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Invited presentation at the 2018 Southern Agricultural Economics Association Annual Meeting, February 2-6, 2018, Jacksonville, Florida

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Determinants of Participation and Intensity for Commercial-based Activities in Coastal Louisiana

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Abstract

This study investigates the determinants of participating commercial-based activities for a sample of wetland owners in coastal Louisiana. A double-hurdle model is used to accounts for both participation and the intensity of participation decisions. The empirical results suggest that variables such as *age*, *participating in other commercial-based activities*, *hunting lodge/camp*, *active management*, and *land_type_one* were found to significantly influence the participation decision while the variables *education*, *land ownership*, *years of ownership*, and *total acreage of other type of land* were found to significantly influence the intensity of participation. In addition, the variables *total acreage of freshwater marsh* and *total acreage of brackish marsh* were found to be significant in both decision equations. The information gathered from this study confirmed that decisions to participate in commercial-based activities and the intensity of participation are related to physical characteristics of the property and socioeconomic characteristics of the landowner.

Keywords*:* commercial-based activities, double-hurdle model, private land, intensity

1. Introduction

Louisiana's coastal wetlands provide a variety of critical economic, ecological, cultural and recreational values to residents of the state and the coastal wetlands of south Louisiana are one of the most important, productive ecosystems in the United States. Benefits of coastal wetlands include flood control, shoreline protection, carbon storage, the provision of biological diversity, and supporting fishery and ecotourism industries (Costanza et al., 1998; Pennings and Bertness, 2001). The coastal zone of Louisiana includes more than three million wetland acres, or about 40% of the nation's total (Lipton et al., 1995). While Louisiana's wetland acreage is vast, the state has experienced a net loss of over 1,900 square miles (1,216,000 acres) of coastal wetlands since the 1930's, representing an acceleration of 10 times the natural land loss rate (Britsch and Dunbar, 1993). The estimated land loss rate has been in excess of 40 square miles per year during the past half century and between 25 and 35 square miles per year during the 1990's. Barras et al. (2003) estimated a current annual average land loss rate of 24 square miles (15,360 acres) per year, which represents approximately 80% of the coastal wetland loss of the entire continental United States. Currently at risk are the remaining coastal wetlands, 80 percent of which are under private ownership. The acceptance of private wetland owners to restoration programs and their participation in these programs are critical if future coastal restoration efforts are to be successful. Encouraging this private investment, however, can be difficult because of the uncertainty as to the impact of any project, the spatially complex nature of expected wetland losses, and the fact that the benefits of wetland restoration tend to accrue to the general public rather than to individual landowners. Dedah (2010) found that almost three-quarters of coastal wetland owners exhibited risk-averse behavior and pointed that the risk averse nature of the majority of coastal landowners along with the relatively low income derived from surface-use activities suggested that unless well-crafted to protect or enhance their private benefits,

opposition by the landowners to publically funded restoration projects is likely to be high, even if the expected public benefits associated with the project are large.[1]

Roberts et al. (1999) reported that across all wetland types (freshwater, brackish, and salt), two types of enterprises - alligator (including egg collection) and hunting (primarily the leasing of property for waterfowl hunting) - comprise the vast majority of surface-based revenues. Many of the coastal properties also yield considerable sub-surface revenues associated with the extraction of oil and gas. Only the surface revenues are considered and surface related income-generating activities refer to alligator harvest and/or waterfowl hunting in this study. According to 2014 Louisiana Summary (Westra, 2014), total Louisiana gross farm value of all wild alligator harvest and waterfowl hunting leases during 2014 were $10.8 million and $33.6 million, respectively. Total gross farm value of all wild alligator harvest and waterfowl hunting from the 20 coastal parishes during 2014 were $9.7 million and $18.4 million, which account for 89 percent and 55 percent of the state total for these two enterprises, respectively. In light of this situation, the primary goal of this study is using a theoretical and empirical model of the factors that motivate coastal landowners to participate in either or both enterprises and the intensity of participation (i.e., the expected returns from participation) from their coastal wetland tracts and, with this understanding, to design potential policy instruments that provide incentives for private coastal wetlands.

