Targeting Nonindustrial Private Landowner Groups for Timber Market Entry

by

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(ABSTRACT)

This study models the timber market entry decisions of nonindustrial private landowners. It involves examining reservation prices both for harvesting timber from existing forest land and for afforestation of marginal agricultural and abandoned land. An important conclusion drawn from these models is that financial returns are not the only drivers of these decisions. Preferences for amenities derived from forests and farmland are also important. An empirical model follows which characterizes willingness to accept for various landowner groups in Virginia and Mississippi. We identify preferences and characteristics of landowners and features of forest sites that are important to the unobserved price specific to each landowner. Estimation results are also used to assess the size of payments needed to encourage harvesting or conversion from agricultural to forest uses with 50% probability. The determination of reservation prices for landowners in different regions aids in forecasting potential timber supplies from NIPF lands that are either actively managed for timber production or are not, as well as from marginal land not yet in forests, under different policy and pricing scenarios. Furthermore, it gives insight into evolving land use patterns.

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INTRODUCTION

Previous NIPF landowner behavior models have largely concentrated on estimating probabilities and levels of harvesting or reforestation (Binkley 1981, DeSteiguer 1982, 1984, Cohen 1983, Boyd 1984, Royer 1985, Brooks 1985, Greene and Blatner 1986, Romm et al. 1987, Straka and Doolittle 1987, 1988, Dennis 1989, 1990, Hardie and Parks 1996, Kuuluvainen et al. 1996) . Some recent work has focused on the impacts of acreage set aside (for nontimber activities) on the forest harvesting decision (Pattanayak et al. 2001), and on estimating landowner decisions for activities other than harvesting, namely debt, bequests, and nontimber decisions (Conway et al. 2001, Hultkrantz 2002). There has been a separate set of theoretical literature that considers the landowner decision to participate in harvesting activities (e.g., Fina et al. 2001 reviews this literature). This work derives conditions for existence of a "reservation price" for each landowner. In the context of timber markets, a reservation price represents an offer or payment a landowner must receive before harvesting and selling timber, i.e., active management, as opposed to leaving the trees standing.

The empirical testing and estimation of reservation prices remains an unstudied area of forestry and nonindustrial landowner research. Yet, it may be important in predicting future timber supply from any given landowner or collection of landowners. Many landowners do not harvest, but they do possess reservation prices that could be used as an indicator of when and whether they will enter the market. Without understanding the components of this reservation price, there is no way of knowing how far certain landowners are from participating in forest harvesting. This is especially important for landowners and markets that are impacted by urbanization or forest parcelization. In these cases, there are often large numbers of landowners who are not actively engaged in harvesting or reforesting at any one point in time. The preferences of these landowners, however, and their propensity to enter timber markets in the future (i.e., to harvest) are important factors of future patterns of land use and forest cover.

Although reservation prices have been examined only for the timber harvesting decision, a reservation price would exist in principle for other landowner market activities, such as selling land, or switching land use from agriculture to forest production through reforestation and afforestation efforts. In the arena of government set-aside programs, reservation prices would be defined as the payment a landowner would accept to give up agricultural production and undertake forestry use on an acre of land. The reservation price would depend on expectations of returns from and risks associated with these uses in the future, as well as landowner preferences involving non-income amenities associated with holding agricultural land or forests. Examples of agricultural amenities include the importance of the family farm to the landowner, while examples of amenities landowners obtain from forests include recreation, water quality, and wildlife habitat. Understanding reservation prices, and the landowner components important to them, is important in predicting land conversion whenever amenities could be significant factors in land use choices.

In this study, we examine the conditions under which a given landowner agrees to enter the market for harvesting timber or convert land from agricultural to forest use. We do this by linking the probability of bid acceptance to preferences and characteristics of landowners and features of forest sites for a range of bids. Only when the landowner is offered a bid (or observes a market price) that exceeds their individual reservation price will the landowner choose to harvest. Similarly, if the landowner were to receive some payment as incentive to plant trees on currently open or agricultural land, the landowner will make such a decision only if the payment is greater than the dollar amount they are willing to accept for the switch in land use. This willingness to accept (WTA) is equivalent to a reservation price for land use activities, and like the timber sale reservation price it will depend on preferences of the landowner and income derived from forest and agricultural activities. Both lump-sum and annual payment schemes are examined with respect to land use conversion.

Since reservation prices capitalize landowner preferences for timber, nontimber products, and income/wage possibilities (e.g., see Fina et al. 2001), differences in attitudes for harvesting and other forest management decisions will be realized through differences in reservation prices across landowners. For example, landowners with very high reservation prices might be those that associate higher risk with timber establishment than those with low reservation prices, or they may be characterized by lower debt, higher preferences for nontimber uses of their land, or higher income. Ownership type (absentee v. resident owners, owners of large v. small parcels), broad ownership objectives (future generations, environmental concerns, financial returns), and owner characteristics (e.g., age, income, debt level) may also have substantial influences on preferences and the willingness to enter the timber market. In this study, we uncover characteristics of landowners who are willing to accept low bids as compared to those who require higher offers. Moreover, we assess the size of payments needed to encourage harvesting or conversion from agricultural to forest uses with 50% probability

In some cases, a landowner who does not harvest will never do so, either because their reservation price is higher at that moment than prevailing market prices and offers, or their preferences are such that the reservation price is so high they will never harvest within a reasonable range of observed market prices. Another objective of this study is to examine factors that determine an unwillingness to make a timber sale.

Understanding what drives past land use conversion behavior can also aid in forecasting future patterns of land use and identifying groups of landowners to target with forest policies and set aside programs. With this in mind, we set out to characterize previous conversion decisions made by the landowners as functions of land and owner characteristics. The types of land use shifting that we examine include: conversions from agriculture to forestry, conversions between forestry and agriculture (i.e., in either direction), conversions from forestry to any other use, as well as no conversion of any kind from one land use to another.

We base our econometric models on data from two surveys, completed across different regions of the U.S. South. These surveys were designed to obtain the minimum payment landowners are willing to accept to either harvest timber or switch land from non-forest to forest uses. Focus groups and pretesting were employed to determine the correct levels for the referendum payment categories and the range in bid prices given to landowners in the form of WTA questions. Once the data were collected, models were estimated to show how landowners' willingness to accept or reject bids depends on landowner expectations and market parameters. Although these methods are well known in environmental economics, our application is different because, unlike in the environmental literature where the procedures are used to determine the values of nonmarketed goods, we will use them to value a good (timber or land) with observable market prices. Thus, in our surveys there should be less of the biases normally associated with referendum surveys.

Areas sampled include two Virginia regions, and two regions in Mississippi. Specifically, these regions include the coastal plain pine and piedmont hardwood-pine regions of Virginia, which have similarities with many other areas in North Carolina, South Carolina, and Georgia. In Mississippi, sampling was completed within the bottomland hardwood region of the Mississippi River Delta, and the coastal plain pine regions in the northern and central parts of the state. Descriptive statistics and estimation results will <u>only</u> be reported for the land use version of the Mississippi survey using survey data from the Mississippi River Delta on account of a low response rate (25%) for the timber harvesting version.

The forest harvesting results we provide will be useful to policy makers and members of the timber industry in predicting the participation of nonindustrial landowners in timber market activities under different price scenarios. For example, the results here might be integrated into aggregate timber supply models in order to provide a better means to predict timber supply changes throughout the South or any area where nonindustrial landowners make up a significant share of the supply base. Investigating how reservation prices respond to landowner characteristics and preferences for forest amenities will also reveal the likelihood that certain types of landowners enter and participate in land and timber markets. It is expected that the approaches and results developed in this study will be especially useful for predicting timber supply changes in areas affected by forest parcelization where recent harvesting has declined.

The land shifting results are landowner-specific and are used to assess the size of payment levels needed to encourage conversion from agricultural to forest uses with various probabilities. The results should be useful in future efforts to model the margin between forest and agricultural uses. As is well known, landowners make choices between competing uses which depend on differences in land quality (Barbier and Parks 1998, Brazee and Amacher 2001). The actual pattern of land use for any given area should depend on both the relative returns for the different uses (i.e., the productive capacity of the land), and also on values landowners may attach to non-income benefits they perceive as associated with different types of land uses.

These "amenity" values are not reflected in existing studies that model or consider land use decisions, which are based only on returns of each land unit in each possible use. We demonstrate that amenities to both forest and agricultural production can be quite important in the determination of reservation prices, and therefore are also important in predicting the minimum payments landowners would accept to enroll land in any program where land conversion is expected. The results should also be useful in efforts to develop acreage response equations and prediction equations for land in forest production.

The remainder of the paper is structured as follows. Chapter 1 discusses reservation prices for timber market entry, i.e., timber harvesting. In Section 1, we present a theoretical model of timber harvesting behavior that characterizes the reservation price specific to each landowner, followed by an empirical specification given in Section 2. Section 3 presents the forest harvesting survey instrument design including a payment table that follows the multiple bounded discrete choice approach (Welsh and Poe 1998) where a landowner is asked to reveal whether or not he/she would accept various bids for harvesting or land use shifting along with a confidence rating. This section also details the survey implementation procedures. Section 4 contains a discussion of general descriptive statistics, while Section 5 details harvest payment table statistics. Estimation results for various harvest bid functions are given in Section 6. Section 7 contains extensions of the reservation price methods of Section 6. It offers probability predictions for bid acceptance associated with different payment schemes, interprets hypothesis testing results to determine whether a 'not sure' vote is equivalent to a rejection, and discusses marginal effects of important variables in the harvest bid functions. Section 7 also provides a sample selection model that describes both likelihood and intensity of harvesting.

Chapter 2 applies the reservation price concept to land use conversion behavior, specifically to the act of afforesting agricultural or abandoned land. Section 1 introduces a theoretical model of conversion behavior based on existing land rent-based models (Barbier and Parks 1998, Brazee and Amacher 2001) that is modified to include amenity preferences. Section 2 provides the econometric model. A description of the land use survey instrument and sampling procedures are given in Section 3. Sections 4 and 5 provide general descriptive statistics and payment table statistics, respectively. In Section 6, we present estimation results for lump-sum and annual bid functions. Section 7 contains model extensions, estimated probabilities of conversion for various payment scenarios, hypothesis testing to determine whether a 'not sure' vote is equivalent to a negative vote, and marginal effects of variables with significant coefficients for selected bid functions.

Chapter 3 explores the apriori land use conversion decisions and ownership objectives of NIPF landowners. Section 1 presents estimation results of qualitative response models for each of the types of land shifting activities explained above. Section 2 gives selected marginal effects for important variables in the decision to convert land from agriculture to forest use. Finally, Section 3 contains estimation results for an all-inclusive model of apriori land shifting.

RECENT LITERATURE

Nonindustrial landowners are of interest to forest economists because they control the majority of timberland in the South (over 70%) and elsewhere in the United States (Birch 1996), making their decisions critical to future timber supplies. NIPF lands are often characterized by relatively low timber productivity given that many landowners are reluctant to invest capital in long-term ventures such as timber production. The lack of insurance covering such investments can be a deterrent to timber investment by landowners. Furthermore, landowners are now thought to place considerable value on nontimber benefits associated with standing forest stock (Hartman 1976, Binkley 1981, Boyd 1984, Newman and Wear 1993, Egan 1997), and there has been much recent work pointed at understanding these preferences (Kline 2000, Pattanayak 2001, Conway et al. 2002).

Public intervention is often viewed as necessary to induce landowners to manage their land for timber (Skok and Gregerson 1975, Boyd and Hyde 1989, Bell et al. 1994). Although the justification of such programs is sometimes called into question, an ongoing concern is the specific role government should take in the management of NIPF lands, particularly with regard to tax and incentive design (Amacher 1997). In the United States, the government has relied much more heavily on incentives compared to other countries. Many of these programs for reforestation trace from the 1930's (Goodwin et al. 2002). Recently, incentives have taken the form of funds for research, extension, and technical assistance, as well as tax benefits and input subsidies such as cost sharing of tree planting activities (de Steigeur 1984). The majority of program funding has gone to southern landowners, as detailed by Goodwin et al. (2002).

In this section, we discuss a core of recent econometric studies, many of which are summarized in Table 1. Early on, researchers attempted to identify the most important determinants of landowner harvesting and reforestation investment behaviour. As government programs grew in scope, researchers increasingly examined the decision to participate in reforestation cost-share programs or the decision to leave timber/land as bequests. There has been a shift in attention from assuming nonindustrial forest landowners maximize profits, to viewing their problem as one of maximizing utility

(Hartman 1976, Binkley 1981, Boyd 1984, Max and Lehman 1988, Hyberg and Holthausen 1989). Refer to Boyd and Hyde (1989) and Hyde and Newman (1991) for a discussion of the earlier literature, and to Pattanayak et al. (2001) for an updated review of timber supply modelling as it is related to NIPF landowners.

The behavior of private landowners is far less predictable than industry behavior due to the multi-objective nature of their ownership. Specifically, NIPF landowners may not always respond to prices in the same way that forest industry does; this makes predicting timber supply from NIPF land quite difficult, as noted by Dennis (1989) and Newman and Wear (1993). Newman and Wear (1993) estimated a restricted profit function for NIPF and industrial landowners in the coastal plain region of the Southeast. While the two ownership groups were found to respond similarly to input and output price changes, NIPF owners differed from their industrial counterparts with regards to the value attached to growing stocks, for the amenity values they provide. As a result, Newman and Wear concluded that NIPF landowners can be characterized as profit maximizers, but they also have preferences for amenities. Hultkrantz (1991) compared results from econometrics studies in the U.S. and Scandinavia during the 1980's, showing that NIPF landowners respond to prices, costs, and interest rates in a way that is consistent with profit maximization. However, due to the multiobjective nature of NIPF landowner behavior, it becomes necessary to determine what specific land, ownership, and market factors drive the various management decisions confronting these landowners.

Nontimber management goals are now thought to be a major reason for private ownership of forest land (Hartman 1976, Binkley 1981, Boyd 1984, Newman and Wear 1993, Conway et al. 2002, Pattanayak et al. 2001). Timber production as motivation for owning forest land is often given low priority by nonindustrial owners (Marler and Graves 1974, Hodges and Cubbage 1990, Alig et al. 1990). One explanation, noted by Alig et al. (1990), is the effect increasing wealth has had on nontimber benefits when viewed as leisure goods. Despite these findings, in many cases landowners still appear to have an interest in joint production of timber and forest amenities (Egan 1997, Newman and Wear 1993, Conway et al. 1998, Kline et al. (2000), Pattanayak et al. 2001). However, Worrell and Irland (1975) list impediments NIPF landowners face with respect to timber management in this regard, including lack of knowledge and interest, nontimber goals that are incompatible with timber production, low profit potential, and lack of ability.

Harvest, reforestation, and program participation decisions of landowners are often explored in the NIPF literature using qualitative response models. In these models, the probability of a landowner undertaking some activity is related to prices, costs, interest rates, physical land characteristics, and landowner demographics and preferences. Binkley (1981) modeled the harvest behavior of NIPF landowners in New Hampshire. He found stumpage price to be a significant predictor of harvest behavior, suggesting that the substitution effect of a price increase is stronger than the income effect (see also Dennis 1989). Boyd (1984) investigated the effect of reforestation cost sharing on the harvest decision, but showed that the cost share payment is not a significant predictor of harvesting. Significant variables in the harvest decision included stumpage price, technical assistance, size of landholding, farm occupation, and education. Hyberg and Holthausen (1989) presented both harvest and reforestation models based on survey data collected in Georgia. Several variables were found to be significant in predicting harvesting, including income and land values, which were inversely related to the probability of harvesting. This suggests that wealthier landowners forgo harvest for the amenity values their forest land provides. Stumpage price was negatively correlated with harvesting, while tract size, knowledge of cost share, technical assistance, and farming as an occupation were positive predictors. Dennis (1989, 1990) found the harvest decision to be influenced by income, education, and relative values landowners place on amenities and consumption, as represented by standing stock. The negative coefficient he found on the income variable also suggests, like others, that affluent landowners might be less interested in timber production. In a similar study of Finnish landowners, Kuuluvainen et al. (1996) concluded that high stumpage prices, standing stock and forest growth are all important indicators of timber harvesting by NIPF owners. Conway et al. (2002) examined the behavior of NIPF landowners in Virginia, finding that risk perception associated with growing trees and tract size are important predictors of timber harvesting, while absentee ownership (defined by location of residence greater than 50 miles from the land parcel) negatively influenced harvesting.

Notice from Table 1 that the coefficient on tract size was positive for all of the harvest probability models. In fact, Dennis (1989) predicts changes in timber supply will mainly be attributed to changes in total land area in production, rather than increases in per-acre volume. More harvesting on larger tracts also is supported by an economies-of-scale argument (Dennis 1989, Hyberg and Holthausen 1989, Conway et al. 2002). In light of the tract size finding, an interesting issue policy-makers now face is the current trend towards parcelization of NIPF land into smaller land units, as urbanization and economic growth spreads from city centers. The bulk of research suggests that this may reduce timber availability over a range of prices.

The treatment of timber prices differs among these studies. Dennis (1989, 1990) and Hyberg and Holthausen (1989) used aggregate prices in their models, while Conway et al. (2002) used actual returns for those who harvested and predicted prices for those who did not. Kuuluvainen et al. (1996) used annual prices from written contracts with the individual landowners for the years the landowner made a sale, and regional prices for the years the owner did not sell. Not surprisingly, there has been considerable debate regarding the role that prices play in harvesting decisions. In his study of harvest behavior, Dennis (1989) argued that both substitution and income effects associated with stumpage price increases occur, so that the direction of the effect of price on likelihood of a timber harvest depends on which effect is stronger. He goes further to suggest influence of price on harvesting is a priori ambiguous. Other work has supported this, finding a lack of responsiveness of landowners to stumpage prices in various management decisions (De Steiguer 1984, Brooks 1985, Alig 1986, Dennis 1989, Newman and Wear 1993, Conway et al. 2002, Klosowski et al. 2001). While these studies are numerous, others have identified a significant influence of price on management decisions, particularly for sawtimber harvests (Binkley 1981, Cohen 1983, Royer 1985, Hyberg and

Holthausen 1989, Kuuluvainen et al. 1996). The price influence is positive in all but Hyberg and Holthausen (1989).

Many studies of forestry assistance program participation have been undertaken in the 1990's (Esseks et al. 1992, Bell et al. 1994, Nagubadi et al. 1996, Crabtree et al. 1998). Bell et al. (1994) analyzed landowner participation in Tennessee's Forest Stewardship Program. Individuals most likely to participate were characterized as having a household income of $50,000 or greater, previous experience w/ forestry, actively seeking information regarding land use programs/practices, supporting conservation, or had unmanaged forest, pasture, or cropland as primary uses. They concluded that government should concentrate resources on promoting education, rather than increasing the amount of cost share. Esseks et al. (1992) found Conservation Reserve Program participation to be positively correlated with participation of landowners in technical assistance and forestry experience, and negatively affected by income. Nagubadi et al. (1996) examined cost-share program participation in Indiana. Tract size, membership in forestry organizations, age, and residence on the land were found to be important determinants of program participation. In a similar model of classified forestry program participation by Nagubadi et al. (1996), the same variable coefficients emerged as statistically significant with the exception that neither education nor resident ownership was significant. They suggest use of membership records from forestry organizations to help target landowners with cost-share programs.

Romm et al. (1987) investigated NIPF landowner propensity to invest in forestry or respond to public policies and programs. They note, "The concept of targeting public programs for nonindustrial private forestry has serious problems unless program purpose is rather sharply defined." Hyberg and Holthausen (1989) believe that incentive programs can actually reduce timber supply. Their argument is that as landowner wealth increases, landowners may substitute amenities for timber production, reducing their future harvesting. Kluender et al. (1999) feel that incentive payments often do not lead to additional production from NIPF land, and that cost-share programs have not kept real prices from rising. Brockett and Gephard (1999) undertook a study of the Tennessee Greenbelt program. This program provides preferential property tax treatment for landowners according to land value in its current use, rather than in its "highest and best use," in return for not developing the land. They concluded that tax incentives are too low to affect long-term behavior of NIPF landowners due to development pressures. They are concerned that such tax programs simply reward landowners for making forestry investments they would already make without the tax relief.

Recent NIPF research has examined in more detail the nontimber amenity tradeoffs that forest landowners face. In particular, researchers have become interested in the substitution between harvesting and nontimber preferences (Conway et al. 2002, Pattanayak et al. 2001) and willingness to accept payments to postpone harvesting and capture wildlife benefits (Kline et al. 2000). Conway et al. assumed that harvesting and reforestation decisions are not determined independently of nontimber activity and bequest decisions, i.e., they are not separable (e.g., see Koskela 1989). The nontimber activity decision is modeled explicitly as an endogenous variable by considering the choice of activity and the time spent in an activity. In other studies, amenity values have been proxied for using forest inventory measures (Binkley 1981, Pattanayak 2001). Conway et al. (2002) showed that non-consumptive activities, such as hiking, camping, and observing wildlife, were positive indicators of timber bequest intentions, but recreational activities were not correlated with harvesting or reforestation behavior in their models. Kline et al. (2000) conducted a telephone survey of NIPF owners in western Oregon and western Washington to determine willingness of landowners to accept incentive payments and forgo harvesting (for the sake of protecting wildlife habitat). Willingness to accept was related to ownership objectives, socioeconomic characteristics, and incentive offered. Landowner age, education, income, multi-objective ownership, and incentive payment were positive predictors of willingness to accept, while size of landholding, sales income, and plans to cut trees were negative predictors.

This study examines the timber market entry decisions of NIPF landowners, specifically harvesting and converting land currently in other uses to forest production. Rather than focus on these decisions over a narrow range of market prices as is done in the literature, we investigated behavior taking into account a variety of price scenarios. Forest landowners were asked to participate in one of two versions of a mail survey that elicited votes on a range of harvest or land conversion bids among a variety of site characteristics, demographic/ownership attributes, and preferences. A key finding of this research is that the important determinants of the timber harvesting decision depend on the magnitude of the offer, such that income variables predominantly influence acceptance of low bids and preference variables drive the decision to accept comparatively higher bids.

The empirical estimation of reservation prices for timber harvesting has not been done, despite that the existence of such reservation prices has been established (Fina et al. 2001). This work seeks to ascertain the important components of a landowner's reservation price for harvesting as well as estimate mean willingness to accept. Including both landowners who have and have not harvested will allow for more accurate predictions of future timber market entry and forest cover change.

In addition to examining reservation prices for harvesting and land use shifting into forest production, we considered past conversion decisions as a function of land/owner characteristics and preferences. Similar land use studies have relied on aggregate data which contain few owner-specific variables and therefore fail to capture the effect on behavior of amenity preferences for forests and farms.

SURVEY INSTRUMENT AND SAMPLING PROCEDURE

In this section, we discuss the design of the landowner survey instruments. The objective of our surveys is to elicit landowner votes on acceptance of various bid levels, as well as obtain information on landowner demographics, physical site characteristics, and preferences for amenities from forests and farmland.

