

**Non-industrial Landowners, the Incentive to Forego Harvesting,
and the Importance of Scale of Activities**

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Abstract

Despite all that has been written regarding NIPF landowners, there have not been any studies providing a clear examination of willingness to harvest using a range of harvesting prices. An interesting problem that has not been previously examined is the determination of the relationship between the decision to harvest and the characteristics of owners and their land, such as preferences, landowner type (absentee vs. resident), site qualities, that function in determining potential scale of harvesting activities. This study examines which of these characteristics are important in landowner decisions regarding timber harvesting. Landowner access to land and preferences regarding land use are important in the decision to forego harvesting, while landowner type (absentee vs. resident), access to land, and preferences regarding land use are important in determining scale activities.

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I. Introduction

Non-industrial private forest (NIPF) lands have always been an important provider of the nations timber. NIPF lands are an especially important future timber supply source as a result of the continuing decline in harvesting on government lands and relatively stable harvesting levels on industrial timberlands (Argow 1996). This is also supported by the projection that NIPF lands will supply approximately 60% of the harvested timber volume by 2040 (Hulkrantz 1992). Due to the increasing importance of these lands to timber supply, many studies have examined the harvesting behaviors of NIPF landowners (e.g., Dennis 1989, 1990, Hulkrantz 1992, Hyberg and Holthausen 1989, Koskela 1989, Kuuluvainen et al. 1996).

NIPF lands are defined as parcels with owners that do not possess or operate wood processing facilities (Bliss et al. 1997). Private ownerships, i.e. individuals, partnerships, estates, corporations, clubs, associations, and Indian tribes, account for 73% of timberland and 58% of forestland nationwide (Birch 1996). Within this breakdown of forested land nationwide, the Southern region of the United States accounts for the highest share of NIPF timberland (40%)(Alig and Wear 1992). NIPF lands in the Southeastern United States (Georgia, Florida, North Carolina, South Carolina, Virginia) have recently come under increasing harvesting pressures, as a result of decreased timber availability in other regions (Newman and Wear 1993), and are the focus of many timber supply studies. Also, NIPF lands account for 70% of the 200 million acres of forestland in the Southeastern states (Brunson et al. 1996). In Virginia alone, approximately 15.5 million acres of land are forested, with approximately 77% of these forested lands owned by NIPF landowners (Shaffer and Meade 1997). Similarly, approximately 75% of the timber for forest industries in Virginia is supplied by NIPF lands (Birch et al.1998). The forest industry is one of the primary manufacturers in the state (Hodge and Southard 1992).

Many existing studies of NIPF lands have been initiated for purposes of examining potential landowner participation in federal assistance programs, future timber supply from NIPF lands, and quantifying the gap in harvesting between private and industry lands. Previous studies of NIPF lands follow a general progression in study topics, depending on the policy objectives of the time. The determinants of landowner harvesting behavior and the reforestation investment behavior of landowners were examined in early NIPF studies. These studies generally looked at a few characteristics of landowners, generally demographic characteristics, such as income and occupation, and their affect on harvesting/reforestation practices (Alig et al. 1990). With the

increase in scope of government programs, emphasis was placed on the participation of landowners in reforestation/cost share programs (e.g., Doolittle and Straka 1987, Royer 1987, Romm et al. 1987) or the timber/land bequest decisions of landowners (Hulkrantz 1992). The prevailing assumption in studies examining behavior is that NIPF landowners maximize utility in the determination of timber harvesting activities (Hartman 1976, Hyberg and Holthausen 1989).

Despite all that has been written regarding NIPF landowners, there have not been any studies providing a clear examination of willingness to harvest using a range of harvesting prices. Previous studies focus only on the behavior of landowners that have either harvested or plan to do so in the future (e.g., Greene & Blatner 1986, Dennis 1989, Kuuluvainen et al. 1996). An interesting problem that has not been previously examined is the determination of the relationship between the decision to forego harvesting and a combination of characteristics of owners and their land, such as preferences, landowner type (absentee vs. resident), access to land, that function in determining potential scale of harvesting activities. The purpose of this study is to examine which, if any, of these characteristics are important in landowner decisions regarding timber harvesting. The results will be useful in understanding the effect that changes in market parameters and government policies have on the harvesting decisions of landowners. The results will also guide in designing future policies in order to target those NIPF landowners at the harvesting margin in order to either increase or decrease timber market participation.

Understanding the characteristics of landowners affecting harvesting decisions will have important policy implications. Not only will this study allow for a better evaluation of market trends as land becomes increasingly urbanized and fragmented and individual landowners become an increasingly larger supplier for the market, but it will allow a clearer understanding of the impacts of policies on the forest sector. This awareness can be used in the creation of policies ranging from supply of the timber industry, or for uses of forestland for investment purposes such as the development of carbon sequestration incentives for other industries.

Specifically, this study attempts to determine NIPF owners' willingness to accept payments to enter the harvesting market. In calculating the willingness to harvest, a reservation price is revealed for each landowner. The reservation price is individual-specific and is defined as the price above which a decision maker becomes a willing market participant. The concept of reservation prices is largely theoretical (e.g., see Brazee and Mendelson 1988 and Fina et al.

2001 for a recent review). This study is among the first to determine bounds on the prices that both encourage landowners to harvest, and affect the scale of activities.

Investigation of these aspects of landowner behavior has not been previously examined.¹ Previous literature has largely focused on observed behavior of NIPF landowners (Appendix A, Table 1). Birch (1994), Birch et al. (1998), and Hodge and Southard (1992) examined the harvesting behavior of Virginia landowners. The opinions of NIPF landowners and the general public were compared in studies performed by Bourke and Luloff (1994), Bliss et al. (1997), and Jones et al. (1997). These studies found that NIPF landowners and the general public agree on many facets regarding forest management practices, contrary to what was previously thought. Other studies, e.g., Hardie and Parks (1996), Bell et al. (1994), Argow (1996) have examined the effectiveness of cost share programs or potential entry into these programs by NIPF landowners. NIPF landowner behavior is modeled in studies of Doolittle and Straka (1987), Brockett and Gebhard (1999), Greene and Blatner (1986), Romm et al. (1987), Kuuluvainen et al. (1996), Royer (1987), and Egan et al. (2001). The studies by Dennis (1989, 1990), Hulkrantz (1992), Koskela (1989), Newman and Wear (1993), and Hyberg and Holthausen (1989) examine timber-harvesting behavior, in particular. These studies all concentrate on modeling past landowner behavior and do not consider the potential market entry of landowners who have either not ever harvested or have not harvested recently.

Timber harvesting behavior is generally modeled using time series data, cross-sectional data (Dennis 1989, 1990), or a combination of the two (Alig 1986), and by generalizing NIPF landowner behavior either for purposes of profit maximization or utility maximization (Hyberg and Holthausen 1989). In the examination of behavior of NIPF landowners as potential timber suppliers, most researchers employ functions that assume behavior is based on a profit maximization problem, where amenity values of the landowner are not explicitly taken into account. Studies that do consider amenity values as an influence in the timber harvesting decision do not consider the non-separability of this decision and others in landowner utility maximization.

There is also considerable variation in data used among NIPF studies. Samples of landowners used in studies may be biased as often landowners surveyed have had previous

¹ Alig et al. (1990) did suggest, upon review of NIPF literature, that a clearer understanding of the relationships of landowner management decisions regarding planting, stand treatments, and harvesting was still needed.

contact with some aspect of forestry and thus may have positive attitudes regarding forestry practices. For instance, samples of landowners for some studies (e.g., Alig 1986, Brocket and Gebhard 1999, Doolittle and Straka 1987) are collected for land that is part of a current government program or recent forest survey, thus these landowners have some previous contact with an aspect of forest management. A study by Alig et al. (1990) suggests that studying landowners who indicate previous contact with foresters may increase harvesting probability estimations. Some studies are limited by concentrating on single species (e.g., Newman and Wear 1993, Royer 1987); thus, the affects of policies can only be determined for a single portion of the market. Another variation among studies is the broad definition of acreages that are receptive to policy changes. Bell et al. (1994) concentrates on NIPF ownership of 100 or more acres, Royer (1987) considers those landowners with 10 or more acres, and Johnson et al. (1997) evaluate owners of one acre or more. This can present obstacles in policy formation, as landowners holding various size forests may respond differently to market shocks or government policies as was found in the comparison of large and small-tract landowners by Conway (1998).

As previously stated, prior studies also fall into one of two categories regarding NIPF landowner behavior (Alig et al. 1990). Landowners are either assumed to make decisions that maximize utility, or they are assumed to maximize net present value of their forest investment. The characteristics of these landowners that lead to trade-offs of non-timber benefits with harvesting behavior is rarely evaluated. Exceptions are Conway (1998), Kline et al. (2000), and Pattanayak et al. (2002). While these studies evaluate the characteristics of NIPF landowners that are important to such trade-offs, none have determined the margin for timber market entry based on these characteristics, as is done here.

The primary objective of this study is to identify owner and land characteristics associated with willingness to forego harvesting and the potential scale of activities for landowners indicating a willingness to harvest. Specifically, the objective is to examine the prices that a landowner is willing to accept in order to harvest. By providing a variety of harvesting prices and allowing the landowner's to specify their certainty regarding each price, the margin at which a landowner is willing to harvest can be estimated. Previous studies only examine previous harvesting behavior of landowners or study landowner behavior based on current market prices.

The remainder of this thesis will proceed as follows. Section II contains a summarization of the data collection procedures. A discussion of the general descriptive statistics of important variables in the analysis is included in Section III. In Section IV, the econometric model is presented. Highlights include the use of a basic random utility model to motivate decisions to forego harvesting, as well as potential scale of harvesting activities. Sections V and VI contain the results for landowner willingness to forego harvesting model and the model of scale of activities for landowners indicating a willingness to harvest, respectively. Lastly, concluding remarks regarding these two decisions are offered along with policy implications.

II. Data collection and survey design

A mail survey of landowners was initiated in the fall of 2000 and spring of 2001. The intent of the survey was to obtain data from forest landowners in Southwestern Virginia. Counties sampled included Giles, Montgomery, Pulaski, and Roanoke. An initial pretest of the survey was performed on 75 of landowners from Montgomery County (e.g., see Kennedy 2001). The full survey was then mailed in August 2000, followed by reminder postcards, and the same procedure was followed in April 2001. The survey question design, mailing, and follow-up procedure followed Dillman (1978).

The fall 2000 sample consisted of 1240 mailed surveys. Of those, 223 landowners were surveyed in Giles, 620 in Montgomery, 142 in Pulaski, and 255 in Roanoke County. The number of landowners surveyed was based on a combination of county size, number of landowners in each county, and number of parcels. County tax records were used to obtain essential data (i.e., name, address, and parcel size) from each of the previously mentioned counties. Landowners selected did not include corporate landowners or those holding less than 20 acres, in order to avoid a large percentage of residential landowners. The selection of landowners for the study was based on a random sample from filtered county tax records. In order to gain an accurate evaluation of individual landowners in these counties, the random sampling was designed to avoid repetitive samples of any one individual landowner/tract. The spring 2001 sampling was performed in order to provide a broader sample of landowner data. The second sampling included another 478 landowners in Montgomery County that had not been previously surveyed.

The response rate for the initial pretest was 38% (Kennedy 2001) and the response rate for the fall 2000, removing landowners erroneously surveyed repeatedly, was 34% (Kennedy

2001). The response rate for the spring 2001 was 31.13%, resulting from a return of 141 surveys of 453 usable surveys (478 minus 25 undeliverable). These response rates are consistent with others in the region (Conway 1998, Hodge and Southard 1992).