While literature examining participation in Federal/State wetland-restoration sponsored programs among Louisiana landowners is limited, multiple studies have looked specifically at wetland restoration program participation at a larger scale as well as in other states within the United

[1] Based on a 1998 study by Roberts et al. (1999), net income derived from surface-use activities of the coastal wetlands ranged from a high of $2.25 for freshwater marsh to a low of $0.37 for saltwater marsh. Furthermore, 40% of the owners of freshwater marsh and 67% of the owners of saltwater marsh reported losses.

States (Parks and Kramer, 1995; Pease et al., 1997; Söderqvist, 2003; Forshay et al., 2005; Dedah, 2010; Yu and Belcher, 2011; Zhang et al., 2011). Aside from literature that focused on wetlands, a number of studies have been conducted examining those factors leading to participation in various land conservation programs (Greene and Blatner, 1986; Romm et al., 1987; Bliss and Martin, 1990; Kraft et al., 1996; Nagubandi et al., 1996; Erickson et al., 2002; Elwood et al., 2003; Lambert et al., 2007; Joshi and Arano, 2009; Kauneckis and York, 2009; Matta et al., 2009; Vignola et al., 2010; Greine, 2015). In general, previous studies indicate that a landowners' decision to participate in land related activities (such as ecosystem conservation and wetland restoration program) is affected by a wide range of economic, geographic, and sociological factors (Parks and Kramer, 1995; Kraft et al., 1996; Söderqvist, 2003; Matta et al., 2009; Zhang et al., 2011). Based on a theoretical model of private decision making with spatial heterogeneity, landowners were surveyed as part of this study to obtain information about their socioeconomic characteristics. Next, the intensity of participation was analyzed with respect to the combination of physical characteristics associated with the individual parcels and the socioeconomic characteristics of the wetland owner. Using the results of our earlier efforts and a survey of existing policy instruments, we develop specific policy recommendations to the specific environments encountered in coastal Louisiana as well as the wetland owners. Conventionally, three main econometric methodologies, the standard Tobit model, the Heckit model, and Double-Hurdle model, could be utilized to investigate landowners' decisions concerning participation in income-generating activities and the level of income derived from these activities. While the review of these models is intended to be comprehensive of empirical economic models, it is not comprehensive of empirical household decision models in general.

The remainder of this paper proceeds as follows. Section 2 introduces the theoretical model and data and Section 3 presents the empirical results. Research limitations and policy recommendations are discussed in Section 4 while the last Section provides the conclusions.

2. Methods

2.1. Theoretical Model

The manner in which wetland owners engage in revenue generating activities (i.e., alligator and/or waterfowl hunting activities) is expected to be conditioned on two primary factors: the income-generating characteristics of the property and the characteristics of the landowner. Taken together, these categories would be used to determine whether engaging in a given enterprise activity is considered desirable, and if so, at what intensity (i.e., level of income derived). Since some landowners may choose not to participate in these income-generating activities, a portion of the dependent variables will equal to zero. Elhorst (1993) pointed out that the estimation of models of farm household investment was complicated since most of data include many zero values. Including only positive values in dependent variables leads to sample selection bias and the simple linear regression ordinary least squares (OLS) produces biased and inconsistent estimates (Elhorst, 1993; Worku and Mekonnen, 2012). Greene (2008) suggested that it is necessary to use an approach which can incorporate both discrete and continuous components. To address the statistical issue associated with the dependent variable having a significant number of zero values, the conventional regression models used a binary dependent variable to determine this relationship. Many empirical researchers have looked at factors influencing private investments decision using the discrete choice models with Probit or Logit estimators to estimate the probability of a household's decision (Norris and Batie, 1987; Romm et al., 1987; Featherstone and Goodwin, 1993; Donatos, 1995; Soule et al., 2000; Petrick, 2004; Hagos and

Holden, 2006; Koundouri et al., 2006). Dedah (2010) pointed that the Probit/Logit approaches are useful tools to provide the information on how different characteristics of the landowners and their wetland tracts influence the probability of investment in wetland restoration and maintenance. These models, however, while evaluating the factors influencing a landowner's decision whether to invest, fail to provide information about the level of investment in wetland restoration and maintenance.