Reservation Price and Willingness to Accept

A well-known survey method for the purposes is one based on a referendum approach, used mainly in the contingent valuation literature, and recommended by the NOAA Panel on Contingent Valuation (Cameron 1988, Arrow 1993, see Freeman 1996 for a sample survey). The link between reservation prices and the contingent valuation literature is clear if reservation prices can be thought of as the dollar amount any given landowner is willing to accept to engage in some activity (i.e., harvesting timber or shifting land use). In referendum surveys, willingness to accept (WTA) is estimated by asking respondents to vote yes or no regarding acceptance of a specific dollar offer to undertake some activity. This discrete choice method, first introduced by Bishop and Heberlein (1979), is preferred to asking respondents for their minimum willingness to accept outright in an open ended format since it is easier for respondents to answer and consumers often make similar “take it or leave it” decisions in the marketplace. Normally, WTP is higher (implying WTA should be lower) with the discrete choice format (Welsh and Poe 1998). Our version of this approach specifically follows the newer literature on multiple bounded discrete choice methods (MBDC) (e.g., Welsh and

Poe 1998). In MBDC surveys, respondents are asked to vote on a range of bids at one time, but unlike other work on multiple bids, respondents are also able to rate the confidence they have in their vote. This procedure has been shown more flexible in estimating WTA, as it incorporates both single referendum voting and payment card approaches.

There are many other advantages to using the MBDC approach. It is well documented that different elicitation techniques produce different WTP/WTA estimates (Hoehn and Randall 1987, Carson et al. 2000, Randall 2002), and in fact there may exist a wide range of WTP/WTA values for any individual respondent (Welsh and Poe 1998). It has also been argued that there is a "close correspondence" between different levels of certainty in MBDC and different elicitation techniques. For example, those landowners who state they are "not sure" in a MBDC survey would probably vote "yes" with a dichotomous choice format (Welsh and Poe 1998). Compared to open-ended and payment card formats, higher levels of certainty are expressed with MBDC. One recommendation of Randall (1997) is that a single bounded dichotomous choice (SBDC) instrument, where each respondent is asked to vote yes or no on a single bid, should be used whenever possible. However, there has been recent discussion that this method may overstate WTP (understate WTA) estimates. Further, with single bounded dichotomous choice one also has to choose a distribution of dollar levels. Finally, the SBDC method could be thought of as a special case of MBDC. Instead of being offered one price, respondents are able to indicate the level of certainty that they would accept over a range of prices. Therefore, the MBDC format yields more information per respondent which may result in more precise estimates of WTP/WTA. However, since the respondent is presented with a range of offers, starting point bias, whereby a landowner's decision to accept or reject a bid is influenced by the other price offers in the table, could affect the estimates. One other disadvantage of the MBDC approach is that unlike the referendum method, it is not incentive compatible; prospective program participants would normally be presented with a single offer only.

For our study, we used market information and pre-testing to identify the range of appropriate bids that were offered to landowners for harvesting timber or shifting an acre of existing agricultural land to forest production through afforesting. Given that a range of bids are presented to each landowner, it is more likely that reasonable market values fall within this range. Since market information and stocking levels are generally available, we were able to postulate a range of values for under-stocked and highly stocked forests.

Despite that we closely adhere to the methods for contingent valuation, it is worth mentioning that, in the forest harvesting case, the reservation prices we seek to study represent landowner decisions regarding *market*, and not nonmarket, goods. In our survey instrument, the landowner is asked whether he/she would accept a dollar amount to harvest his/her existing forests or to switch existing agricultural land to forest production. Well-defined prices and costs exist for these activities. Therefore, we expect fewer of the biases than contingent valuation surveys involve when asking WTA for changes in the quality of a strictly nonmarketed good where prices are not well defined.

Survey Instrument Design

The survey instruments used for both Mississippi and Virginia landowners have several features in common. Each survey is presented in Appendix 1. There are two basic versions, and two sections within each version. One version included bid questions for harvesting forests for the property specified in the accompanying cover letter (see Appendix A.2). The other version included bid questions related to shifting land out of current open or agricultural use into forest production (see Appendix A.3). The land use version also included bids stated on an annual and lump-sum basis to retain consistency with current land set aside programs such as the Conservation Reserve Program.

The MBDC approach and the survey itself were constructed to follow guidelines in the literature on contingent valuation, where these methods are used to recover willingness to accept. More specifically, our survey instruments include a discussion of the proposed market scenario before the referendum question is asked which contains a description of the payment vehicle (lump sum or annual bid), as well as background information to help the respondent understand exactly what is being valued. For both versions of the survey, this discussion includes identification of both the market benefits (e.g., timber income) and nonmarket benefits (e.g., provision of wildlife habitat and recreational opportunities) of forest land, information regarding how often forests can generally be harvested, and estimates of actual stumpage prices and forest establishment costs. For the land use version of the survey, additional information is included about the amount of time it takes for a young forest to be naturally established on farm land that is taken out of production.

Referring to the payment tables in each survey (question 10 in A.2 and questions 10-11) in A.3 and A.4), landowners were given a range of bid levels and were asked to indicate whether they would accept the specified bid and with what degree of confidence. Possible responses listed in the payment table include: definitely yes, probably yes, not sure, probably no and definitely no. The 'Not Sure' category follows the recommended guidelines discussed in Bishop et al. (1995) and Randall (1997) for survey design in contingent valuation, and is similar to the "no answer" recommendation of the panel. Landowners who voted 'not sure' in response to any bid in the payment table were asked to explain why they voted that way. Possible responses to this question included in both versions of the survey include lack of familiarity with the land tract, not being the primary decision-maker for the land tract, and lack of understanding of the referendum question. An additional response was included in the timber harvesting survey version for not knowing if forests exist on the property, while other responses specific to the land use version of the survey include never wanting to switch land use and lack of open/agricultural land on the property. Finally, an option was included in the harvesting version of the survey to allow the landowner to indicate they would never sell the timber on the property sampled. This "would not vote option" follows recommendations set forth in the NOAA panel report on contingent valuation (Arrow 1993) as well as Carson et al. (1995) and Haener et al. (1988).

The range of bids presented in each payment table was ordered on a logarithmic scale, from the lowest to the highest, again in accordance with the MBDC method. Specific bid levels in this range were created using Timber Mart South stumpage price data for 1999 and stocking for mature forests at harvest derived from standard region-specific yield tables, as well as focus group meetings conducted during the sampling. Several pre-tests of the survey instrument were also conducted during spring 2000, prior to the full-blown survey mailing. These pre-test instruments consisted of open-ended questions where landowners were asked the bid level that would induce them to either harvest or switch an acre of open/agricultural land into forest production. Data on recent Conservation Reserve signup payments were used as a check for counties sampled using the land shifting version of the payment table, as well as to refine ranges for the land conversion bids.

Other parts of the survey instrument follow the design of Conway (1998) and adhere to Dillman's (1974) total design method. Questions were asked regarding the management plans and history of the property, income and other demographic information, and participation in various programs and groups. Other questions considered bequest motives, participation in recreational activities on the land, and whether the landowner holds "absentee" or "resident" status (e.g., see Conway 1998). Finally, several questions were asked regarding the landowner's property, such as average slope, size of trees, number and miles of private roads, and allocation of land across various agricultural crop and other land use categories.

Sampling Specifics -- Virginia

The study area included the coastal plain pine and piedmont hardwood-pine regions of Virginia. Both versions of the survey instrument were mailed to randomly selected landowners in fall of 2000. Landowner names and addresses, as well as property specifics were obtained from courthouses in the counties sampled. Landowners who owned less than 20 acres were excluded, to remove the possibility that subdivision and residential neighborhood addresses were sampled (although referring to the appendix, each survey had a specific question directed toward residential neighborhood property owners). Corporate properties were not included in the sampling list.

Pre-testing was undertaken twice, first on 100 landowners from Montgomery County, with a response rate of 38%, and second on 80 landowners in Roanoke County with a response rate of 40%. The pretest included an open-ended question regarding willingness to accept for harvesting timber and shifting land use from agricultural into forest production. The pretest allowed us to determine reasonable ranges of bid levels, and also to refine survey questions and format to maximize response rates.

The forest harvesting payment table version of the full-blown survey was sent to 635 landowners in Montgomery County, 260 in Roanoke County, 150 in Pulaski County, and 225 in Giles County. After rejecting those surveys that were returned because they were undeliverable and discarding repeat landowners, a total of 358 landowners had responded, for a final response rate of 36%. This response rate is consistent with other landowner surveys in our area and region (Hodge and Southard 1992, Conway et al. 2002). The land use payment table version of the survey was sent to 1,000 landowners in the primarily agricultural counties of Hanover, Sussex, and Southampton. The final response rate for this mailing was 30%.

The survey mailing and follow-up procedure followed methods outlined in the classic survey design work of Dillman (1978). For example, the full survey included a postcard follow-up, which was sent to landowners that had not responded within two weeks of the initial mailing.

3.3 Sampling Specifics – Mississippi

In Mississippi, sampling was completed within the bottomland hardwood region of the Mississippi River Delta, and the coastal plain pine regions of the northern and central parts of the state. The survey instruments used in Mississippi, and the procedures used to develop the survey payment tables, are similar to the ones developed for use in Virginia. Some specific questions regarding types of timber, reforestation, and agricultural practices were changed to reflect the local situation. The full-blown survey was mailed in the summer of 2001 to 2,000 landowners. Those sampled with the land shifting payment table version of the survey included 1,000 landowners in the predominantly agricultural counties of Tunica, Tallahatchie, and Leflore within the Mississippi River Delta. Those sampled with the forest harvesting payment table survey version included 1,000 landowners in the predominantly loblolly pine counties of Jones, Covington, and Amite. These counties were chosen for variation in the type of forest that would normally be harvested or planted. For example, the harvesting version was sent to an area of the state managed for loblolly pine plantations, while the land use version was sent to primarily agricultural counties in the northern Mississippi River Delta. A low response rate of 25% was obtained from both survey mailings. Landowner lists for both surveys were obtained from existing Mississippi State University databases.

CHAPTER ONE: RESERVATION PRICE FOR TIMBER MARKET ENTRY

1 MODEL OF RESERVATION PRICE FOR TIMBER MARKET ENTRY

In this section, we introduce a model that describes the timber market entry decision of NIPF landowners. This model is an adaptation of the referendum model developed by Hanemann (1984), whereby an individual compares the indirect utility derived from two states: one representing the situation before a welfare change has occurred and the other after the change. Note that Cameron (1987) developed a similar model based on expenditure minimization that is dual to the Hanemann model when the stochastic portion of each model is zero (McConnell 1990).

We describe a landowner's reservation price for harvesting an acre of timber implicitly in our model as the compensating variation for this activity. Compensating variation is defined as the amount of money required to leave an individual at the same level of utility before a welfare change as after. When dealing with a welfare reducing change, such as timber harvesting, compensating variation is equivalent to willingness to accept (WTA), or the payment required to make a landowner as well off without the timber as he/she was with the timber. If the compensating variation is less than or equal to the per-acre harvest bid, a landowner will accept the bid, otherwise the bid will be rejected. We will show that a landowner's reservation price for timber harvesting, or compensating variation, is a function of amenity preferences, forest stock, and site characteristics amenable to forest production.

The utility function representing the status quo, i.e., the situation where the landowner rejects the harvest bid choosing not to harvest is:

U_0 = U (no compensation, no timber harvesting). (1)

The utility function for the case where the landowner accepts the harvest bid is:

U_1 = U (compensation, timber harvesting on one acre). (2)

More specifically,

$$U_0 = \int_0^\infty B_f(t)e^{-rt}\,dt - c \tag{3}$$

and

$$U_1 = \left[\frac{e^{-rT}py(T) + \int_0^T B_f(t)e^{-rt}\,dt - c}{\left(1-e^{-rT}\right)}\right], \tag{4}$$

where B_f represents the amenity value to the landowner associated with holding unharvested timber stock, t is time, T is the rotation age, c is the per-acre planting cost, r is the discount rate, p is the stumpage price (i.e., harvest bid), and y is the timber volume at the rotation's end. If the landowner chooses not to harvest timber, equation (3) applies and the landowner receives amenity benefits ad infinitum, but no harvest income. This is the case where the rotation age is infinite. On the other hand, if the landowner accepts the bid, he/she is in the situation represented by equation (4). Here, the landowner receives timber income as well as amenity benefits up until the time of harvest. Since all exogenous market parameters are assumed constant over time, rotation age is also constant. Note that equation (4) is equivalent to the Hartman (1976) model.

The landowner's objective function is:

$$\text{MAX}_{\text{w.r.t}\ \delta,T}\quad \delta\left[\frac{e^{-rT}py(T)+\int_0^T B_f(t)e^{-rt}dt-c}{\left(1-e^{-rT}\right)}\right]+(1-\delta)\left[\int_0^\infty B_f(t)e^{-rt}dt-c\right], \tag{5}$$

where δ represents the decision to accept the bid and harvest, thereby constrained at 0 or 1. Thus, the landowner has two choice variables, δ and T, representing the choices of: (1) whether to harvest or not and (2) the rotation age (if δ = 1, the landowner chooses to harvest), respectively. The first order condition with respect to the harvest decision, δ , indicates that the harvest bid must be such that the difference in the level of utility is positive, i.e., $\Delta U = U_1 - U_0 \geq 0$ (or $U_1 \geq U_0$), to induce the landowner to harvest an acre of timber. In other words, a landowner will choose to harvest if and only if subtracting equation (3) from equation (4) yields a positive value:

$$\Delta \text{U} = \text{U}_1 - \text{U}_0 = \left[\frac{e^{-rT}py(T)+\int_0^T B_f(t)e^{-rt}dt-c}{\left(1-e^{-rT}\right)}\right]-\left[\int_0^\infty B_f(t)e^{-rt}dt-c\right]\geq 0. \tag{6}$$

If the bid, p, is equivalent to the compensating variation for harvesting an acre of timber, then the landowner is indifferent between harvesting and not harvesting, and

$$e^{-rT}py(T)=\int_T^\infty B_f(t)e^{-rt}dt\,. \tag{7}$$

Equation (7) implies that p must be such that discounted timber income is greater than or equal to discounted amenity values from holding unharvested timber stock from time T to infinity in order for a landowner to harvest and sell timber. In other words, the harvest bid must exceed the compensating variation.

2. ECONOMETRIC MODELS OF TIMBER MARKET ENTRY

We use a parametric approach from the contingent valuation literature to estimate willingness to accept compensation for timber harvesting on an acre of forest land, whereby the referendum decision is treated as a binary choice. Our econometric models follow from the utility maximizing model discussed above in Section 1. We assume that utility is comprised of a systematic component (V_δ) as well as a random component (ε_δ), where $\delta = 0$ if the landowner rejects the bid and $\delta = 1$ if the landowner accepts it. We also assume that individual owner characteristics and preferences as well as features of the site enter the utility function, and designate these S. The probability that a respondent will accept the harvest payment follows from equation (6) and is defined as:

$$\begin{aligned}
\Pr(\delta = 1) &= \Pr(U_1 \geq U_0) \\
&= \Pr(V_1 + \varepsilon_1 \geq V_0 + \varepsilon_0) \\
&= \Pr(V(\delta{=}1, I + p; S) + \varepsilon_1 \geq V(\delta{=}0, I; S) + \varepsilon_0) \\
&= \Pr\{\varepsilon_0 - \varepsilon_1 \geq V(\delta{=}1, I + p; S) - V(\delta{=}0, I; S)\}, \qquad (8)
\end{aligned}$$

where I is exogenous income and p represents compensation for harvesting a single acre of timber, i.e., the bid. Assuming $\varepsilon = \varepsilon_0 - \varepsilon_1$ has a logistic distribution, we can estimate equation (8) with a binary LOGIT model, where a landowner accepts the bid if a "probably yes" or "definitely yes" response is given; otherwise the bid is rejected. The LOGIT model is the most widely used regression model in discrete choice CV studies (Cooper 1994). Simple LOGIT referendum CV models should always include the bid variable on the right hand side at a minimum (Loomis and Gonzalez-Caban 1996). We include a variety of owner demographics and preferences as well as ownership characteristics that are captured in S, in addition to the bid. If a landowner is presented with multiple bids at one time, and asked to vote on each of those bids with various levels of confidence, the parameters of equation (8) can be estimated with a multinomial LOGIT model for each bid level. Here, the dependent variable, δ, takes a value of zero to four for definitely no, probably no, not sure, probably yes, and definitely yes responses, respectively.

A sample selection model can also be estimated which consists of a binary PROBIT model representing the decision to never harvest timber (regardless of price) or harvest (with the condition that the stumpage price must cover the compensating variation for harvesting), followed by an OLS regression that determines the required harvest payment. The dependent variable in the second-stage bid regression approximates a reservation price for timber harvesting and is defined by the first payment the landowner marked "probably yes" or "definitely yes" for those who accepted a payment within the provided range and a much higher value for the landowner who would not accept a bid within the specified range. Notice that a "never harvest" response in the first stage of the decision process does not comply with economic theory. For a sufficiently high stumpage price, all landowners should be willing to harvest timber from their land. Nonetheless, approximately 21% of the landowners in our study indicated on their surveys that they would never harvest no matter what the amount offered, by checking such a box following the payment table.

The lowest bid for which a respondent voted "definitely yes" or "probably yes" approximates his/her reservation price, and can be inferred from equation (7) by solving for p^*. From equation (7), it is clear that a landowner's reservation price is positively related to amenity benefits derived from standing timber, and inversely related to timber volume (and therefore site characteristics amenable to production). Since a landowner's reservation price can't be measured exactly, we will denote it in stochastic terms as $p^* + \eta$. A landowner will choose to harvest if the offered bid is at least as high as his/her reservation price, i.e., $p \geq p^* + \eta$. If η is correlated with ε ($= \varepsilon_0 - \varepsilon_1$ from equation (8)), then a sample selection model can be estimated.

3. GENERAL DESCRIPTIVE STATISTICS OF VIRGINIA LANDOWNERS—FOREST HARVESTING SURVEY VERSION

Descriptive statistics for the forest harvesting version of the Virginia survey are presented in Table 3. Complete descriptions of all variables used in this study are located in Table 2. Data transformations were performed to convert some variables into a form compatible with our econometric models. For example, gross income is measured categorically in \$10,000 increments in the surveys (following Dillman 1978) and subsequently transformed into a continuous variable for model estimation by using midpoints of all ranges. A dummy variable indicating absentee or resident ownership was also created from survey data that specified how many miles from the land parcel the landowner resides. Landowners whose residences are located more than fifty miles from their land tracts are considered "absentee" (Shaffer and Meade 1997, Conway 1998) and are so indicated in this study. Contrariwise, those who lived within fifty miles of their tracts are considered resident landowners. Similarly, a dummy variable was created from survey data on size of the parcel, in terms of acres. Land parcels that are more than fifty acres in size are viewed as large, while tracts that are less than fifty acres are considered small. The general survey statistics that follow relate to demographic attributes, ownership characteristics, site characteristics, and landowner preferences, and discussion of these statistics is divided accordingly.

3.1 Demographic Attributes

The average age of the surveyed landowners is 59.6 years. This result is consistent with the findings of Conway (1998) who surveyed a similar area in Virginia found an average age of 59.7 years and Dennis (1989) who obtained a similar figure for northeastern landowners. The average household has 2.4 children, which is in line with current national estimates. Almost half of the respondents are retired, the remainder of which tend to be employed, and 54% hold a college degree. In a study of landowner attitudes towards managing NIPF land by Bourke and Luloff (1994), 45.7% of the landowners completed college. Average family income for the year 2000 was close to $80,000, which lies between the value of $53,000 obtained by Hodge and Southard (1992) and $91,000 found by Conway (1998), both for Virginia. Many landowners earned a significant amount of income from the sale of agricultural products. Average reported debt is $66,000 per landowner, with home mortgages ranked as the largest source of debt. This value is low compared to what is later reported in this study for Mississippi ($76,000) and compared to the $103,000 figure reported in Conway (1998).

3.2 Site and Ownership Characteristics

Survey respondents characterized the general terrain of their land as being either mountainous or hilly, which is consistent with the topography of the study area. Slope is expected to be a negative predictor of timber harvest activity, as forest access is restricted in the steeper areas. Road access may be a positive predictor of harvesting by NIPF landowners, although it is often excluded from harvest models. Landowners reported an average length of private roads of 1.06 miles for their properties.

Land tenure may be an important indicator of reservation prices for timber harvesting and land conversion. Approximately 30% of respondents indicated that they inherited at least a portion of their land, while 74% bought all or part of the land. Average length of ownership is 42 years, suggesting that many of the land parcels have belonged to the families of the respondents throughout most of their lives. Again, tract size has been shown in the literature to be a positive indicator of timber harvesting, perhaps owing to economies of scale ((Dennis 1989, Hyberg and Holthausen 1989, Conway et al. 2002). Average tract size as listed in county tax records is 87 acres, allocated among agricultural land (38 acres), forestland (68 acres), open/abandoned land (7 acres), and land devoted to residential use (1.5 acres). Notice that the sum total of the acres allotted to each use, as reported by the landowners, is greater than the tract size figure given in the courthouse records. We suspect this is on account of small errors in estimation by the landowners.

Absentee ownership of forest land is prevalent in Virginia, with most estimates ranging from 14-22% (Conway et al. (2002), Shaffer and Meade (1997), Birch (1995)). Hodge and Southard (1991) approximated a much larger percentage (32%). For these studies, landowners are labeled 'absentee' if they reside more than 50 miles from their land parcels. For this study, 14% of the landowners are absentee; absenteeism was defined in the same manner. On average, this cohort of landowners lives 357 miles away.

3.3 Landowner Preferences

Landowner preferences are often left out of qualitative response models of harvest behavior, especially when aggregate data are used. However, whether or not a particular landowner will choose to enter the market for timber depends in part on their preferences for amenities derived from forestland (i.e., see equation 7). In response to questions regarding payment that a particular landowner would require to harvest an acre of timber on their land, 21% of the owners indicated that they would never harvest regardless of price. This finding demonstrates how valuable nontimber benefits are to NIPF landowners, and this should play an important role later when we formally examine these conditions. Whether or not a landowner really would never harvest, no matter what the price that is offered, cannot be inferred from the survey responses. Survey participants were also asked to rate the degree of risk that they perceive is involved with losing timber to a host of natural occurrences, as well as the risk involved with making a timber investment as opposed to other investment opportunities, on a scale of one to five (one being the least risk and five the most). The average response to the first question pertaining to risk was 2.49 and for the latter, 2.96. Past harvests should certainly be an indicator of future harvesting activity. Twenty-nine percent of landowners reported a timber sale from the tract of land in question at sometime during their tenure. This figure is much lower than predictions made for the South from similar surveys, ranging from 45%-62% (Hodge and Southerland (1992), Moulton and Birch (1995), Conway et al. (2002)). The average time since the sale of timber for this group of landowners was 3.8 years.