The survey instrument (Appendix B) consisted of 31 questions, with most questions offering discrete choices (yes or no) to allow for relative ease of completion (Dillman 1978). Access to land was evaluated using questions regarding the surveyed property such as an assessment of the general terrain, the existence of permanent structures, an estimate of the existing miles of roads, and residence on property. Landowner preferences were assessed using a variety of questions. Preferences were evaluated by ascertaining the level of the importance of various reasons for owning land, such as, environmental reasons, to keep for future generations, scenic beauty, income from timber production, land investment/real estate, recreation, and primary residence. The assessment of landowner preferences also included evaluations of the future intentions of landowners for land and trees. Landowners were also asked to rate the degree of risk associated with growing trees as opposed to typical investments and the degree of risk associated with timber loss as a result of natural occurrences. A determination of the type of landowner was evaluated using questions regarding the number of years the landowner has owned the property, whether the landowner's primary residence was on the property, and the distance of the primary residence to the property. The survey included questions evaluating the amount of time the landowner spent in individual recreational activities on their property. General demographics, such as, the number of children, income, and education level of each landowner were also ascertained in the survey.

The main objective of the forest survey was to determine the price that an individual landowner would be willing to harvest by evaluating their willingness to accept a payment for harvesting a hypothetical acre of forest. The procedure for eliciting these responses adhered to the "payment table approach" of Welsh and Poe (1998). The payment table question (Appendix B, question 10) followed the multiple bounded discrete choice format and required landowners to determine the price per acre that they would be willing to harvest. The landowner was given a range of per acre dollar value options for harvesting that they could select from among the choices of 'definitely not', 'probably not', 'not sure', 'probably yes', and 'definitely yes' in regards to harvesting one acre of mature trees. This format provides an advantage over other widely used methods of contingent valuation in analyzing future policy implications in that it

allowed for an assessment of individual landowner certainty with regards to harvesting at various prices (Welsh and Poe 1998). The per acre dollar value ranges for harvesting in the payment table were approximated from information gathered on the previous year's (1999) stumpage prices published for Virginia in Timber Mart-South. The average price for an acre of timber was calculated using stumpage prices from Timber Mart-South and standard yield tables for the respective survey area. The range of dollar values for harvesting an acre was then calculated using a logarithmic distribution from the average price for an acre of timber. If the landowner selected a price at which they would agree to harvest by indicating either 'probably yes' or 'definitely yes', they were considered willing to harvest. A no answer option was provided when eliciting responses for the harvesting decisions with inclusion of the 'not sure' option in the payment table.

Landowner's selecting either 'probably yes' or 'definitely yes' for any of the harvesting prices provided in the payment table were then prompted to select a level of harvesting that would be considered for their hypothetical acre. Landowners were asked to indicate how much of their forest on their property they would consider harvesting and were given the options of 25%, 50%, all, or other, for both the lowest and highest price that they selected either the 'probably yes' or 'definitely yes' option in the payment table. Landowners could also select the option of "I will never harvest my forest no matter what", which will be referred to further on in this analysis as the willingness to forego harvesting. Other characteristics (Table 1) of landowners with potential for harvesting activities or indicating a willingness to forego harvesting are discussed further in the next section.

III. Definition of variables and descriptive statistics

III.1. Defining variables

A variety of land and owner characteristics were evaluated to determine their effect on landowner willingness to forego harvesting and scale of harvesting activities (Table 1). Transformations of some variables were performed in order to improve model estimation. Income of landowners was assessed using a list ranging from less than \$10,000 to \$200,000 or greater, by \$10,000 increments. In order to establish an accurate assessment of income, the midpoints of these levels were used to create a list of new income variables, which were then combined to create an average income variable. The creation of this variable assures that income is not endogenous to any of the models.

A variable was created to indicate absentee landowners. Absentee landowners do not permanently reside on their forestland and are thought to have decreased access to local assistance and information regarding forest management (Shaffer and Meade 1997). A landowner was considered absentee if their main residence was more than fifty miles from the surveyed property, which is a definition corresponding to previous studies (e.g., Conway 1998, Schaffer and Meade 1997).

Using an assessment of the number of days a landowner spent hunting on their property, a dummy variable was created as an instrument for removing this potentially endogenous variable from the right hand side of the models. The dummy variable was assigned a value equal to one if the landowner indicated any time spent hunting on the land within the last year, and a value of zero otherwise. As the original assessment of time spent hunting on property by the landowner is a decision, it was thought that it might be endogenous to the models. A test was performed in order to determine if the original variable indicating number of days spent hunting on the property was endogenous to the model of landowner willingness to forego harvesting and will be discussed further in Section IV.1.

The prices that landowners selected ‘probably yes,’ ‘definitely yes,’ or ‘either’ of the aforementioned choices from the payment table (Appendix B, question 10), were also potentially endogenous decision variables. A two stage least squares process was therefore used to predict the chosen prices for the categories of ‘probably yes’, ‘definitely yes’, or ‘either’, prior to estimating the harvesting scale models. Harvesting scales were then used as the dependent variables in the second stage logit estimations of the potential scale of entry for landowners who are willing, with the predicted price variables (Table 2) included among the independent variables.

III.2. General descriptive statistics

The average landowner (Table 2) in this study exhibits similar characteristics to those found in previous analyses of Virginia landowners (e.g., Hodge and Southard 1992, Birch 1994, Conway 1998). The characteristics of the responding landowners will be divided into four categories, as some of these categories will be used later.

III.2.A. Demographics

The average age of landowners surveyed was 59.7 years, with a standard deviation of 13.2. This is consistent with a survey performed by Conway (1998) that found an average age of

60, and similar to a study performed by Hodge and Southard (1992), where those landowners aged 60 or older accounted for 50% of respondents. A majority of landowners responding to the survey were employed (53%), while the other portion was made up mostly of retirees (44.9%). The proportion of retired respondents was the same as found by Hodge and Southard (1992), while the percent of employed landowners and percentage of married landowners (80%) were consistent with Conway (1998).

Of the responding landowners, a high percentage, 55%, completed college, while 19.5% completed some college, and 17% completed high school. The education level of respondents is higher than that of Hodge and Southard (1992), where 35% of respondents had completed some college or college and 25% of respondents had completed postgraduate degrees. An increase in education level is believed to increase response rate, thus the high percentage of college graduates was expected.

Acquisition of land is thought to influence the harvesting decision. Landowners who inherited their land represented 27.7% of the respondents, while 76% purchased their property. These land acquisition percentages correspond to those found by Conway (1998). Note that these percentages add to more than 100% as landowners could have inherited some of the surveyed property and bought adjacent parcels. The average landowner surveyed owned 64.7 acres of forestland, 34.6 acres of agricultural land, 6.9 acres of open land, and 1.4 acres of other land, i.e. garden, river, pond, residence. The average forested tract size is smaller than the 125.04 acres reported by Conway (1998), but is larger than the 29 acres reported by Birch (1996). Landowners with smaller parcels were also the predominant respondents in the Virginia study by Hodge and Southard (1992), with 80% owning 250 acres or less. The concentration of this survey on one physiographic region could account for the deviation in forestland tract size found in this study from that found in previous Virginia landowner studies.

Average length of ownership for those sampled is 30.5 years. This varies from the 43% of landowners, reported for the Southern United States, that had owned land for 16 years or less (Birch 1996). Average length of ownership found in this study corresponds with a study of Oregon and Washington landowners reporting a 27-year average length of ownership (Johnson et al. 1996). The mean income of the landowners sampled was \$80,644.95. Although smaller than the average income of \$91,142.19 obtained by Conway (1998), the mean income in this study is

higher than the mean value (\$52,750) calculated from the data obtained by Hodge (Birch et al. 1998).

III.2.B. Landowner preferences

The preferences of landowners regarding the past use of trees, future intentions regarding trees and land, reasons for having land, and risk associated with trees and timber, are considered important in evaluating landowner behavior. Both Conway (1998) and Pattanayak et al. (2002) have indicated that such characteristics are important in determining the production of timber and non-timber amenities by non-industrial owners.

Bequest motives are thought to play an important role in the management of land (Hulkrantz 1992, Amacher et al. 2002). The majority of landowners surveyed, 74%, plan to leave their land to heirs, implying that landowners will generally avoid any harvesting activities. While only 39% of landowners have future plans to bequeath timber on their land to heirs. The aforementioned results can be compared to the 53% (Conway 1998) of landowners with intentions to leave land/trees to heirs.

Approximately 21% of landowners never plan to harvest their timber in the future. This percentage is smaller than the 59% returned by Hodge and Southard (1992) and the 38% of Birch et al. (1996). Similarly, the 26% of landowners who have previously sold timber in this study is small compared with the 62% found by Conway (1998) and the 56% found by Hodge and Southard (1992). However, the variation in previous timber harvesting experience between surveys could be a result of question interpretation, as the question was directed based on previous sale of timber in this study, which may not be synonymous with “timber harvesting” as specified in other studies.

Landowners in this survey sample perceive a low degree of risk when it comes to comparing growing trees to other investment opportunities. The mean score, with 1 being the least risk and 5 being the most risk, was 2.4 with a standard deviation of 1.1. Similarly, landowners perceive the degree of risk associated with losing timber to natural causes as neutral, with a score of 2.9 and a standard deviation of 1. Landowners in this study are more risk neutral than landowners in other Virginia studies; this may be a result of greater familiarity with land as a result of smaller forested acres when compared with previous Virginia landowner studies.

Landowner motives can be evaluated by determining the importance of reasons for ownership. Landowners consider that owning land to keep for future generations is relatively

important with a mean score of 4 and a standard deviation of 1.3. This reinforces the notion that bequest motives are strong among forest landowners. The importance of environmental reasons to landowners in this study, e.g., protection of habitat, water quality, and protection against soil erosion, had a mean score of 3.7 and a standard deviation of 1.3. This corresponds with results of Brunson et al. (1996), where respondents rated the reasons of providing wildlife habitat, preserving natural beauty, personal recreation, and satisfaction of owning land highest (in descending order) as important for owning forestland. The motivations of land investment/real estate for holding land are also found to be somewhat important to this sample of landowners, although not as important as environmental reasons, with a score of 3.3 and a standard deviation of 1.5. A low value of importance attached to land investment is typical for Virginia forest landowners; Birch (1996) found that 12% of landowners considered land investment a primary reason for owning land. It should be noted that the importance of owning land for purposes of land investment is not included as a preference variable in future sections of this analysis.

III.2.C. Access

Absentee landowners accounted for approximately 16% of the respondents. The percentage of absentee owners is similar to, but slightly under Conway's (1998) 22%, but is the same as that predicted by Schaffer and Meade (1997). Landowners were considered to have improved access to local education and assistance programs regarding land management if they resided on or within 50 miles of their forestland. Thus, 88% of the landowners had improved access to their land, with 48% actually residing on the surveyed property.

The landowners in this survey classified the general property terrain as rolling hills or steep and mountainous (55% and 54% respectively²). This type of terrain is thought to impede access to timber resources of the land and possibly prevent management activities such as harvesting. The average length of dirt/paved roads on properties sampled was 0.99 miles with a standard deviation of 1.83. Average road length is smaller than the 1.86 miles indicated by Conway (1998), but the sample region in this study is less affected by urban sprawl than the counties sampled in Conway's study. Access to the land also improves with the presence of permanent structures on the property as familiarity with the landscape is thought to benefit

² Landowners were not specifically asked to check only one terrain type, therefore these percentages are a result of multiple selections of terrain descriptors.

access. Existing structures (house, barn, other) were present on 72.5% of the surveyed properties.

In summary, the average responding forest landowner in the counties of Montgomery, Giles, Pulaski, and Roanoke surveyed in 2000 and 2001 was 59.7 years old and an employed, married, college graduate who purchased their property about 38 years ago and lives on the surveyed property. The average parcel owned is comprised of 64.7 forested acres, 6.9 agricultural acres, and a permanent structure, with 0.99 miles of roads situated on steep and mountainous terrain. Typical landowners have land bequest motives and are risk neutral regarding timber investment and tree loss. Landowners also consider it fairly important to own land to keep for future generations and for environmental reasons.

VI. Econometric model

In this section, a model is described to analyze land use and harvesting decisions of a representative forest landowner. The model will show how preferences and amenities on both forest and agricultural land are important in the realization of a reservation price.

The idea of an economic margin across different land uses and activities is central to understanding reservation prices and landowner market entry. Therefore, the objective of the model must be to explain how forestland use depends on the margins defining returns across various uses and differences in land quality, and how amenities of forest stock and agricultural production are important to these margins. The decisions made regarding land use ultimately define the reservation prices for forest harvesting and land set aside.