Since the primary objective of this study is to determine the factors that motivate private coastal landowners to participate in income-generating activities and the factors that affect the level of income derived from theses actives, the Tobit model can handle this problem and allows for the analysis of the factors affecting the joint decision (Greene, 2003). However, the Tobit model is very restrictive in its parameterization to determine the probability of participation and also the level of participation (Yen and Huang, 1996). In the Tobit model, the censored variable (participation) and expected value conditional on the level of participation are estimated by the same factors. This model considers only the dependent variable to be censored at zero and ignores the source of zero observations (Newman et al., 2003; Martínez-Espiñeira, 2006). Whereas the Tobit model was designed to deal with estimation bias associated with censoring, Heckman (1979) pointed out that estimation on selected subsample results in selection bias and proposes the two-stage estimation procedure (known as the Heckit model) to deal with the problem associated with the zero observations generated by the non-participation decision. The Heckit model overcomes the selection bias by using a full sample Probit estimation in the first stage, followed by a corrected self-selection estimation carried out in the second stage. The model assumes that these two stages are affected by different sets of independent variables and there are no zero observations in the second stage.

Cragg (1971) proposes the Double-Hurdle (DH) model, which generalizes the Tobit model by introducing an additional hurdle which must be passed before observing any positive values. Similar to the Heckit model, the first hurdle refers to the participation decision and the second hurdle refers to the level of participation decision. Both models allow the possibility of estimating the first and second stage equations using different sets of explanatory variables. The difference is that the DH model permits potential zero values in the second stage. By using a Probit estimator to model the participation decision, zero observations on the dependent variable can be either attributed to corner solutions or nonparticipation. The DH model also allows the decision participating in income-generating activities and the level of income to be treated separately. Therefore, a separate stochastic process can be used to model the probability of participation and the level of participation (Carroll et al., 2005).

2.1.1. The DH Model

The decision process of private landowners can be divided into a two-stage decision making process. In the first stage, the wetland owner must decide whether to participate in income-generating activities. Conditional on the outcome of the first stage, the second stage considers the desired level of income to be forthcoming from these activities. As noted by Detre et al. (2010), observing a positive level of income requires that two distinct stages be passed with the use of a latent variable in the first stage allowing for the modeling of the complete decision-making process. The decision as to whether to participate is expected to reflect the individual's perceptions and attitudes toward those factors influencing income-generating activities and is at least partially based on beliefs by the wetland owner as to whether participation in such activities would yield a positive return on investment. These beliefs are not directly observed. Instead, a binary variable denoting whether these beliefs will be positive or negative could be observable

from a survey question asking whether the individual would undertake income-generating activities under any circumstances. A yes (no) response would indicate whether the individual is open (or not) to the concept of deriving income from the property. Given a positive outcome in the first stage, the landowner decides in the second stage the desired level of income derived from these activities subject to the physical characteristics of the property. The desired level of income subject to the physical characteristics of the property may differ from that associated with profit maximization, with the differential depending (in part) upon the socioeconomic characteristics of the wetland owner.

The decision process above suggests a DH model with sample selection (Atanu et al., 1994; Shonkwiler and Shaw, 1996; Woldehanna et al., 2000; Dhakal et al., 2008; Detre et al., 2010) that is adapted within a Tobit estimator because survey results will likely show that many landowners generate no revenues from their coastal properties for either or both enterprise activities considered in this study. This statement is supported by Roberts et al. (1999) in their analysis of income derived from surface-use activities among wetland owners. Cragg (1971) first proposed the DH model as a generalization of the Tobit model in the context of analysis of household durable expenditures by allowing the possibility that a factor might have different effects on the probability of acquisition and the magnitude of acquisition. It hypothesizes that individuals must pass two separate hurdles before they are observed with a positive level of consumption. In other words, the general equations of the DH model extend the standard Tobit and Heckit models to overcome the zero income. Following Jones (1989), the specification of the DH model can be expressed as

Stage 1: Participation decision equation

$$y_{1i}^{*} = x_{1i}\beta_1 + \epsilon_{1i};\ \epsilon_{1i} \sim N(0,1) \qquad (1)$$

$$y_{1i} = \begin{cases} 1 \; if \; y_{1i}^* > 0 \\ 0 \; otherwise \end{cases} \quad (2)$$

Stage 2: Level of income equation

$$y_{2i}^* = x_{2i}\beta_2 + \epsilon_{2i};\; \epsilon_{2i} \sim N(0, \sigma^2) \quad (3)$$

$$y_{2i} = \begin{cases} y_{2i}^* \; if \; y_{1i} = 1 \; and \; y_{2i}^* > 0 \\ 0 \;\; if \; y_{1i} = 0 \end{cases} \quad (4)$$