Landowners were asked to divulge their reasons for owning forests, by ranking them in order or importance (one being the least important, five being the most important). Preserving scenic beauty was most preferred, with an average score of 4.18. Holding land for future generations was a close second, with a score of 4.07. Environmental protection and recreational use on the land received a score of 3.70 and 3.69, respectively. Holding land as a real estate investment had a mean score of 3.33, suggesting that respondents are more interested in nonmarket benefits than financial returns when it comes to motivation for land ownership. Timber production was cited as the least important reason to own forest land, with a score of 1.82, further implicating amenity benefits as the most important reason to own land. Recall that timber production is often given little attention by NIPF landowners (Marler and Graves 1974, Hodges and Cubbage 1990, Alig et al. 1990).

Several survey questions were designed to evaluate the future intentions of landowners regarding the management of their land parcels. Seventy-two percent of the respondents conveyed that they planned to pass land to their heirs in the future, while

25% indicated that they would rather sell their land in the future. When posed with a question concerning future plans for the timber, 24% of landowners said they eventually would harvest it and 17% plan to sell the timber with the land. Conway et al. (2002) reported that 53% of landowners in their study intend to bequeath land and/or timber to their heirs. Understanding the bequest motives of NIPF landowners is crucial to making accurate predictions of timber supply since timber and land bequests affect the future contiguity and size of the forest sector (Hultkrantz 1991, Conway et al. 2002).

4. PAYMENT TABLE STATISTICS— TIMBER HARVESTING SURVEY VERSION

In this section, we present descriptive statistics specific to the payment table portion of the survey. Recall there are two versions of this table, one that records votes on various bids for harvesting, and one that records votes on bids for land conversion to forest use. The payment table in the forest harvesting version contains a series of per-acre harvesting bids. The prices range from \$500 - \$13,000 and increase logarithmically. The landowners were asked not only to indicate whether or not they would be willing to accept each of the bids, they were also asked to rate the degree of confidence they had with their votes. Possible responses to the bids included ‘definitely no’ (DN), ‘probably no’ (PN), ‘not sure’ (NS), ‘probably yes’ (PY), and ‘definitely yes’ (DY). An example of the payment table given in the forest harvesting version of the survey is located in Appendix 1. The payment table statistics are exhibited in Tables 4 – 12 of Appendix 1. In addition to providing statistics for the full sample, they are also stratified according to parcel size, absentee/ resident ownership, and bequest motives of the landowner. Note that for Tables 4-12, the rows do not sum to one; this is attributed to the lack of response by some landowners to specific price offers.

Table 4 provides payment table statistics for the full sample, in terms of the percentage of landowners who responded positively within each voting category, for each bid amount. Notice that the higher the bid, the higher the probability of providing either a “probably yes” or “definitely yes” vote and the lower the likelihood of providing either a “probably no” or “definitely no” vote. This supports the assumption that consumers are rational decision-makers. Although the incidence of “probably yes” votes fluctuates as harvest bid level increases, a general upward trend is noticeable. “Definitely yes” votes consistently increase and considerably so (e.g., 2% of the landowners voted DY in response to the $1,000 bid, while 36.5% of the landowners voted DY in response to the $13,000 bid). The percentage of landowners providing “probably no” votes initially increases as bid level rises, as landowners begin to change their vote from “definitely no” for each successive bid, until the $3,500 bid is reached, whereupon further increases result in a decline of PN votes, as expected. The incidence of DN votes declined steadily from 59% to 11.8% as harvest payment increased from $1,000 to $13,000. Votes in the ‘not sure’ category are positively related to bid increases for the $500 to $5,000 range, after which they generally decline, as landowners become more confident about their willingness to accept the bid.

In Tables 5 and 6, the responses to the payment table are divided according to whether the landowner is considered absentee or resident. Again, an absentee landowner not only resides off the land parcel in question, but also lives at least 50 miles away from the parcel, in accordance with the literature (Shaffer and Meade 1997). Since absentee landowners often have diminished access to their land and are generally less educated about timber production, we expect more negative replies to the bids than would be given by the resident owners. Comparing Tables 5 and 6, we find slightly higher percentages of negative (i.e., PN or DN) votes for the absentee group. Shifting attention to the DY voting category, we discover a significant increase in positive votes between the $5,000 and $6,500 bids (from 10% to nearly 28%) for the absentee landowner group, as shown in Table 5. A similar increase occurred for the resident landowners, but between the $6,500 and $8,000 bids, suggesting that resident landowners in this study actually require a higher price for their timber. Similarly, a slightly higher percentage of absentee landowners would be willing to accept the $8,500, $10,500 and $13,000 bids. However, it should be noted that a slightly lower percentage of absentee landowners would accept the lowest bids of $500 and $1,000.

Tables 7 and 8 split the responses according to parcel size. A land parcel is labeled “large” if county records indicate that it is at least 50 acres in size; all other parcels are considered small. Since more timber harvesting occurs on the larger land parcels, where more timber is present, we anticipate lower reservation prices for this group, i.e., we expect more positive responses to the harvest bids from this group, as compared to owners of the smaller tracts. Comparing the responses from Tables 7 and 8, we observe that more of the large tract owners are willing to accept the $8,500, $10,500, and $13,000 bids. However, more of these landowners reject the lower bids of $500, $1,000, and $2,000 with a DN vote. Another interesting conclusion drawn from these tables is that small tract owners appear less sure about whether to accept a bid, as exemplified by the higher percentage of “not sure” votes in response to the majority of bids. Since the large tract owners tend to be more educated about timber production and pricing, it is conceivable that they would be more confident of their votes and more aware of how the hypothetical offers presented to them in the survey compare to current market stumpage prices.

Whether or not the landowner intends to pass timber on to heirs in the future may also influence his/her current reservation price for harvesting. Therefore, we also expect a disparity in the responses between these two landowner types. Tables 9 and 10 contain the payment table responses of the landowners with and without bequest motives, respectively. The most obvious difference in voting behavior between these two landowner groups concerns positive (PY or DY) voting. Landowners with bequest motives are less likely to accept the price offers presented to them, indicated by fewer PY and DY votes, in compliance with their wish to hold on to the timber for future generations.

Lastly, we explore differences in voting behavior for landowners with incomes above and below the mean of $ 78,281.25. Statistics for these landowner groups are found in Tables 11 and 12. Surprisingly, the landowners with the higher incomes are more likely to accept any of the hypothetical harvest offers, as shown by a higher percentage of PY and DY votes and lower percentage of PN and DN votes for most of the bids. Moreover, they seem to be more confident of their voting, with proportionately fewer “not sure” responses.

Overall, the payment table statistics indicate that the landowners who reside within 50 miles of their land parcel, own tracts 50 acres and larger, or lack bequest intentions are more likely to accept a range of hypothetical bids in return for harvesting an acre of timber, compared to their counterparts. Resident landowners and small tract owners appear less certain of their votes, with a higher percentage of "not sure" responses. Landowners with and without bequest intentions do not vary significantly with regards to voting confidence.

5. RESERVATION PRICE ESTIMATION FOR TIMBER SALES

The payment table descriptive statistics described above imply a positive relationship between harvest bid and likelihood of acceptance by NIPF landowners for a variety of ownership types, in accordance with the economic assumption that consumers are rational decision-makers. Significant differences in voting behavior were found for the different types of landowners we investigated implicating specific groups to target with policies and programs intended to boost timber supply. To further identify landowners who may be interested in timber harvesting, we estimate multinomial LOGIT (MNL) models that relate probabilities of choosing each of the voting categories (i.e., 'definitely no', 'probably no', 'not sure', 'probably yes', 'definitely yes') to bid level and landowner type as well as to particular site characteristics and preferences of the landowners. Our main objective is to establish what owner attributes and physical characteristics of land parcels most influence the timber market entry decision and with what degree of confidence. Alternatively, it is important to understand what drives the decision never to harvest timber regardless of how high stumpage prices are. An additional question posed in the survey directly followed the payment table and elicited landowner votes to never harvest no matter how high the bid in order to facilitate study of this decision (see Appendix A.2). We estimate a binomial LOGIT model based on responses to this inquiry that relates the decision not to participate in timber markets to the same set of land and owner characteristics as included in the specification of the multinomial LOGIT models of bid acceptance. Estimation results from this model will be presented first, followed by discussion of the MNL models.

It is important that we take account of the most important variables affecting market entry in our modeling efforts, which means exploring a variety of site characteristics and landowner demographics, without disregarding the personal preferences of the owners. Recall from equation 6 of the theoretical model presented in Section 1 that amenity benefits in addition to financial returns influence likelihood of timber harvesting, i.e., market entry. If a landowner has strong amenity preferences, whether they are connected with environmental quality, preservation of wildlife habitat, recreation, or aesthetics, market entry may be less likely to occur. Therefore, if we fail to include variables to capture such preferences, we will have an incomplete representation of NIPF owners with regards to timber production decisions.

Specific site characteristics that we examine in the models explained below include parcel size as reported in county tax records and length of private roads on the property, a measure of access to the timber. Number of acres currently devoted to forests, average slope of the property, and existence of a structure (house, barn, other), all attained from our survey, did not influence either the decision to not participate in timber markets or likelihood of bid acceptance and were therefore excluded from the equations. Demographic attributes include annual income for the year preceding the survey, employment status, total accumulated debt (from home mortgages, car loans, education loans, credit cards, etc.), and number of children (useful as a proxy for heirs). Ownership characteristics that we explore include distance between the landowner's residence and land parcel, measured in miles, as a proxy for absenteeism (which did not perform as well when entered into the equations), whether the landowner inherited all or part of the parcel and length of land tenure. Finally, variables representing owner preferences consist of time spent recreating on the land, intentions to pass timber on to heirs (as oppose to making a timber sale), preferences for environmental protection as motivation for owning land, preferences for bequests as reason for owning land, and risk perception concerning investing in timber production as opposed to other types of investments.

5.1 The Decision Not to Enter the Timber Market

The decision not to participate in timber markets is represented with a binomial LOGIT model, where the dependent variable corresponds to whether the landowner indicated on the survey that he/she does not intend to harvest timber regardless of price. From Table 3, it is evident that 21% of the sample responded in this way. Clearly, this group of landowners must either have amenity preferences with regards to their land parcels that preclude them from managing for timber or perceive timber investments to be risky (that is, unless trees doesn't already exist on their parcel). We are interested in what specific land and owner characteristics influence whether landowners will object to selling their timber. Identifying such landowner groups will aid policymakers in their efforts to increase productivity from NIPF lands, perhaps by targeting them specifically for education-based programs that may help sway their decision not to harvest.

Table 13 exhibits estimation results for the binomial LOGIT model involving the decision to not participate in timber markets. This model is based on 142 observations after accounting for missing data. Dummy variables indicating whether the landowner plans to pass timber on to heirs in the future (PLANGIVE) and whether all or part of the land parcel was inherited (INHERIT) both seem to influence the decision. In addition, length of private roads contained on the property (ROADS) and number of children (CHILDREN), which serves as a proxy for heirs, are important. The PLANGIVE and ROADS variables both exhibit positive coefficients that are statistically significant. If a landowner intends to bequeath timber to their heirs, it makes sense that they would be less likely to accept payment for it. While we anticipated that landowners with good road access would be more likely to participate in the timber market, this was not the case. In fact, private roads on the property seemed to be an indicator that the landowner did not wish to harvest, regardless of price. These results seem to suggest that landowners with bequest intentions and/or good road access are good candidates for education-based forestry programs. From Table 3, it is clear that many landowners included in the survey hold agricultural land in addition to forest land (specifically, the average landowner owns 68 forested acres and 38 acres devoted to agricultural uses). Perhaps the landowners with good road access tend to farm their land. The CHILDREN and INHERIT variables both have negative coefficients, suggesting that the more heirs a landowner has and the more likely the landowner is to have inherited at least a portion of their land, the less likely the landowner is to indicate that he/she will never harvest timber, indicating a willingness to enter the market for timber. These groups of landowners should perhaps be targeted for instructional programs that provide such services as assistance with management plan design and implementation as well as cost-share programs for tree planting and subsidies for land set aside activities.

5.2 Multinomial LOGIT Models of Payment Acceptance for Harvest of a Single Acre

In Section 2, we provided motivation for estimating a multinomial LOGIT (MNL) model of acceptance/rejection of a harvest bid, in terms of providing a definitely no, probably no, not sure, probably yes, or definitely yes vote. In this section, we estimate such a model for each bid level. Estimation results are found in Tables 14 – 21. The bid levels increase logarithmically as follows: $500, $1,000, $2,000, $3,500, $5,000, $6,500, $8,500, $10,500, and $13,000 per acre. The definitely no, probably no, not sure, probably yes, and definitely yes votes are referred to as DN, PN, NS, PY, and DY, respectively. Note that one decision must be omitted in order to estimate an MNL model. For these models, the "definitely no" (DN) vote is dropped. To make the results manageable, we will generally track each variable across the bid levels within a single voting category. We will focus on threshold values that indicate where in the line of price offers certain landowner types make the transition from being unsure about the bid, or rejecting it altogether, to consistently providing a probably yes or definitely yes vote to all bids that are greater than or equal to this value. These threshold values approximate reservation prices for the various landowner groups. We do not present results for the \$500 bid, since there was insufficient variation in the dependent variable upon model estimation, due to rejection of this bid with a DN vote by the majority of survey participants.

The landowners who are involved in non-consumptive recreational activities on their land such as hiking, wildlife observation, and camping, seem to be unsure about whether or not they will accept the lower bids, indicated by the positive and statistically significant sign the variable NONCONS carries for the "not sure" vote for the \$2,000, \$3,500, and \$5,000 price offers. These landowners consistently vote "probably yes" for the \$10,500 and \$13,000 bids. The voting behavior of this group of landowners implies that they want to keep standing timber for recreational purposes, and that it would take a bid as high as \$10,500 per acre for them to seriously consider harvesting trees from their land. This is consistent with equation 7 above, which shows reservation price to be positively dependent on amenity values of forestland. The PLANGIVE variable takes a value of one if the landowner plans to give all of the timber on their land to heirs in the future; otherwise it is zero. For the \$1,500 and \$3,000, and \$6,500 bid levels, the landowners with such intentions tend not to check the "probably yes" box. In fact, each of the voting categories in the model carries a negative sign for all bid levels \$6,500 and lower (with the exception of the NS vote for the \$1,000 bid), which leads us to believe that the majority of these landowners voted "definitely no", and have no intention of harvesting timber when confronted with reasonable market stumpage prices. For the higher bids of $8,500, $10,500, the landowners with timber bequest motives begin checking off the “not sure” box (although not in significant numbers), and when faced with the highest bid of $13,000, a significant percent of them accept the bid with a “definitely yes” vote. The MILEFROM variable is an indicator of the distance between the landowner’s residence and his/her tract of land. Typically, landowners who live greater than 50 miles from their properties are considered “absentee” (Shaffer and Meade 1997) and many of them own land for investment purposes. Therefore, we expect that as the distance between the residence and the property increases, so does the probability that the landowner will accept a payment in return for timber harvesting. The MILEFROM variable carries a negative sign for the PN, NS, and PY votes for the $1,000 offer, but there weren’t enough DY votes to obtain any regression results for this voting category. This implies that most of the landowners who do not reside on their property rejected the $1,000 bid with a “definitely no” vote. However, the coefficient on this variable consistently holds a positive sign for the PY and DY votes for the $2,000, $5,000, $8,500, and $10,500 bids, implying that nonresident landowners are willing to accept lower bids than the other landowner types we have discussed thus far. The coefficient on MILEFROM is positive and statistically significant for the PY vote at the $3,500 and $10,500 bids as well as for the DY vote at the $8,500 bid. Notice, however, that most people chose DN for the $6,500 bid. Although a definitive threshold value of acceptance cannot be given for this variable, we postulate it to be somewhere between $6,500 and $8,500 per acre.

The income level of the landowner seems to negatively affect reservation price for harvesting, although the votes are all over the board for the various bid levels. For this reason, we will focus only on the statistically significant votes. Surprisingly, as income level of the landowner increases so does the probability that the landowner will vote “probably yes” for the $1,000 offer. From Table 4, only 8% of the landowners who voted on the $1,000 bid voted probably yes or definitely yes. The coefficient on the INCMID variable is also positive and significant for the DY response to the $6,500 bid and the PY response to the $13,000 bid, and is negative and significant for the PN responses to the $2,000 and $8,500 bids. Once again, no specific threshold value of acceptance can be defined, since the landowners do not consistently accept bids greater than a certain value. However, the results found here may be an indication that as a landowner’s income rises, the probability that he/she will accept a bid and harvest timber increases, even for low bids.

Unlike the income variable, the variable that indicates whether or not the landowner inherited his/her land seems to be negatively related to acceptance of a harvest bid. For example, the coefficient on the INHERIT variable steadily holds a negative sign for the PY and DY votes for the price offers at or below $3,500 as well as for $6,500, $8,500 (DY only), and $10,500. Further, the probability of placing an NS vote is positive for all price offers $6,500 and above and significant at the 5% level for the $10,500 and $13,000 bids. It isn’t until the $13,000 level that landowner votes shift towards the “probably yes” or “definitely yes” categories and even then, most landowners said they were not sure they would accept the bid, i.e., the coefficient on INHERIT is positive and significant at the 5% level for the NS vote. Therefore, the threshold value of acceptance for those landowners who inherited their land is greater than $13,000 per acre. Recall from the binomial LOGIT model representing the decision not to participate in the market for timber that the INHERIT variable which signifies whether the landowner inherited any portion of the property exhibited a negative coefficient. This seems to suggest that while landowners who inherited the land tend to require a high price for their timber, they are not strictly opposed to harvesting.

The existence of roads on the property once again is an indication of access to the timber. Thus, we would expect those landowners with a good network of roads to be likely to harvest trees. Interestingly, Table 13 implies that this is not the case for the landowners we sampled. Recall, Table 13 describes the binomial LOGIT model where the dependent variable takes a value of one if the landowner will never commit to harvesting trees from his/her land no matter what the proposed bid and a value of zero otherwise. As we saw earlier in this section, the length of roads in existence on the property is a positive predictor of the decision to never harvest. The multinomial LOGIT model results attest to that. For bid levels up to $6,500, the landowner with good road access is likely to report probably no or definitely no; the probability of voting PN by these landowners is significant for the $2,000 bid and the probability of not voting PY is significant for the $3,500 and $5,000 bids. For $8,500 and above, the landowners in this group consistently vote PY and DY. However, none of the coefficients for the ROADS variable are statistically significant for bids $5,000 and above, so any threshold value of acceptance is greater than $13,000 per acre. Since road length is an indication of access to timber, it represents a characteristic of the land that can potentially increase timber stock. Therefore, we expect reservation price to be positively determined by road length. What we did not expect, however, was that those with good road access are likely to report they would never harvest at all.

On large tracts, timber production and recreational activities can jointly occur. Therefore, we expect tract size to positively influence a landowner's decision to accept a bid and harvest timber from an acre of their land. Table 13 shows tract size to be negatively related to the decision to never harvest timber at any price, although this relationship is not statistically significant. In the MNL models, the ACRES variable is only significantly related to the PN vote and is so for the \$3,500, \$5,000, and \$8,500 price offers, where there is a negative relationship. This implies that the landowners with the larger tracts are highly unlikely to vote "probably no" to these mid-range votes. However, due to weak relationships between the ACRES variable and the probabilities of voting "probably yes" and "definitely yes" for various bid levels, it is unclear as to what bid level the larger parcel owners will consistently accept.

Recall from discussion of the econometric model above, that equation 7 implies that individual preferences for amenities are important in determining reservation prices. The ENVIREA variable takes values ranging from one to five according to how important the environment is as a reason for owning land, where one is not important and five is very important. Generally, those landowners who are concerned with the environment are opposed to disturbing the ecosystem and wish to keep the trees on their land. The MNL model presented here reveals this. For the \$3,500 and \$10,500 price offers, the PN vote is a likely choice of the environmentally motivated landowners in our sample, with statistical significance at the 10% level. In contrast, the NS vote is highly unlikely for this landowner group at the $5,000, $8,500, and $10,500 bids. The only bid level where a PY vote is significantly chosen by these landowners is $3,500, and the DY response is never significant for any bid level. Therefore, as expected, the reservation price for harvesting by environmentally motivated landowners tends to be greater than $13,000 per acre. Like the ENVIREA variable, the FUTGEN variable ranges from one to five where one is not important and five is very important; here values coincide with how meaningful keeping land for future generations is to the landowner. Since timber and money are treated equally in terms of inheritance taxes, it is unclear apriori as to how landowners will choose to vote on the different harvest payment offers. Not only is the PN vote unlikely for all bids $6,500 on up in the MNL model presented here, but the PY vote has a significant probability of being chosen for the bids $8,500 and above. Thus, the threshold level of acceptance seems to overwhelmingly be at the $8,500 bid. The coefficients of the FUTGEN variable are not statistically significant at the 10% level for any other voting category at any bid level.

The EMPLOYED variable is a dummy variable that tells us whether or not the landowner holds a job. The coefficients on this variable are only significant for the NS and PY votes at the $3,500 bid, indicating that the voting behavior of the landowners is not significantly influenced by whether or not the landowner is currently employed. Recall from Table 3 that the majority of the landowners in this sample who are not currently employed have retired from the workforce. The model results suggest that there may be no significant difference between the employed and retired landowners in terms of financial status. The DEBT variable provides a measure of how much the landowner currently owes to creditors. A significant percentage of landowners with high levels of debt provided a not sure vote for the $2,000 price offer and a probably yes vote for the $5,000 offer. However no other relationships between debt and voting on harvest bids are clear. So, it seems that other characteristics of the land/owner override any effect debt load may have on the landowner's reservation price for timber harvesting. Recall from Table 13 that debt was positively, although not significantly related to the decision to never harvest trees at any price.

The YRSOWN variable indicates how long the land has been in the owner's possession. The threshold value of acceptance of a harvest payment is greater than $13,000 for the landowners who have owned the land the longest. The longer the landowner holds the land, the more likely he/she is to vote "not sure" for the $2,000, $3,500, and $6,500 bids. For the $2,000 bid, the coefficient on the YRSOWN variable is positive and significant for the PN, NS, and PY voting categories. It makes sense that the longer the landowner has had possession of the land, the more hesitant he/she would be about harvesting the trees on it. Those who have owned the land for many years probably place sentimental value on the trees. The degree of risk a landowner perceives to be involved with timber production is captured by the RISK variable. In the survey, the landowners were asked to rate their degree of risk perception on a scale from one to five with one for not risky and five for very risky. We would expect that the landowners who believe it is risky to grow trees would want to harvest the trees before they lose them to such phenomena as wind/ice storms, insects, and disease. For all bids $6,500 and greater, there is a high probability that the landowner who perceives risk will not check the NS box, meaning they are somewhat sure as to how they will vote. For the $5,000 and $6,500 bids, these landowners tend not to check the PY or DY box. This leads us to believe that it generally takes an offer greater than $6,500 for this group of landowners to commit to harvesting. At the $8,500 bid, the PN, PY, and DY categories are checked by the landowner, and at the $10,500 and $13,000 bids, the votes are concentrated in the PY and DY categories (although neither category individually has a significant percentage of the votes), indicating that the threshold value of acceptance is around $10,500. Recall the CHILDREN variable, which simply tells us how many children the landowner has, is a negative predictor of the decision to never harvest (see Table 13), meaning those with children are likely to commit to harvesting timber if the price is right. The MNL results imply that the landowners with children are opposed to harvesting at any of the price offers presented to them in the questionnaire. For example, they are unlikely to check the DY box for the $5,000 and $6,500 offers or the PY box for the $10,500 and $13,000 offers. Therefore, it is evident that this group of landowners is not completely opposed to harvesting, they would just require a very high price for their timber. Chances are, their children are the future heirs of the property. If prices are high enough, it seems these landowners would choose to harvest and bequeath the money from the timber sale rather than standing timber. Again, timber and money are treated the same when taxed as inheritance, so this makes sense.

