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Private Market Alternatives for Maintaining Wetland Viability in Coastal Louisiana: A Double-Hurdle Approach

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PRIVATE MARKET ALTERNATIVES FOR MAINTAINING WETLAND VIABILITY IN COASTAL LOUISIANA: A DOUBLE-HURDLE APPROACH

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DEDICATION

This dissertation is dedicated to my parents, Wanying and Defu, my wife, Miao, and my sons, Gavin and Gabriel.

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ABSTRACT

The coastal zone of Louisiana contains more than three million wetland acres, or about 40 percent of the nation's total. Since 1930, Louisiana has experienced a net loss of over 1,900 square miles of coastal wetlands. 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. 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. The primary goal of this research is to examine the factors that motivate private coastal landowners to participate in income-generating activities and the level of income derived from their coastal wetland parcels and with this understanding to assess current and potential policy instruments that might provide incentives for private coastal wetlands stewardship.

Using data collected from a sample of coastal wetland owners, a double-hurdle model was used to econometrically identify the determinants on the participation and level of participation in income-generating activities. The results based on the estimated parameters and marginal effects confirmed that decisions to participate in income-generating activities and the level of participation are related to physical characteristics of the property and socioeconomic characteristics of the landowner.

CHAPTER 1 INTRODUCTION

1.1 General Background

Louisiana's coastal wetlands provide a variety of 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. 1997; Odum 1988; 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; LOSCO, 2005).

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 (LCWCRTF and WCRA 1998; CPRA 2000; 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.[1] This loss implies that wetlands revert to open water, thus causing shifts in land uses and ecological functions. There are a number of factors contributing to this loss. In part, natural evolutionary processes, including sea-level rise, land subsidence, erosion, saltwater intrusion, tropical storm, and hurricane impacts contribute to coastal wetland losses. Human disturbances also share a large part of the responsibility for the balance of wetland growth and decline. Historic decisions to levee the Mississippi and Atchafalaya rivers and to construct the Gulf

[1] Barras et al. (2003) pointed out that the current land loss rate at an average of 24 square miles (15,360 acres) per year. The rate of coastal land loss in Louisiana represents 80% of the coastal wetland loss in the entire continental United States (LCWCRTF 1998)

Intracoastal Waterway, ship channels, and access canals for hydrocarbon resource exploitation are primary reasons for the land loss. Channelization led to the redirection of alluvial sediments away from the coast, exacerbated erosion, and accelerated saltwater intrusion (Barras et al. 2003; Dunbar et al. 1992; LaCPRA 2007). These human-based forces have led to a situation where 160 -200 million metric tons per year of sediments, once enriching the coastal wetlands, are now delivered directly onto the outer continental shelf (Caffey and Shexnayder 2003). Other factors, including upstream dams and soil conservation practices, have modified the movement of freshwater, suspended sediment, and made the coastal ecosystem more susceptible to saltwater intrusion have also contributed to the loss of these wetlands (Caffey et al. 2003).

1.2 Problem Statement

Without significant action, and based on the current loss rate, Louisiana will lose an estimated additional 800 thousand wetland acres by the year 2040 (Desmond, 2005). Wicker (1980, 1981) suggested that up to 60% of the Louisiana wetlands currently at risk can be managed to minimize further losses, mainly through the control of water flows and the restoration of coastal vegetation. More recently, Turner (1999) has suggested that small-scale projects, such as the construction of 'artificial' crevasses, spoil bank management, and terracing appear to be particularly cost effective in wetland restoration and creation efforts. While the technology necessary for management varies in complexity and cost (Spicer et al. 1986; Turner 1999), in most cases solutions will either impact or be implemented on private lands.

In 2006, over 2 million residents -more than 47% of the state's population according to U.S. Census estimates- lived in Louisiana's coastal parishes (U.S. Census Bureau, 2007). Currently at risk are the remaining coastal wetlands, 80% 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. 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 (measured by changes in net income to the landowner) are likely to be small and, potentially, negative.[2] The risk averse nature of the majority of coastal landowners (Dedah, 2010) in conjunction with the relatively low income derived from surface-use activities suggest 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.[3, 4]

1.3 Research Justification

Roberts et al. (1999) report 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.[5] In light of this situation, this dissertation proposes to develop a comprehensive framework for understanding the motivation among coastal landowners to participate in either or both of these enterprises and the physical characteristics of the property and socioeconomic characteristics of

[2] Small private benefits from a publically-funded restoration project are the outcome when property changes associated with that project yield only marginal positive income changes to the landowner. Negative private benefits accrue when the landowner's post-project income as a result of project implementation is reduced.
[3] Dedah (2010) found that almost three-quarters of coastal wetland owners exhibited risk-averse behavior.
[4] 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.
[5] 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 in this study with the exception that, as discussed later, sub-surface revenues may influence owner participation in the generation of surface revenues as well as the intensity of participation.

the landowner that determine the intensity of participation (and, as such, the expected returns from participation). Beginning with a theoretical model of private decision making with spatial heterogeneity, landowners are surveyed as a part of this dissertation to obtain information about their socioeconomic characteristics, including attitudes toward the use of their properties for income-based activities, attributes of their properties, revenues derived from their properties (associated with the two enterprises), and attitudes towards coastal restoration projects. Next, this research proposes to analyze the participation rate and the intensity of participation (i.e., revenues generated from the two enterprises) with respect to the combination of physical characteristics associated with the individual parcels and the socioeconomic characteristics of the wetland owner. As discussed in the Approach section, this will be accomplished using a double-hurdle decision model where the first 'hurdle' considers the participation decision (yes, no) and the second hurdle provides an estimate of revenues conditioned on the outcome of the first hurdle. This analysis will be conducted for the two enterprises.[6] Finally, the results for the implications regarding the use of various policy instruments to determine the likelihood of acceptance among landowners to these various instruments and landowner's willingness to participate in wetland restoration programs are evaluated. Importantly, an attempt will be made to tailor these instruments to the specific activities, environments, and characteristics of landowners in coastal Louisiana.

Federal laws and programs recognize that the best stewards of coastal resources are likely to be local communities and their citizens.[7] State and federal budgets to encourage local

[6] As mentioned before, the two enterprises include alligator and waterfowl hunting.
[7] For example, the National Estuary Program (NEP) encourages local communities to take responsibility for managing estuaries and maintaining the wide range of biophysical, economic, recreational, and aesthetic values of the systems. Much of the monetary and technical resources for these efforts come from federal and state programs, such as those established under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA).

stewardship, however, are relatively small in relation to needs. Consequently, if coastal restoration and management needs are to be met in Louisiana, public funds must be leveraged to private investment. Encouraging this private investment can be difficult because of the uncertainty as to the impact of any project on the income-generating potential of a given project, the spatially complex nature of expected wetland losses, and the fact that the benefits of wetland restoration tend to accrue to the public rather than to individual landowners. The overriding goal of this project is to add to our limited knowledge of coastal wetland income-generating activities and to use this increased knowledge to help craft restoration program scenarios that are more likely to be accepted by wetland owners and in which they will be more willing to actively participate.

1.4 Study Objectives

The overall goal of the proposed research is to develop a theoretical and empirical model of the factors that motivate private landowners to participate in and generate surface-based income from their coastal wetland property and, with this understanding, to value potential policy instruments that provide incentives for private coastal wetlands stewardship. Specific objectives include:

1. Determine the characteristics of coastal Louisiana landowners, including their attitudes toward the use of their property for income-generating activities, the actual use of their wetland holdings as a source of income-generating activities, knowledge and opinions regarding cost-sharing programs, and their general socioeconomic profile;[8]

[8] More than 5 million acres of coastal wetlands are contained in Louisiana's coastal zone with approximately 80 percent of this 5 million acres held privately. These percentages, in addition to ongoing state-level efforts at large-scale restoration, make Louisiana an ideal case-study for empirical application of a private decision-making model.

2. Determine the physical characteristics of the wetland properties, including type of wetland, total acreage of different marsh types, and presence of a hunting lodge/camp, etc.;

3. Estimate, using a double-hurdle modeling approach, the importance of specific property and landowner characteristics on participation rates and the intensity of participation (i.e., the level of income-generating activities) in the two primary enterprises conducted on coastal Louisiana wetland properties (i.e., alligator and waterfowl hunting enterprises); and

4. Based on results from the preceding objectives, assess the potential impact of policy instruments designed to encourage private landowners to participate in cost-sharing and other federally sponsored projects that would maintain/enhance their coastal wetland holdings.

1.5 Dissertation Structure

The dissertation consists of seven chapters. Chapter 1 provides an introduction and problem statement, highlighting the study objectives and theoretical and policy related contributions. To accomplish these objectives, the remainder of the dissertation is organized as follows. Chapter 2 reviews the literature relevant to this dissertation topic, including studies which analyse those factors that contribute to landowner participation in various programs. Chapter 3 presents the development of a theoretical model describing a landowner's participation decision. The double-hurdle model approach and logic of the research method is presented in Chapter 4. Issues of survey and data validity are considered in Chapter 5, including sampling strategy, data collection techniques and a descriptive summary. Chapter 6 presents the empirical

results while Chapter 7 provides a brief summary of the findings and evaluates the potential policy implications.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Understanding landowners interest and requirements for participation in income-generating activities is one aspect of the planning process. Another aspect of the process is identifying the private landowner and their wetland characteristics that are conducive to income-generating activities. Research exploring private landowners attitudes towards coastal wetland restoration and maintenance in Louisiana is limited. While limited, some studies have been conducted that identify those factors considered by private landowners to be important in the conservation and restoration decision-making process. In general, previous studies indicate that a landowner's decision whether 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. To further understand the most important factors influencing a landowner's participation decision, this chapter reviews some of public regulations and academic studies related to various restoration programs. The following section provides some of the laws and regulations which notably impact wetland conservation. Section 2.3 briefly reviews the current wetland restoration efforts and potential policy instruments in coastal Louisiana, while Section 2.4 provides a review of relevant studies that explore factors which contribute to a landowner's participation decision process. A brief summary be set up in Section 2.5.

2.2 Policies and Programs Related to Wetland

Over the past 40 years, the U.S. population has increasingly begun to recognize that wetlands provide a variety of goods and services including water purification, flood protection,

shoreline stabilization, and fish and wildlife habitat. The importance of wetlands has been prioritized, to some extent, by federal, state, and local policies encouraging their protection. Thus, the policy features and regulatory factors that influence landowners participation must be considered. A brief introduction of some regulations and programs is given in this section.

The Clean Water Act

Yaich (2011) pointed out that the essential wetland protection legislation was initiated in 1972 with the passage of the Clean Water Act. This Act regulated the dredging and filling of waters of the United States, including wetlands, and has required the replacement of wetlands lost to development under a policy now known as "no net loss of wetlands policy". No net loss was first adopted as a national policy in 1988 under George H. W. Bush administration. The goal of the policy is to balance wetland loss due to economic development with wetlands reclamation, mitigation, and restorations efforts so that each newly impacted wetland has to be replaced with a wetland of the same size and with similar wetland functions and values (NWPF 1987).[9] Section 404 of the Clean Water Act is the primary vehicle for Federal regulation to deal with wetland issues.

There are a number of U.S. government agencies that are in some way legislatively mandated to ensure the protection of wetlands. These agencies include: (1) the Department of Defense, U.S. Army Corps of Engineers (Corps); (2) the U.S. Environmental Protection Agency (EPA); (3) the Department of the Interior, U.S. Fish and Wildlife Service (FWS); (4) the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA); and (5)

[9] Turner et al. (2001) highlight that simple ratios of area do not indicate equivalent replacement of functions based on different types of mitigation (creation, restoration, enhancement, or preservation) and each different mitigation type yields different degrees of function and wetland functions expressed by each site can vary greatly.

and the Department of Agriculture, Natural Resources Conservation Service (NRCS) (Votteler 1996).

The Corps and the EPA share the responsibility for issuing permits to those individuals who wish to dredge or fill wetlands, and these permits often require "compensatory mitigation" under Section 404 of the Clean Water Act (Hough and Robertson 2009). However, the EPA has the authority to veto the permit if discharge materials at the selected sites would adversely affect such things as municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational resources. The FWS and NOAA provide the Corps and the EPA with comments about the potential environmental effects of pending Section 404 permits. [10]

The Farm Bill

The 1985 Farm Bill was the first act that officially established the Conservation Reserve Program (CRP) aimed to slow wetland loss to agricultural conversion (Hayden, 1990). The CRP is a cost-share and rental payment program under the United States Department of Agriculture (USDA) and is administered by the USDA Farm Service Agency (FSA).

The USDA Forest Service and the USDA Natural Resources Conservation Service (NRCS) provide technical assistance for CRP. NRCS's natural resources conservation programs provide assistance with respect to reducing soil erosion, enhancing water supplies with groundwater recharge, improving water quality, increasing wildlife habitat, and reducing damages caused by floods and other natural disasters (O'Brien, 2008). The CRP encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to

[10] See Copeland (1999) for more detail.

vegetative cover, such as cultivated or native bunchgrasses and grasslands, wildlife and pollinators food and shelter plantings, windbreak and shade trees, filter and buffer strips, grassed waterways, and riparian buffers.

The Wetlands Reserve Program (WRP) was established by the 1990 Farm Bill (including a major change to the CRP) and expanded the list of eligible lands to include marginal pasture lands converted to wetlands or established as wildlife habitat. The WRP was a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. NRCS provided technical and financial support to help landowners with their wetland restoration efforts through WRP.

The new Farm Bill, enacted on February 7, 2014, merged the former Wetlands Reserve Program, Grasslands Reserve Program, and Farm and Ranchlands Protection Program into a new program called the Agricultural Conservation Easement Program (ACEP).[11] Funding for wetland and grassland protection expired Sept. 30, 2013, and the 2014 Farm Bill reinstates funding for these critical efforts under ACEP (NRCS, 2014). The ACEP provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands. Under the wetland reserve enrollment options, NRCS may enroll eligible land through:

- Permanent Easements: conservation easements in perpetuity. NRCS pays 100 percent of the easement value for the purchase of easement and the restoration costs;
- 30-Year Easement -easements that expires after 30 years. Under 30-year easements, NRCS pays 50 to 75 percent of the easement value for the purchase of the easement.

[11] See Chite (2014) for more detail.

Additionally, NRCS pays between 50 to 75 percent of the restoration costs;

- Term Easements - easements that are for the maximum duration allowed under applicable State laws. NRCS pays 50 to 75 percent of the easement value for the purchase of the term easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs; or
- 30-Year Contracts - available only to enroll acreage owned by Indian tribes, and program payment rates are commensurate with 30-year easements.

Swampbuster

Swampbuster is a provision of the Food Security Act of 1985 (were introduced in the 1985 Farm Bill, with amendments in 1990, 1996 and 2002). The Swampbuster provisions are intended to discourage the conversion of wetlands to agricultural production use. Farmers will be ineligible for all or a portion of certain federal farm program benefits, including loans, subsidies, crop insurance, and price support programs if he/she converting a wetland area to produce an agricultural commodity after November 28, 1990 unless an exemption applies or the functions of the wetland that was converted (Lamunyon, 1994).

The Water Bank Act

The Water Bank Act (WBA) represents federal legislation enacted to promote the preservation of U.S. wetlands (Beckman 1971). The Act authorizes the Secretary of Agriculture to enter into land restriction agreements with landowners and operators to preserve wetlands and retire adjoining agricultural lands. The agreements (contracts) are entered into for a period of 10 years and can be renewed at the time of expiration. In return, the landowners are entitled to annual federal payments and the total annual payments were limited to $10 million in any year

(Act, Endangered Species 1973). The annual maximum payments increased from $10 million to $30 million after 1980. Authorized by WBA, the Water Bank Program (WBP) aims to (1) preserve and improve wetland as habitat for migratory waterfowl and other wildlife; (2) conserve surface waters; (3) reduce soil and wind erosion; (4) contribute to flood control; (5) improve water quality; (6) improve subsurface moisture; and (7) enhance the natural beauty of the landscape.

The North American Wetlands Conservation Act

To preserve North American wetland ecosystems, waterfowl, and the other migratory birds, fish, and wildlife, the United States Congress passed the North American Wetlands Conservation Act (NAWCA) in December 13, 1989. This act authorizes a wetlands habitat program to protect, restore, and manage wetland ecosystems and associated habitats for migratory birds and other wetland wildlife in the United States, Mexico, and Canada. The United States Fish and Wildlife Service is responsible for facilitating these funding. The program encourages private-public cost-sharing through standard and small grants programs. The standard grants program supports projects in all three countries and the small grants program supports only conservation projects in the U.S. Funds contribute towards conservation projects not eligible to match if it comes from the U.S. federal sources (Wilson et al. 1997).[12] The appropriation authorization for NAWCA may not exceed $75 million for FY 2007 through FY 2012. Funding for NAWCA expired in September 2012.

[12] See detail from The North American Wetlands Conservation Act, 16 USC 4401-4413.

2.3 Wetland Restoration Status in Louisiana

2.3.1 Current Wetland Restoration Efforts in Louisiana

In an effort to address the problem of Louisiana's coastal land loss, the U.S. Congress passed the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) in 1990. The CWPPRA program has allocated more than $1.5 billion for construction and operation of projects since in 1990. In 1998, the COAST 2050 report estimated that an additional $14 billion was needed to address Louisiana's land loss problem. In 2002, the Louisiana Coastal Area (LCA) Restoration Program requested that $14 billion, but only $1.9 billion was authorized in 2004 through the Water Resources Development Act (WRDA). Furthermore, attempts to get federal royalties from petroleum activities off the state's outer continental shelf (OCS) were unsuccessful until 2005, when a one-time payment of $540 million was allocated to Louisiana under the Coastal Impact Assistance Program (CIAP). In 2007, the Gulf of Mexico Energy Security Act (GOMESA) approved more OCS revenue, and it is now projected that the state will receive $210 million annually through 2017 and $650 million annually after 2017. Despite these increases, the Coastal Protection and Restoration Authority (CPRA) recently estimated that $100 billion would be needed to fully integrate coastal restoration and protection (Graves 2009). Given current sources of projected funding, that means that Louisiana will have only 13% of the funds needed to accomplish its coastal wetland restoration goals (Wang, 2012).

2.3.2 Potential Policy Instruments in Louisiana

Not all policy options 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. As differentiation in a

landowners resources, opportunities, and attitudes increases, the complexity of the response to a given policy will also increase. This may require that policy instruments be tailored to specific landowner and property characteristics. In practice, the effectiveness of public goals to encourage private coastal restoration efforts may depend upon more than just a simple method of making transfer payments. In particular, it may be more effective to implement a portfolio of policy instruments to increase the range of options available for private landowners (Caffey et al. 2003). The reason for this is that private landowners with different situations are likely to exhibit heterogeneous preferences over a range of relevant land use alternatives. A wide range of management approaches have been proposed for the general problems of land and water conservation and ecosystem restoration in the United States (USEPA 1999). General categories of these approaches, with some specific examples relevant to coastal Louisiana, include:

- Public land purchases. Federal programs such as the Coastal Wetland Planning, Protection and Restoration Act (CWPPRA) and the Land and Water Conservation Fund (LWCF) have enabled the purchase and restoration of a small percentage of the coastal wetlands in Louisiana. Many private landowners, however, may be reluctant to sell their properties, preferring other means of achieving restoration goals.
- Public purchase of permanent or temporary conservation easements. Federal programs located in the Departments of Agriculture, Interior, and Commerce provide small levels of funding for the purchase of conservation easements on private coastal wetland properties.
- Establishing new markets for land. One existing but underutilized approach is the establishment of wetland mitigation banks through which credits for wetland restoration can be bought and sold. Another potential approach is the establishment of a market for

carbon credits; brackish marshes such as those in the Louisiana coastal zone are believed to have a good potential for carbon sequestration.

- Implementing innovative tax incentive programs. One potential incentive scheme involves severing, where needed, surface and subsurface property rights so that oil and gas producers may continue to exploit subsurface minerals but also may take advantage of reduced taxes for undertaking surface restoration efforts. A second example in this category would be shifting towards the taxing of land activities and not property size (Seidemann and Susman 2002). This latter approach is a landowner-specific approach that could be developed and refined using the results of this research.
- Subsidies for plant, fish, and wildlife management. Examples include bounties on the eradication of nuisance species, such as nutria (Myocastor coypus), an herbivorous rodent whose behavior is extremely destructive of wetlands. Another example includes programs to compensate landowners for conserving protected species, such as the US Fish and Wildlife Service's Private Stewardship Grants Program.

2.4 General Factors Affecting Landowner's Participation

2.4.1 Factors Affecting Landowner's Participation in Wetland Restoration Programs

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 (i.e., the United States and other countries) as well as in other states within the United States. Based on county acreage enrolled in the Wetland Trees Practice of Conservation Reserve Program (CRP), Parks and Kramer (1995) constructed cost schedules for expected acres of wetlands restored to examine the probability of

farmer participation in wetland restoration programs in the United States. The authors employed a logit model to identify factors which may influence the decision among farm operators whether or not to enroll in wetland-related practices. They pointed out that, in general, *opportunity costs*, *program payments*, and *land quality* were all statistically significant in determining enrollments and the model explained roughly half of the variability in enrollment. Results from the analysis suggest that farmers become less likely to participate in wetland restoration program as income derived from agriculture production increases. The positive and statistically significant coefficient for *government payments* variable indicated that the amount of government payments received per acre is associated with higher participation. The authors suggested that *age* and *ownership* were also important factors in the participation decision. Involvement in wetland restoration programs was positively related to the *age* of the farmers as well as the proportion of land operated by full or part-time farmers.

Pease et al. (1997) randomly selected 305 individuals from 2,500 landowners who participated in three wetland restoration programs (the WRP, the Emergency Wetland Reserve Program, and the Partners for Fish and Wildlife Program) within states to determine landowners attitudes towards wetland restoration for the purpose of outlining potential improvements associated with future restoration programs. This research explored demographic and farm characteristics of participants in these program. Most landowners in this survey had small and medium sized properties, and most landowners earned 20% or less of their income from farming.[13] From this survey, the authors found that *wildlife* plays an extremely important role in attracting landowners to restore wetlands. Eighty-four percent of the respondents reported that providing habitat for wildlife was extremely important in their decision to restore a wetland tract.

[13] Around forty percent of landowners owned their property for less than ten years.

The authors pointed that *altruistic considerations pertaining to wildlife*, *future generations*, and *natural beauty* were very important factors affecting landowner's restoration decisions. Although 90% of the landowners in the survey reported receiveing *financial assistance* for wetland restoration, only 10% reported this factor to be extremely important in their decision to participate in wetland restoration. The authors suggest that high variation in the attitudes among landowners with respect to receiving financial *assistance* indicated that a reduction in easement payments or help with restoration would decrease the likelihood of participation. After examining landowners opinions as to why other landowners do not participate in wetland restoration activities, the authors found that "dislike of government programs" and "unaware of restoration programs" were the primary reasons.

Forshay et al. (2005), based on data covering four counties in south-central Wisconsin, examined ecological monitoring data in relation to perceptions among landowners regarding the federally funded Wetlands Reserve Program (WRP). As a part of this study, the researchers surveyed former and current landowners to assess landowner satisfaction with the restoration process, participation in planning and implementation, reasons to enroll in the WRP, and activities within the restoration sites. The authors assumed that economic and ecological factors were related to satisfaction and pointed out that participation in the WRP was influenced by *perceived opportunity costs*, *program payments*, and *land quality*. Survey results indicated that an increase in agricultural benefits tended to decrease participation while an increase in the net benefits of wetland restoration increased participation. Landowners opinions and satisfaction with the program were also found to influence restoration participation. In addition, the authors employed logistic and ordinal logistic regression models to identify factors influencing a landowner's decision on restoration enrollment. The results indicated that several factors

motivated landowners to enroll in the WRP including: (1) *protection of the environment*, (2) *economic incentives*, and (3) *recreational opportunities*. The *recreational opportunities* reflected nonmonetary benefits such as *recreation and protection of land*, and that these nonmonetary benefits were weighted more heavily than other factors by landowners when deciding whether to participate in the WRP program.

Concerning risk perception, Dedah (2010) investigated the factors that influence private landowners to invest in coastal wetland restoration and maintenance activities in Louisiana. He surveyed private coastal landowners to determine their general socioeconomic characteristics, attitudes toward risks, attitudes toward wetland conservation, current uses of landholdings, and previous investments in wetland restoration and maintenance projects. Based on this survey data, he used two econometric models - the Tobit and double-hurdle model, to determine how various factors influence the probability and the level of investment in coastal restoration.[14] A likelihood ratio test was then employed to determine which of the two specifications was, from a statistical viewpoint, more appropriate. Based on the results from the likelihood ratio test, the researcher concluded that the double-hurdle model was the appropriate model with the implication being that the decision to invest in wetland restoration and the level of investment are determined by different processes. The double-hurdle results indicated that degree of risk aversion plays an important role in landowner's decisions to invest in wetland restoration and maintenance activities. Specifically, the level of investment in wetland restoration and maintenance projects decreases in association with the level of risk averseness exhibited by the landowner. Furthermore, landowners with properties in risk-prone areas along the coast were found to be

[14] The Tobit model is based on the assumption that the decision whether or not to invest and the level of investment are made simultaneously while the double-hurdle model is based on the assumption that the two decisions are determined sequentially.

less likely to invest in wetland restoration than among those landowners with properties in less risk prone areas. In addition, factors including *property size, attitudes toward wetland restoration and maintenance, income related to the property, participation in government wetland programs, ownership structure*, and *land use* were found to significantly influence a landowner's decision to invest in wetland restoration and maintenance in coastal Louisiana.