Finally, the observed level of income is determined as

$$y_i = y_{1i} \cdot y_{2i} = x_{2i}\beta_2 + \epsilon_{2i} \;\; if \; y_{1i}^* > 0 \; and \; y_{2i}^* > 0 \quad (5)$$

In this specification, a positive level of income y_i is observed if $y_{1i}^* > 0$ and $y_{2i}^* > 0$. This illustrates the DH element to the model. y_{1i}^* is a latent endogenous variable representing the decision to participate in income-generating activities for landowner i, y_{2i}^* is a latent variable representing the level of income for landowner i, y_i is the observed level of income for a landowner i. x_{1i} is a set of landowner characteristics and beliefs that influence the landowner's decision to participate in income-generating activities, x_{2i} is a vector of physical characteristics of the property (e.g., total acres and percent in different wetland types and open water) that affect the landowner's level of income. β_1 and β_2 are vectors of estimable parameter. In this formulation, (x_{1i} ; x_{2i}) may contain the same common explanatory variables, although their corresponding effects on the two hurdle equations might be quite different. ϵ_{1i} is normalized to 1 since the outcome of the first hurdle is binary. Both error terms, ϵ_{1i} and ϵ_{2i}, are assumed to be normal and independently distributed and can be written as

$$\begin{pmatrix} \epsilon_{1i} \\ \epsilon_{2i} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right] \quad (6)$$

The independent DH model is estimated using maximum likelihood technique and the log likelihood function is given as

$$lnL = \sum_{0} \ln\left[1 - \Phi(x_{1i}\beta_1)\Phi\left(\frac{x_{2i}\beta_2}{\sigma}\right)\right] + \sum_{+} \ln\left[\Phi(x_{1i}\beta_1)\frac{1}{\sigma}\emptyset\left(\frac{y_i - x_{2i}\beta_2}{\sigma}\right)\right] \quad (7)$$

where "0" under the summation sign denotes the summation over the zero observations in the sample (level of income y_i is zero) and "+" indicates summation over the positive observations (level of income y_i is positive); $\Phi(\cdot)$ and $\emptyset(\cdot)$ demote standard normal cumulative distribution function and standard normal probability density function (*cdf* and *pdf*), respectively. The first term on the right-hand side indicates that the zero observations are affected by both participation and level of participation decisions. This is in contrast with Heckit model which assumes that all zero observations arise only from the participation decision. The additional term in equation (7), $\Phi\left(\frac{x_{2i}\beta_2}{\sigma}\right)$, contributes the effect of possible zero values in the second stage decision in the DH model. The first term captures the possibility of observing zero values in the second stage decision and thus indicating the second stage is represented like a Tobit model. The second term on the right-hand side indicates summation over the positive observations; this term expresses the conditional probability distribution and density function coming from censoring rule and observed positive values. In this study, the former denotes the probability of passing the participation hurdle, and the latter indicates the density of observing non-zero income from participating in income-generating activities. Estimation of the above model will empirically determine the importance of economic versus other criteria related to the income generating potential of coastal wetland properties. It is worthwhile noting that the second stage of the two-step process represents a modified Hedonic model. The parameter estimates of the DH model provide direct information indicating the significance of the explanatory variable and the direction of its influence on the dependent variable. Thus, based on the empirical results forthcoming from the model estimation, one can determine the implicit price of different

property characteristics as they relate to income derived from the two enterprise activities as well as the implicit prices of human capital (e.g., presence of a lodge or waterfowl blinds).