Model assumptions include the presence of a single landowner holding land of varying quality. Once a landowner chooses forest production, he/she harvests and replants rotations ad infinitum. Exogenous market parameters, such as interest rates are assumed constant over time for the empirical estimations, and as a result rotation age for land devoted to forest production is constant for all rotations, *ceteris paribus*. Land quality differences create margins between alternative land uses, and the landowner will choose uses to maximize the current and future rents on every hectare. These margins are explicitly defined by the preferences that landowners obtain from either agriculture or forestry and market parameters. For example, a landowner with high quality land is more likely to engage in a high valued land use such as agriculture, while a landowner with lower quality land is more likely to engage in forest production or abandon land. This assumes the rent curve describing the value to the landowner of different competing land

uses is of a certain form, i.e., constantly declining in value as the quality of land decreases. Preferences for amenities, and even the landowner's financial asset situation, can change this rent distribution, as will be shown below.

The landowner's objective function is:

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

where A= agricultural land; F= forestland; G= abandoned land³; T is the rotation age; c is the per hectare planting cost; B_f(.) represents amenity benefits from holding unharvested forest stocks. This amenity function could be defined either as a function of hectares devoted to forest production and time, or simply as a function of forest stock, since stock, y(t), is only a function of time. In other words, it is possible to write B_f(y(t),x)=B_f(t,x), where x is a variable of integration over land quality and represents hectares of various land quality devoted to different uses (given by the limits of integration). In the above equation p is the timber stumpage price; w(.) is the per hectare production land rent to the alternative use⁴; B_a(.) represents calendar time benefits (amenities) from holding agricultural land that are not related to income production; and y(t) is the per hectare timber volume function.

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., Parks et al. 1998, Brazee and Amacher 2000), but it is modified to include preferences for amenities. These preferences are consistent with empirical studies of NIPF landowners, and their presence suggests that payments for land set aside or conversion from one type of land use to another cannot simply be defined by the lost productive returns. Finally, it is assumed that the representative landowner's total land holdings equal Z=A+F+G.

The objective function assumes that the marginal net returns of increasing land quality are higher for the high-valued (agricultural) use. In other words, the rent gradient is steeper over land quality for the alternative use when compared to the rent gradient for forest production. This assumption ensures that the alternative use is higher-valued than forest production on land of higher quality, which is consistent with observed land use patterns.

³ Assumes abandoning land is costless.

⁴ w(.) is the net present value from a perpetual stream of rents. It is also possible to write R(./)r, where R represents the per hectare annual land rents that accrue from the alternative use.

Using the total landholdings constraint and assuming nonnegativity constraints for the land uses A, F, G, the Lagrangian can be written as⁵,

$$L(A, F, G, \mathbf{I}) = \int_0^A [w(x) + \int_0^\infty B_a(x, t)e^{-rs} ds] dx + \int_A^{A+F} \left[\frac{e^{-rT} py(T, x) - c}{(1 - e^{-rT})} + \int_0^T \frac{B_f(x, t)e^{-rt}}{(1 - e^{-rt})} ds \right] dx + \int_{Z-G}^Z 0 dx + \mathbf{I} [Z - A - F - G] + \mathbf{a}A + \mathbf{b}F + \mathbf{g}G \quad (1)$$

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

Note that it is possible to simplify rents due to agricultural amenities, since this can be assumed constant over time, i.e., it does not depend on any specific level of resource stock as does the forest amenity function $B_f(\cdot)$. Thus, it can be written more formally,

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

The presence of agricultural amenities is consistent with a landowner who may attach non-production values to farming, such as leaving the family farm in agricultural production for heirs.

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

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

$$L_F(A, F, G, N, T, \mathbf{I}) = \frac{e^{-rT} py(T, A + F) - c}{(1 - e^{-rT})} + \int_0^T B_f(A + F, t)e^{-rs} ds - \mathbf{I} + \mathbf{b} = 0 \quad (4)$$

$$L_G(A, F, G, N, T, \mathbf{I}) = -\mathbf{I} + \mathbf{g} = 0 \quad (5)$$

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

$$L_I(A, F, G, N, T, \mathbf{I}) = Z - A - F - G = 0; \quad (7)$$

⁵ 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.

$$\mathbf{a}A = 0; \quad \mathbf{b}F = 0; \quad \mathbf{g}G = 0; \quad \mathbf{h}N = 0. \quad (8)$$

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 forest production, keeping in mind that this rent includes both merchantable timber value and amenities of not harvesting and holding the stock on a certain number of hectares devoted to forest production. The differences in agricultural and non-timber amenities are important in the 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 conditions⁶. Condition (5) implies that the landowner shifts hectares into forest production until marginal land rent equals 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 Hartman condition (Hartman 1976). Finally, conditions (7) and (8) ensure that nonnegativity and land constraints are satisfied.

There is one type of reservation price embodied in this theory – this is the minimum price a landowner will be willing to accept to harvest mature forests from hectares devoted to forest production. This must be derived from examining conditions under which a positive rotation age is an interior solution to the above problem, i.e. using (6)

$$T > 0 \Leftrightarrow \frac{e^{-rT}}{(1 - e^{-rT})^2} \int_A^{A+F} (py_T(T, x)(1 - e^{-rT}) - rpy(T, x) + rc + B_f(x, T)e^{-rT}) dx \geq 0, \quad \text{or}$$

$$p^* \geq \frac{-B_f(x, T)e^{-rT}}{y_T(T, x)(1 - e^{-rT}) - ry(T, x)} \quad \text{for } x \in [A, A + F] \quad (9)$$

where the denominator of the RHS is nonpositive if $r > 0$. The reservation price, p^* , 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.

Solving the first order conditions of (1) gives the optimal allocation of land and a prediction of forest volume to be harvested. The prediction of forest volume can be related to the determination of harvesting scale. Hectares in idle production are implicitly assumed to not generate income or produce amenities. The above interpretations would continue to hold if this

was not the case, but there would be slight modifications because rents to idle land would need to be added in (5) (e.g., these rents would take the form of (2)). Then to ensure the landowner held land in forest production, the net rents to having hectares in forest production would need to be at least as great as the rents accruing to idle land. The theoretical model can be refined using results of the empirical model estimations.

V. Estimation results

Estimation was performed for both willingness to harvest at various prices in the payment table, and the level of harvesting decisions. The willingness to harvesting was modeled as an ordinary logit model, while the harvesting scale decisions were modeled using the two-stage least squares (2SLS) process. This process was used in estimating the harvesting scale decisions in order to ensure that the first price a landowner selected either ‘probably yes’ or ‘definitely yes’ to harvest were exogenous. This process was not used for the willingness to forego harvesting model as an endogeneity test (Section IV.1.A) was performed and there were not any variables determined to be endogenous.

V.1. Willingness to forego harvesting estimation results

With the rejection of missing data, there were 215 observations used in the estimation of willingness to forego harvesting. The chi-square value for the regression was 63.68, which suggests that it was statistically significant. There were ten significant variables with a p-value less than 15% (Table 3). The variable describing landowner bequest motivation regarding timber on their land is significant at the 10% level. The positive coefficient for those landowners with intentions to leave their trees to heirs suggests that people exhibiting this characteristic are more willing to forego harvesting. However, landowners who acquired their land through inheritance are less likely to forego harvesting, indicated by the negative coefficient for this variable that is significant at the 15% level.

The variable for roads is significant at the 5% level. This suggests that the miles of roads on a landowner’s property play a part in the decision to forego harvesting. The small positive coefficient is somewhat counterintuitive. Access via existing roads is thought to increase timber management activities, but this estimation suggests that landowners with roads present on their

⁶ One could easily alter the amenity function so that the stock of forest was important, i.e., by specifying the B(.) function as B(x,y(t)). It can be shown that the model above and results generally continue to hold, and forest amenities which are either decreasing, increasing, or a complex function, of the forest stock.

property may be less receptive to timber harvesting. However, increased access to land may contribute to a landowner's involvement in recreational activities, and thus values for land amenities may have a greater influence on the harvesting decisions of these landowners. The sign of the coefficient for the variable regarding miles of roads corresponds to the negative coefficient significant at the 5% level for the first price that a landowner selected 'definitely yes' at the 100% harvesting level.

The variable for perceived degree of risk associated with timber loss due to natural causes has the expected sign and is significant at the 5% level. A negative coefficient for risk is expected, i.e. landowners who associate a high degree of risk with timber management will enter into the harvesting market sooner or at lower timber prices than landowners associating a lower degree of risk with timber management. The variable regarding the number of forested acres also has a negative coefficient and is significant at the 15% level. Similarly, Kline et al. (2000) found a negative coefficient for the variable representing total forested area owned in the evaluation of landowner willingness to forego harvesting over a ten-year period. The variable indicating an employed landowner increases the willingness to harvesting, as shown by the positive coefficient at the 5% significance level. Studies by both Dennis (1989) and Hyberg and Holthausen (1989) indicate that a higher alternate (from timber production) income decreases the need to generate income from timber harvesting. The variable accounting for amenity values associated with days spent hunting has the expected sign and is significant at the 5% level. A negative coefficient for this variable is expected, as those who spend time hunting on their land are more likely to enter the harvesting market in order to maintain or increase wildlife habitat through forest management activities.

The landowner preference variables are all statistically significant in the determination of landowner willingness to forego harvesting. The preference of owning land for environmental reasons is significant at the 15% level and has a positive coefficient as expected. Likewise, Kline et al. (2000) found that owners with multiple objectives regarding their land were willing to accept payments to forego harvesting for ten years. The preference variable regarding the importance of keeping land for future generations has a negative coefficient at the 5% significance level. Although the sign for the coefficient on the variable describing the importance of keeping land for future generations is not what might be expected, it is reasonable. Landowners who perceive importance in keeping land for future generations may also consider

themselves as land stewards, thus increasing their willingness to harvest for the purpose of land management. The variable depicting landowner preferences regarding land/real estate investment also has a negative coefficient and is significant at the 15% level. This corresponds to the thought that landowners who hold land for income purposes want to maximize their investment (Nagabudi et al. 1996) and thus are more willing to harvest timber in order to fulfill this motivation.

V.1.A. Endogeneity test results for the willingness to forego harvesting model

A test was performed on the model of willingness to forego harvesting to determine if any of the independent variables used for assessment of landowner amenity values were endogenous. The independent variables of particular concern included the assessment by the landowner of time spent involved in recreational activities. The recreational activities (Appendix B, question 16) were classified either as non-consumptive (all activities apart from hunting) activities, or as hunting, a consumptive activity. The endogeneity test included estimating the original logit model (including all variables), retaining the residuals from this estimation, and then performing a regression of these residuals on independent variables. The null hypothesis is that the independent variables are not significant in the regression of residuals and therefore are not endogenous to the model.

The null hypothesis is accepted for the non-consumptive and consumptive recreation activities used in the assessment of landowner amenity values in the willingness to forego harvesting model (Table 4). It was also determined by this test that there were no endogenous variables in this model. However, a dummy variable for the decision by a landowner to spend time hunting was employed in the estimation of willingness to forego harvesting in order to ensure the model could not be affected by the potential endogeneity of this decision.

V.1.B. Hypothesis testing for estimation of willingness to forego harvesting

Groups of variables were dropped from the willingness to forego harvesting model in order to determine their relative importance to the estimation results. These groups were classified as access, preference, and landowner type, and included those variables listed under similar headings in Section III.2.A–C. Landowner type, not listed as a heading in Section III.2, included the variables describing absentee and resident landowners, as well as, the variable accounting for the number of years the property has been in the current landowner's possession.

The estimation of the willingness to forego harvesting model without landowner type variables was not obtainable due to convergence and thus will not be discussed further in this section.

The null hypothesis for the hypothesis tests was that the model did not change as a result of the absence of variables. The hypothesis testing was performed using a likelihood ratio test. The likelihood ratio test is based on the idea that if the presence of the variables (restricted model) is indeed important to the outcome of the model then the likelihood functions would not differ significantly from that of the model with the dropped variables (unrestricted model) (Kmenta, 1986). The degrees of freedom for this test are the difference in number of restrictions between the restricted and unrestricted models.