To summarize, the MNL model results imply that nonresident ownership and high income are characteristics of NIPF landowners consistent with low reservation prices for timber. Fewer government incentives seem necessary to induce landowners with these attributes to participate in timber markets. On the contrary, involvement in onsite recreational activities, resident ownership, lengthy tenure, inheritance of all or part of the land parcel, environmental motives for possessing land, perceptions that timber investments are risky, and having children all seem to be indicators of relatively high reservation prices. Landowners with these ownership characteristics and preferences should perhaps be the focus of government attention when it comes to policies and programs directed towards boosting timber supply from NIPF lands, since these landowners are not opposed to harvesting but may require compensation beyond current market prices. Timber bequest intentions and good road access are qualities consistent with opposition towards harvesting activities, or non-entry in timber markets. Perhaps education-based government programs with or without subsidization would be effective in encouraging market involvement by landowners with these preferences and site characteristics. Neither employment status nor personal debt significantly influenced voting on harvest bids. While parcel size is negatively related to the likelihood a landowner will reject low bids with a ‘probably no’ vote, suggesting that large tract owners may have comparatively low reservation prices (as expected), there is no clear relationship between parcel size and ‘probably yes’ or ‘definitely yes’ responses to harvest bids.

6. EXTENSIONS OF RESERVATION PRICE METHODS AND HYPOTHESIS TESTING FOR HARVEST PAYMENT DATA

6.1 Selective and Random Sampling of Bids

In this section, we are concerned with how the landowners would vote if they were each presented with just one harvest payment offer that varies from owner to owner according to a logarithmic scale, as is the case with the referendum literature. We use two additional methods to characterize the harvest reservation prices of landowners. The first method involves systematically sampling from the bid levels by applying the lowest bid to the first landowner, the next highest bid to the second landowner and so on for the entire sample. We then create an ACCEPT variable, which takes a value of one if the landowner provided a PY or DY vote to the assigned bid and a value of zero for a DN, PN, or NS vote. Next, we develop a binomial LOGIT model relating acceptance/rejection of the bid to land, owner, and preference variables, as follows:

$$Y = a_0 + a_1X_1 + a_2X_2 + e \qquad (9)$$

where X_1 is some vector of explanatory variables, X_2 is the bid level, and e is an error term. Y is a dummy variable measuring whether the respondent voted yes for the bid given. Note that this method may not perfectly coincide with the referendum method in that ignoring all other price offers could result in some degree of starting point bias, whereby a landowner's decision to accept or reject a bid is influenced by the other price offers in the table. Model results are presented in Table 22. Notice that as harvest payment increases, as revealed by the BID variable, rate of acceptance also increases indicating that the law of transitivity holds for the landowners in this sample and that they represent rational decision-makers. The INHERIT variable is negatively related to the probability of acceptance, which is agreeable to the MNL results presented above in Section 5, where the more likely the landowner was to have inherited the land, the less likely he/she was to vote PY or DY for any bid, and the threshold value of acceptance was found to be greater than $13,000. No other variables predict probability of acceptance at the10% level of significance or below.

The second alternative method we used to characterize reservation prices involves randomly sampling one bid for each landowner from the entire range of bids, and then following the steps taken above to come up with a similar binomial LOGIT model of the relationship between acceptance/rejection of the bid and important variables. This method too ignores all other bids and so only approximates the referendum approach. Table 22 also presents the results for this model. Five variables seem to drive the decision to accept a bid for timber harvesting in that their coefficients are significant at the 10% level and below. These variables include BID, ROADS, EMPLOYED, YRSOWN, and MARRIED. As was true with the selectively drawn sample, as harvest payment increases, rate of acceptance of the bid increases, providing further evidence that landowners are rational decision-makers. The ROADS variable, which represents total length of private roads on the property, is a negative predictor of bid acceptance. Recall that the threshold value of acceptance for the landowner with good road access was found to be greater than the highest bid of $13,000 in the MNL model presented in Section 6, contrary to our predictions. Additionally, we discovered that the likelihood of deciding never to harvest timber regardless of price was positively correlated with the ROADS variable, as reported in Table 13. While employment status does not seem to affect voting behavior when considering the entire range of bids, as the likelihood of holding a job increases, so does probability of acceptance of a single randomly drawn bid. Remember that the working landowners represent the younger portion of the respondents. Perhaps they have not yet thought about the option of passing timber on to their future heirs and see timber harvesting as a good way to supplement their salaries. The length of time the land has been in the owner's possession is also positively related to probability of acceptance of the bid. This result is contrary to what we discovered from the MNL model estimation results for multiple bids. Recall, the threshold value of acceptance was found to be greater than the highest bid of $13,000 for the owners who have owned their properties the longest. The landowners who are married are less likely to accept the price offers, exhibited by the negative and statistically significant coefficient on the MARRIED variable. Perhaps this group of survey participants tends to place high amenity values on their trees. Note this variable was not included on the right hand sides of either the binomial LOGIT model of nonparticipation in timber markets or the MNL models presented above, due to lack of statistical significance.

In summary, our results indicate that different conclusions about timber market entry by NIPF landowners can be drawn from models based on landowner voting on a single harvest bid that varies from owner to owner than from models derived from landowner votes on a range of bids. For example, while employment status positively impacted acceptance of a single bid, implying that working landowners have relatively low reservation prices, this variable did not influence voting on multiple bids. Further, while length of ownership was an indicator of high reservation prices in the MNL models of multiple bids, it was a positive predictor of bid acceptance, and therefore a sign of low reservation prices, in the binomial LOGIT models predicated on a single bid. The ROADS and INHERIT variables, however, were negatively correlated with bid acceptance for both model types, indicating high reservation prices for owners with good road access and inherited land.

6.2 Further Analysis of Bid Levels: Obtaining Probability Predictions for Willingness to Accept

6.2.1 Mean Willingness to Accept

One advantage of both the referendum and MBDC methods is that we can calculate mean willingness to accept directly from the coefficients of the binomial LOGIT models discussed in Section 6.1. This involves derivation of a "grand constant" that makes use of the selectively and randomly drawn bids only and disregards all other bids presented to the landowners. Thus, the mean WTA estimates obtained using this method approximate those that would be derived from referendum data. We begin by deriving a grand constant for each of the models presented in Table 22. We then use this with the estimates to obtain mean WTA for the selectively and randomly sampled bids.

The grand constant, C, is defined as

$$C = \hat{a}_0 + \hat{a}_1 X_1 \tag{10}$$

for each observation, where ^ indicates the estimated regression coefficient and X_1 is a vector of all explanatory variables except the bid variable. Now, from Equation (9) we can express the predicted probability of taking a bid, making use of the grand constant, as

$$\hat{Y} = C + \hat{a}_2 X_2 \tag{11}$$

In this equation, $\hat{Y}$ is the predicted probability that the landowner chose a particular bid level, X_2. Expected willingness to accept follows from Equation (11) as:

$$\text{E (WTA)} = \frac{C}{-\hat{a}_2}, \tag{12}$$

where $\hat{a}_2 < 0$. Notice that the grand constant differs for each landowner, because the X_1 variable levels differ in the sample for every observation. Thus, we use averages of the X_1 variables when solving for E (WTA). Table 22 displays the mean willingness to accept estimates of \$11,967.09 and \$10,855.61 for the selectively and randomly drawn harvest bids, respectively.

The linearity assumption was tested for each of the models presented in Table 22 using the RESET method. First, the squares of each of the significant regressors were added to each equation, and then the equations were re-estimated. None of the parameter estimates associated with these additional terms is significant at the 10% level. Next, likelihood ratio testing was performed to compare results for the linear and nonlinear models. The hypothesis that the models are statistically similar cannot be rejected. Therefore, the test results suggest that linearity is plausible for the binomial LOGIT models of bid acceptance from which these probability predictions are derived. The "grand constant" method outlined above is therefore appropriate for these models.

6.2.2 Spreadsheet Approach to Obtaining Probability Predictions for Willingness to Accept Using Entire Range of Bids

We used a spreadsheet approach to predict harvest bids required for certain probabilities of acceptance that makes use of the entire range of bids presented to the landowner, i.e., derived from the MBDC approach. This method will be referred to as the "spreadsheet approach" in what follows. The spreadsheet approach involves recording estimates of the lowest price that each landowner would accept to harvest an acre of his/her trees, as indicated by the lowest price for which the landowner checked either the 'probably yes' or 'definitely yes' boxes. These reservation price estimates are then sorted in order of magnitude. Averages of the bids are taken for each 5% increment, again ranging from 5% to 95%. These averages represent the predicted payments needed for harvesting to occur at the various probabilities. We will compare the results from the two different approaches below.

We computed the probability of bid acceptance and associated average bid level for the full sample as well as for a truncated sample including only those landowners who revealed a willingness to harvest at a price within the limits of the payment table offers. In addition, the table shows the lowest bid level from the payment table that all landowners in a given probability category would accept. For the full sample of survey participants, just 5% indicated a willingness to accept a bid of $1,000 to harvest an acre of their trees, with an average reservation price of $737.70. Fifty-percent of the landowners would harvest for $10,500, with an average reservation price of $4,678.69. Forty-seven percent of the landowners indicated that they would not harvest for a price within the bounds of the payment table. Of the truncated sample, the mean reservation price for the bottom 5% of the sample in terms of minimum WTA was \$506.17. Fifteen-percent of the landowners would be willing to accept a bid of \$1,000, with an average reservation price of \$835.39. Fifty-percent would accept \$5,000 or more, with a mean reservation price of \$2,338.2. Ninety-percent would accept \$10,500, and all of the landowners would accept \$13,000 (in accordance with how the sample was truncated), with an average reservation price of \$5,086.42. For the full sample, required harvest payment, for an acre of trees, was almost double that of the truncated sample for the majority of probability categories. Notice that the reservation prices approximated with the spreadsheet approach, which takes the entire range of bids from the payment table into consideration, are much lower than those calculated with the grand constant approach, which only considers a single bid. This finding seems to suggest that the referendum approach to soliciting votes on harvest bids results in much higher reservation price estimates than the MBDC approach. However, recall that the selective and random sampling of landowner votes on a single bid from our payment table only approximates referendum data since all other bids are ignored, which may have influenced the voting.

6.2.3 Spreadsheet Approach to Obtaining Probability Predictions for Willingness to Accept Using Single Bids

We used a similar spreadsheet approach to predict probability of acceptance for each bid level from the payment table that makes use of the selectively and randomly drawn single bids. This approach involves sorting the offers in order of magnitude and then sorting the replies in terms of whether the landowner accepted the bid with either a PY or DY vote, or did not accept the bid with a NS, PN, or DN vote. The number of times each bid was chosen is recorded along with the number of landowners who accepted the bid. The ratio of acceptances to number of offers is then recorded for each bid level. For the selectively drawn bids, only 3% of the landowners would be willing to accept $500 to harvest an acre of trees. Close to 10% of the landowners would accept a payment of $1,000. There is a large jump in predicted probability of acceptance between the $1,000 and $2,000 bids, with 33% acceptance at the $2,000 level. Between 31% and 42% of the landowners would accept bids between $3,500 and $8,500. Finally, as much as 64% of the landowners would accept bids of $10,500 and $13,000.

For the randomly drawn bids, almost 6% of the landowners would accept payment of $500 to harvest an acre of timber. This is double the percent derived from the selectively drawn bids. Close to 13% would accept $1,000 and the same percentage of landowners would accept a bid of $2,000. Between 34% and 44% of the landowners would take a bid between $3,500 and $8,500. These numbers approximate what was found for the selectively drawn bids. Finally, 37% and 51% of the landowners accepted bids of $13,000 and $10,500, respectively. These numbers are between 8% and 14% lower than for the selective sample, although the same pattern of a higher rate of acceptance for the $10,500 bid than the $13,000 bid emerged regardless of which sampling method was used.

6.3 Hypothesis Testing

Another objective of this study was to determine how to characterize a "not sure" vote in terms of whether it approximates a "probably no" vote, a "definitely no" vote, or stands alone as an entirely separate decision. It has been argued in the contingent valuation literature that an "I don't know" response is statistically similar to a "no" vote when using standard elicitation techniques (Carson et al. 1995). In order to test this theory, we drop one decision from the multinomial LOGIT models presented above, re-estimate the models, and then employ likelihood ratio testing where the null hypothesis is that the restricted and unrestricted model parameter estimates are identical.

In the first case, we treat the PN and NS votes as one decision and therefore are left with a four-choice model for each bid, where the choices are: DN, PN/NS, PY, and DY, as opposed to the five-choice models we originally had. Next, we perform likelihood ratio (LR) testing to determine whether or not the two types of models differ statistically. Again, the null hypothesis is that the two model types are statistically similar. Therefore, we can deduce whether the "probably no" and "not sure" votes represent distinct decisions, from this testing. Table 23 presents the LR test results. It appears that there is a statistically significant difference between the two model types for the $1,000, $2,000, $3,500, and $6,500 bids, indicating that PN and NS should not be grouped together as one decision in these cases; they are indeed separate decisions. For the $5,000 bid and for all bids $8,500 on up, however, the models are statistically similar, implying that PN and NS can be treated as one decision only for these higher price offers.

For the second set of LR tests, we treat DN and NS as one decision. Again, this leaves us with four choices: DN/NS, PN, PY, and DY, as opposed to the five choices we had previously. We then compare how statistically similar the models are with likelihood ratio testing. Here, the DN and NS votes only vary significantly for the lowest ($1,000) and highest ($13,000) bids, reinforcing the theory that a vote of "not sure" can be treated as a "no" in most cases. However, it is interesting that a "definitely no" and "not sure" vote were found to be more alike than a "probably no" and "not sure" vote, prompting us to recommend that the "don't know" response be provided in similar studies eliciting willingness to accept and to caution others not to make judgments regarding what a landowner really means by an unsure vote, in terms of whether it closely approximates a negative vote, without conclusive statistical evidence.

6.4 Sample Selection Model

We further examine reservation prices of landowners for timber sales by specifying a sample selection model, consisting of a decision process whereby the landowner first decides whether to never harvest or harvest, followed by a bid regression that determines the required harvest payment. The dependent variable in the second-stage bid regression approximates a reservation price for timber harvesting and is defined by the first payment the landowner marked "probably yes" or "definitely yes" for those who accepted a payment within the provided range and $1,000,000 for the landowner who would not accept a bid within the specified range. The reservation price of $1,000,000 was chosen simply to indicate that these landowners would not accept a reasonable offer to harvest the trees from their land; the price would have to be exorbitant. Much lower prices (as low as $50,000) were also tried for this landowner group, with no significant changes in the coefficient estimates. Note that another approach would be to simply exclude these landowners from the sample.

Table 24 presents the results of the sample selection model. We will discuss the second-stage bid regression. A few additional variables were included in this model, that have not yet been introduced, including FUTHEIR, STRUCT, ACREFOR, INCTIMB, and HIGHS. FUTHEIR is a dummy variable representing whether the landowner plans to bequeath land to heirs in the future. The STRUCT variable indicates whether any type of building exists on the property. ACREFOR tells us how many acres the landowner has specifically devoted to forest use. INCTIMB is a variable denoting how much income the landowner earned from timber sales in the year 2000. Lastly, HIGHS indicates whether high school is the highest level of education reached by the landowner.

Five variables are significant in this regression at the 10% level and below. They include MILEFROM, DEBT, CHILDREN, MARRIED, and HIGHS. Reservation price seems to be negatively related to distance between the landowner's residence and property. Again, absentee landowners typically own land for investment purposes, implying that they may attach lower amenity values to their forests, causing them to be more willing to sell timber, i.e., accept a bid. Recall from the MNL models discussed in Section 5.2 that nonresident landowners were willing to take a comparatively low price for their timber. Total debt accumulated by the landowner is also found to be inversely related to reservation price, implying that the landowners with high debt are willing to accept a lower price for their timber than those landowners who are less constrained financially. Number of children and marital status are each positively related to reservation price. Perhaps the landowners who are married and have children place higher amenity values on their trees. Lastly, the landowners with high school diplomas but lacking college degrees are likely to have lower reservation prices.

CHAPTER TWO: RESERVATION PRICE FOR AFFORESTATION OF AGRICULTURAL AND ABANDONED LAND

1. MODEL OF RESERVATION PRICE FOR LAND USE CONVERSION

In this section we present a model outlining a representative landowner's choices between land uses, and showing how preferences for amenities on both forest and agricultural land are important in the realization of reservation prices. The objective is to illustrate how land use depends on margins defining returns across various uses and differences in land quality, and how amenities to standing forest stocks and agricultural production are important to these margins. Ultimately, it is the reservation prices for each landowner that defines their willingness to participate in incentive-based land conversion programs.

We consider a single landowner holding land of varying quality. If the landowner undertakes agricultural production on any acre, s/he collects annual returns forever equal to the profits from growing the crop. Once the landowner chooses forest production on any acre, s/he harvests and replants rotations ad infinitum and collects periodic rents that depend on forest growth. The landowner may also value non-income amenities to forest and agricultural land uses. Examples for forest land include hunting and other forms of recreation, water quality, and bequest motives. Agricultural amenities include benefits the landowner perceives from continuing the tradition of the family farm, or a general love for farming as a profession.

Differences in quality of land create margins between alternative land uses; the landowner will allocate land among the various uses in a way that maximizes the discounted stream of monetary and amenity rents on every acre. As is often the case in practice, optimal land use will exist on a continuum that depends on land quality, with agricultural uses devoted to higher quality (higher-valued) land and forest uses devoted to lower quality land. However, preferences for amenities that landowner obtain from either agriculture or forestry also factor in defining these margins. For example, a landowner who attaches a high value to amenities derived from forest stocks may devote higher-valued land to forest production.

This discussion implies that the rent curve describing the value to the landowner of different competing land uses is of a certain form, i.e., declining in value as the quality of land decreases. It also implies that landowner preferences for amenities can change this rent distribution. A landowner objective function that captures these features is as follows,

$$MAX_{\ w.r.t.\ A,F,G,} \quad \int_0^A [\frac{w(x)}{r} + \int_0^\infty B_a(x,t)e^{-rs}ds]dx + \int_A^{A+F} [\frac{e^{-rT}py(T,x)-c}{(1-e^{-rT})} + \int_0^T \frac{B_f(x,t)e^{-rs}ds}{(1-e^{-rT})}]dx + \int_{Z-G}^{Z} 0dx$$

where A denotes acres in agricultural production, F denotes acres in forest, and G denotes acres that are currently idle or abandoned;[1] Implicitly assumed is that agricultural land is reserved for the highest quality levels, where quality is indexed by x. T is the rotation age for land in forest production; r is the market interest rate, c is the per hectare planting cost; $B_f(.)$ represents amenity benefits from holding unharvested forest stocks that are not related to income from harvesting trees. This amenity function could

[1] This assumes abandoning land is costless.

be defined either as a function of acreage devoted to forest production and time or forest stock, since forest stock y(t) is only a function of time, i.e., $B_f(y(t),x) = B_f(t,x)$, where x is a variable of integration over land quality and represents acreage of land in the various quality classes (given by the limits of integration); p is the timber stumpage price, and w(.) is the average annual income rent from agricultural production (per acre), $B_a(.)$ represents calendar time non-income benefits from holding agricultural land; and y(t) is the per acre timber volume function. The representative landowner's total land holdings equal $Z = A + F + G$. For the purposes of illustration and simplicity, all exogenous market parameters, such as interest rates, are assumed constant over time; as a result the rotation age for land devoted to forest production is constant for all rotations.

The basic set up of the objective function is similar to other land rent-based models in that there is a smooth distribution of land rents and uses over space (e.g., Barbier and Parks 1998, Brazee and Amacher 2000), but is modified to include amenity preferences. These preferences are more consistent with empirical land management for nonindustrial landowners, and their presence suggests that payments for land set-aside or conversion from one use to another is not simply defined by lost productive returns, as most of the literature assumes. The objective function also assumes the marginal net returns of increasing land quality are higher for the high-valued use. That is, the rent gradient over land quality for the alternative use is steeper than the rent gradient for forest production. This assumption ensures that the alternative use is higher valued than the forestry use on land of higher quality, which is consistent with observed land use patterns.

Using the total landholding constraint and including nonnegativity constraints for acreage use A, F, G, the Lagrangian can be written as,[2]

$$L(A,F,G,\lambda) \;=\; \int_0^A [\frac{w(x)}{r} + \int_0^\infty B_a(x,t)e^{-rs}ds]dx + \int_A^{A+F} [\frac{e^{-rT}py(T,x)-c}{(1-e^{-rT})} + \int_0^T \frac{B_f(x,s)e^{-rs}ds}{(1-e^{-rT})}]dx + \int_{Z-G}^{Z} 0dx$$

$$+\lambda[Z-A-F-G]+\alpha A+\beta F+\gamma G, \qquad (1)$$

where α, β, γ, are the multipliers on the constraints for nonnegative agricultural, forest, and abandoned land acres, and λ is the multiplier on the total land constraint, Z.

Before proceeding, note we can simplify rents to agricultural amenities, since these can be assumed constant over time, i.e., they do not depend on any specific level of stock, like $B_f(.)$ does. More formally, we could write,

$$\int_0^\infty B_a(x,t)e^{-rs}ds = \frac{B_a(x)}{r} \qquad (2)$$

The presence of agricultural amenities is consistent with newer work that shows individuals may attach values to farming.