In an international context, Söderqvist (2003) used a mail questionnaire instrument from a random sample of 200 Swedish farmers who live in the Kavlinge River drainage basin to determine the willingness to participate in a catchment-based program for wetland creation in an agricultural district in Southern Sweden. Based on data obtained from this survey, the author examined farmer's motivations to participate in this program using a Probit regression model. Four groups of explanatory variables, scale of farm operation characteristics, geographical location of the farm, the farmer's characteristics, and subjective values and beliefs, were considered in the model. The results from the Probit regression analysis indicated that *perceptions of public environmental benefits* was an important factor influencing a farmer's willingness to participate. These perceptions were in turn likely to depend on a farmer's knowledge of how nature works and what information he/she had received. The results also showed that *attitudes* and *perceived advantages and disadvantages* were important factors in determining a farmer's willingness to participate in the wetland restoration program, while the factor *more associated with farm profitability* was not found to significantly influence the likelihood of participation. The author pointed out that *perceived advantages and disadvantages* would have a strong impact if private agricultural benefits were the dominant motive for participation. In addition, *age* was found to significantly influence a farmer's decision. This

study concluded that besides financial factors, private and public environmental benefits were also important related to participation decisions.

To quantify perceived costs among landowners within the Prairie Pothole Region of Saskatchewan in Canada, Yu and Belcher (2011) estimated the compensation required for private landowners to conserve wetland and riparian zones and evaluated the influence of farm characteristics and landowner attitudes on conservation decisions. They surveyed a total of 4,110 landowners in two distinct regions and the overall effective response rate for the two study sites was 6.1% resulting in a total of 212 completed surveys used for economic analysis. Two econometric models, a binary Probit model and a multinomial Probit model, were employed to evaluate the willingness to accept compensation for conserving riparian areas based on a proposed 10-year payment program. Results from the binary and multinomial Probit analyses suggested that the *magnitude of the conservation payment* was an important factor driving a landowner's conservation adoption decision. A one dollar per acre increase in the annual conservation payment was found to increase the probability of acceptance of the payment by 0.6% and 0.8% for the binary model and multinomial Probit model, respectively. The variable *farm size* was found to significantly influence the likelihood of participation in both models. The results indicated that landowners of small farms (defined as land area less than average farm size of 1,719 acres) were more willing to adopt the wetland conservation contract than other landowners. Farmers perceptions of private costs and benefits associated with the wetlands were also found to influence attitudes toward conservation. Farmers who believe wetlands are beneficial and provide a perceived private benefit were found to be more likely to participate in the conservation program and/or would be willing to do so for a lower payment. The coefficient associated with the variable *wetland important for wildlife* was found to be negative and

significant in the multinomial Probit model, suggesting that landowners who believe that wetlands are important for wildlife will be less willing to adopt wetland conservation. The authors found that the *age* of the landowner did not significantly influence the landowners' decisions in the binary Probit model, while *age* was found to significantly and negatively impact on the probability of adopting wetland and riparian conservation in the uncertain multinomial response model. This implied that younger landowners were more likely to participate in wetland conservation program, while older landowners were less likely to adopt wetland and riparian conservation. This research also suggested that *financial incentives* might be quite costly and ineffective if it was the only policy in use.

In the same time period, Zhang et al. (2011) examined the main factors that influence farmer's willingness to participate in the conversion of cultivated land to wetlands (CCW) among farmers in Northern China. A total of 330 households were randomly selected in 11 villages that were chosen from the list of households provided by the Sanjiang National Nature Reserve (NNR) Administration. This study received a high response rate (94%) by using face-to-face interview with a local manager cooperation. Of the distributed questionnaires, 310 completed surveys were returned. Based on the data collected from the questionnaire, a binary logistic regression analyses was used to determine which factors influenced farmer's willingness to participation in the CCW project. The results indicated that *age* had a negative impact in explaining the level of participation, implying that older famers were less likely to participate in restoration project. The *level of education* was found to have a positive influence on the probability of participation. Farmers without cultivated land and/or with lower annual income were also found to exhibit more positive attitudes towards wetland restoration. This study also suggested that geographical location and the perceived benefits and risks were relevant factors in

determining participation. The amount of cultivated land and geographical location influenced the main income sources of local farmers. The results indicated that attitudes whether or not to support the restoration project were associated with farmers' agricultural lifestyle and economic conditions. The results further showed that farmers perceptions towards the benefits and risks associated with wetland restoration implied that individuals had different perceptions and attitudes towards the CCW project. Farmers were more positive to the restoration project if they were aware of the benefits associated with their participation and were more aggressive to the project if they paid more attention to risks associated with their participation. Furthermore, the authors pointed out that it would encourage famers participation if the government provide fair compensation.

More recently, Guan et al. (2015) explored whether a farmer's willingness to participate in Poyang lake wetland restoration (the largest freshwater lake in China and one which provides a large buffer for flood management in several provinces in the Middle and Eastern China as well as providing wildlife habitat) was influenced by information about wetland functions and benefits. The in-person interviews, which included a wetland educational video, drawn from a random sample of 1,009 individuals with farms in and around the wetlands were conducted by the China Agricultural Survey Service Jiangxi Field Office. Information collected during the interview process included each farmer's attitude to participate in wetland restoration program before and after watching the education video, as well as each farmer's socioeconomics and demographics characteristics. In this survey, a farmer's willingness to participate was measured in a 5-point Likert scale (with 1 indicating extremely not willing to participate and 5 indicating extremely willing to participate). The authors first compared the information treatment effect

using the paired t-test as well as the propensity score matching (PSM) approach.[15] This study suggested that after watching the video, willingness to participate in the restoration project improved by one level (from "willing" to "extremely willing" with the increase from one level to the next being statistically significant). Furthermore, ordered Probit and a binary Probit analyses were conducted to investigate how individual farmer characteristics and/or farmer household attributes may influence willingness to participate and the information treatment, respectively. Results from ordered Probit regression analysis indicated that *information* was found to significantly and positively affect willingness to participate. In addition, *gender, number of seniors in the household* and *number of migrant days away from home* were found to positively associate with willingness to participate while *number of agricultural laborers in the household* and *farmland size* were found to negatively associate with willingness to participate. The authors concluded that *education information* has a positive effect on the program participation and suggested that government educational program could effectively enhance farmer participation in the wetlands restoration program.

2.4.2 Factors Affecting Landowner's Participation in Different Conservation Programs

Aside from the above studies that focused on wetlands, a number of other studies have been conducted examining those factors leading to participation in various land conservation programs. Kraft et al. (1996) explored farmer's willingness to participate in the USDA's Water Quality Incentive Program (WQIP), which was held as the centerpiece of the 1990 farm bill's nonpoint source reduction mandate. From a selected sample of 2,067 farmers whose properties are critical for surface or groundwater quality located in ten diverse counties in the Corn Belt

[15] Propensity score matching (PSM) is a statistical matching approach to estimate the causal effect of a treatment and to reduce the bias (Rosenbaum and Rubin 1983).

Region (Midwestern United States), a total of 770 completed surveys were returned and used for economic analysis (an overall effective response rate of 37%). Based on this survey data, the authors employed a binomial logistic regression analysis to determine the factors influencing a farmer's willingness to participate in the WQIP. Results from the regression analysis indicated that (1) *farmers' attitudes toward governmental involvement with wetland regulation*; (2) *education*; (3) *tenure status*; (4) *contact with Natural Resources Conservation Service (NRCS)*; and (5) *percentage of farm sales derived from specialty crops* were found to significantly influence the likelihood of participate in the WQIP. Specifically, more educated farmers who had more positive attitudes toward wetland regulations, who had more contact with an NRCS expert, and who had a larger percentage of their gross farm income from specialty crops were more likely to participate in restoration programs. Meanwhile, *private landownership* was found to have a positive impact on the willingness to participate in incentive programs. The authors pointed out that trust plays an important role for landowners to participate in the NRCS-sponsored WQIP.

By using the Agricultural Resource Management Survey (ARMS) annual data from 2001 to 2003, Lambert et al. (2007) determined the factors that influence a farm household's decision to participate in conservation programs. A cumulative Probit regression was used to determine the likelihood of participation. For analysis, the variables including the business, operator, and household characteristics of farms and three practices group were constructed for comparison purpose.[16] In addition, the authors employed a multinomial logit regression to determine the factors of farm structure, household, and environmental characteristics that influence a

[16] See Lambert et al. (2007). These practices included standard practices, decision aids, and information/management-intensive practices.

landowner's decision whether or not to participate in the conservation practices. Results from the cumulative Probit regression analysis indicated that *cattle/dairy, cost/output ratio, tenure, off-farm income share, retired, dual off-farm income, share income with other household, wetland,* and *manufacturing share,* were found to significantly influence the likelihood of a farm operator using one or more conservation techniques. Results from the multinomial logit regression analysis indicated that variables: *high value* crops, *grain crop, hogs, asset turnover ratio, commodity payments, female operator, operator works off farm, spouse works off-farm, dual off-farm income, retired,* and *manufacturing,* were found to significantly influence the likelihood of a farm operator participating in conservation practices. This research suggested that smaller farms and specialty operators were less likely to participate in intensive practices but were more interested in flexible practices.[17] Furthermore, the authors pointed out that the expert advice plays an important role in prompting participation in specialized conservation practices.

A body of literature also examines those factors hypothesized to influence participation in forest management and investment decisions among nonindustrial private forest (NIPF) landowners (Greene and Blatner, 1986; Romm et al. 1987; Bliss and Martin, 1990; Nagubandi et al. 1996; Erickson et al. 2002; Elwood et al. 2003). Joshi and Arano (2009) extended the emphasis of landowner studies and investigated landowners participation decision in several forest management activities.[18] The authors used a mail survey from a randomly selected sample of NIPF landowners of West Virginia and achieved a response rate of 20%. A binary logistic regression was employed for each of the activities to determine the factors affecting an NIPF

[17] Special operators refer to those people who consider themselves retired or whose primary occupation is something other than farming. Flexible practices refer to those practices that save time and effort and do not require major changes in established practice (Lambert et al. 2007).
[18] These forest management activities include timber harvest, silvicultural activities, property management activities, and wildlife habitat management and recreation improvement activities (Joshi and Arano 2009).

landowner's decision. The results suggested that the model used for property management activities explained 31% of the variation, while the models explained less than 30% variation for the other three activities. Meanwhile, variables including landowner characteristics, ownership, and management characteristics were found to significantly influence the probability of the participation decisions.[19]

A study by Matta et al. (2009) observed the willingness among Florida non-industrial private forest owners to participate in a conservation program that required restrictions beyond the existing regulations for silvicultural best management practices (BMPs) in return for financial incentives. The authors used a random sample of 1,500 landowners in four counties in North Florida who owned at least ten acres of land.[20] This research employed a multinomial logit model to determine the factors affecting the probability of participation. The results from the regression analysis indicated that *age*, *income*, *education*, *years of ownership*, *property location*, *place of residence*, and *membership of forestry* were found to significantly influence participation. Specifically, more educated younger owners who had a higher incomes and had more years of forestland ownership were more likely to participate in forest practices. Landowners who were a member of forestry or conservation organization and lived on the property and the land located rural area, were found to have a higher probability of engaging in a conservation program. In addition, the authors found that the mean incentive payment was about $95 per ha per year and found that the mean willingness to accept payments ranged from $37 to $151 /ha/year.

[19] See Joshi and Arano (2009). These variables include *age*, *education*, *profession*, *income*, *ownership size*, *period of forestland acquisition*, *distance of the forestland to the place of residence*, *whether the forestland was purchased or acquired through inheritance or as a gift*, *primary objective of forestland ownership*, and *presence of a written forest management plan*.

[20] See Matta et al. (2009). These counties include Alachua, Putnam, Walton, and Bay.

In terms of voluntary programs targeting resource conservation on private land, Kauneckis and York (2009) examined private landowner participation in voluntary forest conservation programs.[21] From a random sample of 7,780 landowners, a total of 490 landowners were interviewed by a research team in Monroe County with an overall effective response rate of 53%. A binary logistic regression was employed to evaluate the factors that influence the probability of participation. In order to account for problems associated with endogeneity, two different two-stage models were employed for mixed agriculture, forest and residential uses (AFR), and mix forest and residential uses (FR), respectively. Results from the binary logistic regression analysis suggested that variables: *total other acres owned in state, parcel size, membership in non-forest program*, and *distance to urban area*, were found to significantly influence the probability of participation in voluntary forest conservation programs. The two-stage regression model from AFR land use suggested that variables: *total other acres owned in state, parcel size, membership in non-forest program, distance to urban area*, and *forest acres*, were found to significantly influence the probability of participation in voluntary forest conservation programs for AFR land use. The two-stage regression model from FR land use suggested that variables: *total other acres owned in state, membership in non-forest program*, and *distance to urban area*, were found to significantly influence the probability of participation in voluntary forest conservation programs for FR land use. The authors pointed out that landowners who used a parcel for forest, forest with agricultural, and a combination purposes were found to be less likely to participate in conversation programs than landowners who used the parcel for residential.

[21] Forest land use refers to forest uses only (F), forest use combined with residential use (FR), forest with agricultural use (AF), and a combination of forest, agricultural and residential uses (AFR) (see Kauneckis and York 2009).

Similar to the voluntary programs examples, a number of factors have been identified as important regarding ecosystem services conservation efforts. Vignola et al. (2010), in an analysis of those factors determining participation in a soil conservation program in the Birris watershed in Costa Rica, surveyed private farmers to determine their general socioeconomic characteristics, beliefs associated with soil management, attitude toward risk associated with soil management, and attitude to values associated with soil management variables. Based on this survey data, the authors used a factor analysis method to determine how various factors influence the level of soil conservation among three different farmer groups.[22] Results from the analysis suggested that there was a negative relationship between risk perception of impacts of agricultural activities on erosion and values regarding short-term benefits of erosion with conservation effort. The results also suggested that variable with interaction terms were found to significantly influence farmers decisions regarding the soil conservation program. The authors suggested that an efficient soil conservation program should consider a complex set of factors to better promote participation among farmers in the region. The authors also suggested that providing technical assistance plays an important role in promoting participating in soil conservation practices.

Based on a random sample of 695 farmers, Greine (2015) surveyed pastoralists in the tropical savanna rangelands in Australia during April-July 2013 f. Based on the survey data, the author used factor analysis to explain how attitudinal and motivational variables influence farmers choices whether to participate in conservation contracts focusing on the agri-environmental (payment-for-environmental services) schemes (AES) across north Australia. A mixed multinomial logit and latent class (LC) models were used to determine factors (contract

[22] Three farmer groups were constructed in this analysis based on the location of farmers.

attributes, business characteristics, and farmer's motivations and attitudes) that influence the decision process among farmers.[23] The mixed multinomial logit model suggested that contract attributes were found to significantly influence participation while the LC models showed that attitudinal profiles were found to influence farmers intentions of undertaking protection contract. The author pointed out that program education was an important factor in promoting landowner participation in private conservation and highlighted that motivations and attitudes were significant in the decision-making process.

2.5 Summary

General factors that influence landowners decisions regarding participation in various conservation/restoration programs have been reviewed and identified in this chapter. With an increasing understanding of the importance of wetlands, the United States government provides rules, regulations, and incentives to guide (and restrict) private landowners regarding preservation and conservation 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 summary, 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 socio-economic factors are important. The various studies described in the above literature review give an overall picture of the factors associated with landowners participation. Economic incentives (program payments), education, wildlife habitat,

[23] Latent class model is a statistical method to identify unobservable subgroup using categorical and/or continuous observed variables.

recreation, and protection had, in general, a positive influence on the participation decisions. Institutional programs promoting technical assistance and availability of expert advice should be strengthened given their positive effect.

This chapter discussed the wetland related policy and regulations and focused on identifying the factors that affected private landowners decisions to participate various land conservation programs. The next chapter will present the basic theoretical framework for landowners decision making process.

CHAPTER 3 THEORETICAL PERSPECTIVE

3.1 Introduction

This chapter presents a limited view and discussion of the theoretical methodologies that describe individual participation decision process and will be utilized in Chapters 4, 5 and 6. Chapter 2 previously outlined the literature in the area of landowners participation with a particular focus on the literature that uses survey data. A number of alternative methodologies used in the current literature were discussed and put forward as options for the analyses of the landowner survey data. Landowners may have to decide whether they will participate in income-generating activities on their property and if so, what is the level of participation maximize their optimal income derived from these activities over time. The traditional utility theory have been developed to analyze landowners behavior. The conceptual model of landowners participation in this dissertation rests on a behavioral theory of utility theory. Section 3.2 presents a brief view of theoretical framework of utility function used in household' decision process. Section 3.3 extends the basic utility theory to the expected utility method and Section 3.4 discuss the net present value rules and the choice of discount rate, while the final section of this chapter gives a brief summary.

3.2 The Utility Theory

The concept of utility is central to theories of decision making. Utility theory is the foundation of neoclassical economic demand theory. This theory states that consumption of goods or services provides satisfaction, or utility, to consumers. With a limited budget constraint (wealth or income), individuals face the problem that how to allocate purchases out of that budget constraint to maximize utility. A number of utility theories have been developed to

analyze households' behavior. The basic hypothesis of utility maximization is that a rational household will always choose a most preferred bundle from set of feasible alternatives as long as certain properties (completeness, transitivity, and non-satiation) are satisfied.

Consider the problem in this research: the rational landowners know when they choose to participate in income-generating activities on their properties and how much expected income could be derive from these participation. Landowners seek to make the most of the available opportunities given the limited resource they face. According to utility theories (Keeney and Raiffa 1976; Von Winterfeldt and Edwards 1982), landowner's behavior is characterized by a set of attributes (e.g., physical characteristics of the property and socioeconomic characteristics of the landowner). The landowner assesses his subjective value or utility for each attribute on the option to participate in income-generating activities. Finally, the overall evaluation of the option is based on a weighted combination of its utilities, and the option producing the greatest evaluation is chosen. In microeconomics, the utility maximization problem is the problem consumers maximize their utility with limited resource. The traditional utility (U) maximization problem faced by the household can be expressed as

$$\max_{x_1,\cdots,x_n} U(x_1, x_2, \cdots, x_n)$$

$$s.t. \sum_{i=1}^{n} p_i x_i \leq Y \qquad (1)$$

where p_i is the price of the ith elementary goods, n is the total number of goods, and Y is the landowner's income. The idea here is that the individual chooses a vector of inputs $x=(x_1,\ldots,x_n)$

to maximize his/her utility subject to the budget constraint that says he/she cannot spend more than his/her total wealth. Assume an individual chooses a set of inputs, *x*, to maximize his/her utility and there is no set of *x'* from the alternative where *U(x') > U(x)*. Then, the marginal utility is given by $MU_X = \frac{\partial U}{\partial x_i} > 0$, which means the additional satisfaction one receives by adding one more unit of a good. In general, utility from adding goods follows a pattern of diminishing marginal utility. As more and more of a good is added, each new unit gives some utility but less than the previous unit. Another important term in utility theory is marginal rate of substitution (MRS). The idea of the marginal rate of substitution is that it is a measure of the willingness of individuals to trade less of one input for more of the other, keeping their level of satisfaction constant. If an individual is adding such that his/her utility is maximized, two conditions must be satisfied. He/she must be spending all of his/her budget (otherwise, she could get more utility by adding more) and his/her MRS must equal the ratio of prices, Px_1/Px_2. The price ratio represents the opportunity cost of one more unit of *X1* in terms of *X2*. So, in words, this last condition means that he/she must be willing to give up *X2* to get *X1* at the same rate as the opportunity cost of *X1*. This is just another way to say his/her marginal utility per dollar is equal for both goods $MRS = \frac{MU_{X1}}{MU_{X2}} = \frac{p_{x1}}{p_{x2}}$.

This theory can be used to explain how a landowner to attain his/her maximum utility under limited budget and other constraints. Applying the utility maximization theory to this study, landowners maximize their utility (level of income derived from income-generating activities) subject to the physical characteristics of the property and socioeconomic characteristics of the landowner constraints. And landowners will achieve his/her maximum utility given that the certain conditions met (e.g., marginal utility of one input over another one

equal to the price ratio). The neoclassical theory predicts that consumer demand will represent this optimizing behavior for all goods and services under their limited budget. This model does a good job of representing the incentives facing individuals and adjustments individuals make in response to changes in prices, income where risk and uncertainty are not usually mentioned (Kahneman and Thaler 2006). The maximization problem, however, is presented as static in this case. That is, the budget is exhausted entirely with current purchases in order to maximize current utility. So there is no sense of forward-looking decisions or savings out of a budget in order to provide future utility. Further, this static framework is limiting if individuals want to talk about decisions today which generate or affect utility in the future with uncertainty. In reality, landowners make their decision to participate in income-generating activities often facing the conditions of uncertainty, which have effects on the economic decision. Landowners have to account for the uncertainty from the changes of physical and socioeconomic conditions for their decision. Therefore, expected utility theory could be more appropriate associated with decision making process in income-generating activities.

3.3 The Expected Utility

As mentioned, the desired revenue derived from participating in income-generating activities is subject to different sources of uncertainty including the changes of physical conditions of property, the changes of socioeconomic status of landowners, the changes of policy instruments, the changes of market demand, and natural disaster (e.g., hurricane). Suppose a landowner consider to participate in income-generating activities on his/her properties (comprised by wetland and other type of land) at time t, let W_t be the total acreage of wetland used for income-generating activities and assume the uncertainty is the probability of hurricane

occurrence, h, defined as a random variable.[24] The $C(T_t; h)$ is the net cost (include both fixed and variable costs) associated with the participation and $I(W_t; h)$ represents the optimum annual income (net income) derived from income-generating activities on his/her wetland parcel.

Based on the expected utility function developed by Von Neumann and Morgenstern (1944, 1947, and 1953), the present value of expected utility function can be written as

$$NEU = \int_0^{\infty} e^{-rt} EU[I(W_t; h) - C(T_t; h)]dt \tag{2}$$

where *NEU* represents the present value of expected utility, r is the discount rate, and t is the year. The $U(\cdot)$ is the individual's von Neumann-Morgenstern utility function and this function can be generalized to three distinct groups based on their risk preferences. $EU(\cdot)$ exhibits risk aversion if and only if $U(\mathrm{x})$ is a concave function of x (diminishing marginal utility function). $EU(\cdot)$ exhibits risk seeking (or loving) if and only if $U(\mathrm{x})$ is an increasing function of x (increasing marginal utility function). $EU(\cdot)$ is risk neutral if and only if $U^*(\cdot)$ is a concave transformation of $U(\cdot)$ (a linear utility function). Thus, a landowner will chose to participate in income-generating activities given that the *NEU* is positive (i.e., the expected discounted utility of the derived income exceeds the discounted utility of the costs). The expected value gives a way to measure the relative value of particular choices when considering risk or uncertainty and provide useful information to evaluate different choices (Arrow and Lind 2014).

[24] Total acreage of wetland used for income-generating activities is the difference between total acreage of land (T_t) owned by the landowner and total acres not used (TN_t) for income-generating activities (include non-wetland (N_t) and wetland not used for income-generating activities (WN_t)). The non-wetland acreage is zero in the case of total acreage of land are all wetland.

In the cases some uncertainty or risk involved in a participation decision, individuals need to adapt this idea to incorporate the probabilistic nature of a range of possible outcomes. As it stands, expected utility theory is widely used in theoretical and practical analysis. A number of recent studies have been conducted using this approach associated with landowners decision. Feder and Onchan (1987) used the expected utility approach associated with the attitude of risk averse to estimate the impact of land ownership security on farm investment and land improvements. A few years late, Feder et al. (1992) applied the expected utility framework to evaluate the importance of factors related to tenure security, farm size, and credit availability in determining farmers' decision on agricultural investment. To investigate factors affecting off-farm investment of farm households, Mishra and Morehart (2001) used the framework of von Neumann-Morgenstern utility function that recognizes risk and assumed the farmer is to maximize the expected value of a subject to an income constraint. Based on the expected utility theory, Adams (1998) explored the effects of remittances on the accumulation of physical assets in one rural area. In the context of wetland restoration and maintenance, landowners face substantial levels of uncertainty about how future climatic, economic, and institutional factors that will affect the level of income derived from participating income-generating activities and payoffs from their investments. Dedah (2010) employed the expected utility framework through hypothetical investments distributions with different levels of risk and expected net returns to measure the risk preferences of landowners. Isik and Khanna (2003) used a nonlinear mean-standard deviation expected utility function to determine the impacts of risk aversion and uncertainty about weather and soil conditions on the decision to adopt site-specific technologies and the levels of cost-share subsidies required to induce adoption. Furthermore, the potential impact of risk aversion on investment decisions in the presence of uncertainty has been

empirically explored using the expected utility framework (Koundouri et al. 2006; Kim and Chavas 2003; Antle 1983).

