presented in Table 3 are difficult to interpret. One of the reasons is that the same vector of

TABLE 4
LAND USE TRANSITION PROBABILITIES AND ELASTICITIES OF PROBABILITIES WITH RESPECT TO PROPERTY TAX (RPL)

Transition (Retension)	Predicted Probabilities	Elasticities of Transition Probabilities with Respect to Property Tax Per Acre on			
		Agriculture	Forestry	CRP	Developed
Agriculture→Agriculture	0.9687	−**0.0051**	0.0021	0.0002	0.0047
Agriculture→Forestry	0.0190	0.2731	−**0.1278**	0.0003	0.0042
Agriculture→CRP	0.0059	0.2731	0.0041	−**0.1316**	0.0042
Agriculture→Developed	0.0064	0.0319	0.0002	0.0000	−**1.1199**
Forestry→Agriculture	0.0075	−**0.1824**	0.0972	0.0000	0.0026
Forestry→Forestry	0.9885	0.0011	−**0.0007**	0.0000	0.0024
Forestry→CRP	0.0001	0.0011	0.1171	−**0.1177**	0.0024
Forestry→Developed	0.0039	0.0002	0.0184	0.0000	−**1.1121**

Note: The numbers in bold indicate own elasticities (e.g., elasticities of conversion to certain land use with respect to change of property tax on this land use).

coefficients is a component in all utility functions, thus in our model one coefficient influences sixteen elasticities. Table 4 presents matrices of partial elasticities[4] of the probabilities of land-use conversion or retention with respect to property taxes for RPL model. Partial elasticities are calculated at sample means separately for agricultural and forestry initial land uses. The diagonal elements of the matrices (shown in bold) are "own" elasticities indicating percentage change of conversion probability to certain land use with 1% change of property tax on this land use. For example, with an increase of property tax on forestry land by 1% probability of transition from agriculture to forestry land use will decrease by 0.1278%. The off-diagonal elements are cross-elasticities that show the effect of the change of property tax for certain land use on conversion to another land use. For example, an increase of property tax on agricultural land by 1% would increase probability of conversion form agricultural to forestry land use by 0.2731%. As expected, cross-elasticities of transition probabilities with respect to property taxes are positive while own elasticities are negative. Furthermore, the cross-elasticities are not equal, which indicates that IIA property is relaxed by introduction of random parameters into the model.

The absolute values of elasticities are small. This means that the probabilities of land-use transition or retention are relatively inelastic with respect to property taxes. In order to evaluate the effect of current use valuation program in Louisiana, we perform a simulation for the period 1992–1997 using actual data (with property tax on agricultural, forestry, and CRP lands based on use values) and using alternative scenario where property tax on agricultural, forestry, and CRP lands would be determined based on market values. In 1992, average use values of forest and agricultural lands were approximately \$150/acre and \$300/acre, respectively. In the same time average market values of forest and agricultural lands were approximately \$290/acre and \$1,000/acre, respectively. Removing current use valuation program would approximately double property tax on forest land and triple property tax on agricultural land. The simulation results are presented in Table 5. Abandonment of current use valuation would cause additional loss of 162 thousand acres (2.1%) of agricultural lands, additional gain of 154 thousand acres (1.3%) of forest lands, and additional gain of 5.5 thousand acres (0.2%) of developed lands over five years period. In

[4] Partial elasticities of the probabilities with respect to attributes of the outcomes are calculated as $\eta_j = \frac{\partial P_j}{\partial x} \cdot \frac{x}{P_j} = (1 - P_j)\beta x$.

TABLE 5
SIMULATION OF LAND USE CHANGES FOR THE PERIOD 1992–1997

	Changes by Land Use, Thousand Acres (% of Restrictive Land Use)			
Scenario	Agricultural	Forestry	CRP	Developed
With current use valuation	−189.6 (−2.5%)	78.1 (0.6%)	3.0 (2.1%)	108.5 (12.8%)
Without current use valuation	−351.6 (−4.6%)	232.5 (1.9%)	5.1 (3.6%)	114.0 (13.4%)
Difference	−162.0 (−2.1%)	154.4 (1.3%)	2.1 (1.5%)	5.5 (0.6%)

the same time, it would have very little effect on conversion to CRP.

VI. CONCLUSION

This article analyzes the effect of property taxes and current use valuation program in Louisiana on land-use changes between rural and developed land uses, as well as among rural land uses during the period 1982–1997. The use of RPL model allows accounting for temporal correlation between observation of the same sample plot in the panel data, heterogeneity of marginal utility of property taxes among landowners, as well as complex substitution patterns between alternative land uses. The results of the model estimation show that land quality is an important factor affecting allocation of land between agricultural and other land uses while urbanization plays an important role in conversion to developed land use. Higher return to a particular land use increases the probability of conversion to this land use and decreases the probability of converting to other land uses, which is consistent with results of most of the studies of land-use change (e.g., Lubowski, Plantinga, and Stavins 2006).

Higher property tax to a particular land use decreases the probability of retention in, or conversion to this land use and increases the probability of converting to other land uses, which supports the underlying theory of land rent. However, land-use transition probabilities are inelastic with respect to property taxes. Although there were studies analyzing effect of property taxes on farmland loss and supply of agricultural lands, as to our knowledge, these results were not previously reported within comprehensive land-use change models, which would allow assessing effect property taxes on the land-use change between agriculture and forestry. In particular, we found that property taxes have significant effect on the changes between agricultural and forestry lands.

Effect of property taxes on land-use change has an important policy implication by allowing evaluation of effectiveness of property tax policies such as current use valuation on land-use change. We performed a simulation of abandonment of current use valuation during 1992–1997 using our sample of NRI plots. The results of simulation show that while slowing down development of rural lands, this policy has a far greater impact on the land-use change by also preventing conversion of some of the marginal agricultural lands to forestry uses. This consequence contradicts other governmental land-use public policies, such as Conservation Reserve Program and Conservation Reserve Enhancement Program that attempt to reduce erosion and excess agricultural production by converting cropland to long-term, resource-conserving covers such as forest or permanent grasses. To the extent that other states or political jurisdictions use a use-value program similar to that of Louisiana, one might expect the results reached in this paper apply to these states or political jurisdictions as well.

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