2.2. Data

2.2.1. Survey Design and Response

The survey was developed based on the tailored design method for mail surveys, which consisted of a booklet survey, a postcard reminder, and a replacement survey (Dillman, 2011). This survey collected information about a landowner's decision to participate in income-generating activities and income derived from this participation in 2016. It also provided the physical characteristics of the property as well as socioeconomic and demographic characteristics of the landowner. The mailing list of private coastal landowners was obtained from coastal zone parish assessor's offices. Landowners in these costal parishes might participate in income-generating activities on their wetland parcels. Due to data and budgetary limitations, only five coastal parishes (Cameron, Lafourche, Plaquemines, Terrebonne, and Vermilion parishes) were chosen in this study. Total gross farm value of all wild alligator harvest and waterfowl hunting from these five coastal parishes during 2014 were $6.5 million and $17.2 million, which account for 60 percent and 51 percent of the state total and account for 68 percent and 93 percent of the 20 coastal parishes total for these two enterprises, respectively (Westra, 2014). Following Dedah (2010), this study stratified landowners into three groups based on the number of wetland parcels they owned using the 1,159 wetland parcels as the sample frame. The first group included all landowners with only one wetland parcel. The second group included all landowners with two wetland parcels, and the third group included all landowners with more than two parcels (this latter group largely consisting of large corporations). The survey was not sent to the third group since landowners who own various wetland parcels might make diverse participation decisions

for different activities on different parcels, but the designed questions for this research is attempting to have landowners pay more attention on alligator harvest and/or waterfowl hunting activities from a specific wetland parcel.

After eliminating duplicate parcels, parcels without mailing addresses, landowners listed with three or more parcels, and publicly owned properties, the sample was reduced to a total of 941 landowners and this represents the population to which the survey was distributed. An initial wave of survey packages, including a cover letter, questionnaire, a GIS parcel map, and a self-addressed postage-paid envelope, was sent to 525 landowners who own the wetland property in Cameron, Lafourche, and Terrebonne parishes in January 2016. Approximately two weeks later a reminder post-card encouraging landowners to fill out the survey was sent out. Following the same structure, a second wave of survey was sent to 416 landowners who own the wetland property in Plaquemine and Vermilion parishes in April 2016. In total, surveys were sent to 166 landowners in Cameron, 209 landowners in Vermilion, 221 landowners in Terrebonne, 138 landowners in Lafourche, and 207 landowners in Plaquemines parish.

Removing the undelivered surveys resulted in a final sample size of 866 wetland parcels. Of the 866 surveys that were initially mailed out, 153 were returned fully or partially completed by the respondent (including those, which were returned with no information when the respondents indicated that the ownership of property had changed). The final observation used in the analysis is 122 with the response rate of 14%. The respondents owned a total of 99,425 acres. In terms of the total wetland acreage controlled by the survey respondents, these landowners owned approximately 2.9% of the total wetland acreage in Louisiana's coastal zone (3.4 million acres). However, much of the wetland acreage throughout the coastal zone is owned by major corporations and these corporations were purposely excluded from the survey.

2.2.2. Variables

Definitions as well as descriptive statistics of response and explanatory variables utilized in this study are presented in Table 1. The response variable, *income-generating activities participation* in the first stage represent a binary variable equal to 1 if the landowner *i* reports that he/she participated in income-generating activities in 2015 and 0 otherwise. From the full sample, about 41% landowner participated in income-generating activities. *Level of income from income-generating activities* is the response variable in the second stage, which represented by a continuous variable equal to income in dollars for landowner *i*. The average income among landowners who participated in income-generating activities equaled $12,204 with a standard deviation of $13,657.

Many studies indicated that socioeconomic variable such as age of landowner may or may not significantly influence the landowners' decision to participate in a wetland related activities (Parks and Kramer, 1995; Söderqvist, 2003; Yu and Belcher, 2011). Landowners' level of education positively affects the probability of participation in conservation programs (Kraft et al., 1996; Zhang et al., 2011). Land ownership was an important factor in the decision whether or not to participate in wetland restoration/conservation programs in the United States (Parks and Kramer, 1995; Kraft et al., 1996; Matta et al., 2009). With respect to physical characteristic variable, land type was found to have an important impact on landowners' decision to participate in income-generating activities and derived income (Roberts et al.,1999; Parks and Kramer, 1995). Previous researches provide insight on landowners and other stakeholders perceptions and attitudes towards decisions whether to participate in a given conservation program and have found that a suite of socioeconomic and property characteristic factors are important. The various studies give an overall picture of the factors associated with landowners' participation. Based on

theoretical consideration and limited literature review, the explanatory variables in this study were categorized by the socioeconomic/demographic characteristics of the wetland owners and physical characteristics associated with the individual properties. Landowner characteristics included both socioeconomic and demographic variables as well as variables representing opinions held by the respective landowners. Specifically, socioeconomic/demographic characteristics variables include: *age*, *land ownership*, *years of ownership*, *participating in government program*, *participating in other commercial-based activities*, and *an active outdoor enthusiast*. The property characteristics variables include: *southeast parish*, *hunting lodge/camp*, *active management*, *land type*, *total acreage of freshwater marsh*, *total acreage of brackish marsh*, *total acreage of salt marsh*, and *total acreage of 'other' land*.