The estimation of the willingness to forego market entry model without access and landowner preference variables was successful (Table 5). The null hypothesis that the model did not change with dropped variables is rejected at a significance level of 0.01 for both of the unrestricted models. As a result, access and preference variables are both indicated as influential in the determination of landowner willingness to forego harvesting. This reinforces the significance of the preference variables in the original estimation of the model and indicates the importance of the access variables as influential in the overall estimations. In fact, from the results of the likelihood ratio test, landowner preference variables are the most important of the variable groups dropped to the estimation of willingness to forego harvesting. Also, the importance of the preference and access variables in the willingness to forego harvesting model coincides with the non-separability of decision making as suggested by Conway (1998) and Pattanayak (2002).

V.1.C. Marginal effects of willingness to forego harvesting

Marginal effects are defined as the change in the probability of the decision with respect to a unit change in an explanatory variable and are similar to elasticities for continuous dependent variable models (Greene 1996). For instance, a landowner with the intention of leaving land to future heirs is 7% more willing to forego market entry (Table 6). This corresponds with the results of Hodge and Southard (1992) where the idea that landowners were saving the land for their heirs was among the primary reasons given for not harvesting. Similarly, a landowner indicating the presence of roads on their property is 4% more willing to forego harvesting. Those landowners who view that it is important to own land for environmental reasons have a 2.5% greater chance of indicating a willingness to forego market

entry than those who believe otherwise. Such amenity values associated with land ownership have been linked to an increase in time between harvests by Newman and Wear (1993). Also, employed landowners are 12% more likely to forego harvesting than those without employment.

Those landowners who perceive some risk associated with losing timber to natural causes are approximately 5% less willing to forego harvesting. This corresponds to the increased likelihood of harvesting behavior for risk perceiving landowners found by Conway (1998). A landowner acquiring land through inheritance is 8.6% less willing to forego harvesting. Similarly, landowners who view importance in owning land for future generations are also about 5% more likely to enter the harvesting market. Hunting decreases a landowner's probability of indicating a willingness to forego harvesting by 11%. This is supported by the study by Kuuluvainen et al. (1996) who found that owners valuing both monetary and nonmonetary benefits of land harvested more than other groups. Those landowners who view land investment as an important reason for owning land are approximately 2% less willing to forego harvesting. Lastly, a landowner with an increased number of forested acres is 1% less likely to indicate a willingness to forego harvesting. The positive influence of larger tract size on harvesting has been documented by Alig et al. (1990) and Hyberg and Holthausen (1989), also Greene and Blatner (1986) found larger tract size to be associated with timber management behavior.

VI. Potential scale of activities for landowners who are willing to harvest

Landowners were determined potentially willing to harvest if they favorably responded, selecting either the choice 'probably yes' or 'definitely yes', for any price for harvesting offered in the payment table previously described. The potential scale of harvesting was then determined through an assessment of the area a landowner would be willing to harvest (25%, 50%, all (100%), or other) for the lowest price chosen in the payment table at which the landowner selected either 'probably yes' or 'definitely yes'. The selection of "other" as a harvesting scale level was not modeled due to poor response.

Again, a two-stage instrumental variable approach was used to estimate the potential scale of harvesting, pairing a predicted first price the landowner is willing to harvest and the affirmation decision ('probably yes', 'definitely yes', and 'either'⁷) with each scale of harvesting. Actual regressions of the first price a landowner was willing to accept to undergo harvesting

⁷ This category was created for those individuals selecting either the 'probably yes' or 'definitely yes' affirmation, as some landowners did not indicate an acceptable price for each affirmation.

selections in the payment tables did not perform well as is indicated by F-test results of 0.81, 1.2, 0.83, respectively, and thus will not be discussed further. Price predictions in the first stage governed the number of observations used in the logit models of the degree of harvesting, i.e. all harvesting scale models where the first price a landowner indicated a willingness to harvest with the ‘probably yes’ affirmation have 137 observations. Despite the fact that all of the estimations for the various combinations of affirmation and scale performed well (Tables 7 and 8), only the selection of the 50% harvesting scale for the first price a landowner indicated ‘definitely yes’ and the selection of 100% harvesting scale for the first price a landowner indicated ‘either’ will be discussed further.

VI.1. Choosing the harvesting level of 50% for the first price a landowner was willing to accept for harvesting as indicated by the selection of ‘definitely yes’

There were 112 observations and nine significant variables, excluding the constant, for the selection of the 50% harvesting level for the first price a landowner was willing to accept for harvesting and indicated ‘definitely yes’ (Tables 7 and 8). Income does not have much effect on an individual landowner’s willingness to harvest at the 50% scale, indicated by the very small positive coefficient at the 10% significance level. This corresponds to the thought that income is not the sole determining factor in the harvesting decision (e.g., Kuuluvainen et al. 1996, Conway 1998, Pattanayak et al. 2001).

The variable describing those landowners who previously inherited land has a strong negative influence that is significant at the 5% level for the selection of the 50% level of harvesting at the first price a landowner was willing to accept for harvesting by indicating ‘definitely yes’. This does not correspond with the findings from the model of willingness to forego harvesting, most likely due to the scale of harvesting as is indicated by the coefficient at the 100% harvesting level for the variable describing those landowners who previously inherited land. A negative coefficient at the 1% significance level for the variable indicating the number of children a landowner has, is estimated for landowner’s selecting to harvest at the 50% scale. It could be thought that the presence of children may increase market entry, due to the income generating capabilities of timber harvesting. However, keeping in mind that the average age of landowners is 60, it is reasonable to conclude that the bequest option, i.e. keeping timber to benefit future generations either for financial or esthetic reasons, takes precedence at this scale of harvesting.

The variable accounting for absentee landowners is significant at the 5% level and has the expected sign, corresponding to that found with the willingness to forego harvesting model. A positive coefficient for absentee landowners indicates this characteristic increases the willingness to accept harvesting activities at the 50% level. Shaffer and Meade (1997) suggest such behavior, citing that absentee landowners may be more receptive to forest management. Absenteeism has a consistent positive influence on the acceptance of the 50% harvesting level at the first price a landowner indicated willingness to harvest for all affirmation categories. The variable indicating presence of permanent structures on a landowner's property also increases willingness to accept harvesting activities at the 50% scale and is significant at the 5% level.

Landowners who have previously entered the market are likely to harvest at the 50% level, as is suggested by the positive coefficient for the variable indicating previous timber sale experience. This pattern is consistent with the findings of Bell et al. (1996), where landowners indicating experience with forestry programs were 17.2% more likely to participate in a forest stewardship program. The presence of roads on a landowner's property improves the likelihood a landowner will accept the 50% harvesting level for the first price the landowner is 'definitely' willing to harvest. The variable indicating the miles of roads on a landowner's parcel is positive and significant at the 15% level. The positive coefficient at the 10% significance level for the variable describing a landowner's intention to leave trees to future heirs suggests that plans to bequest trees to future heirs increases a landowner's likelihood of harvesting at the 50% scale. This may seem contradictory to what is expected. However, landowners with timber bequest motives may be more likely to manage timber resources with harvesting levels closer to typical levels of individuals that support growth and health of the forest. Landowners with such motives are also likely to evaluate harvesting decisions differently than those without such motives, as suggested by Hulkrantz (1992).

VI.2. Choosing the harvesting level of 100% for the first price the landowner was willing to accept for harvesting as indicated by selecting 'either'

The selection of the 100% harvesting level for the first price a landowner was willing to accept for harvesting by indicating either 'probably yes' or 'definitely yes' in the payment table resulted in 153 observations. Landowners indicating an acceptable first price for harvesting activities and this combination of certainty levels provided the most observations among the degrees of certainty regarding the selection of a first price the landowner was willing to harvest,

as might be expected. There were seven significant variables for this particular selection of harvesting scale and combination of certainty (Tables 7 and 8).

Absenteeism has a negative coefficient at the 15% significance level for the decision to harvest at the 100% level at the threshold price. This contrasts with the positive effect of absenteeism found in the selection of the 'definitely yes' category and the 50% harvesting scale, but this is probably a result of the scale of harvesting activities. Absentee landowners may be more conscientious of esthetics and thus less likely to harvest all of their timber, supported by the opposition of absentee owners to timber harvesting (Conway 1998) and as previously stated, referenced by Schaffer and Meade (1997). The variable describing bequest motives in terms of intentions to leave land to future heirs also has a negative effect on harvesting activities at the 100% scale. The coefficient for this variable, significant at the 10% level, suggests that those landowners with such motives are not willing to enter the market at such a high scale of harvesting.

However, contradictory to what was found for the 50% harvesting scale, a positive coefficient for the variable indicating a landowner who acquired land via inheritance occurred at the 5% significance level for landowners selecting the 100% harvesting scale for the first price they are willing to harvest. This suggests that those who previously inherited land may be willing to fully enter the market, possibly to maximize profits as they may not have the same amenity values as previous owners, and is reinforced by the positive coefficient for this variable for all affirmations at a 100% harvesting scale. As a result of an increased likelihood of using forestry incentives (Kluender et al. 1996), landowners acquiring land through inheritance might be more willing to harvest at this scale. A positive coefficient is returned for landowners with children. The coefficient is significant at the 5% level, indicating that those landowners who have children may be more likely to manage by harvesting at the 100% scale as opposed to harvesting at the 50% scale. Intuitively, if timber resources are used as an additional source of income for either children or retirement purposes, which might be consistent with the high average age, then a landowner may manage with the intention of maximizing profits, and in doing so would decide to harvest at the 100% scale. This is reaffirmed by the consistent statistical significance of a positive coefficient for landowners with children for all degrees of affirmation at this level of harvesting, and by Romm et al. (1987) who suggested that age

decreased timber investment probabilities (i.e. these owners are probably cashing in their investment).

The variable for the assessment of perceived risk of loss of timber due to natural causes has a negative coefficient and is significant at the 15% level. This does not coincide with what might be expected from the previous results generated in the willingness to forego harvesting model. Also, it is often thought that landowners associating a high degree of risk of timber loss due to natural causes may be more likely to harvest early or at lower prices (Conway 1998). However, the insignificance of either of the variables describing the assessment of perceived risk associated with timber investment and loss in the remaining estimations indicates that risk assessment is not likely to influence the landowner's decision regarding the potential scale of market entry.

The probability of market entry by landowner's willing to harvest at the 100% scale is decreased by the presence of permanent structures as indicated by a negative coefficient significant at the 5% level. This result is intuitive, although it is contrary to what was found for the 50% harvesting scale. For example, it has been suggested by Kuuluvainen et al. (1996) and Newman and Wear (1993) that NIPF landowners have amenity values associated with forest land and thus a conclusion that can be drawn might be such landowners would be less likely to enter all of their timber into the market, but likely to enter the market at lower scales. Land investment motives increase the likelihood that a landowner will enter all of their timber into the market. A positive coefficient for the variable associated with land investment motives is significant at the 5% level and suggests that individuals who place importance on owning land for investment purposes exhibit such behavior. Again, these individuals most likely place a low value on forest amenities and thus enter a market in order to maximize their investment.

VI.3. Hypothesis testing for potential harvesting scale of estimations

As mentioned previously under the willingness to forego harvesting description (Section V.1.B), groups of variables were removed from the potential scale of market entry estimations in order to determine their relevance to the models. The instrumental variable approach was maintained for all scales of harvesting when variables were dropped to perform the tests. The groups of variables removed included those determining access, landowner type, and preference variables. The likelihood ratio test was again used to test the null hypothesis that the model did not change as a result of the lack of restrictions (Table 9).