Although the expected utility approach has been widely used and accepted in various scenarios, it is not without its flaws. In particular, many experiments have shown that people routinely violate the behavioral axioms (Quiggin, 1982; Machina 2009). Kahneman and Tversky (1979) pointed out that among other things, how preferences of individuals are inconsistent among same choices, depending on how those choices are presented in their prospect theory. Anand (1995) stated that rationality does not require transitivity, independence or completeness and argued that despite the normative and evidential difficulties the general theory of decision-making based on expected utility is an insightful first order approximation that highlights some important fundamental principles of choice, even if it imposes conceptual and technical limits on analysis which need to be relaxed in real world settings where knowledge is less certain or preferences are more sophisticated. Despite arguments shown that expected utility theory have some shortcoming, the expected utility model could be used as the basic model for landowners decision to participating in income-generating activities in this study.

Assume landowners can maximize the expected present value of net income from participating in income-generating activities by choosing optimal level of wetland (W_t) used for these activities. Thus, maximize equation (2) subject constraints that the total acre of wetland used for income-generating activities is the difference between total acreage of wetland owned by the landowner and the total acreage of land not used for income-generating activities (i.e., $W_t = T_t - TN_t$). The landowner's optimal expected level of income can be found by solving the Hamiltonian

$$H = EU[I(W_t; h) - C(T_t; h)] + \lambda(T_t - TN_t) \tag{3}$$

Then, the first-order conditions for maximization are

$$\dot{H_{T_t}} = E\left\{U'(\cdot)\left(\frac{\partial I(W_t;\ h)}{\partial T_t} - \frac{\partial C(T_t;\ h)}{\partial T_t}\right)\right\} + \lambda = 0 \tag{4.1}$$

$$\dot{H_{TN_t}} = E\left\{U'(\cdot)\frac{\partial C(T_t;\ h)}{\partial TN_t}\right\} - \lambda = 0 \tag{4.2}$$

$$\dot{H_{W_t}} = E\left\{U'(\cdot)\frac{\partial I(W_t;\ h)}{\partial W_t}\right\} + \lambda = 0 \tag{4.3}$$

$$\dot{H_{\lambda}} = T_t - TN_t = 0 \tag{4.4}$$

Rearranging equation (4.1) and substituting lambda with equation (4.2) yields

$$E\left\{U'(\cdot)\left(\frac{\partial I(W_t;\ h)}{\partial T_t} - \frac{\partial C(T_t;\ h)}{\partial T_t}\right)\right\} = -E\left\{U'(\cdot)\frac{\partial C(T_t;\ h)}{\partial TN_t}\right\} \tag{5}$$

Applying the formulas that *Cov(X,Y) = E(XY) - E(X)E(Y)*, *E(X+Y) = E(X) + E(Y)*, and *Cov(X,Y₁+Y₂) = Cov(X,Y₁) + Cov(X,Y₂)* yields

$$\begin{aligned} &EU'(\cdot)E\left(\frac{\partial I(W_t;h)}{\partial T_t} - \frac{\partial C(T_t;h)}{\partial T_t}\right) + Cov\left(U'(\cdot),\left(\frac{\partial I(W_t;h)}{\partial T_t} - \frac{\partial C(T_t;h)}{\partial T_t}\right)\right) \\ &\qquad = -EU'(\cdot)E\left(\frac{\partial C(T_t;h)}{\partial TN_t}\right) - Cov\left(U'(\cdot),\left(\frac{\partial C(T_t;h)}{\partial TN_t}\right)\right) \end{aligned} \tag{6}$$

Simplifying equation (6) yields

$$E\left(\frac{\partial I(W_t;h)}{\partial T_t}\right)$$

$$= E\left(\frac{\partial C(T_t;h)}{\partial T_t}\right) - E\left(\frac{\partial C(T_t;h)}{\partial TN_t}\right) \tag{7}$$

$$+ \frac{Cov\left(U'(\cdot), \frac{\partial C(T_t;h)}{\partial T_t}\right) - Cov\left(U'(\cdot), \left(\frac{\partial I(W_t;h)}{\partial T_t}\right)\right) - Cov\left(U'(\cdot), \left(\frac{\partial C(T_t;h)}{\partial TN_t}\right)\right)}{EU'(\cdot)}$$

The left-hand side of equation (7) stands for the expected marginal income associated with the level of wetland used for income-generating activities. The first term on the right-hand side of equation (7) represents the expected marginal cost associated with total land owned by the landowner, while the second term on the right-hand side is the expected cost associated with the land that not used for income-generating activities. The third term on the right-hand side exhibits landowners preference toward risk. The positive and negative of this term represented landowners risk preference of risk aversion and risk seeking, respectively. Therefore, risk aversion landowners would chose to participate in income-generating activities on their wetland parcels if the expected marginal income associated with the level of wetland used for income-generating activities excessed the marginal cost associated with the total land minus the cost associated with the land that not used for income-generating activities and the additional risk cost associated with the participation.

3.4 The Net Present Value Rule

A traditional decision making rule is the net present value rule (NPV). The NPV approach calculates the present value of a series of different future costs and benefits. In the NPV function, costs and benefits of a project need to be identified with the same units and appropriate discount rates should be taken into account. Then the NPV can be calculated to make

comparison between or among alternatives. Assume Net present value (NPV) is the value of all projected net benefits in today's dollar terms from an action (participate in income-generating activities). The basic ideal of the NPV rule applied to this study is that the landowner should participate in income-generating activities if the expected income derived from these activities exceeds the cost of participation; and the landowner will not consider to participate in these activities if the expected income derived from these activities less than the cost of participation. Projected net benefits are simply the sum of benefits minus costs in each time period under a specific discount rate. The equation is given by:

$$NPV = \sum_{t=0}^{T} \frac{B_t - C_t}{(1+r)^t} = \sum_{t=0}^{T} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{T} \frac{C_t}{(1+r)^t} = PVB - PVC \quad (8)$$

where B_t is the sum of benefit in time *t*, C_t is the sum of cost in time t, *r* is the discount rate and *t* is the year. *PVB* and *PVC* stand for total present value of benefit and total present value of cost, respectively.

The major factors affecting present value are the time and the discount (interest) rate. The change in the discount (interest) rate would have a significant effect on net present value analysis. In theory, it is not difficult to solve these problems. Comparison can be made between the costs and benefits when they are discounted. In equation 8, the *PVB* and *PVC* received in time *t* with discount rate *r* ($0 \leq r \leq 1.0$). A higher discount rate means a greater preference for things now rather than later (Hanley and Spash, 1993). The lower discount rate reflects simply a less intense preference for the present and does not reflect a preference for the future over the present (Uyar 1993). Although discounting is the most appropriate method for accumulating

costs and benefits over time, it is sometimes difficult to identify a consensus discount rate when assessing a project with a long time horizon. If using common discount rates between 4% and 10%, the costs or benefits in a very long time horizon often have little impact on NPV (Holland et al. 2010).

Following Parks (1993), Zhao and Ziberman (1999), and Dedah (2010) model specifications, assume a risk neutral landowner consider to participate in income-generating activities on his/her properties (comprised by wetland and other type of land) at time t, let α be describe physical characteristics of property and socioeconomic characteristics of landowner that influence the level of income derived. The $C(T_t; \alpha)$ is the net cost (include both fixed and variable costs) associated with the participation and $I(W_t; \alpha)$ represents the optimum annual income (net income) derived from income-generating activities on his/her wetland parcel. Assume the net income function $I(\cdot)$ is increasing and concave (e.g., $\partial I(\cdot)/\partial(W_t) > 0$ and $\partial^2 I(\cdot)/\partial^2(W_t) < 0$). The landowners can maximize the present value of net income from participating in income-generating activities by choosing optimal level of wetland (W_t) used for these activities, to maximize

$$NPI = max \int_0^{\infty} [I(W_t;\ \alpha) - C(T_t;\ \alpha)]e^{-rt}dt \tag{9}$$

subject to a constraint that describes the flow of wetland acreage used for income-generating activities at the end of period $t(\dot{W}_t)$,

$$\dot{W}_t = T_t - TN_t;$$

Landowners optimal level of income can be found by solving the Hamiltonian equation

$$H = [I(W_t;\, \alpha) - C(T_t;\, \alpha)] + \lambda(T_t - TN_t) \tag{10}$$

Then, the first-order conditions for maximization are

$$\dot{H_{T_t}} = \frac{\partial I(W_t;\, \alpha)}{\partial T_t} - \frac{\partial C(T_t;\, \alpha)}{\partial T_t} + \lambda = 0 \tag{11.1}$$

$$\dot{H_{TN_t}} = \frac{\partial C(T_t;\, \alpha)}{\partial TN_t} - \lambda = 0 \tag{11.2}$$

$$\dot{H_{W_t}} = \frac{\partial I(W_t;\, \alpha)}{\partial W_t} + \lambda = 0 \tag{11.3}$$

$$\dot{H}_{\lambda} = T_t - TN_t = 0 \tag{11.4}$$

Rearranging equation (11.1) and substituting lambda with equation (11.2) yields

$$\frac{\partial I(W_t;\, \alpha)}{\partial T_t} = \frac{\partial C(T_t;\, \alpha)}{\partial T_t} - \frac{\partial C(T_t;\, \alpha)}{\partial TN_t} \tag{12}$$

The left-hand side of equation (12) shows that the marginal income associated with the level of wetland used for income-generating activities, while the first term on the right-hand side of equation (12) represents that the marginal cost associated with total land owned by the landowner (first term) minus the cost associated with the land that not used for income-generating activities (second term). Therefore, landowners could optimize the net income by choosing a level of wetland $T_t = T_t^*$ used for income-generating activities under the conditions that the marginal income associated with the level of wetland used for income-generating activities excessed the marginal cost associated with total land minus the cost associated with the land that not used for income-generating activities.

3.5 Summary

This chapter provided a brief review on the theoretical analysis of household decisions. The common assumption is that landowners maximize their utility under a set of constraints. Based on the theory of utility maximization, landowners make their decision to participate in income-generating activities subject to the physical characteristics of the property and socioeconomic characteristics of the landowner constraints. Considering risk and uncertainty, landowners may have to decide whether they will participate in commercial-based activities on the wetland property and how to allocate their resources to achieve the optimal income derived from these activities over time. While the basic principle of utility maximization embodied in these decision rules underlie all economic models, the specification of net returns will vary with different decision context. These theories discussed in this chapter provide an organizing framework for understanding these questions: what are the decisions and how it should be made, and what are the factors influencing those decisions? The remainder of the dissertation develops an empirical context to test the theoretical implication. Next chapter will present the empirical model of landowner decision for participating income-generating activities on the wetland property.

CHAPTER 4 ECONOMETRIC SPECIFICATION

4.1 Introduction

The previous chapter provided a discussion of the theoretical considerations with respect to household decision behavior. This chapter presents the empirical model to estimate the factors that motivate private coastal landowners to participate in and generate income from their coastal wetland property. 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 (a function of location and attributes) and the characteristics of the landowner (including attitudes, opportunity costs, and ability to actively manage property). Taken together, these categories would be used to determine whether engaging in a given enterprise activity is considered desirable by a specific landowner and, if desirable, what is the intensity of participation (i.e., level of income derived) One main objective of this study is to examine the factors that motivate private coastal landowners to participate in and generate-income from their coastal wetland parcel. Since some of the 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 a large number of 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 these relationship. A number of empirical researchers have looked at factors influencing private investments decision using the discrete choice models with probit or logit estimators and, assuming a logistic or normal distribution, estimated the probability of a household's decision (Donatos 1995; Mishra and Morehart 2001; Petrick 2004; Romm et al. 1987; Soule et al. 2000; Koundouri et al. 2006; Norris and Batie, 1987; Featherstone and Goodwin, 1993; Hagos and Holden, 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 or not to invest fail to provide information about the level of investment in wetland restoration and maintenance. Since one of the primary objectives of this research 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, also called censored regression model (Tobin 1958), 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 and there are limitations with respect to the use of this model when the proportion of zero values for the dependent variable is significant. 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; Martinez-Espineira, 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. He proposes the two-stage estimation procedure (known as 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 is no zero observations in the second stage.

Cragg (1971) proposes the double-hurdle model, which generalizes the Tobit model by introducing an additional hurdle which must be passed before observing any positive values. Similar to 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 double-hurdle 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 double-hurdle 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).

As mentioned, the first stage of the double-hurdle model, or the first hurdle, in the current analysis represents the decision by a wetland owner whether or not to participate in income-generating activities, while the second stage represents the desired level of income. According to the assumption of the Heckit model, all the observed observations are positive in the second stage. In the double-hurdle model, however, there are zero observations which have potential

positive level of income. In this research, therefore, a double-hurdle model is presented as an empirical framework to examine the effects of various factors on both participation in and intensity of participation.

Section 4.2 briefly introduces the underlying theory of the Tobit model. The Heckit model is discussed in Section 4.3 and Section 4.4 outlines the empirical models used in the study. Section 4.5 discusses model specification, while the last section presents the summary and conclusion.

4.2 The Standard Tobit Model

The standard Tobit model is defined as

$$t_i^* = x_i\beta + v_i;\ v_i \sim N(0, \sigma^2) \tag{13.1}$$

$$t_i = \begin{cases} t_i^*\ if\ t_i^* > 0 \\ 0\ otherwise \end{cases} \tag{13.2}$$

where t_i^* is a latent unobserved endogenous variable which represents landowner *i's* desired level of income for participating in income-generating activities, t_i is the corresponding observed variable which measures actual level of income for a landowner i. x_i is a vector of potential explanatory variables that influence the landowner's decisions to participate in income-generating activities, and β is a vector of the associated parameters to be estimated. In this model, v_i is assumed to be a homoskedastic and normally distributed error term. The equation (13.2) implies that the observed desired level of income are positive continuous value if the positive level of desired income is realized, and no particular value of t_i is necessarily observed

when $t_i^* \leq 0$. Note that since there are no negative values for income, the dependent variable t_i could be censored at zero without any loss of generality. Therefore, the observed zero on the dependent variable can be either "true" zero (i.e. due to landowner's deliberate choice) or censored zero (i.e. caused by data collection methods). Essentially the Tobit model suggests that the latent variable t_i^* represents desired levels of income which for some landowners is unobservable. These unobserved desired levels of income are transformed to a single value representing zero level of observed income. The Tobit model therefore assumes that there are landowners with zero levels of income who would like to participate in income-generating activities (i.e. have a desired level of income). Compared to an OLS regression, the main advantage of the Tobit model is using both zero and positive observations. As such, it yields estimates that are unbiased as well as consistent.

Using maximum likelihood method, the likelihood function of standard Tobit is given by

$$lnL = \sum_{0} \ln\left[1 - \Phi\left(\frac{x_i\beta}{\sigma}\right)\right] + \sum_{+} \ln\left[\frac{1}{\sigma}\emptyset\left(\frac{t_i - x_i\beta}{\sigma}\right)\right] \quad (14)$$

where "0" under the summation sign denotes the summation over the zero observations in the sample (level of income t_i is zero) and "+" indicates summation over the positive observations (level of income t_i is positive); $\Phi(\cdot)$ and $\emptyset(\cdot)$ denotes standard normal cumulative distribution function and standard normal probability density function (*cdf* and *pdf*), respectively.

4.3 The Generalized Tobit Model (Heckit Model)

As mentioned, to correct the sample selection bias, which arises when interest centers on the relationship between independent and dependent variables but data are available only for the

observed positive values of the dependent variable, Heckman (1979) proposes the two-stage estimation method. The first stage estimates the participation decision and the second stage estimates for level of participation. According to Heckman (1979) and Flood and Gråsjö (1998), the standard Tobit model can be modified as

Stage 1: Participation decision

$$d_i^* = x_{1i}\beta_1 + u_i;\ u_i \sim N(0,1) \tag{15.1}$$

$$d_i = \begin{cases} 1\ if\ d_i^* > 0 \\ 0\ otherwise \end{cases} \tag{15.2}$$

Stage 2: Level of participation decision:

$$t_i^* = x_{2i}\beta_2 + v_i;\ v_i \sim N(0, \sigma^2) \tag{15.3}$$

$$t_i = \begin{cases} t_i^*\ if\ d_i = 1 \\ 0\ if\ d_i = 0 \end{cases} \tag{15.4}$$

In this specification, separate sets of factors are assumed to influence the decisions to participate in income-generating activities and the actual level of income from these activities. x_{1i} and x_{2i} are vectors of explanatory variables in the two stages of the decision, respectively. Hence, the model assumes that the decisions of participation and level of participation are affected by separated sets of factors. These variables are also assumed to be uncorrelated with their respective error terms (u_i and v_i). As in Tobit model, β_1 and β_2 are corresponding vectors of parameters. d_i^* is a latent variable that denotes binary censoring, d_i is the observed value representing the participation decision (i.e. $d_i = 1$ implying that the landowner reports

participation in income-generating activities on his property; otherwise it takes the value zero). Hence, the actual level of income t_i equals the unobserved latent value t_i^* only when a positive participation decision is reported; otherwise, it takes the value zero. In this case, the error terms u_i and v_i are assumed to be normally and independently distributed, which implies that there is no relationship between the two stages of decision.

Heckman (1979), however, assumes that the two error terms are correlated and the first stage dominates the second one. Therefore, the error terms follow the bivariate normal distribution

$$\begin{pmatrix} u_i \\ v_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{pmatrix}\right] \tag{16}$$

where ρ represents the correlation coefficient of the error terms. The domination assumption means the participation is a deliberate choice. Then the model is estimated by Probit for the decision on participation and standard OLS for the positive participation decisions. The log-likelihood function for the case that the error terms are correlated is given by

$$lnL = \sum_0 \ln\left[1 - \Phi\left(\frac{x_{1i}\beta_1}{\sigma}\right)\right] + \sum_+ \ln\left[\Phi\left(\frac{x_{1i}\beta_1 + \frac{\rho}{\sigma}(t_i - x_{2i}\beta_2)}{\sqrt{1-\rho^2}}\right)\frac{1}{\sigma}\emptyset\left(\frac{t_i - x_{2i}\beta_2}{\sigma}\right)\right] \tag{17}$$

If the error terms are independent (i.e. ρ=0), then the log-likelihood function is simplified as:

$$lnL = \sum_0 \ln\left[1 - \Phi\left(\frac{x_{1i}\beta_1}{\sigma}\right)\right] + \sum_+ \ln\left[\Phi(x_{1i}\beta_1)\frac{1}{\sigma}\emptyset\left(\frac{t_i - x_{2i}\beta_2}{\sigma}\right)\right] \tag{18}$$

4.4 The Double-Hurdle Model

Cragg (1971) first proposed the double-hurdle 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 this research, 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 (participation decision). Conditional on the outcome of the first stage, the second stage considers the desired level of income to be forthcoming from these activities (subject to the characteristics of the property). As noted by Detre et al. (2010), observing a positive level of income requires that two distinct hurdles 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 (stage 1) 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 property.

Given a positive outcome in the first phase, the landowner decides in the second phase the desired level of income generating activities subject to the physical characteristics of the property. The desired level of income subject to the physical characteristics of the property (stage 2) 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 double-hurdle model with sample selection (Saha 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 of the enterprise activities considered in this study. [25] The double-hurdle extends the standard Tobit and Heckit models to overcome the zero income. The general equations of the double-hurdle model is similar as the Heckit model, but there is a slight modification in the equation. Following Jones (1989), the specification of the double-hurdle model can be expressed as following

Stage 1: Participation decision

$$d_i^* = x_{1i}\beta_1 + u_i;\ u_i \sim N(0,1) \tag{19.1}$$

$$d_i = \begin{cases} 1\ if\ d_i^* > 0 \\ 0\ otherwise \end{cases} \tag{19.2}$$

Stage 2: Desired level of income

[25] This statement is supported by Roberts et al. (1999) in their analysis of income derived from surface-use activities among marsh owners.

$$t_i^* = x_{2i}\beta_2 + v_i;\ v_i \sim N(0, \sigma^2) \tag{19.3}$$

$$t_i = \begin{cases} t_i^*\ if\ d_i = 1\ and\ t_i^* > 0 \\ 0\ \ if\ d_i = 0 \end{cases} \tag{19.4}$$

Finally, the observed level of income is determined as

$$y_i = d_i \cdot t_i \tag{19.5}$$

In this specification, a positive level of income y_i is observed if $d_i^* > 0$ and $t_i^* > 0$. This illustrates the double-hurdle element to the model. d_i^* is a latent endogenous variable representing the decision to participate in income-generating activities for landowner *i*, t_i^* 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. u_i is normalized to 1 since the outcome of the first hurdle is binary. Both error terms, u_i and v_i, are assumed to be normal and independently distributed and can be written as

$$\begin{pmatrix} u_i \\ v_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right] \tag{20}$$

As in the Tobit and Heckit model cases, the independent double-hurdle model is estimated using maximum likelihood techniques with the log likelihood given as follows,

$$lnL = \sum_{0} \ln\left[1 - \Phi(x_{1i}\beta_1)\Phi\left(\frac{x_{2i}\beta_2}{\sigma}\right)\right] + \sum_{+} \ln\left[\Phi(x_{1i}\beta_1)\frac{1}{\sigma}\emptyset\left(\frac{t_i - x_{2i}\beta_2}{\sigma}\right)\right] \quad (21)$$

The first term on the right-hand side denotes the summation over the zero observations in the sample. It 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 (21), $\Phi\left(\frac{x_{2i}\beta_2}{\sigma}\right)$, contributes the effect of possible zero values in the second stage decision in the double-hurdle 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 (Fabiosa, 2006). In this research, 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. 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 blinds).

Furthermore, under the assumption of independent, homoscedastic, and normally distributed between two error terms, the log-likelihood function of the double-hurdle is the

summation log-likelihood of Probit model and truncated regression model (McDowell, 2003; Aristei et al. 2008). The log-likelihood function can be maximized by maximizing the two components separately (Jones, 1989; McDowell, 2003). The parameter estimates of the double-hurdle model, however, provide little direct information besides indicating the significance of the explanatory variable and the direction of its influence on the dependent variable. The economic interpretation frequently focuses on the analysis of the marginal effects of repressors on the expected value of y_i for limited dependent variable models (Jones and Yen, 2000). Thus, to fully understand the magnitude of the relationship between the explanatory and dependent variables, the marginal effects using the maximum likelihood results obtained from the estimated model need to be explored. Based on different definitions of the expected value of the dependent variable y_i, three different marginal effects can be calculated. The unconditional expected mean (overall effect on the dependent variable) is the one of most interest in this model. This term is written as $E(y_i/x_{2i})$ and can be decomposed into two parts. By using the McDonald and Moffitt (1980) decomposition, the unconditional expected value of the double-hurdle model can be expressed as (Yen and Jensen, 1996)

$$E(y_i) = P(y_i > 0) * E(y_i|y_i > 0) \tag{22}$$

where $P(y_i > 0)$ is the probability of income and $E(y_i|y_i > 0)$ is the conditional expected level of income. Following Burke's (2009) notation, the probability of participation is given by

$$P(y_i > 0/x_{1i}) = 1 - P(y_i = 0/x_{1i}) = \Phi(x_{1i}\beta_1) \tag{23}$$

The expected value of y, conditional on $y>0$ is

$$E(y_i/x_{2i}, y_i > 0) = x_{2i}\beta_2 + \sigma * \lambda\left(\frac{x_{2i}\beta_2}{\sigma}\right) \quad (24)$$

where *λ(.)* is the inverse Mills ratio $\lambda(\cdot) = \frac{\emptyset(\cdot)}{\Phi(\cdot)}$. After substituting equations (23) and (24) into equation (22), the unconditional expected value of *y* can be expressed as follows

$$E(y_i/x_{1i}, x_{2i}) = \Phi(x_{1i}\beta_1)\left\{x_{2i}\beta_2 + \sigma * \lambda\left(\frac{x_{2i}\beta_2}{\sigma}\right)\right\} \quad (25)$$

Taking the first derivative of equations (23), (24), and (25) with respect to the explanatory variable x_j yields the double-hurdle marginal effects of the explanatory variable x_j on the probability of income, the conditional level of income, and unconditional level of income. So, the marginal effect of the explanatory variable x_j on the probability of income is expressed as

$$\frac{\partial P(y_i > 0/x_1)}{\partial x_j} = \beta_{1j}\emptyset(x_1\beta_1) \quad (26)$$

where β_{1j} is the element of β_1 representing the coefficient on x_j. The conditional marginal effect of the explanatory variable x_j given that landowners have made a positive level of income is

$$\frac{\partial E(y_i/x_{2i}, y_i > 0)}{\partial x_j} = \beta_{2j}\left\{1 - \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\left[\frac{x_2\beta_2}{\sigma} + \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right]\right\} \quad (27)$$

where β_{2j} is the element of β_2 representing the coefficient on x_j. If $x_j \epsilon x_1, x_2$, the unconditional marginal effect of the explanatory variable x_j is

$$\frac{\partial E(y_i/x_1,x_2)}{\partial x_j} = \beta_{1j}\emptyset(x_1\beta_1)\left\{x_2\beta_2 + \sigma * \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right\} + \Phi(x_1\beta_1) * \beta_{2j}\left[1 - \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\left\{\frac{x_2\beta_2}{\sigma} + \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right\}\right] \quad (28)$$

If x_j is only determining the probability of y > 0, then $\beta_{2j} = 0$, and the unconditional marginal effect of the explanatory variable x_j is

$$\frac{\partial E(y_i/x_1,x_2)}{\partial x_j} = \beta_{1j}\emptyset(x_1\beta_1)\left\{x_2\beta_2 + \sigma * \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right\} \quad (29)$$

On the other hand, if x_j is only determining the value of y with y > 0, then $\beta_{1j} = 0$, and the unconditional marginal effect of the explanatory variable x_j is

$$\frac{\partial E(y_i/x_1,x_2)}{\partial x_j} = \Phi(x_1\beta_1) * \beta_{2j}\left[1 - \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\left\{\frac{x_2\beta_2}{\sigma} + \lambda\left(\frac{x_2\beta_2}{\sigma}\right)\right\}\right] \quad (30)$$

From these marginal effects, elasticities for the probability of a positive income, the conditional level of income, and the unconditional level of income can be derived. In particular, using equation (22), the elasticity for the unconditional mean with respect to x_j can be written as

$$e_j = \frac{\partial E(y_i)}{\partial x_j}\frac{x_j}{E(y_i)} = \frac{\partial P(y_i)}{\partial x_j}\frac{x_j}{P(y_i)} + \frac{\partial E(y_i|y_i>0)}{\partial x_j}\frac{x_j}{E(y_i|y_i>0)} \quad (31)$$

where the first term on the right-hand side denotes the elasticity of the probability of observing a positive income (e_j^p) and the second term on the right-hand side denotes the elasticity of conditional income (e_j^c). The elasticities are calculated at the sample means for continuous variable. For categorical explanatory variables, e_j^p, e_j^c, and e_j represent the percentage changes

in probability of a positive value, conditional level and unconditional level when the value of the variable shifts from zero to one, holding all the other variables constant (Yen and Jones, 1997; Newman et al. 2003).