3. Results of the Double-Hurdle Model

The maximum-likelihood estimates of the double-hurdle model are presented in Table 2 with associated robust standard errors reported in parentheses. Estimates for the participation equation are presented in the second column of the table, while the estimates from the level of participation equation are presented in the third column. Significant variables in the first hurdle equation influence the decision whether or not to participate and can be interpreted as increasing or decreasing the likelihood of participation for income-generating activities. A significant variable in the second hurdle equation indicates an influence on the level of generated income and can be interpreted as increasing or decreasing income. Since the specification of the double-hurdle model allows for zeros in the second hurdle equation, the estimates are based on both positive and zero levels of income. The discussion focuses specifically on the significant variables and their interpretation.

Age was found to statistically influence the likelihood of participation, but did not significantly influence the level of participation. The influence between the two stages was of an opposite direction. Specifically, landowners who are 54 years old or younger were more likely to participate in income-generating activities.

Education was not found to significantly influence the likelihood of participation but it did significantly influence the level of participation. Specifically, landowners, with a college or higher level of education, were found to receive more income from income-generating activities. This supported the hypothesis that there is a positive relationship between *education* and the level of income.

Land ownership (sole ownership) was found to significantly influence the level of participation. Specifically, results indicated that sole-owners received less income than landowners who own the wetland parcel through joint ownership or 'other' ownership structure. One might hypothesize that this finding reflects a time constraint for a sole owner that does not allow him to actively adequately monitor activities on the property, thereby, reducing the probability of him/her actively leasing the property (for waterfowl hunting or the take of alligators).[2]

Years of ownership was found to significantly influence the level of participation. Specifically, the longer the landowner owned the wetland parcel, the less income the landowner derived from commercial-based activities.

Participating in other commercial-based activities was found to significantly influence the likelihood of participation. Specifically, landowners who participated in other commercial-based activities were found to less likely to participate in alligator harvest and/or waterfowl hunting activities after controlling for other factors.

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[2] One might argue that the parcel acreage among sole owners is less than that among joint owners. However, total acreage of the parcel is represented in the analysis via the summation of the different land types.

The presence of a *hunting lodge/camp* was also found to statistically influence the likelihood of participation, but did not significantly influence the level of participation. The influence between the two stages was of an opposite direction. Specifically, landowners who had a hunting lodge/camp on his/her wetland parcel were less likely to participate in income-generating activities.

Active management was found to positively and statistically influence the likelihood of participation but did not significantly influence the level of participation. Specifically, those landowners who actively managed their property for waterfowl habitat were more likely to participate in income-generating activities.

Looking at the *land type* variables, the results showed that *land_type_one* significantly influenced the likelihood of participation, but did not significantly influence the level of participation. Specifically, landowners who own a wetland parcel with only one land type were found to more likely to participate in income-generating activities. While the estimated coefficients for *land_type_two* was found to not significantly influence (from a statistical perspective) the likelihood of participation and the level of income generated from participation.

The variable *total acreage of freshwater marsh* was found to significantly influence (from a statistical perspective) the likelihood of participation as well as the level of income generated from participation. Specifically, an increase in acreage of freshwater marsh was found to result in an increase in participation rate as well as the level of participation (i.e., generated income from commercial-based activities). This finding was also found with respect to brackish marsh.

Finally, the variable *total acreage of other type of land* was found to significantly influence the level of income derived from participation, but did not significantly influence the likelihood of participation.

4. Discussion

4.1. Limitations

The sample of data was drawn from five parishes (Cameron, Vermilion, Terrebonne Lafourche, and Plaquemine parishes) among 20 coastal parishes in Louisiana. Although every effort was made to obtain all available data for econometric investigation in this study, the amount data used for descriptive and empirical statistical analysis is limited. As information from other parishes becomes available, the analysis could be expanded to include these parishes. This would yield a larger database from which to conduct analysis.