The first order conditions for (1) define margins of land use and can be obtained using Leibnitz's rule where appropriate:

2 For convenience, if F > 0, then we assume T > 0, i.e. if land is in forestry, then the optimal rotation age is strictly positive.

$$L_A(A,F,G,N,T,\lambda) \;=\; \frac{w(A)}{r} + \frac{B_a(A)}{r} + \frac{e^{-rT}py(T,A+F)-c}{(1-e^{-rT})} + \int_0^T B_f(A+F,t)e^{-rs}ds - \frac{e^{-rT}py(T,A)-c}{(1-e^{-rT})} - \int_0^T B_f(A,t)e^{-rs}ds - \lambda + \alpha \;=\; 0 \tag{3}$$

$$L_F(A,F,G,N,T,\lambda) \;=\; \frac{e^{-rT}py(T,A+F)-c}{(1-e^{-rT})} + \int_0^T B_f(A+F,t)e^{-rs}ds - \lambda + \beta \;=\; 0 \tag{4}$$

$$L_G(A,F,G,N,T,\lambda) \;=\; -\lambda + \gamma \;=\; 0 \tag{5}$$

$$L_T(A,F,G,N,T,\lambda) = \frac{e^{-rT}}{(1-e^{-rT})^2}\int_A^{A+F}(py_T(T,x)(1-e^{-rT}) - rpy(T,x) + rc + B_f(x,T)e^{-rT})dx = 0 \tag{6}$$

$$L_\lambda(A,F,G,N,T,\lambda) \;=\; Z - A - F - G \;=\; 0; \tag{7}$$

$$\alpha A = 0; \quad \beta F = 0; \quad \gamma G = 0; \quad \eta N = 0. \tag{8}$$

Condition (3) implies that the landowner chooses hectares of the alternative use, so that the marginal land rent from the alternative use net of amenities in the alternative use equals marginal land rent from forestry production, keeping in mind that this rent includes both merchantable timber value and amenities to not harvesting and holding the stock on a certain number of acres devoted to forest production. The difference in agricultural and non-timber amenities plays an important role in this land use decision. Condition (4) implies the landowner chooses land in forest production to maximize the rents of timber harvesting adjusted for non-timber amenities lost when forests are harvested. The time path of amenities in each equation is important also to these conditions.[3] Condition (5) implies that the landowner adds acres in forestry production until marginal land rent equal the marginal value of relaxing the constraint on total land. Condition (6) describes the optimal rotation age on land devoted to forest production and is similar to a Hartmann condition. Finally, conditions (7) and (8) ensure that nonnegativity and land constraints are satisfied.

The margin between agriculture and forest production can be represented using (3) and (4), assuming that A > 0 and F > 0, and eliminating $\lambda > 0$,

$$\frac{w(A)}{r} + \frac{B_a(A)}{r} - \frac{e^{-rT} py(T,A) - c}{(1-e^{-rT})} - \int_0^T B_f(A,t)e^{-rs}ds = 0 \qquad (9)$$

It is clear from (9) that the margin between agriculture and the next best use (forestry) depends on relative future returns from harvesting timber and producing agriculture (first and second terms), but also on the differences between amenities landowners attach to forest and agriculture (second and fourth terms). Given that agriculture in this model is devoted to higher quality land by assumption, a payment which induced the landowner to convert agricultural land to forest production would need to be high enough to move the margin between land uses, accounting for the landowner's preferences. This is formalized in the following equation, which follows from (9), when agricultural use is strictly positive for the landowner, A > 0,

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3. One could easily amend the amenity function so that the stock of forest was important, i.e., by specifying the B(.) function as B(x,y(t)). We can show that the model above and results generally continue to hold, and forest amenities could be considered which are either decreasing or increasing, or some other complex function, of the forest stock.

$$\frac{w(A)}{r}+\frac{B_a(A)}{r}\leq\int_0^T\frac{B_f(A,t)e^{-rs}}{(1-e^{-rT})}ds+\frac{e^{-rT}py(T,A)-c}{(1-e^{-rT})} \tag{10a}$$

This has a nice interpretation with respect to required incentives to convert agricultural land to forest production. The agricultural rents captured by the landowner on A acres, representing both income and amenity values, must be less than the forest amenities and timber harvesting revenue that could be captured in perpetuity by converting.

A similar interpretation can be obtained for incentives to keep an acre in agricultural rather than forest production,

$$\frac{w(A)}{r}+\frac{B_a(A)}{r}\geq\int_0^T B_f(A,t)e^{-rs}ds+\frac{e^{-rT}py(T,A)-c}{(1-e^{-rT})} \tag{10b}$$

which shows that, on each acre left in agricultural production, the annual perpetual rents to crop production plus the perpetual amenities to agriculture must be greater than the periodic income and non-income rents captured from forests. Forests rents include the present discounted sum of all future harvesting (second RHS term) plus amenities to unharvested forest stock that accrue over time.

An important element is the price of timber in these decisions. From (10), a reservation price for forest production and harvesting is clearly related to differences in amenity preferences, features of forest markets and the site that impact forest stocks (through f(.) and c), and other market factors. There are two interpretations of reservation prices, or the minimum price a landowner is willing to accept to first, keep acres in forest production, and second, to harvest from these acres over time. Keeping acres in forest production means that rents to forests in perpetuity must be at least greater to those of land abandonment, or, using (4) and (5), this simply means that net rents to forested acres are nonnegative,

$$\int_{A}^{A+F} [\frac{e^{-rT} py(T,x) - c}{(1-e^{-rT})} + \int_{0}^{T} B_f(x,t) e^{-rs} ds > 0 \qquad (11)$$

The reservation price for forest harvesting is derived from examining conditions under which a positive (finite) rotation age is an interior solution to the above problem, i.e., using (6),

$$0 < T < \infty \Leftrightarrow \frac{e^{-rT}}{(1-e^{-rT})^2} \int_{A}^{A+F} (py_T(T,x)(1-e^{-rT}) - rpy(T,x) + rc + B_f(x,T)e^{-rT})dx \geq 0, \qquad or$$

$$p^* \geq \frac{-B_f(x,T)e^{-rT}}{y_T(T,x)(1-e^{-rT}) - ry(T,x)} \qquad for \qquad x \in [A, A+F] \qquad (12)$$

where the denominator of the RHS is nonpositive if r > 0. The reservation price depends positively on the stream of amenity preferences to forest production, and also on the forest stock and characteristics of the site that lead to increased forest stocks.

Notice that we are implicitly assuming that acres in idle production do not produce amenities. Although this is not necessarily the case, the above results are not different, but only modified slightly by adding a stream of amenities (e.g., like 2)) to condition (5). This implies that the net rents to having acres of land in forest production must now be at least as great as these residual idle land amenities, rather than simply being nonnegative from (11).

Clearly, in (9) – (12) the landowner's preferences for amenities and characteristics of the site and markets that lead to abandonment or land shifting are important to defining behavior.

Equations (10a) - (10b) can be used to determine the present value of a payment that would encourage conversion of A acres from agriculture into forest production ad infinitum. Either an annual payment whose present discounted value equals $w(A)/r + B_a(A)/r$, or a single one time payment of $w(A)/r + B_a(A)/r$, would encourage this conversion. It is worth noting that amenities are an important part of both of these payments, yet would not be reflected in other studies that considered only agricultural returns lost through conversion or examined aggregate data, as these implicitly assume that $B_a(.) = 0$.

To show the importance of landowner preferences to conversion, we can first write the <u>per-acre</u> single payment and annual payment needed to encourage conversion from agriculture to forest production,

$$\frac{\phi(A)}{A} = \frac{L_i}{(A)} = \frac{a_i}{r(A)}, \tag{13}$$

where $\phi(A) = w(A)/r + B_a(A)/r,$ and L_i and a_i are lump sum and annual payments offered to landowner i respectively, and A represents agricultural land area converted to forest production. Total forest land for the landowner after conversion would equal $A+F$ following the model above. Equation (13) shows the relationship between annual and lump sum payments, which must be equivalent in present value terms, given (10) above, to guarantee conversion to forest production at equivalent levels.

2. ECONOMETRIC MODEL OF LAND USE CONVERSION

Equations (10a), (10b), and (12) from Section 2.0 can now be used to specify an econometric model. Recall (10a) specifies when a landowner will choose to shift land from agricultural to forest use. Equation (12) specifies when the landowner will choose to harvest timber on land devoted to forest production. The annual and lump sum payments needed to achieve conversion then follow from (13).

All of these equations are related to the unobserved reservation price of each landowner, because they indicate how large a payment needs to be in order for the landowner to change behavior. As we showed in the theory section, capitalized into this price is the value of the timber that would be harvested and the compensation for lost amenities associated with standing timber. An individual's reservation price also depends on his or her preferences and expectations about future market prices and conditions.

Consider first the derivation of an econometric model to examine the decision to convert A acres from agricultural to forest production. From Section 1, this decision depends on the revenue possibilities of agricultural production (LHS), amenities to agriculture and forest harvesting, and the stream of revenues (i.e., site characteristics and prices) from forest production in perpetuity for land converted to forestry. These terms collectively imply that measures of forest stocking potential and other variables describing forest land quality are also important to the decision, as are agricultural land quality reflected in the potential rents the landowner can capture in agriculture. If the landowner perceives lower amenities associated with standing forests, or if they associate high amenities with agriculture, then the landowner is less likely to convert. In terms of their reservation price, the required payment for conversion is higher, i.e.,

$$\Pr(F > 0) \Leftrightarrow \Pr(\bar{I} \geq \frac{w(A)}{r} + \frac{B_a(A)}{r} - \int_0^T B_f(A,t)e^{-rs}ds - \frac{e^{-rT}py(T,A) - c}{(1-e^{-rT})}) \tag{14}$$

where F > 0 indicates positive forest land conversion (see equation (1)). To formalize these decisions in a form which can be estimated, note that equation (10) specifies when the landowner will convert to forest production. Defining this in stochastic form, we have

$$\Pr(convert) \Leftrightarrow \Pr(I^* \geq \frac{w(A)}{r} + \frac{B_a(A)}{r} - \int_0^T B_f(A,t)e^{-rs}ds - \frac{e^{-rT}py(T,A) - c}{(1-e^{-rT})}), \quad x \in [A, A+F] \tag{15}$$

where a * superscript denotes the reservation price, i.e., is the payment above which a landowner would be willing to convert agricultural land to forest land. This equation suggests that, on land of a certain quality currently devoted to agricultural production, the landowner will convert only if receiving a bid greater than the RHS of (15). This bid is lower as the importance of non-timber activities to the landowner increase, or as characteristics of the site favorable to forest harvesting and forest revenue generation increase in value or quality.

Writing (15) in general terms as the probability that a landowner accepts a bid b_j of some size greater than the critical value, we have

$$\Pr(b_j > I^*) \Leftrightarrow \Pr(b_j \geq \frac{w(A)}{r} + \frac{B_a(A)}{r} - \int_0^T B_f(A,t)e^{-rs}ds - \frac{e^{-rT}py(T,A)-c}{(1-e^{-rT})}), \quad x \in [A, A+F] \tag{16}$$

where b_j is an offer of payment to increase forest land by one unit.

Our premise for this study involves delivery of various bids to landowners via a survey instrument. Equation (16) suggests that a function describing the probability that a landowner will accept the offered bid depends on a comparison of the bid with their unobserved reservation payment. This function can be written,

$$\Pr(b_j > I_i^*) \Leftrightarrow \Pr(b_j \geq \Psi_i[B_f, B_a, y, x, T, A, F; \beta, \Omega, \varepsilon]) \tag{17}$$

where 'i' refers to the landowner, β represents parameters to estimate, Ω refers to other characteristics of preferences embodied in the decision above that are not identified with specific variables in the theory above, and ε is a stochastic error term.

If a landowner were to receive multiple bids for land conversion, the parameters of equation (18) could be estimated using a multinomial logit model which treats the landowner's decision to accept multiple bid levels as a related set of qualitative choices. Assuming the required extreme value distribution for the error term, and noting the fact that the data are individual-specific and do not vary over bid choices, we can formally define the probability of accepting a bid of size b_j from a possible set of alternatives J offered to the landowner as,

$$\mathbf{Pr}(b_j > I_i^*) = \frac{e^{\beta_i^T x_i}}{1 + \sum_{k=1}^{J} e^{\beta_i^T x_i}}, \qquad for \qquad j = 1, \ldots, J, \tag{18}$$

where the offer b_j is identical for all landowners i, β_i are parameters to estimate for each landowner i, and x_i represents variables important to the decision of bid acceptance, i.e., these are given by the elements of $\Psi_i(.)$ in equation (17).

Marginal effects that follow from estimating (18) can be used to determine how explanatory variables, included in x_i, affect the probability that the landowner will accept the bid offered. If the probability that the landowner accepts any bid decreases, this is consistent with the landowner having a *higher* reservation price for conversion. These marginal effects will therefore provide some understanding of the important factors that comprise reservation prices and the decision to accept payments for land set aside programs.

A final econometric model concerns the land use decision. The model in Section 1 presents land use in three different categories, abandoned (open) land, forest land, and agricultural land use. Equations (3) – (5) specify both the qualitative decision as well as the level of each land use. A reduced form would follow from these equations and would show that land use decisions are related to production and income variables, site variables affecting production capability, and landowner preferences for income generation and amenities of unharvested forests or farming.

3. GENERAL DESCRIPTIVE STATISTICS—LAND USE SURVEY VERSION

3.1 Descriptive Statistics of Landowners in Virginia

Descriptive statistics for the Virginia landowners who participated in the land use version of the survey are presented in Table 25. The discussion will again be divided according to the following categories: demographic attributes, site and ownership characteristics, and landowner preferences.

3.1.1 Demographic Attributes

The average age of the landowners is 59.6 years, as it was for the timber harvesting version of the survey. Seventy-five percent of the landowners are married and the average number of children is 2.15. All together, 49% of the landowners are currently employed, while 46% are retired. Almost half of the survey respondents hold college degrees, consistent with Bourke and Luloff (1994), where 46% of the Pennsylvania NIPF landowners surveyed had completed college. The average income for the year 2000 was approximately $76,500. This is very close to the $78,000 figure we computed for the average respondent of the harvesting version of the survey. The average debt is reported as being almost $116,000 per landowner. This is almost double the amount found for the harvesting version.

3.1.2 Site and Ownership Characteristics

Average length of land tenure, as measured by how long the land has been owned by the family, is 56 years, implying that many of the land parcels have been owned by the families of the respondents for their entire lives. Fifty-three percent of respondents indicated that they inherited at least a portion of their land, which is about 20% more than in the harvest version. Only 51% of the landowners paid money for some or all of their land, as opposed to 74% in the harvest version. Again, for our study, an absentee landowner is defined as one who lives more than fifty miles from their land parcel. Recall, in the harvest version, 14% of the landowners are considered absentee, which is consistent with the finding of 16% by Meade and Shaffer (1997) for the entire state of Virginia. In the land use version, 23% of the landowners are considered absentee, which is more consistent with Conway (1998), where 22% of the central Virginia landowners surveyed resided at least fifty miles from their property. The average landowner lives approximately 45 miles away from the property, which is closer in proximity than the 62 mile figure calculated for the harvest version. Non-resident landowners visited their land an average of 78 times during the year 2000.

Fourteen-percent of the landowners personally farm their land, as opposed to either renting it to farm tenants or not farming it at all. The average amount of time the owners have spent farming is 16 years. On average, 45 acres is put to farm use and 133 to forest use. Twenty-nine percent of the landowners in our sample currently carry some form of crop insurance. Average income from agriculture earned by the landowners in the year 2000 was nearly $30, 650 and an average of $3,033 was spent using farm equipment during that same year.

Overall, respondents described the terrain as being either hilly or flat. Recall, the land parcels from the harvest version of the survey were generally hilly or mountainous. Over half of the properties have an existing structure like a house or barn.

3.1.3 Landowner Preferences

Over half of the landowners in this survey participate in non-consumptive recreational activities like hiking and wildlife observation on their land. On average, the landowners spent 11 days hunting in the year 2000. This is evidence that many of the Virginia landowners attach amenity values to the trees on their land, in keeping with the literature on NIPF owners.

Approximately 12% of the respondents have enrolled a portion of their land in the Conservation Reserve Program. When asked to rank their familiarity with this program on a scale from 1 to 5 with 1 being the least familiar and 5 being the most, the average response was 2.62. When asked to rank familiarity with the process of replanting trees, the landowner provided an average response of 3.0.

Survey participants were asked about the degree of risk that they associate with growing trees as well as the risk they perceive is involved with losing crops to disease, insects and floods, on a scale of one to five (one being the lowest and five the highest). The average response to the former is 2.4 and 2.67 to the latter.

3.2 Descriptive Statistics of Landowners in Mississippi

Table 26 presents descriptive statistics for the Mississippi landowners involved in the land use survey. Absenteeism and tract size categories ('large' or 'small') are defined in the same manner as for the Virginia sample. The average age of the landowners is 65 years, a little older than for Virginia. A similar percentage of the landowners are married, and family size, as indicated by the 'children' variable, is identical among the two groups. A slightly smaller proportion of Mississippi landowners is currently employed, as more landowners are retired, which is not surprising, given the average age of 65 years. Over half of the landowners graduated from college, and mean income for the year 2000 was $93,362.57. This is almost 20% higher than what the Virginia landowners reported for the same year. Average household debt of $108,199.15 is slightly lower than the estimate for Virginia.

Average length of ownership is 27 years, nearly 30 years less than for Virginia. However, average time spent in the farming business is between 16 and 17 years for both regions. More Mississippi landowners (approximately 61%) inherited their land than Virginia landowners (53%), which justifies why nearly a third of the landowners hold absentee status (compared to 23% for Virginia), and why they tend to live twice as far away from their land as Virginia landowners. Despite that Mississippi landowners tend to live further from their land, they visit the land more often. So, it is not surprising that 10% more of the landowners are involved in outdoor recreational activities on their land.

Mississippi landowners have much more agricultural land and much less forest land than Virginia landowners. Likewise, average income earned from the sale of agricultural products during the year 2000 is 56% higher than what the Virginia landowners reported. Further, estimates of annual equipment costs are higher for Mississippi. The fact that the Mississippi landowners tend to farm on a larger scale, may impact landowner behavior regarding willingness to accept payment to convert agricultural land to forest use, causing a disparity of acceptable payments for the two regions. Unlike Virginia landowners, most of the Mississippi landowners personally farm their land, with only 20% renting to farm tenants (as opposed to 73% for Virginia). The major crops grown by Mississippi landowners are soybeans and cotton, with 47% and 38% of the sample growing these crops, respectively. The same percentage (29%) of landowners carries crop insurance for both regions.

Over a quarter of the Mississippi landowners have enrolled land in the Conservation Reserve Program, as opposed to 12% for Virginia. Familiarity with the program as well as familiarity with tree planting seems to be similar for the two groups. Further, landowners across the two regions perceive similar risks with growing trees.

4. PAYMENT TABLE STATISTICS—LAND USE SURVEY VERSION

4.1 Payment Table Statistics for Virginia

Payment table statistics for the Virginia respondents of the land use version of the survey are found in Tables 27 - 44. In this version, the landowners were offered a range of per acre prices for converting an acre of their agricultural or abandoned land to forest use. First, these offers came in the form of single lump-sum payments, ranging logarithmically from $1,500 to $12,000 per acre. The second set of offers represented payments to be received by the landowner on an annual basis over a period of thirty years. These offers range from \$15 to \$480. Tables 27-35 contain statistics for the single lump-sum payment offers, while Tables 36-44 present statistics for the annual offers. For each bid level, the landowners were asked to choose from the same set of confidence levels presented in the timber harvesting version of the survey: definitely no (DN), probably no (PN), not sure (NS), probably yes (PY), and definitely yes (DY). The responses for the entire sample are given as well as according to size of the tract, bequest motives, absentee/resident status, and income level. We will focus our discussion on the statistics for the entire sample, which are presented in Table 27 for the single payments and Table 36 for the annual payments. Once again, the rows do not sum to one due to the lack of response by some landowners to specific price offers.

From Table 27, as bid level rises, landowners become more confident about accepting the lump-sum bid. The "not sure" category fluctuates as bid level increases, but probability of choosing the NS category remains in the 12.4-16.4% range for all bids. The "definitely no" and "probably no" votes generally decline as bid level increases, with the decline in the DN votes being the more dramatic of the two. The "probably yes" vote actually declines in likelihood as bid increases, while the "definitely yes" vote increases, as expected. Recall, for the harvest payment data, that the "probably yes" and "definitely yes" options both increased, with the increase being more dramatic for the DY option. The votes are consistent with Equation (12) of the theoretical model above, where the higher the price, the more likely the landowner will choose to shift land from agriculture to forest use. Tables 28 - 35 present the responses to the single payment table according to landowner type. Probability of acceptance in terms of voting "probably yes" or "definitely yes" seems to increase more dramatically with bid level for the absentee landowners rather than the resident landowners, the large tract owners as opposed to small tract owners, the owners with bequest motives versus those without, and the landowners with the higher incomes. Probability of rejecting the bid through voting "probably no" or "definitely no" declines more sharply as bid increases for resident landowners as opposed to absentee landowners, large tract owners as opposed to small, owners with rather than without bequest motives, and the owners with the higher incomes.

According to Table 36, as the bid increases, the landowners are more willing to accept the annual payment, as they were for the single lump-sum payment, in accordance with equation (12) of the theoretical model. The probability of choosing "definitely no" declines sharply, while the probability of voting "probably no" declines much more gradually. As was true for the single payment the NS category fluctuates, remaining in a narrow band, which fluctuates from 10.8 to 12.6% in this case. The likelihood of choosing "probably yes" and "definitely yes" both increase with bid level, with the increase in "definitely yes" votes being much more profound. Tables 37 - 44 display the probabilities of the various responses to the annual payment offers by landowner type. Likelihood of acceptance of an annual payment increases with the payment faster for large tract owners as opposed to small tract owners and higher income owners as opposed to the low income owners, as was the case for the single payment data. However, likelihood of acceptance increases faster for the resident owners than the absentee owners and for the owners without bequest motives than those with bequest motives, which runs contrary to what we found for the single payment data. Probability of accepting the bid declines more rapidly for the same landowner types as we found for the single payment data.

4.2 Payment Table Statistics for Mississippi

Payment table statistics for the Mississippi survey are shown in Tables 45 and 46. Again, landowners were offered a range of per-acre prices for converting a single acre of their agricultural land to forest use. Table 45 contains statistics for single, lump-sum payment offers, while Table 46 presents statistics for annual payments to be made over 30 years. The single payments range from $1,000 to $11,500 per acre, while the annual payments range from $30 to $550 per acre. For each bid level, the landowners were asked to choose from the same set of confidence levels as for the Virginia study: definitely no (DN), probably no (PN), not sure (NS), probably yes (PY), and definitely yes (DY). The responses given in Tables 45 and 46 represent the entire sample.

Table 45 indicates that landowners become more willing to accept a payment to convert land use, the higher it is. Similarly, landowners are less likely to reject a high payment, as exemplified by the downward trend of the “definitely no” votes as bid level rises. Both the “probably no” and “probably yes” votes increase until the bid reaches the $3,500 - $4,500 range, where it then becomes a less likely response. Collectively, the ‘negative’ votes (as indicated by PN and DN) decline as the bid increases and the ‘positive’ votes (as indicated by PY and DY) increase. The probability of placing a “not sure" vote fluctuates between 14% and 22%. The votes are consistent with Equation (10) of the theoretical model, where the higher the price, the more likely the landowner will switch land out of agriculture and into forestry.