4.5 Specification Issues

4.5.1 Heteroskedasticity

The consistency of maximum likelihood estimates for the double-hurdle model are based on the assumptions of homoscedasticity and the normality of u_i and v_i. The homoscedastic assumption, however, is likely to be violated for these cross-sectional survey data in this research. The presence of heteroscedasticity in limited dependent variable model would lead to inconsistent parameter estimates (Maddala and Nelson 1975; Arabmazer and Schmidt, 1981; Lin and Schmidt, 1984). To overcome this problem, the standard deviation of the error term is allowed to vary across observations by specifying it as a function of a set of exogenous variables (Newman et al. 2003 and Aristei and Pieroni, 2008) and defined as

$$\sigma_i = exp(z_i h) \tag{32}$$

where z_i represents the continuous variables in x_i $(z_i \epsilon x_i)$ and h is a conformable vector of coefficients. The exponential specification is chosen as it imposes the desirable income that the standard deviation σ_i be strictly positive (Su and Yen, 1996; Yen, 1993; Yen and Jensen, 1996; Newman et al. 2003). A likelihood ratio test (LR) can be used to test the restrictions (H_0: h =0) against the alternative that is not 0 (H_1: h =0). A rejection of this test indicates that the errors are heteroskedastic.

4.5.2 Non-Normal Error Structure

The double-hurdle model relies on the assumption of normality of errors, u_i and v_i. Similar to the case of heteroscedasticity, the maximum likelihood estimates will be inconsistent if the normality assumption is not tenable (Arabmazer and Schmidt, 1982). One way to accommodate the assumption of normality is by transforming the dependent and latent variables. The dependent variable was manipulated using a Box-Cox transformation (Jones and Yen, 2000 and Moffatt, 2005).

$$Y^T = \frac{Y^\lambda - 1}{\lambda} \qquad 0 < \lambda < 1 \tag{33}$$

Note that linear and logarithmic transformation are two special cases in the Box-Cox transformation above when $\lambda = 1$ and $\lambda \to 0$, respectively. In general, λ would be expected to lie between these extremes (Moffatt, 2005).

The log-likelihood function for the independent Box-Cox double-hurdle model after applying the Box-Cox transformation can be written as (Moffatt, 2005):

$$lnL = \sum_0 \ln\left[1 - \Phi(x_{1i}\beta_1)\Phi\left(\frac{x_{2i}\beta_2 + \frac{1}{\lambda}}{\sigma}\right)\right] + \sum_+ \ln\left[\Phi(x_{1i}\beta_1)Y_i^{\lambda-1}\frac{1}{\sigma}\emptyset\left(\frac{Y^T - x_{2i}\beta_2}{\sigma}\right)\right] \tag{34}$$

This expression is similar to equation (21) but the use of Y^T instead of t_i in the final term requires a Jacobian term $Y^{\lambda-1}$ to be included (Moffatt, 2005).

4.6 Summary

In this chapter, three main econometric methodologies that could be utilized to investigate landowners' decisions concerning participation in income-generating activities have been reviewed. While the review is intended to be comprehensive of empirical economic models, it is not comprehensive of empirical household decision models in general. As was seen in Chapter 2, these models have already been used in the literature to analyze factors affecting landowner's participation in wetland restoration programs and different conservation programs.

These models describe a common situation where the dependent variable is zero for a portion of the population but positive for the remainder of the population. As pointed out in this chapter, the most commonly applied technique in this case is using the Tobit model, which assumes that zero observation occur because of a corner solution. This assumption, however, underlying the Tobit model, may not be applicable in certain situations. Two generalizations to the Tobit model, Heckman model and Cragg's double-hurdle model, in particular were outlined in this chapter. The key similarity between Heckman and double-hurdle model is that there are two separate decision stages.

As discussed, the underlying assumption that whether there is first hurdle dominance or not and whether the choice to participate and the level of income are joint or sequential decisions. The Heckman model assumes that all zero observations are only from participation decision. Compare to the Heckman model, the double-hurdle allows the zero observations are affected by both participation and level of participation decisions. The purpose of this study is to identify the factors that determine both the probability of participating in income-generating activities and the factors influencing the level of income, which involve two stage decision

process. Given the relative merits of each model and previous empirical research, the double-hurdle model appears to most adequately explain landowner's participation decision and level of participation in income-generating activities from their wetland property. The next chapter discusses the survey design and data set that will be used for empirical analysis.

CHAPTER 5 SURVEY AND DESCRIPTION STATISTICS

5.1 Introduction

Previous chapters discussed the empirical methodologies that could be used to examine the research problem introduced in Chapter 1. This chapter outlines and describes the data set that will be used. A landowner's decision to employ coastal wetlands in income-generating activities involves 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 characteristics of the wetland owner (which may also influence his perception of uncertainty). Under simplified economic theoretical conditions, a landowner will enroll his property in income-generating activities as long as the net present value of the expected cash flow from these activities is positive and will utilize the property in such a manner as to maximize profits. A growing body of evidence, however, suggests that this simplified theoretical model does not match actual practices in agriculture and forestry, with factors such as risk and conservation perceptions needing to be considered in order to adequately explain not only participation in an economic enterprise, but also the intensity of participation.

Since the focus of this study is to determine landowner's decisions concerning participation in income-generating activities and the level of participation from their coastal properties, a detailed analysis requires the use of landowner survey data. In this research, the survey was implemented using Dillman's (2011) tailored design method for mail survey. This survey collected information about a landowner's decision to participate in income-generating activities and income derived from this participation. It also provides the physical characteristics of the property and socioeconomic characteristics of the landowner. Thus, the information from

this survey is the primary source of data for this study and this chapter will outline the survey in greater detail. There are two main goals for this chapter. The first is to describe the survey design and response and the methodology supporting the collection of data in the questionnaire. This is presented in Section 5.2. The second main objective is to present a descriptive statistics analysis of response in order to provide a basis for the econometric analysis presented in Chapters 6. This descriptive analysis is presented in Section 5.3 while Section 5.4 provides a summary of the survey data.

5.2 Survey Design and Response

5.2.1 Survey Design and Implementation

Champ (2003) pointed out that a mail survey avoids interviewer effects and allows respondents to complete the survey according to their schedule, and this method is less expensive than in-person or telephone survey. The questionnaire was developed based on the tailored design method for mail surveys, which consisted of a booklet questionnaire, a postcard reminder, and a replacement questionnaire (Dillman 2011). This survey was designed to determine the physical property characteristics and landowner characteristics that influence the participation decision (whether the landowner participates in income-generating activities on a specific property parcel) and the intensity of participation (e.g., revenues generated from the parcel). After a thorough literature review, several iterations of draft questionnaire were developed over several months in early 2015 after which time the questionnaire was sent to several of the Sea Grant extension agents for their review and comments. After making the changes suggested by the Sea Grant agents, the questionnaire was sent to the Louisiana State University Institutional

Review Board Office for approval (IRB NO. E9722 Expires: 01/17/2019).[26] The final survey instrument contained two sections with a total of 23 questions that allowed for quick answers selected from several categories. The last question was more open-ended, which solicited respondent's suggestions and comments on any topics that might not have been adequately covered in this survey. The final version of the questionnaire is given in Appendix B.

The mailing list of private coastal landowners was obtained from coastal zone parish assessor's offices.[27] As shown in Figure 1, landowners in these costal parishes might participate in income-generating activities on their wetland parcels. 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 in, 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, respectively, account for 89 percent and 55 percent of the state total for these two enterprises.

Due to data and budgetary limitations, only five coastal parishes (Cameron, Lafourche, Plaquemines, Terrebonne, and Vermilion parishes) were chosen in this study (Figure 5.2).[28] Based on records from these five parishes assessor's offices, a data set on a total of 1,159 wetland parcels include all information on parcel number, primary owner, mailing address, ward,

[26] See Appendix A.
[27] The state of Louisiana is divided into 64 parishes, of which 20 parishes are located in Louisiana's coastal zone (LDNR 2010). The Louisiana Coastal Zone parishes includes: Ascension, Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Terrebonne, Tangipahoa, and Vermilion. This study is interested in the coastal zone parishes in Louisiana and focus on Cameron, Lafourche, Plaquemines, Terrebonne, and Vermilion five parishes.
[28] 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.

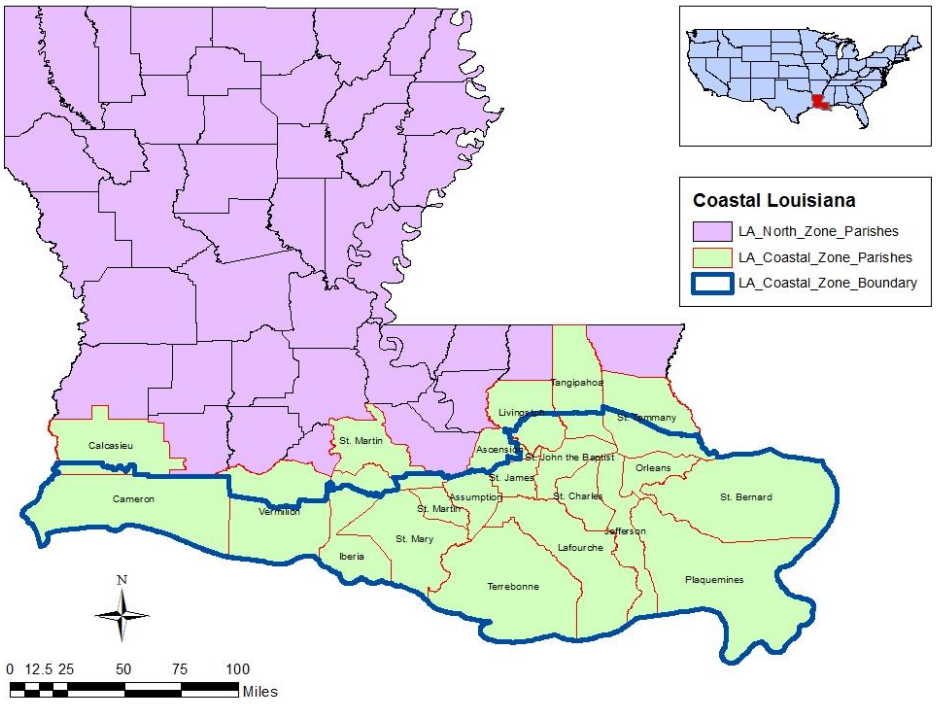

Figure 5.1 Coastal Parishes in Louisiana

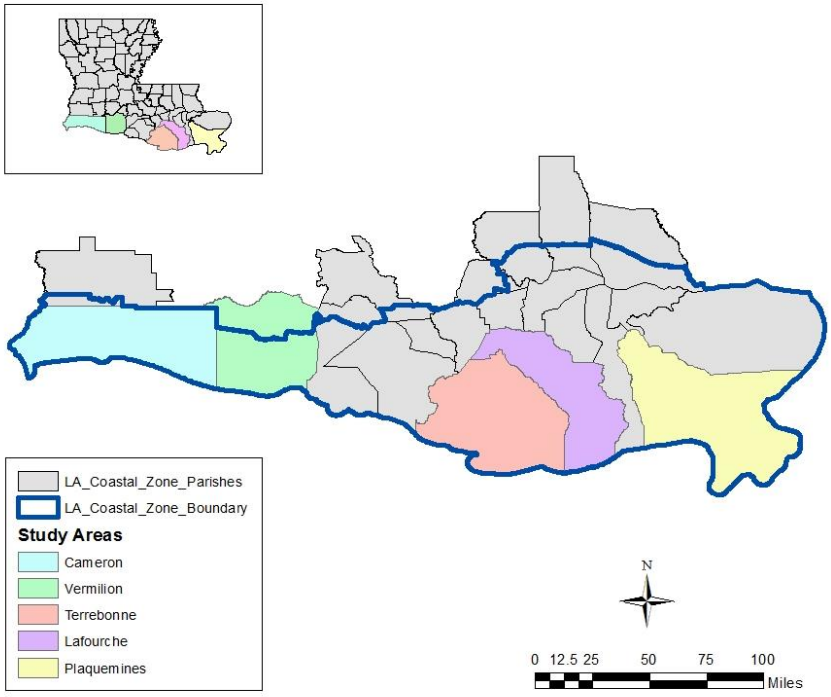

Figure 5.2 Study Area Included Landowners in Five Parishes along Coastal Louisiana

taxable property type, legal description, physical address, parcel items, deeds, and ownership history.[29] From this raw data, a total of 297 wetland parcels was drawn from Cameron parish, a total of 226 wetland parcels was drawn from Vermilion parish, a total of 257 wetland parcels was drawn from Terrebonne, a total of 172 wetland parcels was drawn from Lafourche parish, and a total of 207 wetland parcels was drawn from Plaquemines parish.

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 questionnaire 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 attempt to have landowners pay more attention on alligator harvest and/or waterfowl hunting activities from a specific wetland parcel. Furthermore, landowners with three or more parcels may know little about the activities on individual parcels and may often represent large corporations.

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 questionnaire was distributed.[30] Figure 5.3 shows the distribution of the survey address across the five coastal parishes in

[29] A ward, by definition, is a subdivision of a local authority area, typically used for electoral purposes. Wards are usually named after neighborhoods, thoroughfares, parishes, landmarks, geographical features and in some cases historical figures connected to the area.
[30] Survey 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.

Louisiana. Property owners in the sample were surveyed to determine their attitudes toward the use of individual parcels for income-generating activities, attitudes towards cost-share programs, the actual use of their wetland holdings in terms of the percentage of the parcel being actively used in income generating activities, surface-based revenues generated from these parcels (disaggregated by the categories), and their general socioeconomic profile. While research examining the attributes that lead to income-generating activities from coastal wetland properties has not been conducted, research in the related agriculture and forestry fields is extensive. Based upon a review of this research, information associated with the physical characteristics of the property and socioeconomic characteristics of the landowner were collected for analysis in the current study. In total, the survey was mailed to a sample size of 941 private landowners. Each questionnaire sent to landowners with parcels in Cameron, Lafourche, and Terrebonne parishes included a parcel geographic information system (GIS) map. This GIS parcel map contained information on, parcel boundary, parcel number, listed acres, wetland types, and parcel location from google image (see Figure 5.4 for an example of one of these maps). Two separate GIS

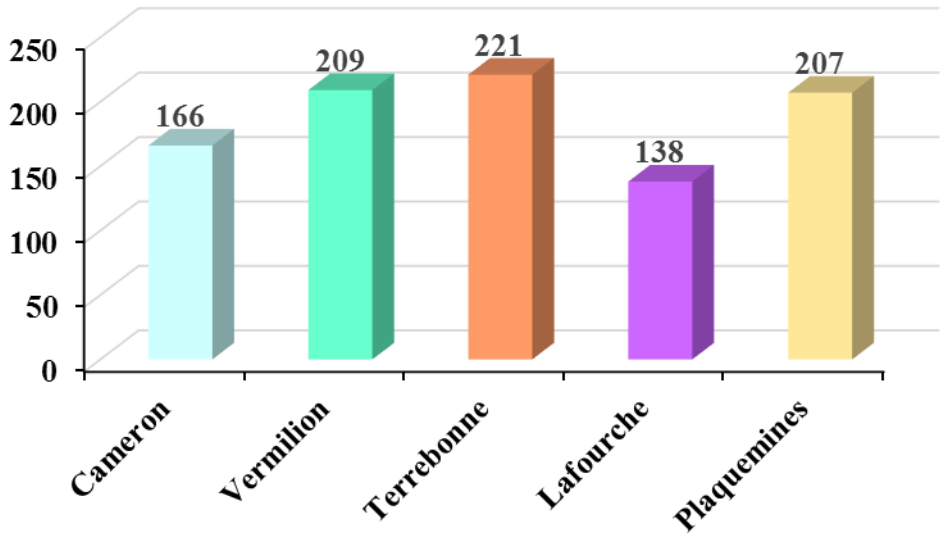

Figure 5.3 Number of Participants Surveyed across Five Coastal Parishes in Louisiana

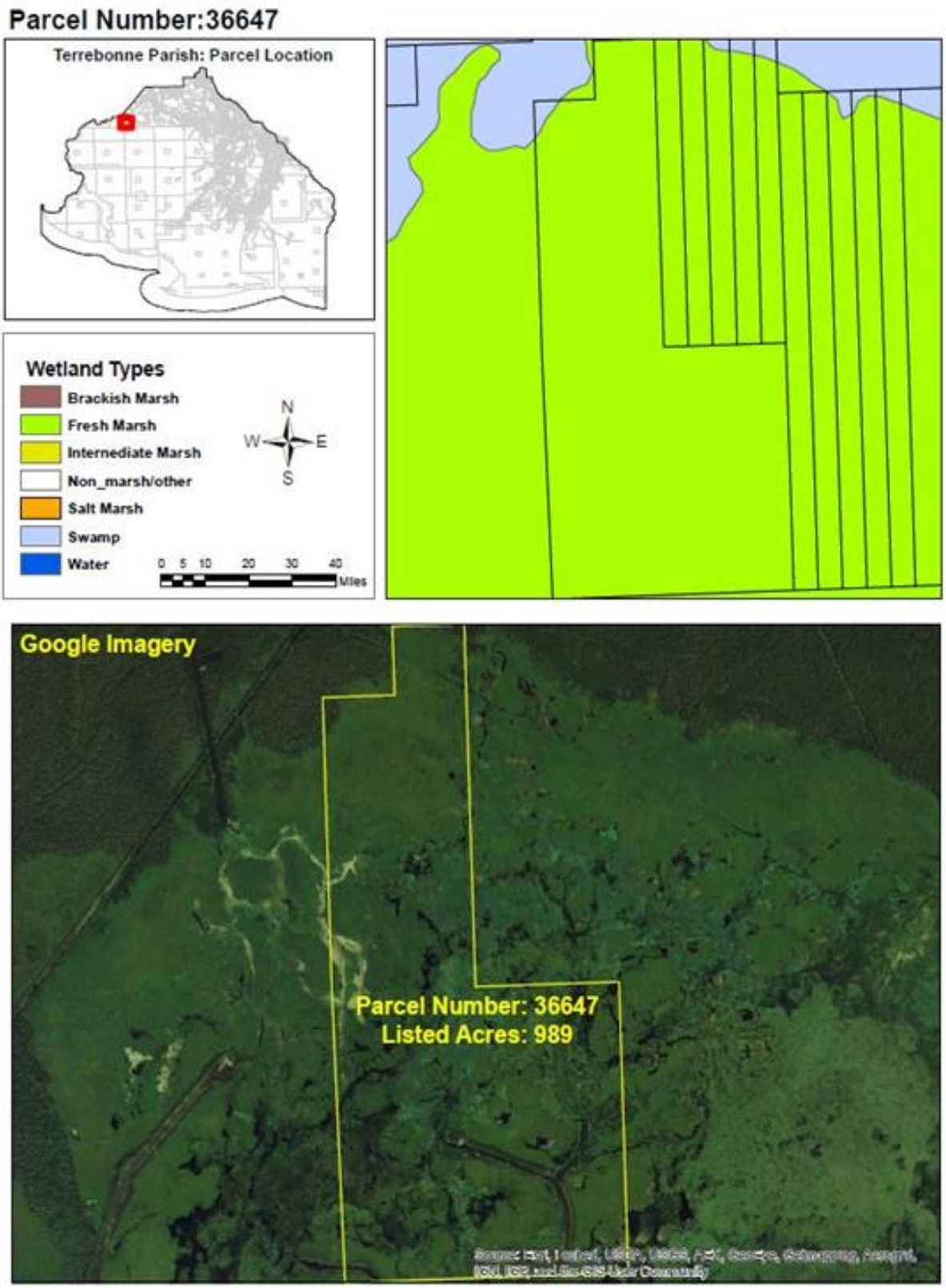

Figure 5.4 An Example of GIS Map of Wetland Parcel in Coastal Louisiana

parcel maps were sent to those landowners with two wetland parcels. These GIS maps, however, were not available for the other two parishes in the study. As such, included in each survey sent to landowners with parcels in Vermilion and Plaquemines parishes was the parcel assessment listing. This parcel assessment listing included information on primary owner, mailing address, ward, legal description, and property class. (See Figure 5.5 for an example of one of these assessment listing). Two assessment listings were provided to landowners in these two parishes who were listed as owners of two wetland parcels.

Vermilion Parish Assessor
2016 Assessment Listing

Parcel#
R2011400

Primary Owner
BAUR, EILEEN HEMLER STOVELL
Mailing Address
P O BOX 107

Ward
2

Legal
1642.47 AC UND 25% INT IN 6570 AC IN:
SEC 28,29,30,31,32, W/2, NE/4 & N/2
OF SE/4 OF SEC 33, S/2 & W/2 OF
NW/4 SEC 20 W/2 OF SW/4 OF SEC 17 T
14 R 4 E (B) 436-7 (PG & TPP)
SEC 35,36,89 LESS APP 23 AC IN NW/4
N OF S DR CANAL OF LIVE OAK PLAT.,
THAT POR OF SEC 25 S OF S DR CANAL
OF LIVE OAK PLAT., THAT POR OF SEC
88 S OF S LIVE OAK DR CANAL T 14 R
3 E SEC 37 T 15 R 3 E (PG & AHT)

Parcel Items

Property Class	Assessed Value	Units	Homestead
FRESH WATER MARSH	11,490	1,642.00	0
TOTAL	11,490	1,642.00	0

Figure 5.5 An Example of Assessment Listing of Wetland Parcel in Coastal Louisiana

The process of surveying respondents followed a modified Tailored Design Method (Dillman 2011). Of the original 941 survey questionnaires, 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.

5.2.2 Survey Responses

Removing the undelivered questionnaires (a total of 75) resulted in a final sample size of 866 wetland parcels. Of the 866 questionnaires 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 response rate was therefore 17.7% (Table 5.1).

The number of responses, by parishes, is shown in Figure 5.6. The parish with the highest number of responses for this survey was Terrebonne parish (47 respondents), followed by Vermilion parish (34 respondents), Cameron parish (26 respondents), Lafourche parish (24 respondents), and then Plaquemines parish (22 respondents). The respondents owned a total of

Table 5.1 Survey Responses

Surveys	First mail-wave	Second mail-wave	Total mail
Delivered	482	384	866
Returned	97	55	153
Response rate (%)	20.10	14.60	17.70

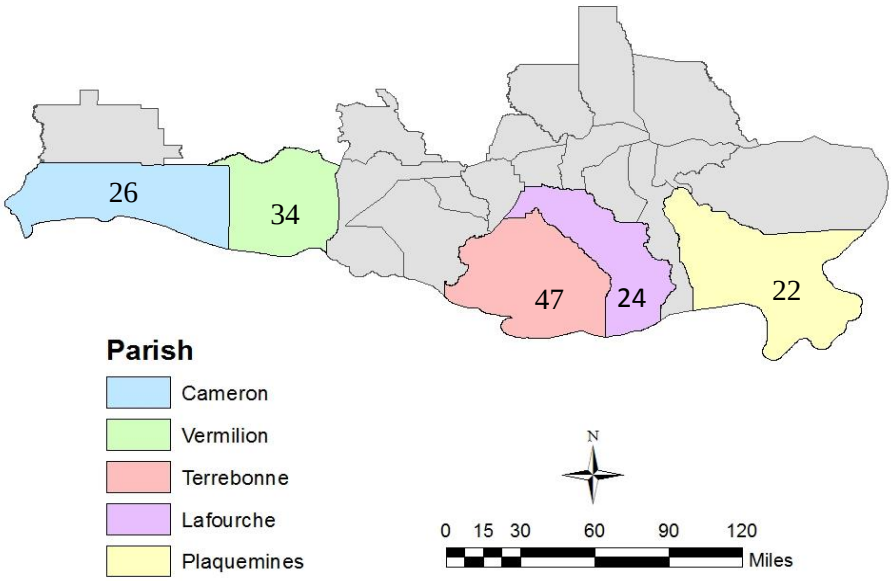

Figure 5.6 Number of Responses from Each Study Parish

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.