The empirical model of Cragg's DH in which the first hurdle uses a Probit model and a truncated normal model in the second hurdle was employed in this study. As discussed in Section 2.1, there are no restrictions on explanatory implying the DH model could be determined by different vectors of explanatory variables in each hurdle. Since the Cragg's DH model assumes independence for error distribution, there is an implication that the results could be sensitive to model misspecification. Thus, it would be desirable to explore dependent DH model and Box-Cox DH models for further research.

This study stratified landowners into three groups based on the number of wetland parcels they owned using the 1,159 wetland parcels as the sample frame and surveys were mailed to landowners who own one or two wetland parcels. Large landowner data set would be considered for model comparison. An alternative, more comprehensive estimation of landowner participation in income-generating activities and level of income would include all landowners. The empirical analysis combined both alligator and hunting enterprises data set and estimated the factors that motivate private landowners to participate in these activities and the factors that affect the level of income derived from these activities on their coastal wetland parcels. Separate

DH models would be desired to estimate the participation effects for alligator harvest and waterfowl hunting for further study.

4.2. Policy Recommendations

The results from this study suggest that only a few landowners participate in state or federal wetland restoration programs. Understanding the various attitudes among landowners toward these programs provides the opportunity for policymakers to better evaluate current and potential approaches to program implementation.

Dscriptive and empirical results suggest potential implications for wetland management and restoration. Specifically, policymakers may consider establishing an education program geared toward the 'smaller' (i.e., non-corporation) coastal wetland owners. Unlike corporations with large coastal tracts, the opportunity costs of remaining abreast of restoration programs and policy are likely large relative to expected benefits for owners of smaller coastal parcels. Thus, any education program would need to be developed with this understanding in mind and tailored accordingly.

Second, as recommended by Coreil (1995), policymakers should consider 'speeding up' and simplifying the application process and modifying restoration contract terms. Many of the complaints were heard about the process of application the term of contract. Policy adjustments need to address the problem that speed up process for applying the wetland restoration program. Shorting and simplifying the application process and modify the contract term would need landowner's participation and collaboration.

Third, policymakers need to ascertain the types of incentives (financial and others) to entice private landowners to accept a wetland restoration project on his/her property. Gaining the cooperation by the coastal landowners, however, is complicated by the fact that while the public

benefits accruing from wetland protection and restoration projects are likely to be large, private benefits are likely to be small and, potentially, negative. If coastal restoration and management needs are to be met in Louisiana, public funds must be leveraged to private investment. Therefore, financial incentives are likely to play an important role in the decision-making process among coastal landowners considering whether or not to engage in specific types of coastal restoration activities. While these financial incentives are important, the potential value of non-monetary incentives should not be minimized.

Finally, the analysis conducted in Section 3 indicates that there are myriad of factors that determine whether a landowner is expected to participate in income generating activities and, if so, the desired level of income. One might try to tailor programs to these findings. For example, results indicated that landowners who participated in a state or federal restoration program would receive less income derived from income-generating activities than landowners who did not participated in these restoration programs. To the extent that these results are valid, one obvious program would be to compensate for any loss in income associated with enrollment in a restoration program. The results, however, also indicate that compensation requirements would vary along several socioeconomic factors as well as factors specific to the parcel in question. Compensation could be enhanced/reduced based on these factors. Not all policy instruments are equally effective in achieving desired social goals given the alternative enterprises and the influence of different property characteristics and socioeconomic characteristics on the income-generating potential of coastal property. Since private landowners with different situations are likely to exhibit heterogeneous preferences over a range of relevant land use alternatives, therefore, as suggested by Caffey et al. (2003), policymaker need to consider a portfolio of policy instruments to increase the range of options available for private landowners.