Table 46 contains annual payment table statistics for the full sample of Mississippi respondents. The same general patterns emerge, for example, as bid increases, landowners are also more likely to accept an annual payment for converting an acre of agricultural land to forest use (and less likely to reject an annual payment). However, the "definitely no" votes decline more sharply than for the single, lump-sum payments. The "probably no" votes increase for all votes below $110, whereupon they start to drop. The "probably yes" votes increase until the bid reaches $200, at which point they also decline. The "not sure" votes fluctuate between 12% and 20%.

4.3 Comparison of Payment Table Statistics for Virginia and Mississippi

Recall that Virginia landowners hold much more forest land and much less agricultural land than Mississippi landowners. They tend to farm on a much smaller scale, earning less agricultural income and spending less money annually to operate farm equipment. So, Virginia landowners have less money and fewer acres invested in agricultural production and more invested in timber production. However, overall, Virginia landowners seem to require a higher payment, i.e. have a higher WTA, for converting a single acre of agricultural land to forest use than Mississippi landowners. For example, while 20% of the Mississippi landowners are willing to accept a bid of $2,500 in return for switching an acre of agricultural land to forestry (i.e., they placed a

DY vote), only 7% of Virginia landowners voted "definitely yes" to the same bid. Similarly, while 50% of the Mississippi landowners put in a DY vote for the $9,500 bid, only 23% of the Virginia landowners placed such a vote for that bid.

Recall that Mississippi landowners are more likely to hold absentee status, live further away from their land, but visit more often. Further, they tend to recreate more on their land, and planting trees often enhances such amenity benefits. They also earn more income than Virginia landowners. Further, Mississippi landowners are twice as likely as Virginia landowners to enroll a portion of their land in the Conservation Reserve Program. This could indicate that Mississippi landowners are more open to the idea of participating in conservation programs, in general.

5. RESERVATION PRICE ESTIMATION FOR LAND USE CONVERSION

We specified two more sets of multinomial LOGIT models similar to those described in Chapter 1 for the timber harvesting version of the survey, following Equation (17) in Section 2. This time, the models characterize the decision to accept or reject a bid for setting aside an acre of agricultural land for forest use. One set of models is based on a single lump-sum payment for the set-aside, while the other is based on an annual payment to be received each year for thirty years. The same voting categories of DN, PN, NS, PY, and DY for definitely no, probably no, not sure, probably yes, and definitely yes, respectively, apply to these models. Once again, a model was specified for each bid level, and the DN vote was dropped in each case to permit estimation.

5.1 Multinomial LOGIT Models of Acceptance of Single Lump-Sum Payment for Setting Aside One Acre of Agricultural Land for Afforestation—Virginia Sample

Estimation results for the multinomial LOGIT models of acceptance of a single payment for setting aside one acre of agricultural land for reforestation are presented in Tables 47 – 55. The bids increase logarithmically as follows: $1,500, $2,000, $2,500, $3,500, $4,500, $6,000, $7,500, $10,500, and $12,000. We used similar variables as in the harvest payment MNL models, with the addition of INCAG, ENROLCRP, and PERSFRM. The INCAG variable represents the amount of agricultural income the landowner earned in the year 2000. The ENROLCRP variable tells us whether or not any portion of the property is enrolled in the Conservation Reserve Program. The PERSFRM variable indicates whether the landowner personally farmed the land as opposed to renting it to farm tenants.

As participation in non-consumptive recreational activities increases, reservation price seems to increase, providing evidence that amenities do influence land use decisions as suggested by Equation (10) in the theoretical model above. While “probably no” and “not sure” are popular responses to the $1,500, $2,000, $2,500, $3,500, and $4,500 bids, a significant percentage of landowners involved in non-consumptive activities checked the “probably yes” box for the higher bids of $6,000 and $7,500. However, many landowners continued to provide a “probably no” vote in response to these bids as well. Further, the landowners involved in recreation on their land chose “not sure” more than any other response to the $10,500 bid, and “probably yes” and “definitely yes” are positive but not statistically significant responses to the highest bid of

$12,000. Therefore, any threshold level of acceptance of a payment to shift land into forestry is greater than $12,000. The coefficients on the MILEFROM variable are only significant for the NS and PY votes at the $1,500 and $2,500 levels and for the PN vote at the $2,000 level, indicating either that the voting behavior of the landowners is not significantly influenced by the distance between the landowner's residence and his/her property, or that the landowners who live far from their properties tend to check the DN box for all bids, and are thus not interested in afforesting any of their agricultural land. Again, since absentee landowners are often less able to make informed decisions concerning their land due to their absence, the latter explanation has intuitive appeal. As is the case with the MILEFROM variable, the INCOME variable seems to have no relationship to the PN, NS, PY, or DY responses to most of the bids. As income increases, the probability of voting "probably yes" increases for the $2,500 and $3,500 bids and the probability of voting "probably no" increases for the $7,500 bid only. Therefore, no threshold level of acceptance can be determined implying either that income does not influence the decision to accept a payment to replant an acre of agricultural land in trees or that income is positively related to the DN choice, i.e., the choice to reject the bids. Again, the latter case has intuitive appeal.

The portion of the landowners who inherited their land as represented by the INHERIT variable tend to cast the NS vote more than the alternative votes for all bids $4,500 and higher, with the exception of the $7,500 bid, providing evidence that this group of landowners has a threshold level of acceptance above $12,000. Recall from Chapter 1 that the landowners who inherited were unlikely to accept a bid as high as

$13,000 to harvest an acre of trees from their land. Perhaps this group of landowners is generally opposed to making land use changes of any sort, wishing to preserve their family history. The coefficients on the ROADS variable are inversely related to the decision to provide a "probably yes" vote to the $2,000 and $7,500 offers and a "definitely yes" vote to the $10,500 and $12,000 offers, which tells us that the landowners with good road access are likely to reject any reasonable bid to grow trees on an acre of their agricultural land; the threshold level of acceptance is greater than $12,000 per acre. Recall from Table 13 that the more roads the landowner had on his/her property, the more likely he/she was to choose to never harvest trees from the land at any price.

Recall that the ACRES variable, which represents the total size of the tract, was used in the harvesting MNL models in chapter 1. We have replaced the ACRES variable with the ACREAG variable, which represents how many acres the landowner currently has specifically devoted to agricultural production. As amount of land in agricultural uses increases, so does the likelihood that a landowner provides a "probably yes" vote to the $4,500, $6,000, and $7,500 bids and a "definitely yes" vote to the $7,500, $10,500, and $12,000 bids. While "probably no" is also a likely response to the $4,500 offer by the landowners with a lot of agricultural land, the PN vote is not significantly chosen for the higher bids. Further, as amount of agricultural land increases, so does the likelihood that the landowner will <u>not</u> check the "not sure" box for the $12,000 bid. Therefore, the threshold level of acceptance of a bid seems to be $6,000 for those landowners with a lot of agricultural land. Since multiple-use management is feasible on the larger tracts, it is conceivable that this group of landowners would be willing to accept a reasonable offer to replant an acre of their land in trees.

We expect the landowners with environmental objectives to be eager to afforest a portion of their agricultural land for benefits like erosion control and carbon storage. Indeed this seems to be the case. The higher the landowner ranked the environment as the reason for owning land, the more inclined he/she was to give a PY vote to the $1,500 and $3,500 offer and a DY vote to any offer $3,500 and above. Therefore, the landowners with environmental objectives seem willing to accept a comparatively low bid for setting aside an acre of their land. The landowners who are concerned with future generations, as represented by the FUTGEN variable, on the other hand, are not as willing to give up their agricultural land. Perhaps these landowners think it is more beneficial to their heirs and the generations to come to continue farming the land than convert it to forest use. The working landowners tend not to check the PY box for the middle range payment offers of $3,500 and $4,500. Further, they seem unsure about whether they should accept the $7,500 offer, and although the coefficients on the EMPLOYED variable are positive for the PY and DY votes for bids $7,500 and above, they lack statistical significance. Therefore, it is unclear as to how employment status influences voting on reforestation payments; there is no apparent threshold level of acceptance for the working segment of the sample. Recall from chapter 1 that the survey participants with jobs were also unsure about how to vote on harvest bids.

The landowners who are constrained by their debt should place less amenity value on their crop and pastureland. Thus, we expect this group of landowners to be willing to accept most bids that exceed the agricultural income they are earning for their least productive acre. As debt load increases, so does the probability of providing a "probably no" vote in response to the $3,500 and $4,500 bids and a "probably yes" vote to the $6,000, $7,500, and $12,000 bids. In addition, voting "not sure" and "definitely yes" on the $12,000 bid is also likely. Therefore, while a specific threshold level of acceptance cannot be determined for the landowners with high debt, it is likely to be somewhere between the $6,000 and $12,000 level. This may be an indication that, generally speaking, the landowners with comparatively high mortgages and other debts in our sample are not entirely constrained by them in terms of their land use decisions. Length of ownership of the land does not seem to affect voting behavior. The longer the landowner has had possession of the land, the more likely he/she is to vote "probably no" to the $2,500 bid. However, no other significant relationships can be found.

The degree of risk the landowner perceives to be associated with timber investments as opposed to agricultural investments is indicated by the RISK variable. We anticipate that the landowners who perceive a great deal of risk in timber production would be opposed to replanting trees on their agricultural land. While a "probably yes" or "definitely yes" vote is often given in response to the bids $7,500 and above, the "not sure" vote is significantly chosen by these landowners for <u>all</u> offers. Therefore, the landowners in our sample who view growing trees as risky don't seem to be completely adverse to reforestation. Perhaps, they feel the risk would be mitigated by a guaranteed lump-sum payment. However, the overwhelming NS response to all offers leads us to believe this group of landowners is still somewhat skeptical about such a land use change.

Having children seems to determine whether the landowner will choose the DY response to all bids \$2,500 and above, as suggested by the positive and statistically significant sign on the CHILDREN variable for these bids. However, the landowners with children are also likely to say they are “not sure” in response to the \$3,500, \$4,500, and \$7,500 bids. Therefore, the point at which they consistently choose “probably yes” or “definitely yes” is at the \$10,500 level, implying that this group of landowners is interested in converting agricultural land to forest use for the right price. As agricultural income of the landowner increases, however, the landowner tends <u>not</u> to provide a PY and/or DY vote to the \$4,500, \$6,000 and \$7,500 bids and no significant relationships between voting behavior and bid level for the higher offers, indicating that as agricultural income increases, a higher payment is needed to convert land to forest use. This is consistent with Equation (10) of the theoretical model above.

Those who have land enrolled in the CRP are likely to check the PY or DY box for all bids between \$1,500 and \$4,500. They also tend to vote “not sure” for the \$1,500, \$2,000, and \$10,500 bids. Despite the significant percentage of NS votes in response to the \$10,500 bid, we expect a threshold of acceptance to occur around the \$2,500 bid. We sense that many landowners involved in the CRP chose not to respond to the higher payment offers, instead filling out the payment table only up to the bid they would accept, resulting in the assignment of a “zero” across the rows after the first acceptable bid. This would explain the lack of significance of the PY and DY votes to the higher bids. No significant relationships are found between landowner voting behavior and the bid for the landowners who personally farm their land. This may indicate that this group of landowners consistently chose the DN response for all bids.

To summarize, large scale farming, environmental motives for owning land, heavy debt load, and participation in the Conservation Reserve Program all seem to be indicators of relatively low reservation prices for land conversion from agricultural to forest use, i.e., in the $2,500 - $6,000 range per acre. On the other hand, involvement in on-site recreational activities, inheritance of at least a portion of the land parcel, existence of private roads, having children, and holding land for future heirs are signs of much higher reservation prices ($10,500 or greater). No clear relationship between reservation price and distance between the landowner's residence and land parcel, annual income, employment status, or length of land tenure was determined. In general, those landowners who believe that growing trees imposes more risk than growing agricultural crops give the impression that they are not completely averse to afforesting a portion of their land parcel, but they seem unsure about how to vote on bids for tree planting. Finally, the landowners that personally farm the land rather than renting to tenants may have largely rejected the land conversion bids with a DN vote, given that no relationship was found between the bid level and any other response.

5.2 Multinomial LOGIT Models of Acceptance of Annual Payment Over Thirty Years for Setting Aside One Acre of Agricultural Land for Afforestation—Virginia Sample

Estimation results for multinomial LOGIT models of acceptance of an annual payment over thirty years for setting aside one acre of agricultural land for forest use are displayed in Tables 56–64. As is true with the single payments, the annual payments are set up to increase logarithmically. In this case, the bids are $15, $30, $40, $60, $80, $110, $150, $200, $280, $380, and $480. For these models, we revert to the set of variables used in the harvest payment MNL models, with the exceptions that we keep the ENROLCRP variable (for all models but that representing the $15 bid) and continue to replace the ACRES variable with the ACREAG variable. The additional variables utilized in the single payment models lack significance and so were dropped from these models. Note that there were only enough observations for the PN and NS votes to the $15 and $30 bids to present estimation results for these voting categories. Similarly, we only present results for the PN, NS, and PY votes in response to the $40 bid and for the PN, NS, and DY votes in response to the $60 bid. Also, notice that no MNL model results appear for the $150 or $380 bids. These regressions did not work due to insufficient variation in the dependent variable, meaning the landowners responded similarly to these particular payment offers.

The "definitely no" vote is the most popular response to each of the annual payment offers. Since the DN vote is dropped in order to estimate these models, we do not have a lot of significance in our estimation results. For this reason, we will focus only on the variables whose coefficients are significant in at least three of the ten models. These variables include NONCONS, DEBT, RISK, and CHILDREN. The coefficient on the NONCONS variable is positive and significant at the 5% level and below for the "probably no" response to the $30, $40, and $60 bids, suggesting that the landowners who are involved in non-consumptive recreational activities on their land reject the lower annual payments for setting aside land for reforestation. These same landowners tend to vote "not sure" to the higher bid of $80 and "definitely yes" in reply to the $280 bid. These results imply that the people who participate in recreational activities in our sample are not strictly opposed to planting trees on an acre of their agricultural land, they would just require a relatively high annual payment to do it. This is consistent with the results presented earlier in this section for a single payment. The landowners carrying heavy debt are likely to check the "probably no" box for the $200 offer and the "probably yes" box for the $280 offer. They tend not to check the "not sure" box for the $200 and $280 box or the "probably no" box for the $480 bid. This may be an indication that the landowners with high debt are generally willing to accept an annual payment somewhere between $200 and $280 per acre for 30 years, which is consistent with our finding of a mid-range willingness to accept of $6,000 to $12,000 above for the single payment. Again, since this threshold level of acceptance is at the upper end of the payment offers, the landowners with high debt in our study may not be very constrained by their debt when it comes to making land use decisions.

We find considerable uncertainty by the landowners who perceive timber production to be risky when compared to agriculture about whether or not they will accept the payment offers. This is exemplified by positive signs on the coefficients of the RISK variable for the NS response that are significant at the 1% level for the $15, $30,

$40, $60, $80, and $280 offers and at the 5% level for the $110 offer. The only other significant relationship we find between the RISK variable and a voting category is for the "probably yes" response to the $480 bid. These results suggest that it would take a very high payment offer for the landowners who perceive risk to accept it. Notice that these results are also consistent with the MNL results above for the single payment offers. Lastly, the landowners with children have a tendency to provide a PY vote to the $80 and $110 bids and a DY vote to the $110 and $200 bids. They are also inclined to respond "not sure" to the $200 bid. While the coefficients on the CHILDREN variable remain positive for the PY and DY responses to the $110 to $280 bid range and the DY response to the $480 bid, these coefficients are not statistically significant, and so no definitive conclusions about a threshold point of acceptance can be reached.

In summary, the landowners involved in recreational activities on their land parcels are not against afforesting their land, they just have a high reservation price. Those who perceive timber investments as risky are uncertain as to how to vote on bids for afforestation, in that they are likely to check the 'not sure' box in response to many of the bids. The landowners with children do not vote on the bids in any consistent way, indicating that having children does not influence voting one way or another. Finally, many of the landowners with high debt are willing to plant trees on at least an acre of their land for $200-$280 per acre, a price well within the limits of the payment table.

5.3 Multinomial LOGIT Models of Acceptance of Single Lump-Sum Payment for Setting Aside One Acre of Agricultural Land for Afforestation—Mississippi Sample

In this section, we present results from estimating multinomial LOGIT models of bid acceptance for conversion of a single acre of agricultural land to forest production for the Mississippi landowners. These results come from landowner responses to the single lump-sum payments, which in this case vary from $1,000 to $11,500 per acre. The same voting categories are once again considered, and include definitely no, probably no, not sure, probably yes, or definitely yes as possible votes. We estimate such a model for each bid level. Estimation results are found in Tables 65-72. The bid levels increase logarithmically as follows: $1,000, $1,500, $2,000, $2,500, $3,500, $4,500, $6,000, $7,500, $9,500, and $11,500 per acre. Again, the definitely no, probably no, not sure, probably yes, and definitely yes votes are referred to as DN, PN, NS, PY, and DY, respectively. The “definitely no” (DN) vote is dropped to permit model estimation. Discussion of the estimation results follows the same format as explained above for the Virginia sample. We will continue to focus on threshold values that indicate the lowest price that landowners consistently find acceptable as payment for land conversion activities. Once again, the usefulness of these threshold values is that they approximate reservation prices for the various landowner groups. Note that we have not included a table of results for the $1,000, $1,500, and $2,000 offers. Most landowners rejected these low bids, which prevented model estimation.

We will focus discussion only on the variables whose coefficients are significant in at least three of the eight models. Therefore, the coefficients on the YRSOWN, CHILDREN, INCAG, ENROLCRP, and PERSRM variables are not mentioned in what follows. The landowners who actively participate in outdoor recreation activities, as indicated by the NONCONS variable, tend to reject the lower bids of $2,500, $3,500, $4,500, and $6,000; the majority of them cast a "probably no" vote to these offers. This group of landowners seems to require a payment of $7,500 or greater. They have a propensity to switch their "probably no" vote to a "definitely yes" vote once this bid level is reached, suggesting that they are very confident about accepting a lump-sum payment of this magnitude in return for changing land use on one acre. Recall, a similar threshold value was found for the Virginia recreationists. Distance between the landowner's residence and his/her land does not seem to impact voting behavior, as was the case for Virginia. Landowners who reside far away from their properties tend to vote "probably no" in response to the $2,500, $3,500, and $6,000 bids. However, they don't consistently vote within any single category for the higher bids; the votes are spread among several different levels of confidence.

The landowners who inherited their property are not very confident about how to vote on the various offers. The "not sure" vote is chosen regularly for the higher bids of $6,000, $9,500 and even $11,500. The Virginia landowners who inherited their land also chose the NS vote more than any other category for the higher bids. The owners of the larger tracts also frequently admitted that they were "not sure" about how to vote on many of the payment offers. This voting category was a popular choice for the $4,500, $6,000, $7,500, and $11,500 bids. The landowners with environmental reasons for owning land are unsure about how to proceed with the voting as well. The NS response was chosen by a significant portion of the landowners for all bids <u>except</u> $2,500 and

$3,500. Despite that the landowners who inherited, the owners of large tracts, and the owners with environmental motives are all unsure about how to vote, the owners with good road access seem confident about how to vote on the payment offers. The presence of roads is negatively related to the decision to place a "not sure" vote (mostly at the 5% level of significance and below) for the middle to upper range bids. However, this group of landowners does not seem to respond in any predictable way to the various bids. Likewise, the landowners who mainly own land for their heirs are fairly confident about voting, but their votes are also spread across the categories for the various bids.

The working landowners are represented by the EMPLOYED variable. They seem to accept the lower bids of $1,000 and $3,000 with a PY vote. However, they fail to vote "probably yes" or "definitely yes" for any of the higher bids, even the highest bid presented to them ($11,500). This seems to indicate that this group of landowners is often unsure about how to vote. We expect landowners with heavy debt to accept a relatively low payment to afforest an acre of their farm land. In fact, a significant portion of the landowners that carry the higher debt loads voted "probably yes" or "definitely yes" to all payment offers $4,500 and greater. Since the "probably no" response was also likely for the $4,500 and $6,000 bids, the threshold value of acceptance seems to be $7,500. For this bid and all higher bids, this particular landowner type chose the DY vote more often than any other vote. Recall that a specific threshold level of acceptance of lump-sum bids could not be determined for the Virginia landowners of this type. Landowners who perceive timber production to be a risky investment, as identified by the RISK variable, are likely to reject all bids $4,500 and below. While they are often unsure about a payment of $6,000, they are likely to accept a $7,500 payment with a PY vote and an $11,500 payment with a DY vote. So, the threshold level of acceptance is between $7,500 and $11,500 for this landowner group, indicating that they are not strictly opposed to planting trees on their land.

To summarize, Mississippi landowners seem to be less certain about how to vote on lump-sum bids for changing land use on an acre of land than Virginia landowners. Specifically, large-tract owners, those with environmental objectives for their land, landowners who inherited, and those with jobs all indicated they were "not sure" about whether they would accept many of the bids. Moreover, nonresident landowners who reside far from their land parcels and landowners with good road access did not respond to payments in a predictable way. Very few threshold values of acceptance could be obtained for the different landowner types, as a result. However, landowners who participate in on-site recreational activities and those with high accumulated debt tended to have reservation prices within the bounds of the payment table, as low as $7,500 per acre. Therefore, these groups of landowners can be identified as targets of conservation programs. Further, those who perceive timber investments as risky collectively hold a reservation price between $7,500 and $11,500, also in the range of the payment table. Therefore, risk does <u>not</u> seem to be an indicator of non-participation in such programs.

5.4 Multinomial LOGIT Models of Acceptance of Annual Payment Over Thirty Years for Setting Aside One Acre of Agricultural Land for Afforestation —Mississippi Sample

Tables 73-81 present estimation results for MNL models of bid acceptance by Mississippi landowners with respect to annual payments made over thirty years for land conversion from agricultural to forest use. The annual payments range from $30 - $550 per acre and increase logarithmically as follows: $30, $40, $60, $80, $110, $150, $200, $280, $400, $550. No MNL model results are displayed for the $30 bid because the majority of landowners rejected this offer with a DN vote, preventing model estimation. Similar variables are used in these models as in the single payment MNL models discussed above, with the exceptions of the INCAG and PERSFRM variables. These variables lack statistical significance in the single payment offers, implying the voting behavior of landowners does not depend on agricultural income earned in the year 2000 or whether the landowner personally farms the land. The INCMID variable, which represents total exogenous income earned in the year 2000, is used in place of the INCAG variable. As before, we will only discuss those variables whose parameter estimates are statistically significant in at least three of the nine models. Therefore, we do will not report results for the ENVIREA, DEBT, RISK, CHILDREN, or ENROLCRP variables.