A rejection of the null hypothesis that the model did not change as a result of the removal of the access variables can be made at the 0.01 level of significance for landowners accepting the 100% harvesting scale at the first price they indicated willingness to harvest by indicating any of the affirmation categories, the 50% scale of harvesting for the first price a landowner indicated willingness to harvest by selecting 'definitely yes' or 'either', and the 25% harvesting scale for the first price a landowner was 'definitely' willing to accept. While the rejection of the null hypothesis regarding removal of access variables can also be made at the 0.05 and 0.1 levels of significance for the selection of the 25% harvesting scale for the first price a landowner indicated willingness to harvest by selecting the 'either' or 'probably yes' affirmation categories, respectively. The inclusion of access at the above combinations of scale and certainty is thus influential in the determination of the potential scale of harvesting activities of an individual landowner. However, the null hypothesis that the model did not change with the removal of access variables does not significantly differ from zero and cannot be rejected for the selection of the 50% harvesting level for the first price for harvest that a landowner was willing to accept by indicating 'probably yes'.

Removal of landowner type variables resulted in a rejection of the null hypothesis at a 0.01 level of significance for the acceptance of the 50% scale of harvesting by a landowner indicating willingness to accept harvesting by selecting a price and any of the affirmations (Table 9). Similarly, rejection of the null hypothesis occurred at the 5% level of significance for the 100% harvesting level for the first price a landowner was willing to accept harvesting indicated by selection of any of the affirmation levels. This suggests that landowner type variables are important to decisions regarding harvesting activities at the higher levels (100% and 50%) of harvesting. The null hypothesis cannot be rejected when landowner type variables are removed for the 25% harvesting scale. This indicates that the variables regarding absenteeism, residence, and number of years land has been owned do not appear to influence harvesting activities at the 25% scale. The lack of influence of landowner type variables on the 25% harvesting scale decision may be due to the poor response rate for this level of harvesting, as this may lead to a lack of variation in this data.

Dropping preference variables resulted in a rejection of the null hypothesis that the model does not change at the 0.01 level of significance for the 100% harvesting scale and any of the affirmation categories that a landowner indicated an acceptable price for harvesting, the selection

of the 50% harvesting scale and an acceptable harvesting price by indicating categories ‘definitely yes’ or ‘either’, and the selection of 25% harvesting scale by landowners indicating an acceptable harvesting price using the categories ‘probably yes’ or ‘either’ (Table 9). The null hypothesis can also be rejected at a 0.05 significance level for the 50% scale for landowners indicating an acceptable first price for harvesting by selecting the ‘probably yes’ category. Preference variables are important for the determination of a range of harvesting activities. It should be noted that the null hypothesis cannot be rejected for the landowners selecting the 25% harvesting level for the first price they are ‘definitely’ willing to harvest.

In summary, access variables are consistently more important than other groups of dropped variables in the estimations of potential scale of harvesting activities at the 50% and 100% scales. The one exception is for the selection of the 50% harvesting level for the first price a landowner is ‘probably’ willing to harvest. Landowner type variables are the most important group of dropped variables in determining potential scale harvesting scale activities at the 50% harvesting level for a landowner selecting a price that they are willing to harvest at by indicating ‘probably yes’. This is the only case where this group of variables is most important in the determination of the potential scale harvesting activities by a landowner. Landowner type variables are generally the least important when compared with other groups of dropped variables, especially with regards to harvesting activities at the 100% and 25% scales. In determining the potential for harvesting at the 25% level, landowner preference variables are more important than other groups of dropped variables for landowners indicating willingness to harvest by selecting a price at the affirmation categories of ‘probably yes’ and ‘either’. Again, access variables are the most important group of dropped variables for the selection of the scale of 25% by a landowner selecting an acceptable harvesting price using the ‘definitely yes’ affirmation.

VI.4. Marginal effects of potential scale of harvesting activities for landowners indicating a willingness to harvest

. Again, for purposes of clarity, discussion of the marginal effects of significant variables will be limited to the selection of the 50% harvesting scale by landowners indicating willingness to harvest by indicating an acceptable price using ‘definitely yes’, and the 100% harvesting scale by landowners indicating an acceptable price by indicating ‘either’ category (Table 10).

VI.4.A. Marginal effects of choosing the 50% harvesting scale for the first price a landowner was willing to accept for harvesting as indicated by selecting ‘definitely yes’

Absentee landowners are approximately 34% more likely to enter the market at the 50% harvesting scale. These landowners are not entirely opposed to harvesting, but are opposed to harvesting at the 100 % scale as is indicated by a negative probability for this level of harvesting. Again, an increase by one dollar in a landowner’s income increases market entrance by 0.000191% and therefore income has little effect on the decision to harvest at the 50% scale. The notion that landowner characteristics are more important to intermediate harvesting decisions, as also found by Alig et al. (1990), is consistent with the very small percentages for the income variable at this level of activity for landowners indicating acceptance of a price for harvesting using ‘probably yes’ or ‘either’.

Those landowners who previously inherited their land are 31% less likely to decide in favor of harvesting at the 50% scale (Table 10). Again, landowners who acquired land through inheritance are more likely to use forestry incentives (Kluender et al. 1999) and in doing so are more likely to benefit from such programs by harvesting at the 100% scale. The probability that a landowner will harvest at the 50% scale is increased by 11% with the presence of roads on the property. Landowners with a greater amount of roads have an increased likelihood of harvesting at the 50% scale, as the cost for building roads would not be such a deterrent to harvesting at this level with roads already in place. A landowner with children is 12% less likely to enter the market at this scale than a landowner without children.

Previous entrance into the timber market improves the likelihood landowners will harvest at the 50% scale by approximately 25%. Previous timber harvesting experience also increases the probability of selecting the 25% scale by landowners selecting an acceptable harvesting price using the ‘definitely yes’ affirmation. Those landowners with previous timber sale experience are probably more familiar with forestry practices and thus are willing to harvest at lower scales. Landowners with permanent structures on their property are 26% more likely to enter the market at this level of selective harvesting. This level of market entry suggests these landowners exhibiting this characteristic are not opposed to harvesting, as might be concluded from the results at the 100% harvesting scale, but rather such landowners are more likely to practice relatively conservative management of timber resources. Bequest motives regarding timber resources are likely to increase the probability a landowner will harvest at the 50% scale by

approximately 23%. The positive influence of timber bequest motives on market entry at the 50% harvesting level along with the negative significant coefficient for such motives at the 25% harvesting level and for the variable indicating land bequest motives at the 100% scale suggest that a landowner with bequest motives is most comfortable with harvesting at the 50% level.

VI.4.B. Marginal effects of choosing the 100% harvesting scale for the first price a landowner was willing to accept for harvesting as indicated by selecting ‘either’

As previously alluded to, absentee landowners are 20% less likely to enter 100% of their forested acre into the market (Table 10). The absentee landowner is much more likely to enter the market at a scale of 50%, as is indicated by the positive significant coefficient throughout the affirmations for the price a landowner is willing to harvest. Those landowners with intentions of leaving land to future heirs are 189% less likely to enter the market at the 100% level. Hulkrantz (1992) suggested that the existence of bequest motives were important to forest management decisions. These landowners most likely have some sense of obligation with regards to their land and are thus less likely to harvest all timber for esthetic and bequest purposes.

Landowners who have inherited land have a 22% increased likelihood of harvesting at the 100% level. A landowner perceiving a high degree of risk associated with timber loss due to natural causes is 7% less likely to manage by harvesting at this level. Due to risk aversion, landowners may be more willing to enter at lower prices or sooner than other landowners and thus manage their timber to avoid such risks.

Harvesting at the 100% scale by landowners with children increases by 7%, suggesting that these landowners may place less value on amenities and are thus willing to fully enter the market. Opposition to market entry at lower scales, as indicated by a negative coefficient, further supports the lack of emphasis on amenities by landowners exhibiting this characteristic. A landowner indicating the presence of existing structures is 38% less likely to harvest at the 100% scale. Results indicate that these landowners may be opposed to entering 100% of their forest into the market, but not to market entry entirely. Land investment motivation increases the likelihood of harvesting at the 100% scale by 7%. Further suggesting that landowners with investment motivations desire to maximize profits as is shown by the significance of both the positive coefficient for harvesting activities at the 100% level and the negative coefficient for the 50% harvesting level.

VII. Conclusions

This study evaluated the relationship between the decision to enter the harvesting market and the characteristics of owners and their land, such as preferences, landowner type, and access, that function in determining potential scale of market entry. It was shown in the empirical analysis that these characteristics are indeed important factors in the decisions to forego harvesting and scale of harvesting activities. The empirical analysis was based on data from a survey of forest landowners in four counties Southwest Virginia conducted in 2000 and 2001. In evaluating the margin of market entry, a reservation price is revealed for each landowner. This study allows for a determination of the bounds on the prices that both encourage landowners to harvest and the effect on the scale of harvesting.

The empirical analysis evaluated landowner characteristics, such as preferences, that lead to tradeoffs of non-timber benefits with harvesting behavior. There was a smaller population of landowners indicating a willingness to forego timber harvesting (21%) than previous studies of Virginia landowners (e.g., Hodge and Southard 1992, Conway 1998). The decision to forego harvesting is influenced by access and landowner preference variables, as well as other landowner characteristics. Landowner preference variables were the most important group of variables to the willingness to forego harvesting model. An employed landowner is more likely to indicate a willingness to forego harvesting than a landowner who is not currently employed. A landowner who either places a high importance of owning land for the purposes of keeping it for future generations or for land investment purposes is not likely to indicate a willingness to forego harvesting activities. Forested tract size also has a negative influence on the willingness to forego harvesting. However, the existing miles of roads on the property (i.e., improved access) have a positive influence on this decision. These are just a few examples of the influences of owner and land characteristics on a landowner's willingness to harvesting.

Potential scale of market entry by landowners who indicate a willingness to harvest was evaluated using a multiple bounded discrete choice referendum approach. Access characteristics and landowner preferences were found to influence landowners' decisions regarding scale of activities. Landowner type characteristics (i.e., absentee, resident, number of years landowner has owned the parcel) were influential in the decision to harvest at scales of 50% and 100%. A landowner acquiring their land through inheritance is also more likely to enter the harvesting market at the aforementioned scales. This is especially noteworthy with the ongoing increase in

land fragmentation. Landowners indicating the presence of structures on their property are not likely to harvest at the 100% scale, but are likely to harvest at the 50% scale. Such actions support the assumption that amenities, such as esthetic value, are important influences of the harvesting decisions of non-industrial forest landowners. Prices were also significant predictors of a landowner's entrance into the market at the selective harvesting levels of 25% and 50%.

This study contributes to the wealth of NIPF literature in that it is able to determine an individual landowner's acceptable harvesting price. This is accomplished by offering landowners harvesting price options that go beyond the typical examinations of behavior in regards to current (at the time) timber market prices, or evaluating past harvesting behavior of landowners. Using information from the empirical analysis, it is possible to identify landowner characteristics associated with willingness to forego harvesting and the potential scale of activities for those landowners who are willing to harvest. Identification of landowner characteristics associated with either the willingness to forego harvesting or the scale of activities will allow for better development of effective policies focusing on forest management and timber supply issues.

This information will be useful in analyzing the timber supplied by NIPF landowners as well as how changes in market parameters may affect future supplies. Policymakers will find the information useful for many purposes. For instance, the landowner characteristics that function in the decision to forego market entry may be desirable characteristics for targeting land set-aside programs for the purpose of keeping the land in timber, perhaps for motives such as carbon sequestration. Incentives to forego harvesting have not previously been examined. The reservation of land for purposes such as carbon sequestration has usually been examined as a land conversion, i.e., from agriculture to forestry, problem, with lost agricultural opportunity costs as the baseline incentives. Also, by identifying prices that landowner's are willing to harvest, policymakers are aware of the absolute lowest price a landowner will accept and thus may be able to target policies that either function to promote harvesting or preserve land in its current use.

Future work relating to this study could involve a more detailed examination of the margin between current market prices and a landowner's reservation price. With an understanding of this gap that landowners face with regards to market entry, researchers could quantify how far certain landowners are from participating in harvesting activities. Such

information would be valuable in the development of a future timber supply model and in forecasting future changes in timber availability. Another extension of this work may be to examine the behavior of landowners with regards to adjacent landowners. The behavior of adjacent landowners may influence studied landowners favorably, unfavorably, or not at all. Policymakers may be interested in such information in targeting policies that focus on ecosystem management or maybe for the purpose of forming large areas for the purpose of carbon sequestration. There are many facets of NIPF landowners that are still important to the nation's timber supply, and in studying these facets the non-separability of landowner decisions should be kept in mind.