5. Conclusions

This study has integrated current knowledge about wetland use, based on a micro landowner perspective, into a comprehensive economic model of private coastal wetland income-generating activities and provided potential policy instruments for coastal wetland management. A landowners' decision is affected by a number of factors, including expected net returns from engaging in these activities, uncertainty as to the outcome of engagement, and an array of socioeconomic/demographic characteristics of the wetland owner and the physical characteristics of the property. The general decision process of private landowners can be divided into a two-stage decision-making process. Landowners initially decide whether to participate in income-generating activities and then consider the desired level of income derived from these activities. The Cragg's DH model has been applied to the household survey data to determine those factors that motivate private coastal landowners to participate in income-generating activities and the level of income derived from their coastal wetland property. With 80 percent of Louisiana's coastal wetlands are under private ownership, the acceptance of private wetland owners to wetland related programs and their participation in these programs is critical if future coastal management efforts are to be successful. Additionally, with an increasing understanding of the importance of wetlands, cooperation between government agencies and landholders is a critical component of most policy implementation approaches and these policy instruments represent key factor in influencing participation decisions among landowners in coastal area.

Table 1 Variable Definitions and Descriptive Statistics

Variable	Description	Mean	Std.Dev
Response Variables			
Income-generating activities participation	Participate=1; Else=0	0.41	0.49
Level of income ($)	Continuous	12,204	13,657
Explanatory Variables			
Socioeconomic/Demographic Characteristics			
Gender	Male=1; Female=0	0.66	0.47
Race	White=1; Else=0	0.97	0.18
Age	54 years old or younger=1; Else=0	0.15	0.36
Education	Some college degree and above =1; Else=0	0.72	0.45
Land ownership	Sole ownership=1; Else=0	0.31	0.47
Percentage of ownership	Continuous	0.58	0.40
Years of ownership	Continuous	70.87	38.73
Participating in government program	Yes=1; No=0	0.10	0.30
Participating in other commercial-based activities	Yes=1; No=0	0.14	0.35
An active outdoor enthusiast	Yes=1; No=0	0.65	0.48
Property Characteristics			
Southeast parish	Terrebonne, Lafourche, and Plaquemines parish=1; Cameron and Vermilion parish=0	0.66	0.48
Hunting lodge/camp (%)	Yes=1; No=0	0.11	0.32
Active management (%)	Yes=1; No=0	0.13	0.34
Receive sub-surface revenues (%)	Yes=1; No=0	0.37	0.49
Land type			
Land_type_one	Parcels contain one land type=1; Else=0	0.75	0.43
Land_type_two	Parcels contain two land types=1; Else=0	0.18	0.39
Land_type_three	Parcels contain three land types =1; Else=0	0.07	0.35
Total acreage of freshwater marsh	Continuous	734	1,409
Total acreage of brackish marsh	Continuous	510	1,344
Total acreage of salt marsh	Continuous	62	205
Total acreage of other type land	Continuous	341	1,167

Table 2 Maximum Likelihood Estimation of the DH Model

	First hurdle equation	Second hurdle equation
Socioeconomic/Demographic Characteristics		
Age	1.90***	-11116.43
	(0.69)	(11273.45)
Education	0.16	39682.90***
	(0.44)	(13434.68)
Land ownership	-0.72	-47152.33***
	(0.55)	(17517.98)
Years of ownership	_	-253.39*
		(135.19)
Participating in government program	_	-12153.41
		(11946.38)
Participating in other commercial-based activities	-5.48***	_
	(0.87)	
An active outdoor enthusiast	-0.76	_
	(0.51)	
Property Characteristics		
Southeast parish	0.34	-7344.74
	(0.52)	(8531.55)
Hunting lodge/camp	-1.91***	13738.71
	(0.62)	(10933.94)
Active management	10.15***	1059.18
	(1.11)	(18018.51)
Land type		
Land_type_one	1.93**	6649.30
	(0.99)	(11481.36)
Land_type_two	0.32	18771.96
	(0.87)	(13105.26)
Land_type_three	Reference group	Reference group
Total acreage of fresh water marsh	0.0046***	11.85**
	(0.0015)	(5.45)
Total acreage of brackish marsh	0.0011***	5.82*
	(0.0002)	(3.46)
Total acreage of salt marsh	-0.0009	2.75
	(0.0010)	(17.11)
Total acreage of other type of land	0.0003	13.65***
	(0.0002)	(4.74)
Constant	-3.38***	-24962.73
	(0.99)	(22400.95)
Sigma	9260.94***	
	(2007.28)	
Wald $x2$ statistic	1083.74***	

Log-Likelihood	-342.19
Number of observation	122

Notes: Robust standard errors are in parentheses
Asterisks indicate levels of significance: *** = 0.01, ** = 0.05 and * = 0.10

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