5.3 Descriptive Analysis

5.3.1 Characteristics of the Landowner

Table 5.2 presents a summary of the demographic data obtained from the survey. The majority of landowners were more than 65 years old (62%), followed by these landowners who were 55 to 64 years of old (25%). About 11% of respondents were 45 to 54 years old. Most respondents in the survey were male (69%) and 96% of landowners were white.

Table 5.2 General Socioeconomic and Demographic Characteristics of Landowner

Description	Percent (%)	Cumulative percent (%)
Age		
Under 25	0	0
25 - 34	0	0
34 – 44	2.07	2.07
45 - 54	11.03	13.10
55 - 64	24.83	37.93
65 or older	62.07	100.00
Gender		
Female	31.03	31.03
Male	68.97	100.00
Race		
White	96.55	96.55
Asian	0.00	96.55
Native American	0.69	97.24
Black/African American	0.00	97.24
Latino/Hispanic	0.69	97.93
Other	2.07	100.00
Total household income		
Under $20,000	4.39	4.39
$20,000 - $39,999	7.02	11.40
$40,000 - $59,999	13.16	24.56
$60,000 - $79,999	9.65	34.21
$80,000 - $99,999	13.16	47.37
$100,000 - $150,000	18.42	65.79
$Over $150,000	34.21	100.00
Education attainment		
Less than high school	3.55	3.55
High school degree or equivalent	14.18	17.73
Some college	21.28	39.01
College degree	33.34	72.34
Master degree	7.09	79.43
Doctorate	20.57	100.00
Outdoor enthusiast		
Not an outdoor enthusiast	32.41	32.41
An outdoor enthusiast	67.59	100.00
Environmentalist		
Not an environmentalist	27.27	27.27
An environmentalist	72.73	100.00

As reported in Table 5.2, less than 35% of respondents reported that they had annual household income of $79,999 or less while 13% of the respondents had annual household income in the range of $80,000 to $99,999. In addition, about 18% of respondents had annual household incomes ranging from $100,000 to $150,000 while 34% of the respondents reported annual household income over $150,000. With respect to education, a third of the survey respondents reported having a college degree while 20% of the total respondents reported a doctorate degree. Less than 18% of the total respondents reported a high school degree or less. About 68% of respondents answered they are an outdoor enthusiast and 73% of respondents considered themselves to be an environmentalist.

5.3.2 Characteristics of the Property

The respondents indicated that, on average, the relevant property was comprised of 734 acres of freshwater marsh, 510 acres of brackish marsh, 62 acres of salt marsh, and 341 acres of other land (including open water), respectively (Table 5.3). Overall, survey respondents indicated that the property had been in family possession for an average of 70 years with a range from 3 to 150 years (Table 5.3).

Among parcels jointly owned, ownership averaged 27% with a range from 0.3 to 90% (Table 5.3). The most common ownership structure among respondents was joint ownership through an undivided heirship (36%) followed by sole ownership (30%) and joint ownership through a corporation or trust (22%). The remaining 12% of the parcels were owned through some other ownership structures, such as divided interest and joint through a limited liability company (Table 5.3). As shown in Figure 5.7, the most common land type reported by respondents was brackish marsh with approximately a third indicating that their parcel contained brackish marsh. The second most common wetland type was freshwater marsh (23% of the

Table 5.3 Statistical Descriptive of Land Characteristics and Ownership Structure

Description	Mean	Min	Max
Total acreage of freshwater marsh	734	0	6620
Total acreage of brackish marsh	510	0	7370
Total acreage of salt marsh	62	0	1040
Total acreage of other type land	341	0	6570
Years of ownership (year)	70	3	150
Percentage of ownership (%)	27	0.3	90

Ownership type	Percent (%)	Cumulative percent (%)
Sole ownership	30.14	30.14
Joint ownership through an undivided heirship	35.62	65.75
Joint ownership through a corporation or trust	21.92	87.67
Other ownership	12.33	100.00

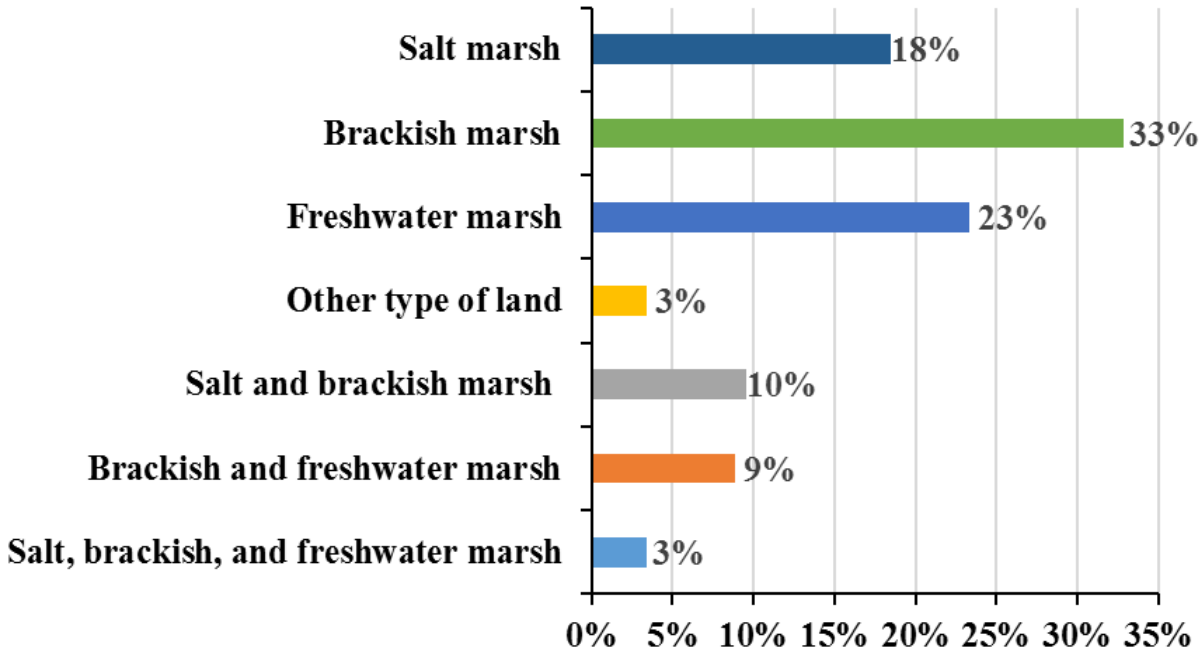

Figure 5.7 Wetland Composition by Coastal Landowners

respondents), followed by salt marsh (about 18% of the respondents). Only 3% of the respondents reported that the parcel subject to study included other land type (non-wetland). About 10% and 9% of respondent indicated that their property had both salt and brackish marsh or had both brackish and freshwater marsh, respectively. In addition, 3% of respondents reported that their land included all three type of wetland (salt, brackish, and freshwater marsh).

In addition to land ownership and type of wetland, the survey sought to determine the use of the property for commercial-based activities. About 41% of the respondents reported that they used their land for some commercial-based activities (Figure 5.8). Following this question, landowners who reported commercial-based activities were asked to indicate the type of commercial activity (activities) on their property. About 66% of respondents reported that their parcel was used for alligator harvest and/or waterfowl hunting activities (Figure 5.9). Primary commercial-based activities were combined into three categories: (1) alligator harvest (including egg collection); (2) waterfowl hunting; and (3) other commercial activities. As shown in Figure5.9, the most common practice was both alligator harvest and waterfowl hunting activities,

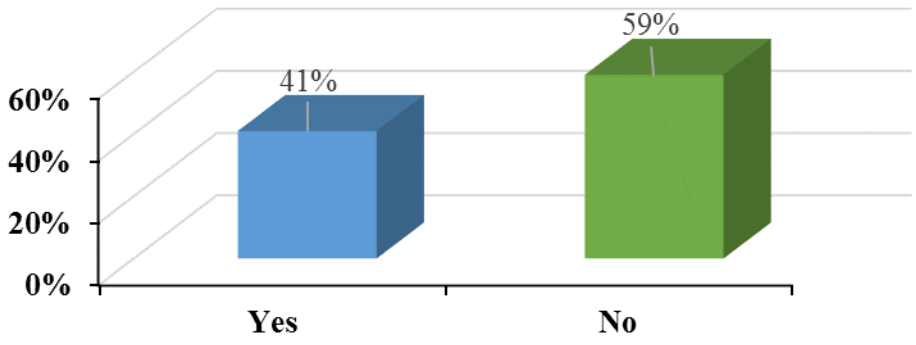

Figure 5.8 Landowner's Responses to Participate in Commercial-Based Activities

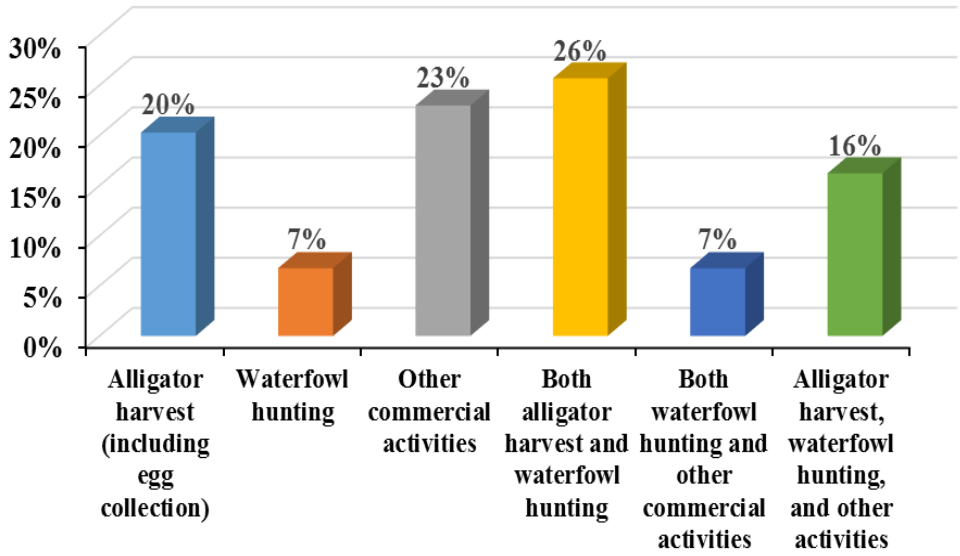

Figure 5.9 Landowner's Responses about Different Type of Commercial-Based Activities

with approximately 26% of the respondents using their land for these two income-generating activities. Almost a quarter reported that their parcel was used for other commercial activities (23%).[31] . Approximately 20% of the respondents reported that their parcels were used for alligator harvest activity only, while 7% of the respondents reported that their parcels were used for waterfowl hunting activity only. In addition, about 16% of the respondents indicated that they used the land for alligator harvest, waterfowl hunting, and other commercial activity. The average income derived from alligator harvest activity among landowners who reported that their parcels were used only for this activity was $7,030 with a range from $200 to $45,000 (Table 5.4). The average income derived from waterfowl hunting activity (leasing) among landowners who reported that their parcels were used for only for this purpose was $6,045 with a range from $500 to $44,000. Average income generated from either or both of these activities were $12,204

[31] According to responding landowners, other commercial-based activities include farming, shrimping, crabbing, grazing, pasture, cattle production, and commercial/industrial land rental for the non-wetland portion of the parcel. Income derived from activities other than alligator harvest and leasing for waterfowl hunting was not the focus of this research.

Table 5.4 Reported Income Derived from Commercial-Based Activities

Description	Mean	Min	Max
Income derived from alligator harvest activity ($)	7,030	200	45,000
Income derived from waterfowl hunting activity ($)	6,045	500	44,000
Income derived from alligator harvest and/or waterfowl hunting activities ($)	12,204	500	45,000
Income derived from other commercial activities ($)	27,442	0	162,863

with a range from $500 to $45,000. In addition, the average income derived from other commercial activities was $27,442 with a range of $0 to $162,863. As shown in Figure 5.10, among respondents who used their parcel for income generating activities (alligator harvest and/or waterfowl hunting), about 74% indicated that there was no hunting lodge/camp on the parcel while about two-thirds indicated that they did not actively manage their property for

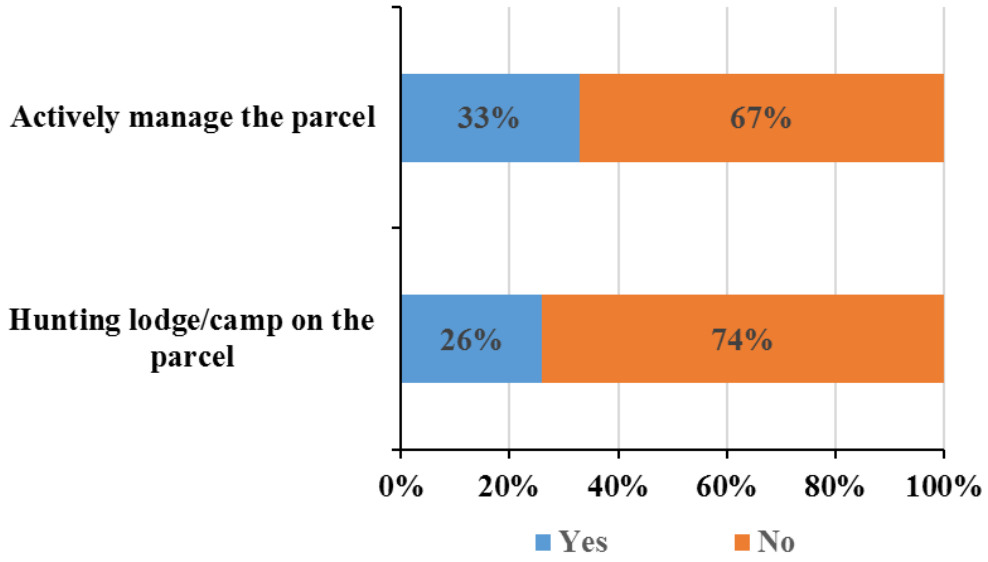

Figure 5.10 Landowners Responses to Active Management the Wetland Parcel for Waterfowl Habitat and Presence or Absence of a Hunting Lodge/Camp on the Wetland Parcel

waterfowl habitat. Finally, 37% of respondents reported that they received sub-surface (oil & gas) revenue from the parcel of interest (Figure 5.11).

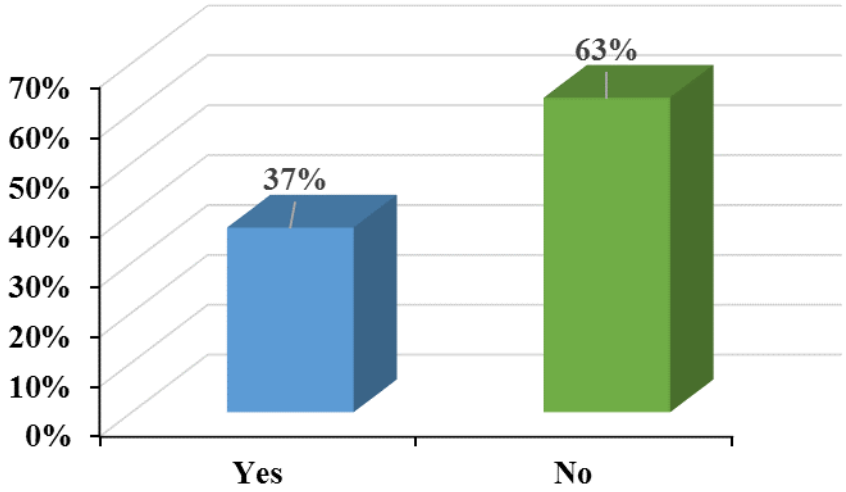

Figure 5.11 Landowners Response to Receive Sub-Surface (Oil & Gas) Revenue

5.3.3 Landowner's Attitude toward Wetland Restoration Program and Policy Instruments

Landowners were asked if they participate in any state or federal wetland restoration program on the property specified in the questionnaire. About 10% of respondents indicated that they participated in some state or federal wetland restoration programs (Table 5.5). Approximately 34% of these respondents reported that they participated in Wetlands Reserve Program or Coastal Wetlands Planning, Preservation & Restoration Act (CWPPRA). About 20% of the respondents reported that they participated in both Coastal Protection and Restoration Authority (CPRA) and CWPPRA programs. About 13% of these landowners reported that they

Table 5.5 Landowner Participated in State or Federal Wetland Restoration Program

	Percent (%)	Cumulative percent (%)
Yes	9.59	9.59
No	90.41	100

participated in CPRA program, while a third of respondents enrolled in other wetland restoration programs (e.g., Migratory Bird Habitat Initiative). The majority of respondents (90%) did not enroll in any wetland restoration programs (Table 5.5). Those landowners who did not participate in any state or federal wetland restoration programs were asked why they did not opt to enroll restoration programs and how much importance they placed on these different reasons: (1) too complicated to apply; (2) don't want long-term contract; (3) not enough financial incentive; (4) need the land for other purposes; and (5) 'other' reasons (see Appendix B: Q14b). They were asked to rate (on a 3-point Likert scale) the importance of each of the reasons (Figure 5.12). The majority of landowners reported that 'other' reasons were the most important factors for the decision to participate in state or federal wetland restoration programs. Respondents reported that 'other' reasons included: (1) don't know anything about the restoration program; (2) applied but be rejected; (3) have no interest on this matter; (4) living in another state; (5) too many heirs; and (6) never thought about it. About 96% respondents indicated that they did not

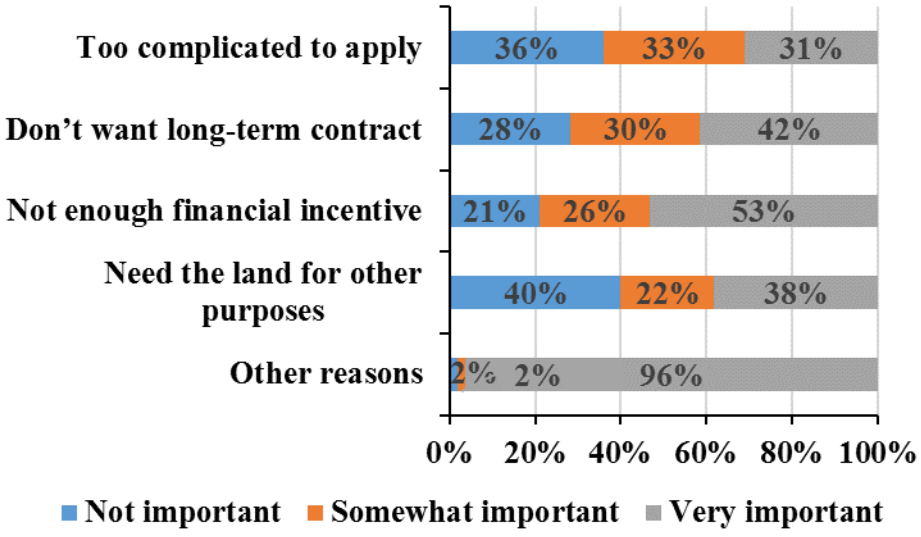

Figure 5.12 Landowners Attitudes Concerning Various Reasons that Influence Their Decisions to Participate in Wetland Restoration Programs

know any of wetland restoration programs. More than half the landowner rated that 'financial incentive' was very important. About 42% reported 'long-term contract' as being very important factor in their decision to participate in restoration program. Almost a third of response indicated that the reason 'too complicated to apply' was very important and 38% of the respondents rated that 'using the land for other purpose' was also a very important factor for enrolling a restoration program. Following this question, the landowners were asked to indicate the importance of the following current or pending policy instruments in regards to wetland restoration in coastal Louisiana. The listed policy instruments include: (1) public land purchases; (2) public purchase of permanent or temporary conservation easements; (3) establishing new markets for land; (4) implementing innovative tax incentive programs; (5) subsidies for plant, fish, and wildlife management; and (7) conservation cost sharing arrangements.[32] As shown in Figure 5.13, the most preferred policy instruments were implementing innovative tax incentive programs and

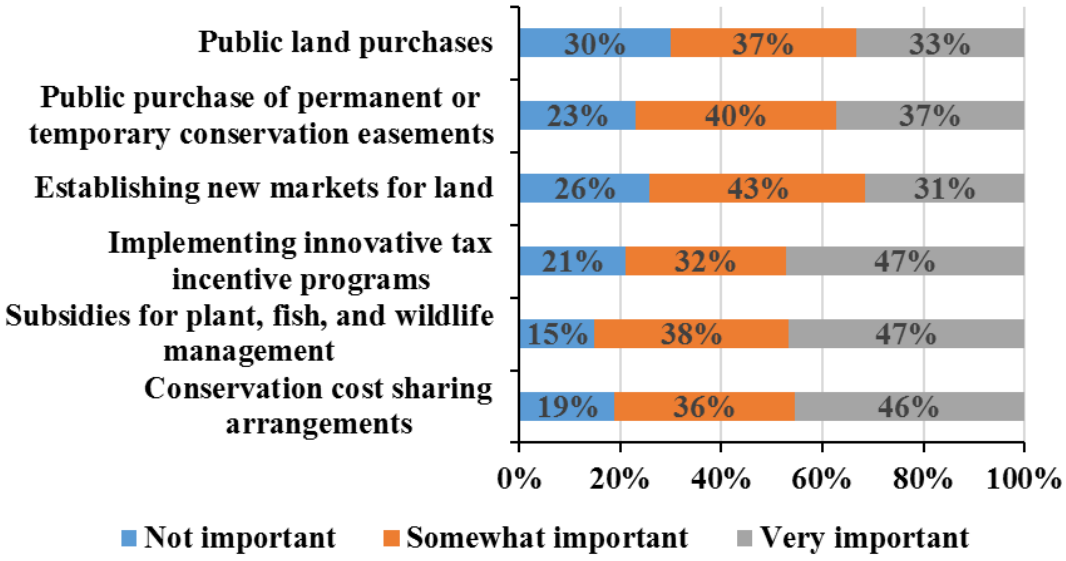

Figure 5.13 Landowner's Preference for Various Policy Instruments in Regards to Wetland Restoration in Coastal Louisiana

[32] See Chapter 2 (Section 2.2.2) for more detail.

subsidies for plant, fish, and wildlife management (47% of the respondents rated both options as very important). The second most preferred instrument was conservation cost sharing arrangements, with 46% of the respondents rating cost sharing as very important. Public purchase of permanent or temporary conservation easements was also popular, with about 37 % of the respondents indicating that this policy instrument was very important. Somewhat less popular were public land purchases and establishing new markets for land. About 33% and 31% of the respondents rated these two policy instruments were very important, respectively.

5.4 Summary

This chapter has presented survey design and descriptive statistics of the data set. The data set will be used to analyze landowner's decision to participate in income-generating activities and the level of participation from their wetland parcels in Chapters 6. Coastal parishes in Louisiana were initially selected for this study and five parishes were selected among 20 coastal parishes due to data limitation. The final mailing list contained a total of 941 wetland parcels. The household survey covered detailed information on the physical characteristics of wetland parcels. This includes ownership type and percentage, property size, wetland types, current land use for any commercial-based activities, total revenue derived from commercial-based activities, and a range of questions about the respondents' participation of government-sponsored wetland restoration programs and perspectives. Landowner's socioeconomic and demographic information were also collected including age, gender, race, income, education, annual household income, favorite outdoor activities, and effort in environmental protection. The description of the survey data provided in Section 5.2 and 5.3 are useful for providing a context to the work that will be carried out in the subsequent chapters. Definition and summary of

response and explanatory variables will be discussed in Chapter 6. The next chapter uses this information, and more, to estimate the empirical double-hurdle model outlined in Chapter 4.

CHAPTER 6 EMPIRICAL RESULTS

6.1 Introduction

This chapter presents an application of Cragg's (1971) double-hurdle model to analyze the decision among landowners whether or not to participate in income-generating activities on their respective coastal wetland parcels and, if so, the intensity of participation. In Chapter 4, the standard and generalized Tobit models were outlined for comparison purposes. The assumption is made within the standard Tobit model that landowners make two decisions simultaneously: (1) whether to participate and (2) the level of participation. The assumption associated with the generalized Tobit model, on the other hand, is that landowners make the decisions in a two-stage process where in the first stage landowners make the decision whether or not to participate in income-generating activities and only after this decision is made do they then determine the level of participation. As such, the double hurdle model entails a sequential two-stage framework and considers the probability of zero level of income from potential participants in the second stage. The key difference between these models is whether zero observations arise solely from non-participation or from either non-participation or participation but non-consumption in the first hurdle stage. Jones (1989) and Garcia and Labeaga (1996) have found that the sequential two-stage decision-making process more accurately reflects households' behavior. Since the sequential decision-making process incorporates both censoring and selection mechanisms, the double-hurdle model is, in general, a more flexible modelling framework than the standard and generalized Tobit models. Dedah (2010) compared the standard Tobit model and double-hurdle model to determine the characteristics of Louisiana coastal wetland owners, including their risk preferences, attitudes toward private restoration and maintenance, the actual use of their

properties, attitudes toward various government incentive programs, and their general socioeconomic profile using household survey data. He found that the double-hurdle model statistically outperformed the standard Tobit model. Wodjao (2007) compared the standard and generalized Tobit models against the double-hurdle model to determine the factors influencing the use of computer and internet at home using American Time Use survey data. The author found that the double-hurdle model is the best econometric specification when compared to the standard and generalized Tobit models.