Table 1: Definition of variables used in estimation of landowner willingness to forego market entry and potential scale of entry for those landowners indicating willingness to harvest from survey of Southwest Virginia landowners (2000/2001).

Absentee	1 if landowner resides > 50 miles from surveyed property, 0 else
Income	Average income of landowner for either 2000 or 2001 (dollars)
Plan to give land to heirs	1 if landowner plans to give all land to heirs in the future, 0 else
Give timber to heirs	1 if landowner plans to give all of the timber that is now on land to heirs in the future, 0 else
Inherited land	1 if landowner acquired land through inheritance, 0 else
Roads (miles)	Length of estimated dirt or paved roads on property (miles)
Environmental reasons	Importance of environmental reasons for owning land (1 is not important, 5 is very important)
Reside on property	1 if landowners primary residence is located on property, 0 else
Years owned property	Estimated ownership of land by landowner (years)
Risk tree growth	Rated degree of risk associated with growing trees as opposed to typical investments (1 is least risk, 5 is most risk)
Risk tree loss	Rated degree of risk associated to losing timber to natural occurrences (1 is least risk, 5 is most risk)
Forested Acres	Estimated forestland on property (acres)
Number of children	Children indicated by landowner (number)
Employed	1 if landowner is presently employed, 0 else
Land for future generations	Importance of owning land to keep for future generations (1 is not important, 5 is most important)
Sold timber in past	1 if landowner has ever had trees cut on land for the sale of timber, 0 else
Flat terrain	1 if landowner classifies general terrain of property as relatively flat, 0 else
Part of timber to heirs	1 if landowner plans to give part of timber to heirs in the future, 0 else
Structures present	1 if landowner has any permanent structures on property, 0 else
Land investment	Importance of owning land for land investment/real estate purposes (1 is not important, 5 is very important)
College	1 if landowner has completed college, 0 else
Days hunted	Estimated time spent hunting on property within last year (days)
Hunter	Dummy variable for number of days spent hunting on land within past year, 1 if days hunted is positive, 0 else
Fppy	Amount of first single payment that landowner agreed to harvest by selecting 'probably yes' (dollars)
Fpdy	Amount of first single payment that landowner agreed to harvest by selecting 'definitely yes' (dollars)
Fpe	Amount of first single payment that landowner agreed to harvest by selecting either 'probably yes' or 'definitely yes' (dollars)
Predicted first price	Predicted first amount from regression analysis that landowner agreed to harvest by selecting 'probably yes', 'definitely yes', or 'either'
Willingness to forego harvesting	1 if landowner indicated that would never harvest forest no matter what, 0 else

Table 2: Descriptive statistics of selected variables from survey of forest landowners in the Virginia counties of Giles, Montgomery, Pulaski, and Roanoke, performed in 2000/2001.

Variable	Units	Mean	Standard Deviation
Age	Years	59.731	13.206
Income	Dollars	80644.947	57623.198
Single	0/1	0.047	0.212
Married	0/1	0.804	0.397
Divorced	0/1	0.067	0.251
Widowed	0/1	0.081	0.273
Agricultural land	Acres	34.596	81.029
Forested land	Acres	64.717	103.879
Open land	Acres	6.926	18.244
Other land	Acres	1.402	13.206
Completed elementary school	0/1	0.043	0.204
Completed junior high	0/1	0.039	0.194
Completed high school	0/1	0.172	0.377
Completed some college	0/1	0.195	0.396
College	0/1	0.554	0.498
Employed	0/1	0.540	0.499
Retired	0/1	0.449	0.498
Unemployed	0/1	0.020	0.141
Inherited land	0/1	0.277	0.448
Sold timber in past	0/1	0.276	0.491
Hunter	0/1	0.371	0.484
Years owned property	Years	30.5	23.580
Absentee	0/1	0.158	0.365
Reside on property	0/1	0.487	0.500
Roads (miles)	Miles	0.994	1.833
Structures present	0/1	0.725	0.447
Flat terrain	0/1	0.087	0.282
Environmental reasons	1,2,3,4,5	3.722	1.297
Land for future generations	1,2,3,4,5	4.079	1.275
Land investment	1,2,3,4,5	3.261	1.500
Give timber to heirs	0/1	0.740	0.439
Part of timber to heirs	0/1	0.038	0.193
Plan to give land to heirs	0/1	0.394	0.489
Risk tree growth	1,2,3,4,5	2.429	1.126
Risk tree loss	1,2,3,4,5	2.929	1.058
Willingness to forego harvesting	0/1	0.207	0.406
Fppy	Dollars	5004.831	3241.490
Fpdy	Dollars	6387.006	3601.799
Fpe	Dollars	4914.894	3406.441
25% harvesting scale	0/1	0.104	0.305
50% harvesting scale	0/1	0.186	0.390
100% harvesting scale	0/1	0.203	0.403

Table 3: Estimated results for landowners indicating willingness to forego harvesting.

Variable	Coefficient (n = 215)	Significance level	Standard Error
Constant	1.024		1.582
Absentee	-0.682		0.803
Income	-4.42E-06		4.78E-06
Plan to give land to heirs	0.908	10%	0.543
Give timber to heirs	0.394		0.675
Inherited land	-1.091	15%	0.693
Roads (miles)	0.545	5%	0.188
Environmental reasons	0.318	15%	0.211
Reside on property	-0.332		0.550
Years owned property	-0.116		0.118
Risk tree growth	0.293		0.229
Risk tree loss	-0.591	5%	0.279
Forested acres	-8.63E-03	15%	5.44E-03
Number of children	8.99E-02		0.159
Employed	1.53	5%	0.523
Land for future generations	-0.596	5%	0.218
Sold timber in past	-0.846		0.671
Flat terrain	0.896		0.677
Part of timber to heirs	-1.72E-02		7.94E-02
Structures present	0.522		0.482
Land investment	-0.235	15%	0.162
College	-0.735		0.526
Hunter	-1.43	5%	0.560

n is number of observations

Table 4: Regression of residuals used in endogeneity test of the model of willingness to harvesting generated using data from survey of Southwest Virginia landowners (2000/2001).

Variable	Coefficient	Significance Level
Constant	0.712	0.386
Absentee	-6.65E-02	0.452
Income	2.02E-07	0.735
Plan to give land to heirs	-6.88E-02	0.318
Give timber to heirs	3.83E-02	0.645
Inherited land	6.63E-03	0.930
Roads (miles)	-7.32E03	0.684
Environmental reasons	4.13E-03	0.865
Reside on property	-4.37E-02	0.563
Years owned property	5.50E-03	0.690
Risk tree growth	4.25E-03	0.882
Risk tree loss	-9.95E-03	0.770
Forested acres	-1.82E-04	0.577
Number of children	5.15E-03	0.809
Employed	1.53E-02	0.797
Land for future generations	-5.70E-03	0.845
Sold timber in past	-1.83E-02	0.756
Flat terrain	3.42E-02	0.748
Part of timber to heirs	-2.13E-04	0.951
Structures present	-3.22E-04	0.995
Land investment	-1.48E-02	0.495
College	-4.06E-02	0.539
Non-consumptive activities	3.88E-05	0.630
Days hunted	-2.81E-04	0.755

Table 5: Hypothesis test results for variable groups dropped in the estimation of landowner willingness to forego harvesting.

Variable groups dropped	Results of likelihood ratio test	Significance level
Access	18.052	2.88E-03
Landowner type	n/a	n/a
Landowner preferences	90.539	1.04E-16

Table 6: Marginal effects of significant variables in the estimation of landowner willingness to forego harvesting.

Variable	Coefficient
Plan to give land to heirs	0.072
Inherited land	-0.086
Roads (miles)	0.043
Environmental reasons	0.025
Risk tree loss	-0.047
Forested acres	-0.001
Employed	0.121
Land for future generations	-0.047
Land investment	-0.018
Hunter	-0.112

Table 7: Estimation results for the predicted lowest price a landowner selected 'probably yes', 'definitely yes', or 'either' and the level of harvesting agreed to at that price.

Variable	100% harvesting scale			50% harvesting scale		
	Fppy n=137	Fpdy n=112	Fpe n=153	Fppy n=137	Fpdy n=112	Fpe n=153
Constant	0.454 (1.423)	1.026 (1.624)	1.417 (1.304)	-2.745 *** (1.431)	-2.676 ** (1.645)	-2.335 ** (1.327)
Absentee	-0.773 (0.655)	-0.934 (0.868)	-0.996 * (0.649)	1.654 *** (0.668)	1.710 *** (0.846)	1.692 *** (0.638)
Income	-3.59E-06 (4.72E-06)	-2.10E-06 (6.18E-06)	-4.17E-06 (4.69E-06)	8.81E-06 ** (4.21E-06)	9.67E-06 ** (5.31E-06)	9.76E-06 *** (4.09E-06)
Plan to give land to heirs	0.315 (0.539)	2.62E-03 (0.711)	0.438 (0.514)	0.626 (0.492)	1.137 ** (0.616)	0.476 (0.456)
Give timber to heirs	-0.583 (0.574)	-0.919 (0.732)	-0.957 (0.550)	0.712 (0.564)	0.592 (0.672)	0.676 (0.544)
Inherited land	1.14 *** (0.571)	1.801 *** (0.810)	1.069 *** (0.547)	-0.787 * (0.541)	-1.567 ** (0.816)	-0.652 (0.502)
Roads (miles)	-0.287 (0.258)	-1.084 *** (0.491)	-0.232 (0.251)	9.92E-02 (0.206)	0.544 * (0.341)	4.17E-02 (0.200)
Years owned property	1.72E-02 (9.81E-02)	-8.25E-03 (0.123)	3.99E-02 (9.40E-02)	-5.98E-02 (9.23E-02)	5.35E-02 (0.117)	-5.34E-02 (8.82E-02)
Risk tree growth	8.17E-02 (0.220)	-0.372 (0.275)	6.67E-02 (0.213)	-8.46E-02 (0.209)	0.311 (0.250)	8.71E-04 (0.199)
Risk tree loss	-0.210 (0.261)	4.45E-02 (0.313)	-0.356 * (0.245)	0.144 (0.267)	-0.212 (0.326)	9.46E-02 (0.235)
Forested acres	-3.35E-03 (2.8E-03)	-2.28E-03 (2.9E-03)	-3.59E-03 (2.56E-03)	-4.9E-04 (2.21E-03)	-3.44E-03 (3.08E-03)	-9.99E-04 (2.11E-03)
Number of children	0.381 *** (0.184)	0.931 *** (0.276)	0.374 *** (0.178)	-0.106 (0.163)	-0.608 *** (0.230)	-0.169 (0.154)
Employed	-0.772 ** (0.471)	-0.268 (0.577)	-0.547 (0.436)	-0.293 (0.441)	-2.93E-02 (0.509)	-0.139 (0.408)
Sold timber in past	0.524 (0.459)	-0.860 (0.625)	-0.324 (0.436)	0.272 (0.424)	1.255 *** (0.543)	0.400 (0.393)
Flat terrain	-1.288 (1.122)	-2.974 ** (1.638)	-1.306 (1.060)	0.221 (1.139)	1.413 (1.383)	0.161 (1.101)
Structures present	-1.534 *** (0.532)	-1.992 *** (0.645)	-1.958 *** (0.509)	1.665 *** (0.620)	1.328 *** (0.664)	1.642 *** (0.580)
Land investment	0.386 *** (0.532)	0.399 ** (0.230)	0.358 *** (0.175)	-9.20E-03 (0.177)	1.328 (0.188)	-0.134 (0.156)
College	-0.321 (0.503)	-0.554 (0.638)	-0.357 (0.465)	-4.27E-03 (0.481)	0.405 (0.583)	-8.53E-02 (0.447)
Hunter	-9.68E-02 (0.490)	0.394 (0.614)	-0.156 (0.465)	0.307 (0.444)	0.429 (0.520)	0.453 (0.418)
Predicted first price	-4.20E-05 (1.09E-04)	-1.33E-04 (0.99E-05)	-4.24 (1.04E-04)	-2.01E-04 *** (9.46E-05)	-9.55E-05 (8.82E-05)	-1.99E-04 *** (9.3E-05)
N is number of observations		Numbers in parenthesis indicate standard error				
*** 5% significance level, ** 10% significance level, * 15% significance level						

Table 8: Continued estimation results for the predicted price lowest price a landowner selected 'probably yes', 'definitely yes', or 'either' and the level of harvesting agreed to at the price.