Landowners who recreate on their property appear willing to accept an annual payment for tree planting. These landowners tend to waffle between accepting and rejecting bids of $150 and lower. They consistently accept bids at the $200 level and above, as shown by the significant coefficient estimates on the NONCONS variable for the PY response to the $280 bid and the DY response to the $200 and $400 bids. Recall, the Virginia landowners who participate in recreational activities had a slightly higher threshold level of acceptance of $280. The landowners who live far away from their property, as represented by the MILEFROM variable, are likely to place either a "not sure" vote or a "probably yes" vote in response to the $150, $280 and $400 bids. A significant portion of these landowners respond with a "definitely yes" vote when confronted with the highest offers of $400 and $550, which suggests that their reservation price lies somewhere in this range. We expect the landowners with the higher incomes to have a higher reservation price for land conversion. Indeed, they are not likely to accept the middle range bids of $150 and $200. However, a large percentage of these landowners do accept the $280 bid, indicating that even the more wealthy landowners in the sample may be interested in receiving payment for tree planting. The more likely the landowner is to have inherited the land, the least likely he/she is to accept a payment within the range given in the payment table. In the MNL models of lump-sum bid acceptance explained above, this group of Mississippi landowners was unsure about how to vote. Length of private roads on the property affects voting behavior for the annual payments the same way it did for the lump-sum payments, in that landowners are confident about their vote (i.e., they are unlikely to place a NS vote), yet responses vary across the voting categories. Tract size is positively correlated with acceptance of votes in the $150 - $550 (middle to upper) range, as indicated by the ACRES variable. It makes sense that the owners of the larger tracts would be willing to convert just an acre of their land to forest use, given that it represents a small portion of their landholding. In the MNL models discussed earlier in this section, the larger the landholding, the more likely the Mississippi landowner was to cast a “not sure” vote on the lump-sum bids. The majority of landowners who indicated in the survey that they hold land predominately for their heirs, as shown by the FUTGEN variable, are willing to accept bids of $200 and higher, despite that the Virginia landowners with such bequest motives were highly unlikely to accept any of the annual or lump-sum offers. Many of the landowners who currently hold jobs, as indicated by the EMPLOYED variable seem willing to accept the $150 and $280 bids; however they did not vote the same way for the higher bids, suggesting once again, that the working portion of the Mississippi sample is unsure about voting. A similar voting pattern applies to length of land ownership, with a large portion of the survey participants who have owned the property for many years, as shown by the YRSOWN variable, accepting the $110 and $280 bids, but a large portion also casting a NS vote for the highest bid of $550.

Mississippi landowners of various types seem to vote differently on annual bids to be received over thirty years than on single, lump-sum bids. For example, Mississippi landowners who reside far from their land parcels tend to accept the annual bids in the upper range of the payment table ($400-$550), however, while they reject the lower lump-sum bids of $2,500, $3,500, and $6,000, no pattern of voting for the higher lump-sum bids was discerned. While the Mississippi landowners who inherited land were unsure about how to vote on the single bids, we found an inverse relationship between inheritance of property and annual reservation price. Further while DEBT and RISK were positively correlated with acceptance of a lump-sum bid of $7,500 or greater, these variables were not significant in the annual payment MNL models. Although there were differences in voting on annual and lump-sum bids by various landowner groups, there were also some similarities. For example, survey participants who participate in on-site recreational activities are likely to accept a lump-sum payment of $7,500 and greater or an annual payment of $200 or greater for land conversion; both are mid-range bids in the payment table. Existence of private roads, as indicated by the ROADS variable, and holding a job, as shown by the EMPLOYED variable, both indicate that votes on the bids will vary significantly from owner to owner.

6. EXTENSIONS OF RESERVATION PRICE METHODS AND HYPOTHESIS TESTING FOR LAND USE DATA

In this section, we are interested in how the landowners would vote if they were each provided with just <u>one</u> payment offer for replanting trees on an acre of their agricultural land that varies from owner to owner according to a logarithmic scale. Again, the referendum literature is based on voting for a single bid. We use the same two methods to characterize reservation prices for land shifting as outlined above in Chapter 1, Section 7.1 for timber harvesting. Recall, the first method involves systematic sampling from the bid levels by applying the lowest bid to the first landowner, the next highest bid to the second landowner and so on for the full sample. The second method involves randomly sampling one bid for each landowner. Recall that sampling according to either of these methods does not result in votes that perfectly coincide with those derived from the referendum method, since ignoring all other bids presented to the landowners could result in starting point bias, in that a landowner's decision to accept or reject a bid may be influenced by the other price offers in the table.

The dependent variable, ACCEPT, in the models presented in this section takes a value of one if the landowner casts a PY or DY vote to the assigned bid and a value of zero for a DN, PN, or NS vote. The ACCEPT variable is shown to be a function of the particular bid level along with physical site characteristics, landowner attributes, and preference variables. Once again, linearity is an important assumption in estimating these models. One way to test linearity is to add the squares of each of the regressors with significant coefficients to the equation, and then re-estimate it. If the coefficients of the added terms are not significant, then linearity is a reasonable assumption. This method is known as the RESET test (Greene 1997). A likelihood ratio test can also be performed to compare model results between the linear and nonlinear specifications. If the two models are found to be statistically similar, then the linearity assumption is reinforced. Results from RESET testing are provided below for each of the binomial LOGIT models.

6.1 Binomial LOGIT Models Based on Selective and Random Sampling of Single, Lump-Sum Bids—Virginia

Table 82 presents estimation results for the binomial LOGIT model of acceptance of a single bid as a function of a variety of land and owner characteristics as well as the particular bid, for the lump-sum payment data from the Virginia survey. The first column displays the results for the selectively sampled bids. Notice that as bid level increases, rate of acceptance also increases, as evidenced by the strictly positive sign on the parameter estimate for the BID variable. This suggests that the law of transitivity holds for the landowners in this sample and that they represent rational decision-makers. Also, notice that four other variables hold statistically significant signs including ENVIREA, FUTGEN, RISK, and RISKCROP. The higher the environment is ranked as a reason for owning land, the more likely the landowner is to accept a bid to replant trees. Once more, it is conceivable that landowners with environmental objectives would want to plant trees on their land for benefits like erosion control, improved habitat for wildlife, and carbon storage. Concern for future generations as a reason for owning land is inversely related to the likelihood of accepting a bid. This is consistent with the multinomial LOGIT model results presented in Section 6.1 for the lump-sum payment offers. As landowners perceive more risk with growing trees, likelihood of accepting a bid to afforest is also shown to diminish, however the more risk a landowner believes is involved with losing crops to disease, floods, or insects as exemplified by the RISKCROP variable, the more likely he/she is to accept a bid. It is comprehensible that the landowners who associate risk with growing crops would want to switch land out of agriculture into another use.

Estimation results for the binomial LOGIT models of bid acceptance using randomly selected lump-sum bids are also displayed in Table 82. Here, just three variables have significant coefficient estimates: ENROLCRP, INHERIT, and BID. As bid amount increases, rate of bid acceptance again is heightened. As probability of enrolling land in the Conservation Reserve Program (CRP) increases, so does the likelihood of accepting a payment to set aside an acre of land for forest use. Since the CRP involves setting aside land previously devoted to agriculture for conservation purposes, it makes sense that the people who participate in such a program might be interested in reforestation. Finally, the INHERIT variable holds a negative coefficient that is significant at the 10% level, suggesting that the landowners who were given their property are opposed to accepting a bid. Recall from Section 6.1 that this is consistent with the rejection of the highest lump-sum payment of $12,000 by many of the landowners who inherited, to replant an acre in trees. This provides evidence that generally speaking, landowners who inherit may be opposed to land use change.

6.2 Binomial LOGIT Models Based on Selective and Random Sampling of Single, Lump-Sum Bids—Mississippi

The same methods for characterizing reservation prices, as explained above in Section 6.1, are applied to the Mississippi data. Table 83 displays the estimation results for the binomial LOGIT models of bid acceptance using the single payment data for Mississippi. The first column shows the results for the selectively sampled bids. As expected, as bid rises, the rate of acceptance increases. Four other variables have significant parameter estimates, including NONCONS, ENVIREA, DEBT, and RISK. Environmental motives for owning land, as measured by the ENVIREA variable is positively correlated with accepting a bid to plant trees, as is the case for Virginia. The perception that timber production is risky hinders bid acceptance among survey participants, as implied by the negative sign on the coefficient estimate for the RISK variable. This result also coincides with the results found for Virginia. Landowner participation in non-consumptive recreational activities also makes landowners less willing to accept a bid. Landowner debt is a positive indicator of bid acceptance, which suggests that landowners in this area may be interested in paying off debts with timber income.

The second column of Table 83 shows the results for the randomly sampled bids. Bid amount once again emerges as a positive predictor of acceptance. Participation in the Conservation Reserve Program (CRP) seems to preclude bid acceptance. CRP participants may already have most of their marginally productive agricultural land enrolled, in which case they would be unable to participate in any other type of land set-aside program. Environmental concerns are positively correlated with accepting a bid, as was the case for the selectively sampled payments presented both to Virginia and Mississippi landowners. Length of private roads is also an indicator of accepting a payment for tree planting.

6.3 Binomial LOGIT Models Based on Selective and Random Sampling of Annual Bids to be Received over Thirty Years—Virginia

Table 84 presents the estimation results for the binomial LOGIT models of bid acceptance for the annual payment data from the Virginia survey. Similar models were estimated using the annual payment data from the Mississippi survey; however no results will be presented for these models due to poor performance. The first column contains the results for the selectively sampled bids. Here, eight variables hold coefficients that are significant at the 10% level and below (aside from the constant term), including ENROLCRP, INHERIT, YRSOWN, RISK, CHILDREN, CROPINS, FAMREFOR, and BID. The CROPINS variable refers to whether or not the landowner currently carries crop insurance of any type. The FAMREFOR variable is an indicator of how familiar the landowner is to reforestation on a scale from one to five, one being not familiar and five being very familiar. Again, the likelihood of accepting a bid increases as the bid itself increases. As the probability of enrolling land in the CRP increases, the probability of accepting the bid actually declines. Recall from Table 83 that a negative relationship was also found between CRP participation and lump-sum bid acceptance by Mississippi landowners for a random sample of offers. Since only a small portion of landowners are enrolled in the program, it is likely that the lower bids just happened to be assigned to them, which would explain this finding. Likelihood of inheriting the land, as opposed to buying it, is also negatively related to bid acceptance, which is consistent with the multinomial LOGIT model results for a single lump-sum payment found in Section 5, as well as the model results presented earlier in this section. Length of ownership is positively correlated with acceptance of an annual payment for planting trees, given the positive sign on the YRSOWN variable, despite that there appears to be no significant relationship between these two variables in the lump-sum payment models representing Virginia or Mississippi landowners.

As landowners perceive timber production to be risky, they become less willing to accept an annual payment to reforest a portion of their crop and pasture land, just as they were less willing to accept a single lump-sum payment. Conversely, the landowners with children seem amenable to accepting a yearly payment. The coefficient on the CROPINS variable holds a negative sign, suggesting that the landowners who carry crop insurance are generally opposed to reforesting any of their agricultural land. These landowners probably rely on farming for their livelihood and may additionally place high amenity values on their crop and pastureland. On the other hand, the landowners who are familiar with reforestation, as indicated by the FAMREFOR variable, are very likely to accept an annual payment for replanting trees. The coefficient on the FAMREFOR variable is positive and significant at the 1% level.

Table 84 also contains estimation results for the binomial LOGIT model of acceptance of the randomly selected annual payment offers. Four variables have significant coefficients, including FUTGEN, RISK, RISKCROP, and BID. Once more, bid level holds a positive sign that is significant at the 1% level, indicating an increase in the rate of bid acceptance the higher the bid. The FUTGEN variable has a negative coefficient, meaning the landowners who own land for future generations may be opposed to accepting an annual payment for reforestation. Note that this variable was also inversely related to acceptance of a single payment by Virginia landowners when the bids were selectively drawn, as shown in Section 6.1. The landowners who own land for future generations probably make up the older portion of the sample. Again, they may place high amenity value on their crop and pasture land, especially if farming played a significant role in their family histories. The coefficients on both risk variables hold opposing signs as they did in the single payment binomial LOGIT model of Virginia landowners. The perception that timber production is risky, as measured by the RISK variable, makes a landowner less willing to accept a payment for reforestation, while the perception that there is significant risk involved with losing crops to disease, floods, or insects, as gauged by the RISKCROP variable, causes a landowner to consider switching land use to forestry on at least an acre of their land currently devoted to agriculture.

So far, this section discussed estimation results for six different binomial LOGIT models representing lump-sum bid acceptance by Virginia and Mississippi landowners and annual bid acceptance by Virginia landowners only. A single bid was chosen for each landowner from the range of bids presented in the payment table using selective as well as random drawing. Bid level was positively correlated with acceptance in each model, as expected. The perception that timber investments are risky was negatively related to acceptance of a payment for reforestation, while the belief that growing crops involves significant risk induced landowners to accept payment to convert agricultural land to forest use. Inheritance of land seemed to be a negative indicator of bid acceptance, as was holding land for future generations. Environmental motivation for owning land generally translated into a willingness to accept payment in return for planting trees. Enrollment in the CRP was a positive predictor of bid acceptance among Virginia landowners with respect to a lump-sum payment, but a negative indicator of both acceptance of an annual payment by Virginia landowners and lump-sum bid acceptance by Mississippi landowners. Each of the variables mentioned thus far held significant coefficients in at least two of the six models. The NONCONS, DEBT, ROADS, YRSOWN, CHILDREN, CROPINS, and FAMREFOR variables were significant in only one of the six models, possibly identifying involvement in on-site recreational activities and carrying of crop insurance as negative indicators of land conversion and debt, road length, length of tenure, as well as familiarity with reforestation as positive predictors of bid acceptance.

6.4 Mean Willingness to Accept—Virginia

Tables 82 and 84 display estimates of mean willingness to accept for the lump-sum and annual payments, respectively, using the Virginia survey data. These were obtained using the "grand constant" approach discussed in Section 6.2.1 of Chapter 1. The mean WTA estimate for a single, lump-sum payment (per acre) is \$8,476.34 for the selectively sampled bids and \$9,701.33 for the randomly drawn bids. The estimate is \$350.82 for the randomly drawn annual payment.

The linearity assumption was tested for each of the models presented in Tables 82, 83, and 84 using the RESET method. First, the squares of each of the significant regressors were added to each equation, and then the equations were re-estimated. None of the parameter estimates associated with these additional terms is significant at the 10% level. Next, likelihood ratio testing was performed to compare results for the linear and nonlinear models. Indeed, the hypothesis that the models are statistically similar cannot be rejected. Therefore, the test results suggest that linearity is plausible for the binomial LOGIT models of bid acceptance from which these probability predictions are derived. The "grand constant" method outlined above is therefore appropriate for these models.

6.5 Hypothesis Testing—Virginia

We are interested in testing for the land conversion models, whether or not a "not sure" vote approximates a "probably no" vote or a "definitely no" vote using the data on lump-sum and annual payments for reforesting agricultural land. We employ the same methods used above in Chapter 1, Section 7.3 on the harvest payment data, where we omit one decision from each of the multinomial LOGIT models, re-estimate them, and perform likelihood ratio testing to determine whether the two model types differ statistically. Again, we first treat the PN and NS votes as one decision, leaving us with a four-choice model for each bid level, where the choices include DN, PN/NS, PY, and DY. We then proceed to treat the DN and NS as a single decision, giving us a similar four-choice model where the choices are PN, DN/NS, PY, and DY. We compare each of these models with the original five-choice model using likelihood ratio testing, where the null hypothesis is that the two models are statistically similar.

Table 85 contains the results of this testing using the lump-sum payment data for the Virginia sample. According to the results in the first column, there appears to be a significant difference between the model where "probably no" and "not sure" are regarded as separate decisions and the model where they are lumped together as a single decision, for all bid levels except \$2,500 and \$3,500. This suggests that a "not sure" vote should not be treated as a rejection of the bid in most cases, when dealing with a single lump-sum payment for reforestation. The LR test results in the second column provide overwhelming support for regarding the "definitely no" and "not sure" votes separately, as exemplified by the rejection of the null hypothesis for all bid levels.

Table 86 displays the likelihood ratio test results using the annual payment data. The first column displays the results of testing whether a "not sure" vote differs from a "probably no" vote. Indeed, we reject the null hypothesis that the models are similar for all bid levels, providing strong support for considering "probably no" and "not sure" as independent responses. The second column, however, suggests that a "not sure" vote approximates a "definitely no" vote for the $30, $40, $60, $280, and $480 bid levels. The two responses only differ statistically for the $15, $80, $110, and $200 bids. This leads us to believe that the relationship between a "not sure" vote and a "no" vote varies according to the specific payment scenario presented to the landowner.

6.6 Marginal Effects—Virginia

6.6.1 Marginal Effects of Important Variables in the MNL Models of Bid Acceptance For a Lump-Sum Payment of $1,500, $3,500, and $4,500

Marginal effects were computed for all regressors of the MNL models of bid acceptance involving the single, lump-sum payments of $1,500, $3,500, and $4,500 for the voting categories of NS and PY for the $1,500 bid and the categories of NS, PY, and DY for the $3,500 and $4,500 bids. These marginal effects determine how a landowner's predicted participation in reforestation efforts will change as preferences and site parameters change. They are presented in Tables 89, 90, and 91. We focus on these three models and the aforementioned voting categories, because they capture the highest number of significant variables. However, marginal effects of all variables for all bid levels can be computed. We will discuss only the marginal effects corresponding to variables in the regressions that are significant in magnitude, meaning 1% and larger.

Although there are several variables that influenced the NS and PY votes for the lowest bid of $1,500, none of the marginal effects of these variables are significant, and so our discussion for this bid amount ends here. There are also many significant variables that affected the decision to choose NS, PY, or DY in response to the mid-range bid of $3,500. While the marginal effects are not significant for the NS and PY votes, many are for the DY vote. For example, a 1% increase in the ranking score representing the importance of the environment as a reason for owning land (on a scale from one to five) resulted in a 5% increase in the probability of choosing to vote “definitely yes” to the $3,500 bid to replant trees on an acre of the land. From Table 67, it is evident that the landowners who value the environment are likely to vote “probably yes” or “definitely yes” in response to the $3,500 bid. A 1 % increase in the ranking of the importance of future generations as a reason for owning land (also on a scale from one to five) led to a 5 % decrease in the likelihood of marking the DY box for the $3,500 bid. The estimation results in Table 67 suggest that the landowners, who care about the generations to come, tend to reject this bid with a NS, PN, or possibly even DN vote. The marginal effects imply that a landowner was 1.4 % more likely to vote DY for every 1% increase in the probability that he/she is employed. In contrast, the landowners who perceive a great deal of risk associated with growing trees were 1.5% less likely to choose DY, and were more likely to mark the PN, NS, or PY boxes. A 1 % increase in the number of children a landowner resulted in a 6 % increase in the probability of voting DY to this bid, indicating that the landowners with children look favorably upon reforestation. The landowners who have land enrolled in the Conservation Reserve Program appear to be

5.5 % more likely to accept the $3,500 bid with a "definitely yes" vote. This supports our earlier finding from Section 6.3 that Virginia owners who participate in the CRP are likely to accept a randomly selected annual payment for tree planting. Lastly, those who personally farm the land rather than renting it to tenants, are 4.5% less willing to place a DY vote, instead voting DN or PN.

With regards to the $4,500 bid, none of the marginal effects are very high for the NS or DY votes, however the marginal effects of three variables affecting the PY vote are significant including EMPLOYED, ENROLCRP, and PERSFRM. For every 1% increase in the likelihood that the landowner currently holds a job, there was a 1.7% decrease in the probability that the landowner chose the PY response to the $4,500 bid. However, recall from the MNL model results concerning lump-sum payment acceptance discussed in Section 6.1 that employment status overall did not seem to influence voting behavior. Similarly, there was a 1.4% decrease in likelihood of responding in this manner for a 1% increase in probability that a portion of the land is enrolled in the Conservation Reserve Program. From the estimation results of the MNL models displayed in Table 68, landowners with land enrolled in this program were very likely to choose the DY response to this bid level. The same marginal effect is found for the PERSFRM variable. However, the landowners who personally farm their land are likely instead to choose PN or DN to the $4,500 bid as they were for the $3,500 bid, providing more evidence that they would rather keep their land for farm use than plant it in trees.

6.6.2 Marginal Effects of Important Variables in the Binomial LOGIT Models of Bid Acceptance for Selectively and Randomly Sampled Single, Lump-Sum Bids

We also computed marginal effects of important variables in the binomial LOGIT models of bid acceptance for the selectively and randomly selected lump-sum bids, presented in Section 6.1. Recall, the bids range from \$1,500 to \$12,000 per acre. Also, recall from Section 6.1 that the selective sampling of bids involved applying the lowest bid to the first landowner, the next highest bid to the second landowner and so on for the entire sample. Next, we created an ACCEPT variable, which takes a value of one if the landowner provides a PY or DY vote to the assigned bid and a value of zero for a DN, PN, or NS vote. A binomial LOGIT model was then designed where the dependent variable represents bid acceptance/rejection. The marginal effects of the explanatory variables for these models are contained in Table 90. The first column presents results for the selectively sampled bids. Notice that a 1% increase in the ranking score of concern for future generations as a reason for owning land resulted in an 8.7% decrease in the probability of accepting a selectively sampled lump-sum bid. The marginal effects corresponding to the MNL models of lump-sum bid acceptance also suggested a negative relationship between this variable and acceptance of the \$3,500 bid. A percent increase in number of children actually led to a 1.9% decrease in bid acceptance, despite the positive relationship between number of children and reforestation payment acceptance found in the MNL results for the \$3,500 bid and the binomial LOGIT results for the selectively sampled annual bids. A 1% increase in familiarity with what is involved with reforesting land, on a scale of one to five, resulted in a 4% increase in acceptance of the bid.

The second column contains the marginal effects of important variables in the decision to accept a randomly assigned lump-sum bid. The FUTGEN and CHILDREN variables continue to have significant marginal effects on bid acceptance, however a 1% increase in the scoring by the landowner of care for future generations as reason for owning land results in only a 3.9% decrease in probability of accepting randomly selected bid, as opposed to the 8.7% decrease found above for the selectively sampled bids. On the other hand, a 1% increase in number of children leads to a 2.5% increase in randomly assigned bid acceptance, while it actually resulted in a 1.9% decrease above for the selective bids.

The marginal effect on the INHERIT variable is quite large. A 1% increase in the likelihood of inheriting the land rather than buying it gave us a 19% decrease in bid acceptance. This suggests that the portion of landowners who inherited land have a very high reservation price for converting land to forest use. Those with environmental objectives, however, see reforestation in a more favorable light; a percent increase in ranking score of the environment translated into a 2.9% increase in bid acceptance. A 1% increase in the degree of perception of risk involved in growing trees, on a scale of one to five (with one being least risk and five being most), leads to a 6% decrease in accepting a bid to plant trees on an acre of their land. Lastly, a 1% increase in the probability that a landowner currently carries crop insurance is associated with an 8% lower probability of bid acceptance.