The empirical results of the double-hurdle model associated with the objectives outlined in Chapter 1 are presented in this Chapter. In Section 6.2, a brief summary of the key variables used in the analysis is presented. Model specification is discussed in Section 6.3 and Section 6.4 presents the results of double-hurdle model along with relevant discussion associated with these results. Empirical simulation is presented in Section 6.5 while a brief summary is provided in the final section.

6.2 Potential Variables

The following section defines the response and potential explanatory variables for the econometric models employed in the current analysis. A list of response and explanatory variables utilized in this study are provided below and descriptive statistics of these variables are reported in Table 6.1.

6.2.1 Response Variables

- *Income-generating activities participation* is represented by a binary variable (d_i^*) equal to 1 if the landowner *i* reports that he/she participated in income-generating activities in 2015

Table 6.1 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 ($)	Continuous	12,204	13,657
Explanatory Variables			
Socioeconomic/Demographic Characteristics			
Gender	Male=1; Female=0	0.66	0.47
Race	White=1; Else=0	0.97	0.18
Age	54 years old or younger=1; Else=0	0.15	0.36
Education	Some college degree and above =1; Else=0	0.72	0.45
Household income ($)			
Household_income_1	Under $60,000=1; Else=0	0.21	0.41
Household_income_2	$60,000 - $99,999=1; Else=0	0.40	0.49
Household_income_3	Over $100,000=3; Else=0	0.39	0.49
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
An environmentalist	Yes=1; No=0	0.68	0.47
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

Table 6.1 continued

Total acreage of salt marsh	Continuous	62	205
Total acreage of other type land	Continuous	341	1,167

and 0 otherwise. From the full sample (N=122), about 41% landowner participated in commercial-based activities.[33]

- *Level of income from income-generating activities* is represented by a continuous variable (t_i^*), equal to income in dollars for landowner *i*. The average income among landowners who participated in commercial-based activities equaled $12,204 with a standard deviation of $13,657.

6.2.2 Explanatory Variables

Explanatory variables 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. Socioeconomic/demographic variables included in the analysis are: (1) *gender*; (2) *race*; (3) *age*; (4) *level of education*; (5) *household income*; (6) *land ownership*; (7) *percentage of ownership*; (8) *years of ownership*; (9) *whether the landowner is participating in a government-sponsored program on the property***;** and (10) *whether the landowner is participating in other commercial-based activities.*[34] Variables representing opinions held by the landowner include: (1) *whether or not the landowner considers himself/herself to be an outdoor enthusiast*; and (2) *whether the*

[33] Commercial-based activities also called income-generating activities, include alligator harvest and/or waterfowl hunting.
[34] As mentioned in Chapter 5, other commercial-based activities include farming, shrimping, crabbing, grazing, pasture, cattle production, commercial/industrial land rental for non-wetland portion.

landowner considers himself/herself to be an environmentalist. The physical characteristics of the property include (1) *the location of the parcel*; (2) *the presence or absence of a hunting lodge/camp*; (3) *whether or not the property was actively being managed for waterfowl habitat in 2015*; (4) *whether the property generates sub-surface revenues*; (5) *land types*; and (6) *total acreage of different land types*.

Socioeconomic/Demographic Characteristics Variables

- *Gender*: For purposes of analysis, *gender* was coded 1 if a respondent was male and 0 if female. The influence of *gender* on participation and the participation level, based on the literature review presented in Chapter 2, shows that, with notable exceptions, males are more likely to participate in government-sponsored programs. From this limited review, it was hypothesized that men are more likely to participate in income-generating activities on their wetland parcels and that income generated from these activities will be higher among males.
- *Race*: For purposes of analysis, *race* was coded 1 if a respondent was white and 0 otherwise. The influence of this discrete variable on whether to participate and the resultant income associated with this participation is unknown given that there is little consistency in previous studies.
- *Age*: For purposes of analysis, *age* was coded 1 if a landowner was 54 years old or younger and 0 otherwise. As mentioned in Chapter 2, the influence of *age* on participation is not consistent across the examined studies. Parks and Kramer (1995), for example, found that involvement in wetland restoration programs by farmers increase with *age*. Söderqvist (2003), on the other hand, found that *age* had a significantly negative influence on farmer's decision to participate in a wetland creation program. Yu

and Belcher (2011) pointed out that the *age* of the landowner does not seem to significantly influence the landowner's decision to adopt wetland conservation. In this research, given the inconsistency among studies examining the influence of age on participation decisions, the expected relationship between age and participation/income in this study is unknown.

- *Education*: For purposes of analysis, *education* was coded 1 if a respondent had a college degree or higher and 0 otherwise. Previous studies suggest that *education* is an important factor influencing owner's participation and income. Zhang et al. (2011), for example, found that landowners, with a higher level of education, were more likely to participate in the conversion of cultivated land to wetlands. Kraft et al. (1996) found that an increased probability of participation in the USDA's Water Quality Incentive Program by those landowners who were more educated. Given the noted relationship between *education* and participation in previous studies, it was hypothesized for this study that there will be a positive relationship between *education* and the likelihood of participation in wetland-generating activities as well as a positive relationship between *education* and the level of income from participating in commercial-based activities.
- *Household income*: For purposes of this analysis, *household income* was categorized into three groups: (1) under $60,000; (2) $60,000 to $99,999; and (3) above $100,000. These three categories were treated as dummy variables, where the reference group is above $100,000. The influence of *household income* on participation is inconsistent in the studies reviewed in Chapter 2. Matta et al. (2009), for example, pointed out that landowners with higher incomes would be more willing to adopt the suggested forest practices. Guan et al. (2015), on the other hand, found that household income exhibited a

negative impact on the decision to participate in Poyang lake wetland restoration. Given the inconsistency among studies examining the influence of *household income* on participation decisions, the expected relationship between *household income* and participation/income in this study is unknown.

- *Land ownership*: For purposes of this analysis, *land ownership* was coded 1 if the landowner is a sole owner and 0 otherwise. Parks and Kramer (1995), for example, pointed that ownership was an important factor in the decision whether or not to participate in wetland restoration programs in the United States. The authors found that higher proportions of land operated by full or part owners were both more likely to become involved in wetland restoration programs. Kraft et al. (1996) also pointed out that *private landownership* plays an important role for landowners to participate in the NRCS-sponsored WQIP and the authors found that there is a positive relationship between land ownership and the willingness to participate in incentive programs. It was hypothesized that landowners who are sole owners exhibit a higher probability of participating in income-generating activities and receive more income from participation.
- *Percentage of ownership*: For purposes of this analysis, *percentage of ownership* (defined as the percentage of the parcel owned by the landowner from the joint ownership) was treated as a continuous variable. The expected relationship between *percentage of ownership* and whether or not to participate in income generating activities is positive.
- *Years of ownership*: For purposes of this analysis, *years of ownership* was defined as the number of years that the property in question was in family possession. The variable of *years of ownership* is an important factor related to the participation decision. Matta et al. (2009) found that longevity of forestland ownership positively influenced willing to

adopt the suggested forest conservation practices. Based on the findings by Matta et al. (2009), the relationship between participation and *years of ownership* in the current study is expected to be positive. Similarly, a positive relationship between *years of ownership* and generated income from commercial-based activities is anticipated.

- *Participating in a government program*: For purposes of this analysis, the variable *participating in government program* was coded 1 if the landowner participated in any state or federal wetland restoration program and 0 otherwise. While enrollment in a government program is hypothesized to influence the decision to participate in income-generating activities, the expected relationship is unknown.
- *Participating in other commercial-based activities*: For purposes of this analysis, the variable *participating in other commercial-based activities* was coded 1 if the landowner participated in any other commercial-based activities and 0 otherwise. While enrollment in other commercial-based activities is hypothesized to influence the decision to participate in income-generating activities, the expected relationship is unknown.
- *An active outdoor enthusiast***:** For purposes of this analysis, the variable *an active outdoor enthusiast* was coded 1 if the landowner considers himself/herself to be an outdoor enthusiast and 0 otherwise. While a variable of this nature was not included in any of the studies reviewed in Chapter 2, one might hypothesize that the landowner is more likely to use the property himself for waterfowl hunting if he considers himself to be an outdoor enthusiast. Hence, one can hypothesize a negative relationship between participation/income and whether the landowner considers himself to be an outdoor enthusiast.

- *An environmentalist*: For purposes of this analysis, the variable *an environmentalist* was coded 1 if the landowner considers himself/herself to be an environmentalist and 0 otherwise. The influence of this discrete variable on whether to participate and the resultant income associated with this participation is unknown.

Property Characteristics Variables

- *Southeast parish*: For purposes of this analysis, the variable *southeast parish* was coded 1 if the wetland parcels located in the southeast coastal parishes (i.e., Terrebonne, Lafourche, and Plaquemines) and 0 for those in the Southwest (i.e., Cameron and Vermilion). In theory, the influence of this discrete variable on participation and income should be negligible if the model is well specified. However, given that the quality of the wetlands in southwest parishes are generally recognized to be of higher quality and this quality is not considered in the analysis, one can hypothesize that participation and income generated from this participation is higher in the southwest parishes than in the southeast parishes.
- *Hunting lodge/camp*: The variable *hunting lodge/camp* was coded 1 if hunting lodge/camp is available on the parcel and 0 otherwise. The presence of a hunting lodge/camp was hypothesized to positively influence the probability of participation and level of income from the participation.
- *Active management*: The variable *active management* was coded 1 if the landowner actively managed his/her wetland property for waterfowl habitat and 0 otherwise.[35] It was

[35] These management activities include water control, vegetation management through burning, cutting, herbicides, etc.

hypothesized that *active management* would have a positive influence on participation and level of income from the participation.

- *Receive sub-surface revenue*: The variable *receive sub-surface revenue* was assigned a value of 1 if a landowner received any sub-surface revenue from the parcel and 0 otherwise. Whether receive sub-surface revenue from the wetland parcel was hypothesized to influence both the probability of participating in income-generating activities and subsequent income.
- *Land type*: The variable *land type* was categorized into three groups: (1) *Land_type_one* denotes the property containing only one land type (i.e., freshwater marsh, brackish marsh, salt marsh, or 'other' land type);[36] (2) *Land_type_two* denotes the property with two types of land combination (i.e., property comprised of freshwater marsh and brackish marsh or property comprised of salt marsh and brackish marsh); and (3) *Land_type_three* denotes the property containing three types of land. These three categories were treated as dummy variables, where the reference group is *Land_type_three*. The influence of these discrete variables on whether to participate and the resultant income associated with this participation are unknown.
- *Total acreage of freshwater marsh*: The variable *total acreage of freshwater marsh* was defined as the total freshwater marsh acres on the parcel and treated as a continuous variable. Parcels used for income-generating activities included in this analysis averaged

[36] Salt marshes are coastal wetlands that are flooded and drained by salt water brought in by the tides. Brackish marshes develop by salt marshes where a significant freshwater influx dilutes the seawater to brackish levels of salinity. A freshwater marsh is a marsh that contains fresh water. The majority of alligators inhabit freshwater. They can only handle being exposed to salt water for a small length of time, but will sometimes live in brackish water. These marshes provide vital food and habitat for several species of migratory waterfowl as well as offering shelter and nesting sites. 'Other' land type refer to non-wetland, including woodland, agricultural land, etc. in this research. From the survey, the majority of landowner reported 'other' land type is agricultural land.

734 freshwater marsh acres with a standard deviation of 1,408 acres (recall from the previous chapter that parcels less than 50 acres were purposely excluded from the analysis). It was expected that landowners who own larger freshwater marsh parcels were more likely to participate in commercial-based activities in 2015with the amount of income derived increasing with total parcel acres.

- *Total acreage of brackish marsh*: The variable *total acreage of brackish marsh* was defined the total brackish marsh acres on the parcel being considered and is treated as a continuous variable. Parcels used for income-generating activities included in this analysis averaged 510 brackish marsh acres with a standard deviation of 1,345 acres. The expected influence of this continuous variable on participation is positive with the amount of income derived also being positive. Based on findings by Roberts et al. (1999), income derived with respect to brackish marsh acreage is expected to be less than that of freshwater marsh acreage.
- *Total acreage of salt marsh*: As with fresh and brackish marsh, salt marsh (*total acreage of salt marsh) was treated as a continuous variable***.** Parcels used for income-generating activities included in this analysis averaged 62 salt marsh acres with a standard deviation of 205 acres. While total acreage of salt marsh is hypothesized to influence the decision to participate in income-generating activities, the expected relationship is unknown.
- *Total acreage of 'other' type land*: For purposes of this analysis, the variable *total acreage of 'other' land type* was defined the total non-wetland acres owned by the landowner and treated as a continuous variable. Parcels used for income-generating activities included in this analysis averaged 341 non-wetland acres with a standard deviation of 1,167 acres. Parks and Kramer (1995), for example, found that higher

benefits derived from agricultural land, the less likely to participate in wetland restoration programs. Based on this limited literature review, it was hypothesized landowners who owned 'other' type of land are less likely to participate in income-generating activities on their parcels and receive less amount income derived from these activities.

6.3 Model Specification

6.3.1 Econometric Specification

The vector of coefficients (β_1 and β_2 in Equations 15.1, 15.3, 19.1 and 19.3 as presented in Chapter 4) illustrate the effect on the participation decision and level of participation respectively, after estimating the Heckit model and the double-hurdle model. In Equations 15.1, 15.3, 19.1 and 19.2, the vector of explanatory variables (x_{1i} ; x_{2i}) may contain the same common variables although their corresponding effects on the two hurdle equations might be quite different.

Unlike the Tobit model, the choice of explanatory variables for participation and level of participation equations of the Heckit model and double-hurdle is complex. Cragg (1971) did not provide a choice theory concerning allocation of explanatory variables between the first and second stages for the double-hurdle model and there is no clear guidance regarding explanatory variables selection in each of stages. Pudney (1989) suggested that the first hurdle is unconnected with economic variables and instead arises from social characteristics factors. Newman et al. (2003) pointed to the fact that variable selection in both stages appears to be subjective and he suggested that the first hurdle is a function of non-economic factors that determine the household's participation decision and that economic variables should be excluded from the first stage. For purposes of this study, a landowner's participation decision is assumed

to be associated with the landowner's socioeconomic/demographic characteristics and the landowners' opinions. The first stage of the process is also augmented with variables representing the physical characteristics of the parcel. The level of income generated from commercial-based activities, the response variable in the second stage of the decision-making process, was assumed to be affected by physical characteristics of the property along with attributes of the landowner.

Given little guidance as to (a) variables that might be relevant to the decision-making process and income-generating process and (b) which stage of the two-stage process would be more appropriate, the choice of explanatory variables for the first and second stage in the Heckit model and double-hurdle model were determined through a lengthy selection procedure. With the particular difficulty in the selection of variables, the choice of variable in each stage in most cases is somewhat arbitrary (Newman et al. 2003). Firstly, following Dedah (2010), the preliminary Probit and Tobit models were estimated using all potential explanatory variables. Then, variables were sequentially deleted until no further improvements (based on significance level of remaining variables) in either the Probit model or the Tobit model (statistically significant at the 10% level or greater) were forthcoming. Then, comparing the results from the previous selection process, different combinations of variables from the list of explanatory variable were reintroduced in the Probit and Tobit models. Thus, the estimation results reported in this research are based on the final set of explanatory variables that had the most explanatory power with economic considerations.

Specifically, the following variables were selected for the first stage of analysis (i.e., the participation decision): (1) *age*; (2) *education*; (3) *household income*; (4) *land ownership*; (5) *percentage of ownership*; (6) *years of ownership*; (7) *participating in other commercial-based*

activities; (8) *an active outdoor enthusiast*; (9) *southeast parish*; (10) *hunting lodge/camp*; (11) *active management*; (12) *land type*; (13) *total acreage of freshwater marsh*; (14) *total acreage of brackish marsh*; (15) *total acreage of salt marsh*; and (16) *total acreage of 'other' type land*. Similarly, the following variables were selected for the second stage of analysis (i.e., the level of participation): (1) *age*; (2) *education*; (3) *land ownership*; (4) *years of ownership*; (5) *participating in government program*; (6) *southeast parish*; (7) *hunting lodge/camp*; (8) *active management*; (9) *land type*; (10) *total acreage of freshwater marsh*; (11) *total acreage of brackish marsh*; (12) *total acreage of salt marsh*; and (13) *total acreage of 'other' type land*. [37]

6.3.2 Model Selection

The Tobit model was estimated using the command '*tobit depvar [indepvars1] [if] [in] [weight], ll[(#)] ul[(#)] [option]*' and the Heckit model was estimated using the command '*heckman depvar [indepvars1], select(depvar_s = varlist_s) [twostep]*' in Stata (Cameron and Trivedi, 2009). The parameter estimates for the Tobit model and the Heckit model with associated standard errors are reported in Appendix D and Appendix E, respectively. The double-hurdle model was estimated using Stata version 12 (StataCorp, 2012). The Stata 12 does not have built-in command to run the double-hurdle model. Thus, the log-likelihood function was estimated by creating a user written program using the command '*craggit depvar1 [indepvars1] [if] [in] [weight], second (depvar2 [indepvars2]) [option]*' in Stata, which is described by Burke (2009). To address potential misspecification errors, such as non-normality and hetroskedasticity, the standard errors were estimated using the robust option 'vce (robust)' in

[37] The level of income distribution histogram is given in Appendix C.

Stata (Cameron and Trivedi, 2009).[38]

To identify the model that best estimates the landowner's participation decision and the level of income derived from this participation, two model specification tests (the likelihood ratio test and the Vuong test) were carried out for model selection (Table 6.2).[39] First, the likelihood ratio test was employed to compare the Tobit model against the double-hurdle specification. In this research, the second hurdle equation of double-hurdle model is a nested version of the Tobit model if there is no separate participation equation. Thus, the null hypothesis is that the restricted Tobit model (which use all variable from second stage equation of double hurdle model) fit the data better. The results of LR test statistical value is $x^2_{(3)} = 2.93$ with a p-value equal to 0.40 (Table 6.2) indicated failing to reject the null hypothesis and suggested the inadequacy of the univariate Tobit specification in modelling the landowner's decision process and suggested that landowners make their decisions in a sequential manner (i.e., in the first stage, landowners make

Table 6.2 Model Specification Statistical Tests

Model comparison	Test method	Test value	P-value	Decision
Double-hurdle model vs. Tobit model	LR test	2.93 (3)	0.40	Reject Tobit model
Heckit model vs. double-hurdle model	Vuong test	1.08	0.00	Reject Heckit model

Note: The degree of freedom of the chi-square statistics in parentheses

[38] Robust standard error is also known as heteroskedasticity-robust standard errors, White-Huber standard errors, or sandwich estimators of variance. The procedure deriving robust standard error do not impose any assumptions on the structure of heteroskedasticity. This is very convenient because it means we can report statistics that work regardless of the kind of heteroskedasticity present in the population. Whether or not the errors have constant variance, it is safe to use the robust standard errors (Wooldridge 2015).

[39] Likelihood ratio (LR) test is a statistical test used to compare two nested models (the null model and the alternative model). Each of the two models are separately fitted to the data and the log-likelihood recorded. The LR test statistic is twice the difference in the log-likelihoods (i.e., 2[ln(likelihood for the full model-ln(likelihood for the reduced model)]). The test statistic is approximately a chi-squared distribution with degrees of freedom equal to df_f-df*r* and the preferred model is determined by the probability of the test statistical value. The Vuong test is LR based test for model selection. It can be used for nested, non-nested, or overlapping model selection.

the decision to participate in income-generating activities and then consider the desired level of income derived from this participation). Second, the Vuong test was used to compare the Heckit model against the double-hurdle model specification. The results of Vuong test statistical value is 1.08 with a p-value equal to zero, indicating rejection of the Heckit model in favor of the double-hurdle model specification in terms of fit (Table 6.2). While the Vuong test showed that the double-hurdle model outperforms the Heckit model, it can also be explained by the maximum likelihood estimates. For example, variables: (1) *education*; (2) *land ownership*; (3) *years of ownership*; (4) *total acreage of freshwater marsh*; (5) *total acreage of salt marsh*; and (6) *total acreage of other type of land* were found to significantly influence (from a statistical point of view) the level of income derived from participating in income-generating activities in the double-hurdle model, but did not significantly influence the level of income in the Heckit model (Appendix E).

The statistical tests and maximum likelihood estimates indicated that both the Tobit and the Heckit models are inadequate in explaining the behavior of landowners with the collected data and suggested that the decision to participate in income-generating activities and the desired level of income derived from this participation follow a two-step sequential decision process. Thus, the double-hurdle is the best specification to examine the factors that influence the likelihood of participation and the level of participation in this research.[40]

6.4 Results of the Double-Hurdle Model

The results in this section are given in two parts. First, maximum likelihood estimates are

[40] An exponential double-hurdle model was also estimated with results presented in Appendix F.

presented and discussed. Second, in order to assess the impact of the explanatory variables on the respondent variable, marginal effects are calculated for both continuous and discrete variables.[41]

6.4.1 Maximum Likelihood (ML) Estimates

The maximum-likelihood estimates of the double-hurdle model are presented in Table 6.3 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.[42] 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.

ML Estimates of Socioeconomic/Demographic Characteristics Variables

Age was found to statistically influence (from a statistical perspective) 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

[41] Discrete variables can only take on two values, 0 and 1. The AME for discrete variables shows how P(Y=1) changes as the discrete variable changes from 0 to 1, holding all other variables at their means (Caudill and Jackson, 1989).

[42] The explanation is that the focus of the analysis relates only to income-generating activities (i.e. alligator harvest and waterfowl hunting). For example, a significant negative coefficient should not be interpreted as implying an increased likelihood of participating in other activities.

Table 6.3 Maximum Likelihood Estimation of the Double-Hurdle Model

	First hurdle equation	Second hurdle equation
Socioeconomic/Demographic Characteristics		
Age	2.14***	-11122.83
	(0.71)	(10280.20)
Education	0.18	39689.41***
	(0.55)	(13440.96)
Household income		
Household_income_one	-0.41	_
	(0.58)	
Household_income_two	-0.20	_
	(0.51)	
Household_income_three	Reference group	_
Land ownership	-1.48*	-47164.67***
	(0.79)	(17532.87)
Percentage of ownership	1.02	
	(0.92)	
Years of ownership	0.0036	-253.46*
	(0.0063)	(135.25)
Participating in government program	_	-12156.48
		(11950.24)
Participating in other commercial-based activities	-5.80***	_
	(0.75)	
An active outdoor enthusiast	-0.68	_
	(0.51)	
Property Characteristics		
Southeast parish	0.41	-7344.87
	(0.51)	(8534.06)
Hunting lodge/camp	-2.12***	13738.38
	(0.65)	(10937.28)
Active management	10.805***	1059.665
	(1.08)	(18022.87)
Land type		
Land_type_one	1.99*	6646.70
	(1.08)	(11483.01)
Land_type_two	0.12	18773.40
	(0.95)	(13107.16)
Land_type_three	Reference group	Reference group
Total acreage of freshwater marsh	0.0044***	11.85**
	(0.0017)	(5.45)
Total acreage of brackish marsh	0.0011***	5.83*
	(0.0002)	(3.46)

Table 6.3 continued

Total acreage of salt marsh	-0.0014	2.75
	(0.0012)	(17.12)
Total acreage of other type of land	0.0002	13.65***
	(0.0002)	(4.75)
Constant	-3.95***	-24968.07
	(1.34)	(22406.95)
Sigma	9262.62***	
	(2008.80)	
Wald *x*2 statistic	1726.19***	
Log-Likelihood	-341.51	
Number of observation	122	

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

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 likelihood of participation and the level of participation. Specifically, results indicated that sole-owners were less likely to participate in income-generating activities and 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).[43]

Years of ownership was found to significantly influence the level of participation, but did not significantly influence the likelihood 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.

ML Estimates of Property Characteristics Variables

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.

[43] 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.

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.

6.4.2 Marginal Effects (ME) Estimates

As mentioned in Chapter 4, since the respondent variables from the double-hurdle model are latent, or unobservable, the maximum likelihood estimates cannot be interpreted in the same fashion as ordinary least square estimates. The maximum likelihood parameter estimates of the double-hurdle model provide an intuitive interpretation of the factors for determining landowner's participation decision and the level of participation. Therefore, to fully understand the magnitude of the relationship between the explanatory and respondent variables, it is necessary to explore the marginal effects using the maximum likelihood results obtained from

the estimated model. Based on different definitions of the expected value of the respondent variable y_i, three different marginal effects can be calculated.[44] The one of most interest is the unconditional expected mean (overall effect on the respondent variable) in this model. All of these marginal effects were estimated using Stata version 12 (StataCorp, 2012) and the reported standard deviations were estimated by using the '*summarize*' command in Stata. These standard deviations, however, describe only the data and should not be considered for inference on average partial effect. Therefore, the standard errors were computed using the delta method with the '*nlcom'* command in Stata for statistical inference (Su and Yen, 1996).

The estimated marginal effects for these variables, along with their delta-method standard errors, are presented in Table 6.4. In this table, 'Probability' refers to the influence of a change in the level of an exogenous variable on the probability of participation. A positive value would imply an increase in the probability of participating in income-generating activities while a negative value would imply the converse. 'Conditional' denotes the level of participation (i.e., generated income) associated with a change in the level of any exogenous variable in the model conditional on participation and, as such, refers only to those landowners who participated in income-generating activities in 2015. A positive value would therefore indicate that landowners who received income derived from these activities would receive a higher amount of participation level (i.e., generated income) with an increase in the exogenous variable of interest and, vice versa, a decrease in the participation level if that exogenous variable is reduced. The 'Unconditional' represents the unconditional effect of a change in the exogenous factor on the

[44] The marginal effects referred to the average partial effects (APE), which is an estimate averaged across the sample observation. As descripted in Chapter 4, the marginal effects can be calculated by differentiating equations (23), (24), and (25) with respect to each explanatory variable.