Variable	25% harvesting scale		
	Fppy n=137	Fpdy n=112	Fpe n=153
Constant	-2.703 ** (1.659)	-2.186 (1.917)	-3.195 *** (1.523)
Absentee	-0.266 (0.766)	1.31E-02 (0.974)	-0.104 (0.751)
Income	3.00E-06 (4.93E-06)	7.62E-07 (6.68E-06)	4.15E-06 (4.56E-06)
Plan to give land to heirs	-1.448 *** (0.660)	-1.492 ** (0.807)	-1.183 *** (0.614)
Give timber to heirs	0.366 (0.617)	0.105 (0.754)	0.491 (0.596)
Inherited land	-0.511 (0.682)	-0.309 (0.887)	-0.571 (0.663)
Roads (miles)	0.357 (0.252)	0.726 ** (0.396)	0.416 ** (0.246)
Years owned property	-0.138 (0.107)	-0.179 (0.163)	-0.118 (0.104)
Risk tree growth	9.38E-02 (0.231)	0.145 (0.297)	8.09E-02 (0.228)
Risk tree loss	0.314 (0.306)	0.168 (0.392)	0.244 (0.301)
Forested acres	-3.39E-04 (3.49E-03)	-1.40E-03 (4.94E-03)	-1.47E-03 (3.55E-03)
Number of children	-0.124 (0.224)	-0.116 (0.280)	-8.22E-02 (0.214)
Employed	1.208 *** (0.558)	1.424 *** (0.653)	1.309 *** (0.530)
Sold timber in past	-0.956 (0.740)	-1.478 * (0.952)	-0.948 (0.700)
Flat terrain	1.134 (1.169)	1.717 (1.546)	1.372 (1.090)
Structures present	-0.151 (0.420)	-0.241 (0.508)	-8.11E-02 (0.396)
Land investment	-0.312 * (0.216)	-0.381 * (0.241)	-0.252 (0.194)
College	-0.172 (0.597)	0.210 (0.759)	1.06E-02 (0.557)
Hunter	-0.351 (0.568)	-0.421 (0.717)	-0.393 (0.531)
Predicted first price	3.38E-04 *** (1.73E-04)	1.90E-04 (1.48E-04)	2.85E-04 ** (1.51E-04)

N is number of observations Numbers in parenthesis indicate standard error
 *** 5% significance level, ** 10% significance level, * 15% significance level

Table 9: Hypothesis test results for variable groups dropped in the estimation of scale of activities for landowners indicating willingness to harvest.

Harvesting scale	Level of affirmation where landowner willing to harvest	Variable groups dropped		
		Access	Landowner Type	Landowner Preferences
100%	'Probably yes'	19.632 *** (0.006)	5.927 ** (0.052)	13.998 *** (0.007)
	'Definitely yes'	33.236 *** (1.1E-06)	7.350 ** (0.025)	20.263 *** (4.4E-04)
	'Either'	28.774 *** (8.7E-06)	7.605 ** (0.022)	20.518 (3.9E-04)
50%	'Probably yes'	5.051 (0.282)	18.715 *** (9E-05)	12.120 ** (0.016)
	'Definitely yes'	23.287 *** (1.1E-04)	8.605 ** (0.014)	13.292 *** (9.9E-03)
	'Either'	26.360 *** (2.7E-05)	12.789 *** (0.002)	17.572 *** (1.5E-03)
25%	'Probably yes'	8.01 * (0.091)	2.276 (0.321)	18.841 *** (8.4E-04)
	'Definitely yes'	12.516 ** (0.014)	1.717 (0.424)	6.151 (0.188)
	'Either'	9.466 ** (0.051)	2.089 (0.352)	17.613 *** (1.8E-03)

Note: Significance levels in parenthesis

* hypothesis rejected at 10% level, ** hypothesis rejected at 5% level, *** hypothesis rejected at 1% level

Table 10: Marginal effects of significant variables in the estimation of scale of activities for landowners indicating willingness to harvest.

Variable	100% harvesting scale			50% harvesting scale		
	'Probably yes'	'Definitely yes'	'Either'	'Probably yes'	'Definitely yes'	'Either'
Constant				-0.591	-0.529	-0.496
Absentee			-0.197	0.356	0.338	0.360
Income				1.9E-06	1.9E-06	2.1E-06
Plan to give land to heirs					0.225	
Give timber to heirs			-1.891			
Inherited land	0.225	0.358	0.221	-0.169	-0.310	
Roads (miles)		-0.216			0.108	
Risk tree loss			-0.070			
Number of children	0.075	0.185	0.074		-0.120	
Employed	-0.153					
Sold timber in past					0.248	
Flat terrain		-0.592				
Structures present	-0.303	-0.396	-0.387	0.358	0.263	0.349
Land investment	0.076	0.079	0.071			
Predicted first price				-4.3E-05		4.2E-05

Variable	25% harvesting scale		
	'Probably yes'	'Definitely yes'	'Either'
Constant	-0.334		-0.363
Absentee			
Income			
Plan to give land to heirs	-0.179	-1.372	-0.134
Give timber to heirs			
Inherited land			
Roads (miles)		0.067	0.047
Risk tree loss			
Number of children			
Employed	0.149	0.131	0.149
Sold timber in past		-0.136	
Flat terrain			
Structures present			
Land investment	-0.039	-0.035	
Predicted first price	4.2E-05		3.2E-05

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Appendix A: A summary of previous NIPF studies

Table 1: A summary of previous NIPF landowner studies regarding timber harvesting and reforestation/cost share participation.

Author	Study Summary	Study Area	Scale of Study	Sampling Coverage		Notes
				Number of samples		
Allig (1986)	Examine changes in land use in Southeast	USDA Forest Service Survey Units	Acres of these units at either 3 or 4 points from 1974 to 1984	70		pools cross section and time series data, describes what has happened and uses to predict what will happen
Bell et al. (1994)	How cost share incentives will effect participation in Tennessee Forest Stewardship Program and other factors that may be involved in participation	Tennessee	Landowners with 100 or more acres	378		identifies characteristics that may increase participation based on goals of program and attitudes of landowners regarding such goals
Brocket and Gebhard (1999)	Determination of the affect of tax reduction on land use practices by comparing participants and nonparticipants in a program that provides such reductions	Tennessee - Franklin County	Forest Greenbelt participants and nonparticipants in Franklin County	188		examined characteristics of landowners regarding behavior and plans for land in future
Dennis (1989)	Determinants of timber supply from private forest and obtaining understanding of relationship between harvesting behaviour and forest, owner and economic variables	New Hampshire	68, 1/5-acre fixed radius plots, measured in 1973 and 1983 plus questionnaire sent to landowners	67		empirical and theoretical results combined to suggest increase in affluent landowners will result in decrease in harvesting
Dennis (1990)	Empirical model of harvest behavior using pooled time-series and cross-sectional data	New Hampshire	68, 1/5-acre fixed radius plots, measured in 1973 and 1983 plus questionnaire sent to landowners	68		suggests that land can either be used for harvesting or for amenities but not both, forest characteristics with landowner characteristics influence harvesting decision

Author	Study Summary	Study Area	Scale of Study	Number of samples	Notes
de Steiguer (1984)	Separation of effects of cost-share program incentives from market responses on reforestation behavior	ACP and FIP programs in AL, AR, FL, GA, LA, MS, NC, SC, TN, TX and MS, FRDC, NC FDP	USDA Forest Service Survey plots in AL where harvesting recorded during	NA	develops and estimate an economic model of NIPF reforestation investment behavior
Doolittle and Straka (1987)	Explain differences between NIPF landowners who regenerated pine stands and those that did not.	Alabama	forestland owners with a written forest stewardship plan on file for at least five years	56	uses a sociological classification method to explain landowner behavior
Egan et al. (2001)	Stewardship program effectiveness	West Virginia	800 woodland owners in each of AR's four physiographic regions	1129	compared activity recommendation with implementation of activities
Greene and Blaher (1986)	Develops model to identify woodland owners receptive to management programs and incentives	Arkansas	area frame survey conducted by NASS	3200 r 41.7%	identifies managers as those who have done two or more timber management practices in the past 5 years
Hardie and Parks (1996)	Cost-sharing level affected number and size of tracts enrolled in reforestation cost component of FIP	Southern pine region of the United States	area frame survey conducted by NASS	Not given	cost sharing stimulates tree planting
Hultkrantz (1992)	Uses overlapping generations model to examine the investment behavior of forest landowners	none - based on equation manipulation	survey and analysis of planting and harvesting activity between 1977 and 1984	Not given	long-term forest investments are evaluated by NPV especially if existing generation has even a very small concern for future generation
Hyberg and Holthausen (1989)	NIPF landowners modeled as maximizing utility, function of income and amenity benefits	Georgia	area frame survey conducted by NASS	Not given	utility maximization is consistent with observed NIPF behavior, more so than profit maximizing behavior

Author	Study Summary	Study Area	Scale of Study	Number of samples	Notes
Johnson et al. (1997)	Surveyed landowners to determine whether anticipation of future regulations was the cause of increased harvesting	Oregon and Washington	Western Oregon and Western Washington - via telephone	1004	not affected greatly by future regulation, noted difference between large and small tract owners
Kline et al. (2000)	Willingness to accept incentive payments (to forego harvesting for 10 yrs) and reasons NIPF owners possess land	Oregon and Washington	Western Oregon and Western Washington	1004	Programs with good potential for success are those that target those forest owners with similar objectives
Koskela (1989)	Analysis of timber harvest decisions under price uncertainty	none - based on equation manipulation			Consumption and harvesting decisions are nonseparable, thus the responses to change in tax rates and structure may considerably differ from those under certainty
Kuuluvainen et al. (1996)	Establish link between ownership objectives and observed harvesting behavior	Finland	Southern Finland	146	Timber sales and ownership objectives are connected (multiojective landowners harvest more)
Munn and Rucker (1995)	Determine direction and magnitude of differences in prices paid for public and private timber and to investigate reasons for differences	North Carolina	timber sales in North Carolina sold from 1987 to 1991	319	Forest Service tracts sell for less than private tracts on a per acre basis
Newman and Wear (1993)	Compares production behavior of nonindustrial and industrial private forestland owners in the SE.	Southeastern states	surveys performed by us forest service from 1984-1988 limited to coastal plane pine production	264	Both owners (industrial and nonindustrial) behave consistently with profit maximizing motives, however nonindustrial owners capture significant nonmarket benefits which is reflected in their production behavior
Pattanayak et al. (2002)	Timber supply conditional on endogenous amenity values	FIA units in 12 states across Southeastern United States	Forest Inventory and Analysis survey units	400	Timber supply is a function of an endogenous distribution of inventory that correlates to ownership and mgmt characteristics

Author	Study Summary	Study Area	Scale of Study	Number of samples	Notes
Romm et al. (1987)	Determine extent of relationship between owner and ownership characteristics and investment behavior	Northern California	Nonindustrial owners of forested field plots established by usda forest service within 15 counties for 1981-84 survey	471	Owners can be classified to identify groups of owners who share similar investment functions and are likely to respond similarly to specific policies
Royer (1987)	Restoration behavior of southern landowners including effects of markets, landowner characteristics and public policy	12 Southern states comprising Southern Pine Region	NIPF conducted final harvests on 10 or more acres of pineland between 1971 and 1981	251	Financial and technical assistance are key to increasing reforestation rates
Shaffer and Meade (1997)	Determined the number of absentee landowners in Virginia	Virginia	Six counties in VA representing all physiographic regions	330	absentee landowners have increased, other lit points to the increase as nothing of concern
Notes: FIA - Forest Inventory and Analysis, ACP - Agricultural Conservation Program, FIP - Forestry Incentives Program, FRDC - Forest Resource Development Program, FDP - Forest Development Program, NASS - National Agricultural Statistics Service, rr - response rate					

Appendix B: Virginia Landowner Survey Instrument 2000/2001

Virginia Landowner Survey 2001



Conducted By:

**College of Natural Resources
Department of Forestry
Virginia Tech
304 Cheatham Hall (0324)
Blacksburg, VA 24061**

Contact People:

**Melinda Jones, graduate student, Virginia Tech, College of Natural Resources, Department of Forestry (SURVEY CONTACT PERSON)
(540) 231-3596**

Greg Amacher, professor, Virginia Tech, College of Natural Resources, Department of Forestry

Example from Montgomery County

Purpose of Our Survey and Need for Your Involvement:

You have been selected to participate in an important survey of forest landowners throughout Virginia. Researchers at Virginia Tech are trying to determine what factors cause landowners to sell timber, or keep land and forests in their family. Your answers to these questions will be important in future predictions about Virginia’s economy and natural resource base. Please answer each question truthfully. There is no “right” or “wrong” answer, so please think about each one carefully and answer as if you faced the situation described. Your answers and information will be kept strictly confidential and will only be seen by the professor and student working on this project. The information collected will never be given out to any government or state agency, company, individual, or other entity. Your information will be identified only by a number and not by your name or address. Landowner names and addresses used for purposes of this mailing will be destroyed as soon as the survey information is received. After the research is complete, all data will also be destroyed. If you would like to obtain a copy of our results to see how confidentiality has been preserved, we will send you a copy if you indicate so on your survey. Thank you for taking the time to help with our research.