6.6.3 Marginal Effects of Important Variables in the Binomial LOGIT Models of Bid Acceptance For Selectively and Randomly Sampled Annual Bids

Marginal effects of the explanatory variables for the binomial LOGIT models of bid acceptance for the annual bids are found in Table 91. The first column contains the marginal effects for the selectively sampled annual payment offers. None of them are significant in magnitude. The second column contains marginal effects for the randomly assigned bids. It is interesting that almost all of the marginal effects are greater than 1% for the random bids. This could have something to do with the rejection of the annual bid payments for reforestation by 74% of the sample. All of the same marginal effects that were significant for the randomly selected single bids are also significant for the randomly selected annual bids, and they carry the same signs. The magnitude of the marginal effects are larger for the ENVIREA (+), FUTGEN (-), RISK (-), CHILDREN (+), and CROPINS (-) variables than they were previously, while they are smaller for the INHERIT (-) variable. In addition, the marginal effects of the ENROLCRP, EMPLOYED, PERSFRM, RISKCROP, and FAMREFOR variables are worth mentioning. A 1% increase in the probability that a landowner has land enrolled in the CRP is unexpectedly shown to lead to a 21% decrease in likelihood of accepting the annual bid. Recall that a small percentage of the sample participates in this program. This result suggests that the landowners who do, either just happened to have been assigned low bids or already enrolled any land available for conservation in the CRP, as may be the case for the selectively sampled annual bids, given the estimation results of the binomial LOGIT model described in Section 7.3. Recall, enrollment in the CRP was shown to positively affect acceptance of a randomly selected, lump-sum bid. A 1%

increase in likelihood that the landowner is employed pointed to a 2% decrease in acceptance of the bid. The same is true for the PERSFRM variable. A 1% elevation in the perception that there is risk associated with growing agricultural crops, as measured on a scale from one to five (one being least risk, five being most risk), resulted in an 8% increase in willingness to accept a bid to reforest an acre of land. Finally a percent increase in familiarity with reforestation led to a 4% increase in annual bid acceptance. The marginal effect of this variable was the same in sign and magnitude for the selectively sampled lump-sum bids.

CHAPTER 3: APRIORI LAND USE DECISIONS AND OWNERSHIP OBJECTIVES

One goal of this study was to examine the reservation prices of landowners to switch land use from agriculture to forest production through reforestation and afforestation efforts. We were interested in determining what characteristics of landowners and the forest site are important in determining these reservation prices. Knowing this will allow predictions of the types of market settings where one can expect rapid turnover of land, or of situations where policies targeting land use (perhaps as a means of increasing forest cover) will be most effective. Other land use studies have relied on highly aggregated data (e.g., Forest Inventory and Analysis) which contain very limited owner-specific variables. Further, the decision to convert land has yet to be analyzed.

In this section, we examine land conversion decisions from the landowner's perspective by characterizing previous conversion decisions made by the landowners as a function of land and owner characteristics. Since we do not have enough data on intensity of land conversion to study it, we focus on the decision itself. We use the same data from the land use version of the Virginia survey that was used for previous models in this study (from Chapter 2), with the addition of some new data on 478 landowners from Montgomery County, Virginia, which we acquired in spring, 2001 using the same survey instrument. The response rate for this mailing was 34%. The types of conversions that we examine include: conversions from agriculture to forestry, conversions between forestry and agriculture (i.e., in either direction), conversions from forestry to any other use, and no conversion of any kind from one land use to another.

Table 92 contains the percent as well as the specific number of landowners, included in the land conversion models, who participated in the various types of land use changes. Notice that roughly the same percentage of landowners converted land out of forest use as into forest use, with the bulk of converting taking place from agriculture to forestry and from forestry to real estate development.

1. BINOMIAL LOGIT MODELS OF LAND CONVERSION ACTIVITY

Table 93 presents estimation results for several land conversion binomial LOGIT models. The dependent variable in the first column, AGTOFOR, takes a value of one if the landowner has switched any land from agriculture to forestry at any time over the ten years preceding the survey, otherwise it is zero. Notice that no constant term appears in the regression, by reason that the coefficient on the constant term appears to be statistically insignificant, and the estimation results are much improved with its removal. This is also the case for the other land conversion binomial LOGIT models that follow. Three of the variables have significant relationships with the decision to switch land out of agriculture and into forestry, including ROADS, AGE, and MARRIED. The ROADS variable, which stands for the total length of all private roads in existence on the property, seems to be a positive predictor of this particular type of land use change. As road length is an indicator of access to timber, this finding has merit. Moreover, good road access suggests that timber production has occurred in the past or is currently practiced on the land. The older the landowner, the less likely he/she is to have converted any land from agriculture to forest use. The owner who is married is also less likely to have participated in this kind of conversion.

The second column contains the estimation results for the regression involving any land use change between forestry and agriculture. All but two of the conversions that were made by the landowners were from agriculture to forestry rather than from forestry to agriculture, so it is not surprising that the same variables are significant in this regression as the last one and that their coefficients carry the same signs. The only difference between these regressions is that here, the coefficient on age is significant only at the 10% level, while it was previously significant at the 5% level.

The third column in Table 93 characterizes the shift from forestry to any other use like open land for wildlife, residential/commercial development, and agriculture. Recall from Chapter 2, Section 1 that normally the rent distribution is such that the best quality land goes to agricultural use, while the lower quality land goes to forest use. Therefore, it is not surprising that when land in Virginia is transferred out of timber production, it is typically either developed or simply abandoned. For our sample, there were twelve cases where land was shifted from forestry to open land or residential/commercial development, and only two cases where land was shifted from forestry to agriculture. Four regressors hold statistically significant coefficient estimates including ACREAG, MILEFROM, DEBT, and YRFARM. The amount of land that is currently devoted to farming, as described by the ACREAG variable, is directly related to ex ante shifting of land out of forestry. The properties with a great deal of crop and pasture land represent the largest tracts, where multi-objective management makes land use change more prevalent. It is interesting that the amount of land dedicated to agriculture does not seem to influence the landowner's decision to shift land from agriculture to forestry, but that it is an important predictor of shifting land out of forestry to real estate development or abandonment. Distance between a landowner's residence and his/her land is inversely related to taking land out of forestry. Since absentee landowners are typically less informed about their land, it is believable that they would be less likely to harvest trees from a portion of the land and then change land use on those acres. As debt load is heightened, the probability of converting land out of forestry is elevated. Most of the people in our sample, who switched land from forest use, did so to develop the land and probably to earn some extra income from a timber sale. The cost of the real estate improvements may represent the majority of debt for these landowners, which would explain this correlation. Finally, time spent in the farming business, as indicated by the YRFARM variable has a negative relationship with converting land from forestry to other uses. Maybe this portion of the survey sample simply doesn't hold much forest land or places amenity value on the forest land, which precludes this type of land conversion.

The last column of the table describes the estimation results for the binomial LOGIT model where the dependent variable represents no land use conversion of any type. Eighty percent of the landowners in our study have not switched land from one use to another over the past ten years. Many variables have significant coefficients for this regression. Among them is the ROADS variable, whose parameter estimate is negative and significant at the 5% level. Recall that this variable was an important predictor of conversion of land from agriculture to forest use. The ENVIR variable also has a negative coefficient, suggesting that landowners who value the environment are apt to change land use. The perception that growing agricultural crops is risky compared to growing trees is likewise negatively related to not converting land, i.e., positively related to a conversion. Recall from Table 92 that most of the land use changes were from agriculture to forestry. The SOY variable tells us whether or not the landowner grows soybeans on the land. This is an important cash crop for the counties of Southampton and Sussex, located in the coastal plain region of Virginia. Recall from Table 25, that 56% of the landowners in our original sample grow this crop. The presence of soybeans on the land tends to reduce the likelihood of land conversion. Since soybeans are grown in the primarily agricultural counties of our survey area, where the land is the most fertile, it seems that greater incentives may be needed to encourage landowners in this area to set aside land for forest use.

Age and being married are positive indicators that the landowner has not switched land use, as evidenced by the positive coefficients on the AGE and MARRIED variables that are significant at the 1 % level. The older married landowners in our sample presumably have children who they will bequeath the land to in the future. If these landowners can be convinced that preserving some acres in forest use would benefit their children, especially if there is a guaranteed monetary return, then these groups may actually be good targets for a land set aside program. It may just take more resources in terms of education and/or a higher payment offer. The DAYSHNT and ACREAG variables both hold negative coefficients that are significant at the 11% level. The DAYSHNT variable indicates how many days the landowner spent hunting on the land in the year 2000. Since hunting is a good indicator of amenity value to forest land, it makes sense that minimal switching of land out of forestry would occur by the landowners who hunt. However, adding more land to forest use is probably welcome by these landowners. The landowners who have a lot of land in agriculture have also made less land use changes on their property. Again, since agriculture tends to represent the highest valued use, it seems that the landowners who hold land that is productive in growing crops and raising livestock would have no reason to switch land out of these uses. However, it is also true that the properties containing a lot of agricultural land are the largest, and can support multiple-use management. Thus, taking the least fertile land and switching it to forest use is feasible for these landowners.

2. MARGINAL EFFECTS OF IMPORTANT VARIABLES IN THE BINOMIAL LOGIT MODEL OF PREVIOUS LAND CONVERSION FROM AGRICULTURE TO FOREST USE

Table 94 presents the marginal effects of important variables in the binomial LOGIT model that characterizes previous land conversion behavior of the landowner in terms of whether or not they have shifted any acres from agriculture to forest use over the ten years preceding the survey. We will discuss the four marginal effects that are significant. They are associated with the MARRIED, CHILDREN, EMPLOYED, and PERSFRM variables. A 1% increase in the probability of being married leads to a 5% decrease in likelihood that the landowner converted any land from agriculture to forestry. However, notice that a 1% increase in the number of children leads to a 1% <u>increase</u> in the likelihood that the landowner made such a conversion. Thus, we believe that the majority of the married landowners from our sample, who have not reforested a portion of their agricultural land in the past, are without children. A percent increase in probability of holding a job is associated with a 2% increase in the probability of making this type of land use change. Lastly, as the likelihood that the landowner personally farms the land increases, the likelihood of converting land from agriculture to forestry declines by the same amount.

3. MULTINOMIAL LOGIT MODEL OF LAND CONVERSION ACTIVITY

We further examine past land conversion decisions by estimating a multinomial LOGIT model where the dependent variable takes a value of zero if the landowner participated in any conversion other than from agriculture to forest use, a value of one if the landowner switched land from agriculture to forestry, and a value of two if the landowner has not switched any land from one use to another over the ten years preceding the mail survey. As is true with all multinomial LOGIT models, one decision is omitted to permit estimation. The decision to participate in a land use change other than from agriculture to forestry is dropped, by reason that our interest lies in the remaining two decisions.

Table 95 provides the estimation results for the MNL model. The first column characterizes the choice to switch land from agriculture to forest use. Three variables have significant coefficient estimates, including EMPLOYED, ENVIR, and SOY. The landowners that work, as determined by the EMPLOYED variable, appear more likely to engage in this type of land use change. Perhaps since these landowners are currently earning income, they can afford to switch their least productive crop/pasture land to forest use, in return for the added amenity value provided from forest land. Notice from Table 93, that the EMPLOYED variable in the binomial LOGIT model characterizing the shifting of land from crop and pasture to forestry also carried a positive coefficient, however it lacks statistical significance. Unexpectedly, the ENVIR variable seems to be negatively related to making the switch from agriculture to forestry. Recall, however, from Table 82, that concern for the environment is directly related to accepting a selectively sampled lump-sum bid to plant trees on a portion of land. Further, recall from Chapter 2, Section 5.1, that landowners who value the environment were more inclined to accept a relatively low bid for reforestation. Therefore, we believe that the landowners who ranked the environment high on their list of reasons for owning land would be eager to participate in a reforestation effort to improve the global climate. Growing soybeans appears to be positively related to planting trees on the land. Perhaps these soybean farmers took their least fertile acres and planted pine plantations.

The second column of Table 95 contains estimation results for the portion of the MNL model describing the decision <u>not</u> to convert any land from one use to another. These results closely mirror the results of the binomial LOGIT model in Table 94 that represents the same decision. The only differences are that the coefficient on the EMPLOYED variable is now positive and significant at the 5 % level, where before it was positive, but not statistically significant. Recall, that the EMPLOYED variable was also a positive predictor of switching land from agriculture to forest use. This leads us to believe that the positive relationship between working and earning income, and <u>not</u> changing land use, may be attributed to a lack of switching of land out of forestry. Again, the working portion of the sample may be in a better financial position to hold onto forest land for its amenity value, even if the monetary returns are not as favorable as other uses. This is more evidence that land use decisions may not be purely based on profit maximization. While the ACREAG variable in the binomial LOGIT model has a negative coefficient that was significant only at the 11% level, here, this variable also holds a negative coefficient, but significance is at the 5 % level.

CONCLUSIONS

Project Summary

The objective of this study was to propose a new way of assessing the market entry potential of forest landowners, for both the timber harvesting decision, and the decision to reforest agricultural land and hold this land in forest production indefinitely. A model was set forth that makes clear the components of the unobserved 'reservation prices' of landowners for each of these decisions. Reservation prices are, by definition, the minimum price or payment a landowner is willing to accept before engaging in one of the decisions. These are generally thought to be a complex function of preferences and site characteristics, as well as characteristics of the market that matches buyers and sellers together for timber and land sales. Understanding what factors are most important to reservation prices, as we do here, will make clear how the economic margin between different uses of forest land arises and changes over time. The fact that our approach does not require any landowners included in the data who have harvested, it will be useful in predicting forest cover changes for rapidly urbanizing areas where landowners may be increasingly absentee.

An empirical application of the model was performed for two regions in Mississippi and Virginia, based on a mail-out-mail-back survey of over 4,000 landowners. Landowners in this survey were asked their willingness to accept a series of bids, and the confidence level they had in voting on each bid. Bids were offered for timber harvesting of various degrees, and for shifting an acre from agricultural production to forest production. The land use payment was further distinguished as either a lump sum or annual payment. Survey response rates were over 30% for Virginia but only around 25% for Mississippi.

We investigated several possible econometric models for analyzing the data. Multinomial models were estimated treating the decision to vote on each bid with varying confidence as statistically joint decisions. We also examined several conventional bid-based models similar to single voting referendum approaches, in addition to methods that specifically identify the important components of reservation prices. Several hypothesis tests were conducted, including whether landowner uncertainty about accepting a bid approximated a rejection of a bid, and we computed bid levels that guarantee market entry for land conversion and harvesting decisions at the 50% level of probability. Comparisons of these results with prevailing market prices gives some indication of how close certain landowner types are to the economic margin for each activity.

Basic Results

We can summarize the important findings in the study as follows:

Result 1:

There are a common set of variables that drive the harvest market entry decision of landowners. However, the importance of variables and the types of variables that are significant depend on offers received by the landowner for harvesting. Each landowner is a price taker, but the landowner unilaterally decides whether to enter the market or not by accepting the prevailing market offers. For example, at low offers, i.e., between 1,000 – 4,000 dollars per acre for harvesting, income and bequest motives, the (related) number of children, and risk perceived growing timber are important in the decision to accept a bid. At higher prices, landowner preferences for environmental goods, employment, and how important the landowner feels about setting aside forests for future generations are important deterrents in accepting bids for harvesting.

Result 2:

Indicators of shifting landowner types (absenteeism) and fragmented landscapes (tract size) seem to be important in the decision of whether to accept an offer for harvesting, but in different ways. Landowners with larger tracts are more likely to accept low bids, i.e., less than $6,000 per acre for harvesting mature hardwoods. The distance a landowner lives from the site and the number of days they spend on their land do not seem to be important factors in bid acceptance. The one exception is that non-resident landowners are more likely to accept lower bids than resident landowners when they do enter the market. These issues have not been explored in previous work.

Result 3:

There is a special type of landowner who decides never to harvest within a reasonable practical range of prices. Those with bequest motives or a large number of potential heirs, as well as those with small parcels, are much more likely to have preferences consistent with never harvesting, at least at prevailing market prices we examine. Those landowners that intend to bequeath timber to heirs have a 20% higher chance of never entering the market for timber harvesting. The practice of including such landowners in censored models may not be appropriate.

Result 4:

There is an interesting connection between preferences and participation in non-timber activities and a landowner's willingness to participate in markets. Much of this has not been elaborated upon in previous models where non-timber benefits are often simulated in data by including the number of acres of forests not harvested. Our results show that, for timber harvesting, those landowners heavily involved in non-timber activities are more likely to be not sure about accepting a price bid, for a large range of prices. In our Virginia sample, it would take a bid of at least $10,500 per acre before the offer was accepted with any regularity by a landowner with high preferences for non-consumptive non-timber activities, such as hiking.

Result 5:

Our results show that a landowner's willingness to accept bids for land conversion is different than the case of forest harvesting. For example, the most important factors in the decision to convert land, i.e., accept offers to switch land use from agriculture to forest production, are income from agriculture, whether the respondent personally farmed the land, and whether or not a portion of the property was already enrolled in the Conservation Reserve Program. Other important factors include amenities the landowner enjoys from forest land, whether the landowner perceives forest production as riskier than agriculture, and the acres of land in agricultural production. Distance of the landowner's permanent residence from the property does not seem to be important in this decision. Interestingly, although preferences for future generations typically was shown to reduce the probability a landowner accepts a bid for harvesting, in the land conversion case preferences for future generations reduced the likelihood that the landowner would accept an offer to reforest agricultural land to forest production.

***Result 6*:**

Our methods show that there is considerable uncertainty surrounding whether landowners close to the economic margin will harvest. Landowners were given the option of voting 'not sure' on each bid offered. A large number of landowners voted this way for a large range of bids and for both land conversion and harvesting decisions. Tests between this response and others indicate some interesting differences in our data. These differences are important in predicting likely future entry into markets for a majority of landowners. For example, for the decisions of accepting lump sum one time bids for harvesting and land conversion, our results show that the 'not sure' vote is significantly different than the 'probably no' and 'definitely no' voting options. Thus, in this case a landowner who is not sure about a bid should not be treated as a rejection for our data. For the land conversion option where landowners were given a bid on an annual basis, we again find that not sure and no votes are significantly different for all types of landowners.

Policy Implications

Our findings carry significant policy implications, especially concerning the types of economic variables which the government could target under various policies and policy schemes. Currently there are several policies targeting reforestation and afforestation of agricultural and open land, such as state and federal forest practice acts, and federal government set-aside (compensation-based) incentives such as those administered through the Conservation Reserve and Wetlands Reserve Programs.

Our approach and findings also suggest a new qualitative means for assessing the prospect of market entry by landowners at prevailing prices, by comparison of the results we find for bids close to existing market prices. This comparison is important in many parts of the South where land patterns are rapidly changing, where parcelization of forest cover is the rule, and where forest land for harvesting is becoming increasingly scarce. We find the following important implications for these issues:

Policy Implication 1:

Our results suggest that it is not desirable to follow the usual practice of estimating models of harvesting and land use behavior which are uniform over all possible prices. We show in a range of models that the basic variables important to willingness to accept bids for conversion or interest and participation in land use change include landowner type and preferences, which can differ across regions. Generally the factors affecting market entry for low payments are different than those for high payments, and the factors important in landowner acceptance of annual bids can be different than acceptance of lump-sum bids.

***Policy Implication 2*:**

Existing models which investigate aggregate land shifting by relating the probability that land will change uses to simple county-level demographic variables may not be accurate predictors for whether a given individual will accept a bid for land conversion and afforestation. This has importance in the search for the types of policies to encourage carbon sequestration on agricultural land. Specific landowner targeting of policies will increase the probability that desired land use change occurs.

Policy Implication 3:

Increased parcelization of forest land accompanied by increasingly absentee landowners, who may have bequest motives for forests, will mean there are significant numbers of landowners who will never enter the market for harvesting at prevailing prices, or even prices that are 50% higher than prevailing market prices.

***Policy Implication 4*:**

Prevailing prices, adjusted for the typical stocking of mature hardwoods in the regions sampled of Virginia, range between 6,000 – 12,000 dollars per acre depending on site quality and other factors such as access. According to our results, this would be sufficient for 50% of landowners sampled to agree to harvest. Throughout our models, we find that the types of landowners who have preferences consistent with never harvesting are different in important ways than those who are close to the economic margin.

***Policy Implication 5*:**

The incentive payments needed to encourage some degree of land conversion are, for the single lump-sum payment range from \$10,885.61 to \$11,967.09 per acre for 50% acceptance. For an annual payment, landowners must receive approximately \$350.82 dollars per year per acre for the same level of acceptance. This suggests that the costs of land use conversion to forest production could be higher than the opportunity costs of lost agriculture. This suggests that there are amenities to agriculture that landowners may be receiving beyond simple agricultural production income, or that transactions costs of conversion from agricultural to forest uses may be perceived as quite high.

***Policy Implication 6*:**

The key policy element to target when attempting to change the distribution of forest cover, via harvesting or land conversion, is the probability that landowners close to the economic margin enter the market for a specific activity. If a landowner moves closer to the economic margin, then they are more likely to enter the market for the activity in question for a small change in market parameters (such as prevailing market prices and offers). With this in mind we have two sub-implications concerning policy design:

Sub-implication 1:

Our results also have implications for choosing policies to either decrease or increase forest harvesting i.e., to change forest cover. The single most important variable to target is the bequest motives of forest landowners. Anything that increases these incentives will increase the extent of cover by decreasing the likelihood that landowners will enter the market for harvesting at prevailing offers. This motive is also correlated with other preferences that are important to the probability a landowner will accept a bid to harvest within the range of normally observed prices. We also show that reduced income, such as via property taxes, may be important in having landowners accept lower price offers, increasing the chance that they enter the market for harvesting. Clearly, taxes and bequests must be managed jointly to create incentives leading to the most efficient distribution of forests over time. Landowners with preferences consistent with never harvesting and those that do not have such preferences should not be lumped together when developing policy goals.

Sub-implication 2:

Our results provide insight with respect to the types of policies that could be employed to encourage land use conversion to forests, perhaps to meet some type of carbon sequestration goal on forest land. Income variables seem to be more important to this decision than are preferences of the landowner. However, non-timber activities may also drive the decision.

Future Work

Our recommendations concerning the directions of future research are as follows:

(1) Confidence intervals for mean WTA estimates could be computed using bootstrapping techniques. Mean WTA estimates could also be adjusted to account for differences in landowner types.

(2) Rates of time preference could be estimated by comparing acceptance of lump-sum and annual payments over a specified time frame (e.g., 30 years).

(3) The results are useful for predicting forest cover changes, e.g., for rapidly urbanizing areas where forest parcelization is occurring. Our models include landowners who have participated in timber markets as well as those who have not.

(4) The reservation price information for land conversion derived from this research could be linked to carbon yield models to estimate the cost of attaining various carbon targets.

(5) The effect of payment structure (e.g., offering lump-sum versus periodic payments) on the performance of land set-aside programs could be assessed. The CRP program involves annual payments; however, landowners in this study were less certain about accepting annual bids for land shifting than they were a single lump-sum payment.

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