Table 6.4 Marginal Effects with Respect to Continuous and Discrete Variables

	Probability	Conditional level	Unconditional level
Socioeconomic Characteristics			
Age	0.20	-2789.79**	-414.09
	(0.26)	(1339.22)	(1079.37)
Education	0.02	9954.77***	4994.59***
	(0.21)	(2072.36)	(1055.01)
Household Income			
Household_Income_one	-0.04		-186.10
	(0.22)		(725.91)
Household_Income_two	0.019		-89.60
	(0.19)		(616.68)
Household_Income_three	Reference group	Reference group	Reference group
Land ownership	-0.14	-11829.69***	-6507.78***
	(0.29)	(2831.15)	(1866.40)
Percentage of ownership	0.10		457.01
	(0.34)		(1185.72)
Years of ownership	0.0003	-63.57***	-29.79***
	(0.0024)	(17.88)	(9.18)
Participating in government program		-3049.05**	-1505.64***
		(1339.69)	(473.45)
Participating in other commercial activities	-0.55*		-2605.72
	(0.28)		(2609.46)
An active outdoor enthusiast	-0.06		-305.34
	(0.19)		(690.45)
Property Characteristics			
Southeast parish	0.039	-1842.22**	-727.63
	(0.19)	(915.61)	(684.27)
Hunting lodge/camp	-0.20	3445.82***	746.90
	(0.24)	(1044.67)	(1292.30)
Active management	1.03**	265.78	4984.59
	(0.40)	(1844.50)	(4931.79)
Land type_one	0.19	1667.10	1717.10
	(0.40)	(1206.33)	(1725.89)
Land type_two	0.01	4708.68***	2377.99*
	(0.35)	(1548.41)	(1233.89)
Total acreage of freshwater marsh	0.0004	2.97***	3.46
	(0.0006)	(0.80)	(3.08)
Total acreage of brackish marsh	0.0001	1.46***	1.22*
	(0.0001)	(0.47)	(0.68)
Total acreage of salt marsh	-0.0001	0.69	-0.27
	(0.0004)	(1.73)	(1.64)

Table 6.4 continued

Total acreage of other type of land	0.00001 (0.00007)	3.42*** (0.75)	1.76*** (0.39)

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

level of generated income (i.e. the total effect) and refers to all landowners (i.e., those who participated in income-generating activities as well as those who did not). Thus, a positive value would indicate an increase in the participation level (i.e., generated income) across all landowners including landowners with zero income from these activities.

It is important to recognize the different interpretations of marginal effect for discrete and continuous variables under the probability, conditional, and unconditional headings in Table 6.4. When the value of a discrete variable changes from zero to one, the discrete effect represents the percentage change in the probability of participation on the probability marginal effect, and it represents the absolute changes in the conditional and the unconditional level of income. For continuous variables, the marginal effect represents the unit change in the response variable for a unit change in the explanatory variable.

ME of Socioeconomic/Demographic Characteristics Variables

The estimates in Table 6.4 indicated that the probability of engaging in income-generating activities was not significantly influenced by the *age* of the landowner. The estimated conditional effect was, however, statistically significant and negative (Table 6.4, column 3). Specifically, the marginal effect with respect to *age* suggested that conditional on participation, landowners who are less than 55 years old were found to receive $2,789 less income from income-generating activities than older landowners. While the conditional effect was statistically

significant, the estimated unconditional effect was not found to significantly influence the level of income derived from participation.

The marginal effects with respect to *education* were positive with respect to both the conditional and unconditional effects but insignificant with respect to the probability (Table 6.4, column 2). The positive and statistically significant marginal effects indicated that education plays an important role on the conditional and the unconditional level of participation (i.e., generated income from commercial-based activities). Specifically, conditional on participation, landowners with more formal education were found to receive $9,955 more income from income generating activities then landowners with less formal education (Table 6.4, column 3). The unconditional marginal effect (Table 6.4, column 4) indicated that more educated landowners were found to receive $4,995 more income from commercial-based activities, on average, than those landowners with less formal education.

The marginal effects with respect to *land ownership (sole ownership)* were all negative but insignificant on the probability (Table 6.4, column 2). The negative and statistically significant marginal effects indicated that *land ownership* plays an important role on the conditional and the unconditional level of participation. Specifically, conditional on participation, sole-owners were found to receive $11,830 less income than landowners who own the wetland parcel through joint ownership or 'other' ownership structure (Table 6.4, column 3).[45] Given the negative effect on conditional level and negative but insignificant effect on probability, the net effect on unconditional income is (negatively) significant and equal to $6,508 (Table 6.4, column 4). One might hypothesize that the negative effect of sole ownership on

[45] There is a relatively high correlation between 'sole ownership' and 'percentage of ownership', as one would expect (0.70) and this correlation may explain the relatively high estimate.

income reflects time constraints among sole owners. Specifically, leasing of property for waterfowl and/or alligator hunting may require monitoring and other activities to ensure that lessees are abiding by the agreed upon rules of use. Time constraints for a sole owner may exceed those in a 'partnership' where the various owners can 'split' monitoring and other activities. Another argument that may be advanced is that the fair market value of more productive properties exceeds that of less productive properties and, as such, would sell for more in the market place. This being the case, a higher amount of capital may be required to purchase more productive properties which, in turn, increase the probability of a partnership.

The negative and statistically significant marginal effects indicated that *years of ownership* plays an important role on the conditional and the unconditional level of participation. Specifically, conditional on having made the decision to participate in income-generating activities, the landowner would receive $64 less income associated with each additional year of ownership (Table 6.4, column 3). The unconditional marginal effect indicated that for each additional year of ownership, the landowner would receive $30 less income, on average (Table 6.4, column 4).

The marginal effect with respect to *participating in government program* indicated that whether to participate in government-sponsored wetland restoration programs plays a negative and significant role on the conditional and unconditional level of participation. Specifically, conditional on participation, landowners who participated in government-sponsored wetland restoration programs were found to receive $3,049 less income than other landowners (Table 6.4, column 3). The unconditional marginal effect indicated that landowners who participated in government-sponsored wetland restoration programs were found to receive $1,506 less, on average, than landowners who did not participate in a government-sponsored wetland restoration

program (Table 6.4, column 4). This finding may reflect commercial restrictions placed on acreage upon enrollment in government programs. This is the case, for example, with acreage enrolled in the CRP and WRP programs.

The marginal effect with respect to *participating in other commercial-based activities* indicated that landowners who participated in other commercial-based activities have a 55% lower probability of participating in income-generating activities (Table 6.4, column 2). While the unconditional marginal effect was not found to significant influence the level of income derived from participation (Table 6.4, column 4).

ME of Property Characteristics Variables

The marginal effect with respect to *southeast parish* indicated that the location variable (*southeast parish*) plays a negative and significant role on the conditional level of income but not on the probability of participation and unconditional level of income derived from participation. Specifically, the conditional marginal effect indicated that landowners who own wetland parcel in southeast of Louisiana were found to receive $1,842 less income (Table 6.4, column 3). This suggests that location was an important factor in determining the level of income but did not affect the decision whether or not to participate in income-generating activities. The 'poorer' quality associated with wetlands in the Southeast vis-à-vis Southwest may explain this finding.

The *hunting lodge/camp* variable exerted opposite effects on probability and the level of participation. With a negative and insignificant sign on probability, landowners who had a hunting lodge/camp on his/her wetland parcel have a 20% lower probability of participating in income-generating activities (Table 6.4, column 2). The conditional marginal effect indicated that landowners who had a hunting lodge/camp on his/her wetland parcel were found to receive

$3,446 more income than other landowners (Table 6.4, column 3). However, given the positive effect on conditional level dominates the negative but insignificant effect on probability, the net effect on unconditional income is positively insignificant and equal to $747 (Table 6.4, column 4).

The marginal effects with respect to *active management* was positively and statistical significant on the probability, but did not significant on the conditional and unconditional levels. Specifically, the results indicated that landowners who actively managed their wetland parcel for waterfowl habitat were more likely to participate in income-generating activities (Table 6.4, column 2).

The marginal effect with respect to *land_type_two* was positive and statistically significant on conditional and unconditional level of income. Specifically, the conditional marginal effect indicated that landowners who own a parcel containing two land types (i.e., property comprised of freshwater marsh and brackish marsh or property comprised of salt marsh and brackish marsh) were found to receive $4,709 more income than other landowners who own a parcel containing three land types (Table 6.4, column 3). The unconditional marginal effect indicated that landowners who own a parcel containing two land types were found to receive $2,378 more income, on average, than landowners who own a parcel containing three land types (Table 6.4, column 4). Furthermore, the positive but insignificant marginal effect on the probability of participation suggested that landowners who own a parcel containing two land types would be more likely to participate in income-generating activities than other landowners who own a parcel containing three land types (Table 6.3, column 2).

The marginal effect with respect to *total acreage of freshwater marsh* indicated that freshwater marsh plays a positive and significant role on the conditional level of income derived from participation, but not on the probability of participation and unconditional level of income. Specifically, the conditional marginal effect indicated that a one acre increase in freshwater marsh translates into an increase in income of $2.97 more income (Table 6.4, column 3). However, the positive but insignificant marginal effect on the probability of participation suggested that if a landowner owns one more acre of freshwater marsh, he/she would have a 0.04% more chance in participating in income-generating activities (Table 6.4, column 2). The positive but insignificant marginal effect on the unconditional level of income showed that if freshwater marsh increase one acre, the landowner would receive $3.08 more income, on average (Table 6.4, column 4).

The marginal effects with respect to *total acreage of brackish marsh* were all positive but insignificant on the probability of participation (Table 6.4, column 2). Specifically, conditional on participation, landowners would receive $1.46 more income per additional acre of brackish marsh (Table 6.4, column 3). The unconditional marginal effect (Table 6.4, column 4) indicated that landowners would receive $1.22 more income from commercial-based activities, on average, as brackish marsh increased by one acre.

Finally, *total acreage of other type land* were characterized by positive and significant marginal effects of conditional and unconditional levels. Specifically, the conditional effect indicated a $3.42 increase in revenue for each additional acre of other land type (Table 6.4, column 3). The unconditional marginal effect indicated that if other type of land increase one acre, the landowner would receive $1.76 more income, on average (Table 6.4, column 4).

6.5 Empirical Simulation

In this research, the final sample is represented by 122 observations. One concern is that the small sample size may result in a lack of statistical representation of the population and result in estimates that are inconsistent. Given the small sample size, therefore, an empirical simulation (resampling) was conducted based on the existing dataset to determine the extent to which the linear double-hurdle model fits the data (i.e., whether the distributions are centered on the true value; implying unbiased estimates). Like the Monte Carlo simulation which is a computerized mathematical technique that involves using repeated random sampling to generate simulated data and used with a mathematical model to solve problems, the basic idea of empirical simulation is based on the data generating process (DGP) and estimate the DGP parameters under some assumptions (e.g., type of distribution) (Cameron and Trivedi 2009).

It is assumed that the distribution of the estimators tends to concentrate at the true parameter values with an increasing sample size (Qusshim et al. 2016). The double-hurdle model was evaluated using the empirical simulation. Following Moffatt (2015), the data generating process is as follows:

First equation

$$\begin{aligned} d_i^* = 1 + 2 * age + 3 * education + 3 * household_{income_1} + household_{income_2} \\ + land_{ownership} + 2 * pct_{ofownership} + 3 * owner_{year} \\ - other_{commercial} + 4 * outdoor_{person} + 2 * southeas_{parish} + 2 \\ * hunting_{lodge} + active_{management} + 3 * land_{type1} + 4 * land_{type2} \\ + 3 * acre_f + acre_b + 2 * acre_s + 2 * acre_o + u_i;\ u_i \sim N(0,1) \end{aligned} \quad (35)$$

Second equation

$$t_i^* = 1 + 2 * age + 3 * education + land_{ownership} + 3 * owner_{year} + state_{program} + 2 * southeas_{parish} + 2 * hunting_{lodge} + active_{management} + 3 * land_{type1} + 4 * land_{type2} + 3 * acre_f + acre_b + 2 * acre_s + 2 * acre_o + v_i;\ v_i \sim N(0, \sigma^2) \quad (36)$$

By the definition of double-hurdle model, the error u_i is independent of the regressors and has a mean of zero, variance of one in the first stage decision equation. The error v_i is independent of the regressors and normally distributed in the second stage decision equation. To check the sensitivity of the estimation procedure, the random and arbitrary numerical coefficients were chosen for each variable in DGP Equations 35 and 36 as the 'true' values. Based on the data set of 122 observations, different sample sizes (n=250, 500, and 1000) were drawn and estimated. Following Cameron and Trivedi (2009), the simulation estimates of $E(\widehat{\beta_j})$ is the estimated coefficient ($\overline{\widehat{\beta_j}} = (1/N)\sum_{n=1}^{N}\widehat{\beta_j}$) and the simulation estimates of $Var(\widehat{\beta_j})$ is the estimated variance ($s^2_{\widehat{\beta_j}} = (1/(N-1))\sum_{n=1}^{N}(\widehat{\beta_j} - \overline{\widehat{\beta_j}})$). The null hypotheses is that in each simulation, the estimated coefficients are equal to the 'true' value (i.e., $H_0: \beta_j = 'true'\ value$) and the alternative is that in each simulation, the estimated coefficients are not equal to the 'true' value (i.e., $H_a: \beta_j \neq 'true'\ value$). A two-tailed t test was used to check the outcome of $H_0\ against\ H_a$ at the level or nominal size of 0.05 (i.e., the rejection rate, which is the proportion of simulations that lead to a rejection of H_0 and this proportion is the simulation estimate of the true test size) (Cameron and Trivedi, 2009).

For each sample size, the average of estimated parameters, the standard deviation (std. dev), the average of asymptotic standard error (std.err), and the rejection rate (rej. rate) were calculated and are presented in Appendix G. For example, $\overline{\widehat{\beta_{age}}} = 1.990$ in first equation over the 250 estimates, which is very close to the DGP value $\beta_{age} = 2.0$. The simulation yields a 95% confidence interval for $E(\widehat{\beta_{age}})$ of [1.434, 2.532]. This interval is quite wide and includes 2.0 suggesting that the estimator is unbiased. The results shows that the mean of estimated parameters are close to the 'true' value of the DGP in all scenarios as the sample size increases suggesting the estimated parameters of the double-hurdle model are asymptotically unbiased and consistent. The $\overline{se\widehat{\beta_{age}}}$ equals to 0.294 in first equation over the 250 estimates and the 95% confidence interval for $se(\widehat{\beta_{age}})$ is [0.289, 0.295]. Since this interval includes $se(\widehat{\beta_{age}}) = 0.294$, there is no evidence shows $se(\widehat{\beta_{age}})$ is biased for $\sigma_{\widehat{\beta_{age}})}$. The mean of the asymptotic standard errors are close to the standard deviation of estimated parameters suggesting the error variance is unbiased and consistent. The average rejection rates are converge to 5% suggesting that there are no significant biases and the asymptotic distribution is approximating the finite-sample distribution in all situations. These simulation results indicated that the large sample theory provides a good approximation to the finite sample distribution.

While the empirical simulation could be used to check if a model fit the data well or not, as with other mathematical models, it also has its limitations. The advantage of this empirical simulation is based on the data generating process and estimate the DGP parameters under some assumptions, this is also its limitation in the sense that assumptions need to be fair. Simulations can lead to misleading results if inappropriate assumptions and inputs are entered into the model. As was discussed earlier, the error term from the first equation are assumed to be independent

with the error term from the second equation. When dependency is considered to the analysis, it may present another possible result if correlation between two errors is assumed and the necessary adjustments should be made if the results that are generated seem out of line. While the empirical simulation does a fine job of illustrating the wide variance of possible results in this research, there are a number of unknown factors that cannot truly be accounted for.

6.6 Summary

This chapter examined the factors that determine both the probability of participating in income-generating activities and the level of income generated from the participation based on the household survey data through a bivariate approach. The LR test and the Vuong test were employed to compare the double-hurdle model against the Tobit and Heckit models and the results suggested that the double-hurdle model is the best econometric speciation to examine landowner's participation decision and the level of participation. A landowner passes two hurdles (whether or not to participate in income-generating activities and level of income) to achieve a positive income value and landowners who participated in these activities might have zero level of income. Because the specification of the double-hurdle model allows for zeros in the second hurdle, thus, the double-hurdle model is able to process zero level of income problems and was carried out to address the issues involved in this research.

The maximum likelihood estimates with robust standard error of the model generated both significant participation effects and level of income effects which provided a more thorough examination of the landowners participating decision in income-generating activities. The maximum likelihood estimation revealed that the likelihood of participation was determined by most of the variables in the model including: (1) *age*; (2) *land ownership*; (3) *participating in*

other commercial-based activities; (4) *hunting lodge/camp*; (5) *active management*; (6) *land_type_one*; (7) *total acreage of freshwater marsh*; and (8) *total acreage of brackish marsh*. The results also indicated that the level of income was determined by the variables: (1) *education*; (2) *land ownership*; (3) *years of ownership*; (4) *total acreage of freshwater marsh*; (5) *total acreage of brackish marsh*; and (6) *total acreage of other type of land*.

An overall view of the parameter estimates through maximum likelihood procedure showed some notable differences in the participation and the level of income equations. First, the estimates of the effect of *age, yeas of ownership*, and *hunting lodge/camp* on participation and level of income showed different signs. Landowners who are 54 years old or younger were more likely to participate in income-generating activities but received less income than other landowners. The longer the landowner owned the wetland parcel, the more likely he/she was to participate in income-generating activities and the less income the landowner received from commercial-based activities. Landowners who had a hunting lodge/camp on his/her wetland parcel were less likely to participate in income-generating activities but received more income than other landowners. The results supported the assumption of the double-hurdle model that a factor might have different effects on the probability of participation and the level of participation (descripted in Section 4.4, Chapter 4). Second, the variables such as *age*, *hunting lodge/camp*, *active management*, and *land_type_one* were found to significantly influence the participation decision but did not significantly influence the level of participation. While the variables *education, years of ownership, total acreage of other type of land* were found to significantly influence the level of participation but did not significantly influence the participation decision. Third, the variables *land ownership, total acreage of freshwater marsh,*

and *total acreage of brackish marsh* were found to be significant in both participation equation and the level of income equation.

To examine the impact of explanatory variables on the respondent variable, marginal effects were calculated for probability of participation, the conditional level of income, and the unconditional level of income. The results from marginal effect estimation revealed that the variables, *participating in other commercial activities* and *active management* were important to determine the likelihood of participating in income-generating activities. With the exception of a few variables (*active management, land_type_one,* and *total acreage of salt marsh* variables), the marginal effect estimation suggested that other variables (*age, education, land ownership, years of ownership, participating in government program, southeast parish, hunting lodge/camp, land_type_two, total acreage of freshwater marsh, total acreage of brackish marsh*, and *total acreage of other type of land),* were important determinants of level of income for those landowners who participated in income-generating activities. While the marginal effect estimation showed that the variables, *education, land ownership, years of ownership, participating in government program*, *land_type_two, total acreage of brackish marsh*, and *total acreage of other type of land,* were important determinants of the unconditional level of income (i.e. overall effect).

It was found that more educated landowners who joint owned the wetland parcel (i.e., joint ownership through an undivided heirship or a corporation or trust) and own a parcel containing two land types were found to receive more income, on average. It was also found that landowners who own more brackish marsh and other type of land received more income, on average. One important determinant of level of income was *participating in government program*. Landowners who participated in government-sponsored wetland restoration program

were found to receive less income from commercial-based activities, on average. It also appeared that landowners who own a wetland parcel located in southeast area in coastal Louisiana and with longer ownership were found to receive less income.

Next, looking at these common characteristic variables may be of interest when it comes to discussing potential impact of policy instruments which designed to encourage private landowners to participate in cost-sharing and other government-sponsored projects. The final chapter summarizes and discusses the research that has been carried out and presented in this dissertation.

CHAPTER 7 SUMMARY AND CONCLUSION

7.1 Summary and Conclusion

The purpose of this research was to develop and estimate an economically valid model that examines those factors that motivate private coastal landowners to participate in income-generating activities from their coastal wetland property. The specific objectives included:

1. Determine the characteristics of coastal Louisiana landowners, including their attitudes toward the use of their property for income-generating activities, the actual use of their wetland holdings as a source of income-generating activities, knowledge and opinions regarding cost-sharing programs, and their general socioeconomic profile;
2. Determine the physical characteristics of the wetland properties, including type of wetland, total acreage of different marsh types, and presence of a hunting lodge/camp, etc.;
3. Estimate, using a double-hurdle modeling approach, the importance of specific property and landowner characteristics on participation rates and the intensity of participation (i.e., the level of income-generating activities) in the two primary enterprises conducted on coastal Louisiana wetland properties (i.e., alligator and waterfowl hunting enterprises); and
4. Based on results from the preceding objectives, assess the potential impact of policy instruments designed to encourage private landowners to participate in cost-sharing and other federally sponsored projects that would maintain/enhance their coastal wetland holdings.

A landowner's 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 decision-making process. Landowners firstly decide whether to participate in income-generating activities and then consider the desired level of income derived from these activities. Since many observed level of income are zero, the linear regression ordinal least square procedures biased and inconsistent estimates.

Although the traditional Tobit model could be used to handle data with many zeros, this model is very restrictive in its parameterization and considers only the dependent variable to be censored at zero and ignores the source of zero observations (Newman et al, 2003; Martinez-Espineira, 2006). While the Heckit model use a two-stage estimation procedure to deal with zero observation, this model assumes that all zero observations are only from first hurdle. The double-hurdle model, however, allows for the zero observation to be affected by both participation and the level of participation decision. In Chapter 6, the standard and generalized (Heckit model) Tobit models were used to compare the double hurdle model. The maximum likelihood estimates, the LR test, and the Vuong test were employed for these comparisons and the results indicated that the standard and generalized Tobit specifications were rejected in favor of the double-hurdle model specification. These results also suggested that landowners make their decision in a sequential decision-making process. A given landowner must first decide whether to participate in income-generating activities. Conditional on having made the choice to participate in income-generating activities, the second stage considers the desired level of income derived from these activities. A landowner passes two hurdles (whether or not to

participate in income-generating activities and level of income) to achieve a positive income value and landowners who participated in these activities might have zero level of income. Because the specification of the double-hurdle model allows for zeros in the second hurdle, this model is able to process zero level of income problems and was carried out to address the issues involved in this research. In summary, this research applied the Cragg's double-hurdle model to determine landowner characteristics and physical property characteristics that affect participation (whether the landowner participates in income-generating activities) and level of participation (e.g., income generated from these activities).

The double-hurdle model with independence was applied to identify the determinants on the participation and level of participation in income-generating activities using the survey questionnaire data. The double hurdle results, based on the estimated parameters and marginal effects, confirmed that decisions to participate in income-generating activities and the level of income are related to physical characteristics of the property and socioeconomic/demographic characteristics of the landowner. In particular, land ownership, total acres of freshwater marsh, and total acres of brackish marsh were found have a major impact on respondent variables based on maximum likelihood estimation. As expected, total acreage of freshwater marsh was positively related to probability of participation and the level of participation. An increase in freshwater marsh acreage serves to increase the likelihood of participation in income-generating activities and an increase in t income. The maximum likelihood and marginal effect estimates showed that landowners who own the parcel through joint ownership (i.e., joint ownership through an undivided heirship/a corporation or trust) or 'other' ownership structure are more likely to participate in income-generating activities and would receive more income, on average. Participation in state or federal wetland restoration programs was an important factor in

determining a landowner's level of income. Landowners who participated in government wetland restoration programs were, on average, found to receive less income from income-generating activities than non-participating landowners. Landowners who owned a parcel containing two land types (i.e., property comprised of freshwater marsh and brackish marsh or property comprised of salt marsh and brackish marsh) received more income than other landowners who own a parcel containing three land types, on average. Additional factors, such as *age*, *education*, *land ownership*, *years of ownership*, *participating in government program*, *southeast parish*, *hunting lodge/camp*, *land_type_two*, *total acreage of freshwater marsh*, *total acreage of brackish marsh*, and *total acreage of other type of land* were found to be important factors to determine the intensity of participation (i.e. level of income).[46]

7.2 Limitations and Further Research

- Data Selection and Availability

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 research, the amount of 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.

- Alternative Models

The maximum likelihood estimates, the LR test, and the Vuong test suggested that the

[46] As defined in Chapter 6, *land_type_two* denotes the property with two types of land combination (i.e., property comprised of freshwater marsh and brackish marsh or property comprised of salt marsh and brackish marsh).

double-hurdle model is the best specification to determine the factors affecting participation and the level participation decisions at both stages when compared to the standard and generalized (Heckit model) Tobit models. This research employed the Cragg's double-hurdle in which the first hurdle use a Probit model and a truncated normal model in the second hurdle. As discussed in Chapter 4, there are no restrictions on explanatory variables implying the double-hurdle model could be determined by different vectors of explanatory variables in each hurdle. Since the Cragg's double-hurdle 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 double-hurdle model and Box-Cox double-hurdle models for further research.