Please check the box in front of your answer, where applicable.

Please answer the following questions for the property specified in the cover letter **only**.

1. A. How did you acquire your land in Montgomery County?

- I INHERITED IT
- I BOUGHT IT

If you BOUGHT the land how much did you pay for the land?

\$_____ PER ACRE, OR

\$_____ TOTAL (# OF ACRES: _____)

B. Is your property in a residential neighborhood _____ YES _____ NO
(IF YES, DO NOT ANSWER ANY MORE QUESTIONS AND RETURN THIS SURVEY USING THE ENVELOPE PROVIDED)

2. How long has the land been owned by you?

_____ YEARS

3. If you were to consider selling your land now, at what price would you consider selling it?

\$_____ PER ACRE

CHECK HERE IF YOU WOULD NEVER SELL YOUR LAND AT ANY PRICE ?

4. A. What do you plan to do with your land in the future?

- GIVE IT ALL TO MY HEIRS
- GIVE ONLY PART OF IT TO MY HEIRS (IF SO, HOW MANY ACRES? _____)
- SELL THE LAND

B. Do you plan on entering your land into an easement program?

- YES
- NO

Reminder: This information will be kept STRICTLY CONFIDENTIAL, and landowner names/addresses will not be attached to these answers.

10. Forests can provide a number of goods and services. If forests are harvested, they provide income for the owner. Standing timber provides habitat for wildlife and recreational opportunities for landowners. Forests can be harvested about once every 50 years in your area, and landowners typically receive \$1,000 - \$6,000 per acre when they harvest depending on the quality of the trees cut (an acre is roughly the size of a football playing field--100 yards by 55 yards). In your area, a new forest will establish itself on cutover land if left alone. Harvesting of trees can also be done in a way to ensure that a new forest is established within one year after cutting.

Suppose you had forests old enough to harvest, and you were given a dollar offer for harvesting. The table below lists specific amounts you could receive per acre by harvesting. For every payment value in the table below, indicate your acceptance level to harvest one acre of your forest.

Would you accept any of the following single payments to harvest one acre of forest?

Payment made to you	Definitely Not	Probably Not	Not Sure	Probably Yes	Definitely Yes
\$500 per acre					
\$1,000 per acre					
\$2,000 per acre					
\$3,500 per acre					
\$5,000 per acre					
\$6,500 per acre					
\$8,500 per acre					
\$10,500 per acre					
\$13,000 per acre					

If you would never harvest your forest no matter what the amount offered, please check here: _____

If you checked the NOT SURE box anywhere in the table above, could you tell us why?

- _____ I AM NOT FAMILIAR ENOUGH WITH MY PROPERTY TO ANSWER
- _____ I AM NOT THE DECISION-MAKER FOR THE PROPERTY IN QUESTION
- _____ I DO NOT KNOW IF I HAVE FORESTS ON MY PROPERTY
- _____ I DO NOT UNDERSTAND THE QUESTION
- _____ OTHER (PLEASE SPECIFY): _____

For the LOWEST amount you checked PROBABLY YES or DEFINITELY YES, indicate how much of the forest on your property you would consider harvesting (check all that apply)
(SKIP THIS QUESTION IF YOU DID NOT ANSWER PROBABLY OR DEFINITELY YES IN THE TABLE)

- 25% _____
- 50% _____
- ALL _____
- OTHER _____

For the HIGHEST amount you checked PROBABLY YES or DEFINITELY YES, indicate how much of the forest on your property you would consider harvesting (check all that apply)
(SKIP THIS QUESTION IF YOU DID NOT ANSWER PROBABLY OR DEFINITELY YES IN THE TABLE)

- 25% _____
- 50% _____
- ALL _____
- OTHER _____

16. Approximately how many **days** were you involved in each of the following activities on your land within the past year? (If no days spent, leave blank)

- _____ BIKING
- _____ BIRD WATCHING
- _____ CAMPING
- _____ FISHING
- _____ FLOWER, PLANT, OR BERRY PICKING
- _____ HORSES / PASTURING
- _____ HUNTING
- _____ OBSERVING WILDLIFE
- _____ PHOTOGRAPHY
- _____ PICNICKING
- _____ RUNNING
- _____ WALKING / HIKING
- _____ OTHER (PLEASE SPECIFY): _____

17. How would you rate the degree of risk associated with growing trees as opposed to typical investments like stocks and bonds? (1 is the least risk, 5 is the most risk)

1 2 3 4 5

18. How would you rate the degree of risk associated with losing your timber to fire, insects, ice damage, or other natural occurrences? (1 is least risk, 5 is most risk)

1 2 3 4 5

19. Have you had trees cut on this tract of land for the sale of timber?

- ___ YES
- ___ NO

If so, approximately how many years ago? _____ YEARS AGO

20. What do you plan to do with the trees that are now on your land?

- ___ EVENTUALLY CUT THE TIMBER
- ___ GIVE ALL OF THE TIMBER TO HEIRS
- ___ GIVE PART OF THE TIMBER TO HEIRS AND SELL THE REST (WHAT PERCENT TO HEIRS? _____)
- ___ SELL THE TIMBER WHEN I SELL THE LAND IN THE FUTURE
- ___ CONSERVATION EASEMENT
- ___ OTHER (PLEASE SPECIFY): _____

The following questions will help us obtain background variables for statistical purposes. As is true for the rest of the survey, all information is strictly confidential.

21. Is your primary residence located on your property in Montgomery County?

- ___ YES
- ___ NO

If you answered NO to question 21:

A. Approximately how many miles away is your primary residence from your land in Montgomery County?

_____ MILES

B. Approximately how many days did you visit your property in 2000?

_____ DAYS

22. What is your age?

_____ YEARS

23. What is your gender?

___ MALE
___ FEMALE

24. What is your present marital status?

___ SINGLE
___ MARRIED
___ DIVORCED
___ WIDOWED

25. How many children do you have? (If none, write "0")

_____ CHILDREN

26. Are you presently:

___ EMPLOYED
___ UNEMPLOYED
___ RETIRED

27. What was your approximate gross family income (before taxes) in 2000?

___ LESS THAN \$10,000
___ \$10,000 TO \$19,999
___ \$20,000 TO \$29,999
___ \$30,000 TO \$39,999
___ \$40,000 TO \$49,999
___ \$50,000 TO \$59,999
___ \$60,000 TO \$69,999
___ \$70,000 TO \$79,999
___ \$80,000 TO \$89,999
___ \$90,000 TO \$99,999
___ \$100,000 TO \$124,999
___ \$125,000 TO \$149,999
___ \$150,000 TO \$199,999
___ \$200,000 OR GREATER

28. What is an estimate of the total amount of money you owe as of March 2001?
(total of home mortgages, car or other loans, credit card balances, etc.)

\$ _____

29. Please rank from highest to lowest how much you owe in the following categories: (1 is your largest debt, 5 is your smallest debt)

_____ HOME MORTGAGE
_____ CAR LOANS
_____ EDUCATION LOANS
_____ CREDIT CARD BALANCES
_____ OTHER (PLEASE SPECIFY): _____

30. What is the highest level of education you have completed?

NO FORMAL EDUCATION

ELEMENTARY SCHOOL

JUNIOR HIGH SCHOOL

HIGH SCHOOL

SOME COLLEGE

COLLEGE (PLEASE SPECIFY HIGHEST DEGREE AND MAJOR):

31. Were you able to understand and complete the survey?

YES _____

NO _____

If NO, can you tell us why?

I DON'T HAVE ENOUGH INFORMATION ABOUT THE PROPERTY YOU ASK ABOUT

I THINK THE SURVEY IS TOO HYPOTHETICAL

I THINK THE SURVEY IS MORALLY OFFENSIVE

I HAVE OTHER REASONS (PLEASE SPECIFY):

Thank you VERY MUCH for taking the time to respond to our survey. If you have additional comments, please write them in the space below. If you would like a copy of our results, please indicate that here.

Curriculum Vitae

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EDUCATION

Master of Science, Forest Management and Economics, Expected May 2002
Virginia Polytechnic Institute and State University, Blacksburg, VA
Thesis: Non-industrial landowners, the incentives to forego harvesting, and the importance of scale activities.
Advisor: Dr. Gregory S. Amacher

Bachelor of Science, Forestry, May 2000
Michigan Technological University, Houghton, MI with high honors

HONORS/AFFILIATIONS

- Robert S. Burruss Fellowship (2000-2002)
- Xi Sigma Pi (Forestry Honor Society) (2001-present)
- Society of American Foresters (1999-present)

TEACHING/RESEARCH

Teaching Assistant (Spring 2002) – Forestry Spring Camp

- Assisted with forest management and economics two day module
- Aided in grading reports

Teaching Assistant (Fall 2001) – Natural Resource and Environmental Economics

- Moderated review sessions
- Assisted with reviewing and grading tests and quizzes

Teaching Assistant (Spring 2001) – Consulting Forestry Business

- Aided in grading papers and tests

Research Assistant (2000-present)

- Identified recipients for Mississippi and Virginia forest and agricultural landowner survey
- Assembled Mississippi and Virginia forest and agricultural landowner surveys
- Assisted with mailing of forest and agricultural landowners in Virginia and Mississippi
- Performed econometric analysis of the data from the forest landowner surveys (VA and MS)

Research Assistant (Summer 2000)

- Entered timber price data for Indonesia from several sources
- Assisted with gathering research articles

SKILLS

Computer Skills: Microsoft Office, Corel Suite, LIMDEP, Lindo, GAMS

COURSES

Applied Microeconomics I	Seminar in Math for Economists
Mathematical Programming	International Agricultural Development and Trade
Principles of Finance	Global Issues in Natural Resources
Elementary Econometrics	Advanced Forest Management and Economics
Forest and Recreation Economics	Intermediate Microeconomic Theory

PUBLICATIONS

Vokoun, M. and G. S. Amacher. 2002. Non-industrial landowners, the incentives to forego harvesting and the importance of scale of activities. in: G.S. Amacher and B. J. Sullivan, eds. Proceedings from SOFEW 2002, Virginia Beach, Virginia.

PRESENTATIONS

Vokoun, M. and G.S. Amacher. 2002. Non-industrial landowners, the incentives to forego harvesting and the importance of scale of activities. Southern Forest Economics Workshop 2002. March 18-20. Virginia Beach, Virginia.