The study shows that there is an insignificant negative relationship between household income and the likelihood of participation in the first hurdle of the double-hurdle model. However, income derived from commercial-based activities are part of annual household income even if it accounts for only a small part of household income and annual household income may correlated with other variables and the error term in the first hurdle, which would imply the potential omitted variable bias (endogeneity). An interesting further research could be conducted by introduce an instrumental variable into the first hurdle equation.

- Consideration of Large Landowners and Different Enterprise

This research 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 the survey questionnaires were mailed to landowners who own one or two wetland parcels.[47] An alternative, more comprehensive estimation of landowner participation in income-generating

[47] See Chapter 5 for more detail for sample stratification.

activities and level of income would include all landowners. This study combined both alligator and hunting enterprises data set and examined those factors that motivate private landowners to participate in these activities and the factors that affect the level of income derived from these activities. Separate double-hurdle models that examine alligator harvest and waterfowl hunting separately may also prove useful in some future study.

7.3 Policy Recommendations

The results from this research showed that only a few landowners participated in state or federal wetland restoration programs. The main reasons that landowners did not enroll any government restoration programs are: (1) too complicated to apply; (2) don't want long-term contract; (3) not enough financial incentive; (4) need the land for other purposes; and (5) other reasons. Not knowing about available programs was one reason given by landowners for not enrolling. With respect to current or pending policy instruments in regards to wetland restoration in coastal Louisiana, most landowners indicated a preference for the implementation of innovative tax incentive programs and subsidies for plant, fish, and wildlife management. Public purchase of permanent or temporary conservation easements were found to be less popular, followed by public land purchases.

Understanding the various attitudes among landowners toward wetland restoration programs provides the opportunity for policy makers to better evaluate current and potential policies. Although limited findings from this research, the descriptive and empirical results presented in Chapter 5 and 6 have potential implications with respect to crafting wetland restoration policy and data collection in coastal Louisiana.

First, policy makers may consider establishing an education program geared toward the 'smaller' (i.e., non-corporation) coastal wetland owners. Unlike corporations with large coastal property ownership, the opportunity costs of remaining abreast regarding restoration programs is likely large relative to expected benefits among many of the 'small' owners of coastal wetland parcels. Thus, any education program would need to be developed with this understanding in mind and tailored accordingly.

Second, as recommended by Coreil (1995), policy makers might consider 'speeding up' and simplifying the application process and modifying restoration program contract terms. Many of the complaints were voiced about the application process and contract terms. Policy adjustments these issues might prove useful.

Third, policy makers need to ascertain the types of incentives (financial and others) to entice private landowners to accept a wetland restoration project on their properties. 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 whether or not to engage in 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 Chapter 6 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. As pointed out in Chapter 2, 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), policy maker need to consider a portfolio of policy instruments to increase the range of options available for private landowners.

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APPENDIX A. COPY OF INSTITUTIONAL REVIEW BOARD APPROVAL

ACTION ON EXEMPTION APPROVAL REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu | lsu.edu/irb

TO: Walter Keithly
Agricultural Economics

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: January 19, 2016

RE: **IRB#** E9722

TITLE: Private Market Alternatives for Maintaining Wetland Viability in Coastal Louisiana: A Double-Hurdle Approach

New Protocol/Modification/Continuation: New Protocol

Review Date: 1/15/2016

Approved X **Disapproved**

Approval Date: 1/18/2016 **Approval Expiration Date:** 1/17/2019

Exemption Category/Paragraph: 2b

Signed Consent Waived?: No

Re-review frequency: (three years unless otherwise stated)

LSU Proposal Number (if applicable):

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Dennis Landin, Chairman

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

APPENDIX B. WETLAND ECONOMIC SURVEY

2015 Wetland Economic Survey

INTRODUCTION

Dear Landowner,

I am writing on behalf of LSU AgCenter and the Louisiana Sea Grant to request your help with an important project. As part of a larger program, we are conducting a survey to understand why people participate in commercial activities (alligator harvest and waterfowl hunting) on their land and how we can improve future coastal restoration/maintenance programs in Coastal Louisiana.

The following questionnaire will take approximately 10 minutes to complete. The information you provide us will be extremely valuable regarding potential policy instruments aimed at encouraging private participation in coastal wetland maintenance and restoration.

Participation is strictly voluntary and you may refuse to participate at any time. WE ASSURE YOU THAT YOUR ANSWERS WILL BE COMPLETELY CONFIDENTIAL. Moreover, the results of the survey will be only reported in a summary format, so again no one will link you to your responses. Please complete the attached questionnaire and return it in the self-addressed postage-paid envelope to us within the next TWO WEEKS.

Thank you in advance for your cooperation. If you have any questions or need help with this survey, please feel free to contact us at:
Phone number: 225-578-6296
Email: walterk@lsu.edu or hwang23@lsu.edu

Note: If you prefer to complete this questionnaire online, please provide your email address and parcel ID to Hua Wang at hwang23@lsu.edu and we will send the appropriate linkage to the questionnaire.

Sincerely,

Walter R. Keithly, Jr.
Survey Project Leader
Louisiana Sea Grant
Louisiana State University

Hua Wang
Survey Project Assistant
Louisiana Sea Grant
Louisiana State University

Enclosed with this questionnaire is a wetland GIS map which according to parish records is identified as a parcel you own in the coastal zone. Later in this questionnaire we are going to ask you to focus on commercial activities associated with this parcel (alligator harvest or waterfowl hunting). And all of your answers will be kept strictly confidential and never associated with your name.

Section 1: General Information

1) Do you own the parcel on the map enclosed with this questionnaire?

□ NO → If **No**, please **stop** here, fold this booklet, place it in the prepaid envelope and drop it in the mail to prevent you receiving future mailings from us. We apologize for the inconvenience and will remove you from the mailing list

□ YES

If **Yes,** please continue to fill out this survey

2) How do you own the specific parcel?
   - □ Sole ownership
   - □ Joint ownership through an undivided heirship
   - □ Joint ownership through a corporation or trust
   - □ Other (please explain)_____

3) If you maintain joint ownership of the parcel, what is your ownership percentage?
   _____ %

4) Based on the enclosed GIS map, is the stated acreage correct?
   - □ NO
   - □ YES

   If no, what is your estimated of the correct acreage?
   _____ acres

5) Approximately how long has this parcel been in family possession?

   _____ years

6) Referring to the enclosed GIS map, what types of wetland do you own on this parcel? (Check the answer to all that apply)
   - □ Salt marsh
   - □ Brackish marsh
   - □ Freshwater marsh
   - □ There is no wetland on this parcel

7) Do you use this property for any commercial-based activities?
   - □ NO – If NO, please skip to **question 14**
   - □ YES – If YES, please proceed to **question 8**

8) Please indicate the commercial activity (activities) on this property? (Check the answer to all that apply)
   - □ Alligator harvest (including egg collection)
   - □ Waterfowl hunting
   - □ Other (please specify)_____

9) What is the total number of acres of parcel you use for the following commercial activities? Please **outline** the area on the GIS map enclosed and select the type of wetland (check all boxes that apply)

   □ Alligator harvest: _____ acres
   (□ Salt marsh; □ Brackish marsh; □ Freshwater marsh □ Other)

   □ Waterfowl hunting: _____ acres
   (□ Salt marsh; □ Brackish marsh; □ Freshwater marsh □ Other)

   □ Other: _____ acres
   (□ Salt marsh; □ Brackish marsh; □ Freshwater marsh □ Other)

10) Is there any hunting lodge/camp on the parcel?

□ NO
□ YES

11) Do you actively manage your property for waterfowl habitat (e.g. water control, vegetation management through burning, cutting, herbicides …)?
□ NO
□ YES

12) What was the revenue derived from the parcel in question from the following commercial activities in 2015? (Again, this information will be confidential)
□ $ _____ Alligator harvest (including egg collection)
□ $ _____ Waterfowl hunting
□ $ _____ Other

13) Do you receive any sub-surface (oil & gas) revenue from this parcel?
□ NO
□ YES

14) Do you participate in any state or federal wetland restoration programs?
□ NO
□ YES

14a). If YES, which program(s) do you participate in?
□ Former Wetlands Reserve Program (WRP) (Merged into Agricultural Conservation Easement Program in 2014 Farm Bill).
□ Water Bank Program (WBP)
□ Coastal Protection and Restoration Authority (CPRA)
□ Coastal Wetlands Planning, Preservation & Restoration Act (CWPPRA)
□ Other (please specify)_____

14b). If NO, why do you not participate? How important were the following reasons for doing so? Check the appropriate box for each statement.

Reasons for not participation (check all that apply)	Not Important	Somewhat Important	Very Important
Too complicated to apply	□	□	□
Don't want long-term contract	□	□	□
Not enough financial incentive	□	□	□
Need the land for other purposes	□	□	□
Other (explain):_____ _____	□	□	□

CONTINUE TO NEXT PAGE

15) How would you rate the following current or pending policy instruments in regards to wetland restoration in coastal Louisiana? Please indicate (by checking a box) the level of importance for each current or pending approach below.

Policy instruments	Not Important	Somewhat Important	Very Important
Public land purchases	□	□	□
Public purchase of permanent or temporary conservation easements	□	□	□
Establishing new markets for land	□	□	□
Implementing innovative tax incentive programs	□	□	□
Subsidies for plant, fish, and wildlife management	□	□	□
Conservation cost sharing arrangements	□	□	□

Section 2: Demographics

16) Which range includes your age?
- □ Under 25
- □ 25 – 34
- □ 35 – 44
- □ 45 – 54
- □ 55 – 64
- □ 65 or older

17) What is your gender?
- □ Male
- □ Female

18) What is your race?
- □ White
- □ Asian
- □ Native American
- □ Black/African American
- □ Latino/Hispanic
- □ Other (please specify) _____

19) Which of the following best describes your total household pre-tax 2015 income?
- □ Under $20,000
- □ $20,000 - $39,999
- □ $40,000 - $59,999
- □ $60,000 - $79,999
- □ $80,000 - $99,999
- □ $100,000 - $150,000
- □ Over $150,000

20) What is the highest level of education you have completed?
- □ Less than High School
- □ High School Degree or equivalent
- □ Some College
- □ College Degree
- □ Bachelor Degree

□ Master Degree
□ Doctorate

21) Do you consider yourself an active outdoor enthusiast?

□ NO
□ YES

If YES, what are your favorite outdoor activities?

_____

22) Do you consider yourself an environmentalist?

□ NO
□ YES

If YES, how would you rate your effort in environmental protection? Please circle the appropriate number (1 with no effort … 5 with great effort).

1----------2----------3----------4----------5

23) Finally, we welcome your opinion on any topics that might not have been adequately covered in this survey, please use the space below**.** Also, if you would like a copy of the final report, please provide an email address and we will send you an electronic version of the report.

I want to thank you for your time and candid answers. You have been very helpful. Please return the survey within the next TWO WEEKS in the self-addressed postage-paid envelope provided.

APPENDIX C. LEVEL OF INCOME DISTRIBUTION

Figure C.1 shows the level of income distribution that the landowners in the sample do not receive any income from income-generating activities and that the level of income varies among landowners that decide to participate.

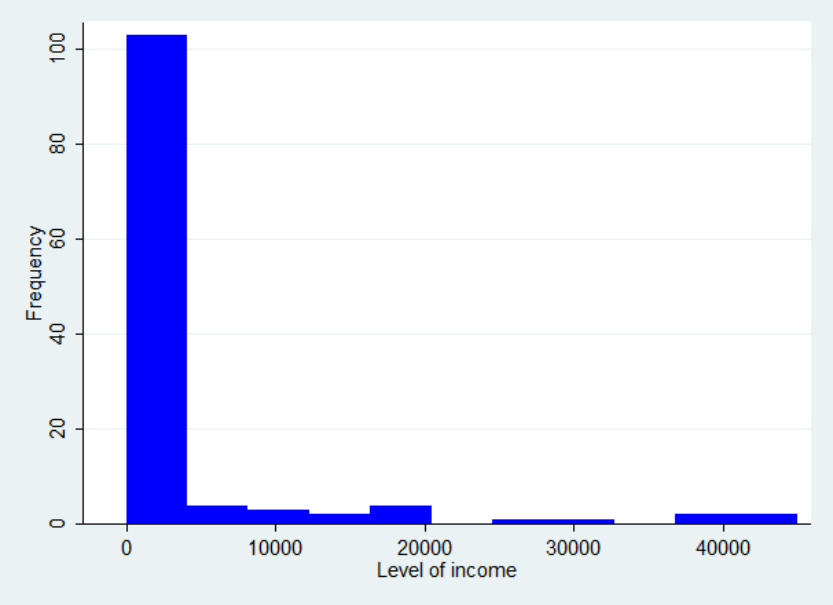

Figure C.1 Level of Income Distribution form Income-generating Activities

APPENDIX D. RESULTS OF THE STANDARD TOBIT MODEL

Table D.1 Maximum Likelihood Estimation of the Standard Tobit Model

	Coefficient	Standard error
Socioeconomic/Demographic Characteristics		
Age	8778.35**	4324.84
Education	7512.26*	4233.29
Household income		
Household_income_one	-2483.36	4427.66
Household_income_two	-4289.36	3394.52
Household_income_three	Reference group	_
Land ownership	-10404.49***	3688.94
Years of ownership	-19.91	46.24
Participating in government program	8040.89*	4515.86
An active outdoor enthusiast	-4222.99	3547.97
Property Characteristics		
Southeast parish	2320.51	3416.91
Hunting lodge/camp	1729.73	5017.29
Active management	19873.58***	5398.32
Land type		
Land_type_one	5589.34	6252.44
Land_type_two	6449.89	6675.75
Land_type_three	Reference group	Reference group
Total acreage of freshwater marsh	5.92***	1.59
Total acreage of brackish marsh	5.66***	1.83
Total acreage of salt marsh	-5.12	9.12
Total acreage of other type of land	4.19**	1.90
Constant	-19550.11**	8516.53
Sigma	10138.00	1294.59
Likelihood ratio statistics	92.76	
Prob > chi-square	0.00	
Log-Likelihood	-370.54	
Number of observation	122	

Note: Asterisks indicate levels of significance: *** = 0.01, ** = 0.05 and * = 0.10

APPENDIX E. RESULTS OF THE GENERALIZED TOBIT MODEL

Table E.1 Maximum Likelihood Estimation of the Generalized Tobit Model

	First hurdle equation	Second hurdle equation
Socioeconomic/Demographic Characteristics		
Age	0.56	2364.37
	(0.47)	(4705.60)
Education	0.74	1986.23
	(0.45)	(7495.88)
Household income		
Household_income_one	0.05	_
	(0.44)	
Household_income_two	-0.45	_
	(0.38)	
Household_income_three	Reference group	_
Land ownership	-0.46	-12163.57
	(0.62)	(4016.12)
Percentage of ownership	-0.12	_
	(0.72)	
Years of ownership	-0.0047	-8.65
	(0.0045)	(69.34)
Participating in government program	_	2085.43
		(4627.12)
An active outdoor enthusiast	-0.29	_
	(0.40)	
Property Characteristics		
Southeast parish	-0.21	3427.79
	(0.34)	(4382.16)
Hunting lodge/camp	0.35	7447.38
	(0.56)	(5811.43)
Active management	_	9498.44
		(6447.50)
Land type		
Land_type_one	0.19	10477.85
	(0.66)	(7526.86)
Land_type_two	0.46	6650.91
	(0.73)	(7799.27)
Land_type_three	Reference group	Reference group
Total acreage of freshwater marsh	0.0022***	-0.65
	(0.0008)	(2.67)
Total acreage of brackish marsh	0.0008**	-1.93
	(0.0004)	(2.94)

Table E.1 continued

Total acreage of salt marsh	-0.0012	11.98
	(0.0015)	(14.85)
Total acreage of other type of land	0.0006	-0.09
	(0.0005)	(2.95)
Constant	-1.23	4365.61
	(0.99)	(11253.96)
Sigma	10064.93	
Rho	-0.96	
Number of observation	122	

Notes: Standard errors are in parentheses

Asterisks indicate levels of significance: *** = 0.01, ** = 0.05 and * = 0.10

APPENDIX F. RESULTS OF THE EXPONENTIAL DOUBLE-HURDLE MODEL

In the case of the conditional mean of the latent variable has an exponential form instead of a linear form, the exponential hurdle model can be used to determine the likelihood of participation and the level of participation. The exponential hurdle model was estimated using the command '*churdle exponential depvar [indepvars1] [if] [in] [weight], select (varlists [,noconstant het(varlisto)]) ll[(#|varname) [option]*' in Stata 14. The maximum-likelihood estimates of the exponential double-hurdle model are reported in Table F.1 with associated robust standard errors reported in parentheses. In order to assess whether a linear double-hurdle or an exponential version is the best econometric specification, the Voung test can be applied to determine the exponential double-hurdle model versus the linear double-hurdle model. The test t value is 5.13 with a probability of zero. This result indicates that the linear double-hurdle model specification is favored over the exponential double-hurdle version.

Table F.1 Maximum Likelihood Estimation of the Exponential Double-Hurdle Model

	First hurdle equation	Second hurdle equation
Socioeconomic/Demographic Characteristics		
Age	2.037***	-0.662
	(0.656)	(0.491)
Education	-0.0175	1.442***
	(0.421)	(0.309)
Household income		
Household_income_one	-0.149	-
	(0.575)	
Household_income_two	-0.0784	-
	(0.468)	
Household_income_three	Reference group	-
Land ownership	-0.768	-1.352***
	(0.603)	(0.408)
Years of ownership	0.00727	-0.0166***
	(0.00650)	(0.00478)

Table F.1 continued

Participating in government program	-	-0.503
		(0.441)
An active outdoor enthusiast	-0.663	-
	(0.435)	
Property Characteristics		
Southeast parish	0.325	-0.494
	(0.495)	(0.332)
Hunting lodge/camp	-1.956*	1.166*
	(1.030)	(0.644)
Active management	10.47***	-0.346
	(1.470)	(0.724)
Land type		
Land_type_one	2.643**	-0.240
	(1.109)	(0.776)
Land_type_two	1.194	-0.368
	(1.009)	(0.725)
Land_type_three	Reference group	Reference group
Total acreage of freshwater marsh	0.00418***	0.000397***
	(0.00113)	(0.000138)
Total acreage of brackish marsh	0.00116***	0.000285**
	(0.000339)	(0.000129)
Total acreage of salt marsh	-0.00106	0.000488
	(0.000918)	(0.000982)
Total acreage of other type of land	0.000167	0.000736***
	(0.000234)	(0.000137)
Constant	-4.663***	8.847***
	(1.163)	(0.828)
Lnsigma	-0.198	
	(0.134)	
Wald *x*2 statistic	361.78	
Log-Likelihood	-318.76	
Number of observation	122	

Notes: Robust standard errors are in parentheses

Asterisks indicate levels of significance: *** = 0.01, ** = 0.05 and * = 0.10

APPENDIX G. EMPIRICAL SIMULATION

Table G.1 Empirical Simulation for Double-Hurdle Model

Variable	True Value	Statistics	First equation			Second equation		
			n=250	n=500	n=1000	n=250	n=500	n=1000
Age	2	mean	1.990	2.009	1.999	1.967	1.996	1.999
		std.dev	0.301	0.295	0.281	0.292	0.290	0.289
		std. err	0.294	0.290	0.285	0.289	0.288	0.287
		rej. rate	0.060	0.056	0.050	0.064	0.042	0.056
Education	3	mean	2.990	2.993	3.005	3.011	2.993	3.005
		std.dev	0.227	0.226	0.215	0.211	0.205	0.199
		std. err	0.224	0.223	0.218	0.214	0.213	0.212
		rej. rate	0.040	0.052	0.049	0.032	0.042	0.053
Household_income_one	3	mean	3.011	2.994	2.998	-	-	-
		std.dev	0.259	0.256	0.250	-	-	-
		std. err	0.260	0.259	0.248	-	-	-
		rej. rate	0.040	0.043	0.055	-	-	-
Household_income_two	1	mean	1.009	1.004	1.002	-	-	-
		std.dev	0.212	0.202	0.200	-	-	-
		std. err	0.214	0.203	0.180	-	-	-
		rej. rate	0.046	0.048	0.052	-	-	-
Land ownership	1	mean	1.011	0.995	1.003	0.982	0.994	1.003
		std.dev	0.359	0.337	0.332	0.221	0.219	0.215
		std. err	0.333	0.330	0.216	0.218	0.215	0.209
		rej. rate	0.088	0.036	0.052	0.056	0.048	0.050
Percentage of ownership	2	mean	1.996	2.002	1.999	-	-	-
		std.dev	0.383	0.378	0.367	-	-	-
		std. err	0.379	0.373	0.370	-	-	-
		rej. rate	0.040	0.042	0.061	-	-	-
Years of ownership	3	mean	2.999	3.001	3.000	2.999	2.999	3.000
		std.dev	0.003	0.002	0.001	0.003	0.002	0.001

Table G.1 continued

		std. err	0.002	0.002	0.001	0.002	0.001	0.001
		rej. rate	0.066	0.056	0.053	0.032	0.038	0.060
Participating in other commercial-based activities	-1	mean	-0.983	-0.994	-1.001	-	-	-
		std.dev	0.286	0.284	0.282	-	-	-
		std. err	0.283	0.282	0.279	-	-	-
		rej. rate	0.060	0.054	0.053	-	-	-
Participating in government program	1	-	-	-	-	-	0.973	0.993	0.999
		-	-	-	-	0.382	0.350	0.344
		-	-	-	-	0.353	0.345	0.339
		-	-	-	-	0.062	0.048	0.049
An active outdoor enthusiast	4	mean	4.015	3.992	4.001	-	-	-
		std.dev	0.220	0.215	0.208	-	-	-
		std. err	0.217	0.216	0.205	-	-	-
		rej. rate	0.044	0.060	0.045	-	-	-
Southeast parish	2	mean	2.006	1.997	2.002	1.989	1.997	1.995
		std.dev	0.221	0.219	0.210	0.229	0.220	0.211
		std. err	0.216	0.214	0.208	0.214	0.213	0.212
		rej. rate	0.064	0.052	0.050	0.048	0.062	0.053
Hunting lodge/camp	2	mean	2.031	1.968	2.006	1.984	1.996	1.999
		std.dev	0.404	0.394	0.373	0.378	0.350	0.340
		std. err	0.385	0.384	0.370	0.364	0.362	0.355
		rej. rate	0.076	0.066	0.040	0.048	0.048	0.050
Active management	1	mean	1.021	0.987	1.009	1.013	1.007	0.999
		std.dev	0.393	0.381	0.364	0.389	0.378	0.373
		std. err	0.383	0.374	0.372	0.374	0.372	0.371
		rej. rate	0.060	0.053	0.052	0.066	0.044	0.052
Land_type_one	3	mean	3.023	2.982	2.987	3.013	3.001	3.000
		std.dev	0.409	0.406	0.393	0.413	0.393	0.386
		std. err	0.397	0.396	0.388	0.392	0.389	0.387
		rej. rate	0.064	0.056	0.052	0.045	0.054	0.052
Land_type_two	4	mean	3.953	4.022	3.984	3.992	4.006	4.004
		std.dev	0.451	0.447	0.432	0.444	0.432	0.421

Table G.1 continued

		std. err	0.448	0.439	0.437	0.428	0.427	0.425
		rej. rate	0.062	0.060	0.050	0.044	0.055	0.054
Total acreage of freshwater marsh	3	mean	2.999	2.999	3.000	2.999	3.000	3.000
		std.dev	0.00015	0.00014	0.00013	0.00015	0.00014	0.00012
		std. err	0.00014	0.00013	0.00010	0.00014	0.00013	0.00011
		rej. rate	0.072	0.060	0.055	0.048	0.048	0.051
Total acreage of brackish marsh	1	mean	1.009	0.999	0.999	1.000	1.000	1.000
		std.dev	0.00015	0.00014	0.00013	0.00015	0.00013	0.00011
		std. err	0.00014	0.00013	0.00011	0.00014	0.00012	0.00010
		rej. rate	0.032	0.064	0.058	0.062	0.046	0.049
Total acreage of salt marsh	2	mean	1.999	1.999	2.000	1.999	2.000	2.000
		std.dev	0.00054	0.00053	0.00052	0.00056	0.00055	0.00052
		std. err	0.00055	0.00052	0.00049	0.00054	0.00053	0.00051
		rej. rate	0.020	0.062	0.042	0.032	0.060	0.055
Total acreage of other type of land	2	mean	1.999	1.999	2.000	2.001	2.000	2.000
		std.dev	0.00016	0.00015	0.00014	0.00016	0.00015	0.00013
		std. err	0.00015	0.00012	0.00010	0.00015	0.00013	0.00012
		rej. rate	0.060	0.058	0.048	0.068	0.040	0.048

VITA

Hua Wang received his Bachelor of Science degree in Business Management in 2002 from the Business School at Xiangtan University and his Master of Science degree in Agricultural/Resource Economics in 2012 from the Department of Agricultural Economics and Agribusiness at Louisiana State University. Hua Wang began to pursuit his Ph.D. degree in Agricultural Economics at Louisiana State University in 2012 and become a candidate for the doctoral degree in 2015. He is expecting to get the doctoral degree in Fall, 2016.