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WILLINGNESS TO PAY FOR POTENTIAL STANDING TIMBER INSURANCE

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Abstract. Landowners rarely insure standing timber, suggesting the limited products available do not appeal to potential clientele. We estimated landowner willingness to pay (WTP) for standing timber insurance. Data were generated through a contingent valuation survey. Questionnaires were mailed to a random sample of Mississippi private forest landowners with 100+ acres of forestland. WTP for standing timber insurance was derived using an interval-censored survival model and a Kaplan-Meier Turnbull nonparametric model. The estimated WTP premium rate was approximately \$3.20 per \$1,000 of standing timber value, well below existing premium rates. This partially explains the underinsurance of standing timber among landowners.

Keywords. Insurance, nonindustrial private forest landowner, standing timber, willingness to pay

JEL Classifications. Q23, Q54, D81, G22

1. Introduction

The value of forest investments (i.e., standing timber) across the United States is substantial, and almost all of them are uninsured.[1] In Mississippi alone, for example, the value of standing merchantable timber exceeds \$31.6 billion.[2] Generally, forest investments have relatively low financial market risk compared with other investments such as stocks, bonds, and other financial instruments

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1 To illustrate, there were 547 nonindustrial private forest respondents to the survey used in this study, randomly selected from the county tax rolls. None had standing timber insurance.

2 Based on volume estimates obtained from the Mississippi Institute of Forest Inventory (http://www.mifi.ms.gov/) and Timber Mart-South prices.

(Mills and Hoover, 1982; Zinkhan, 1990); however, they are typically long term (typically exceeding 25 years from planting to financially mature timber) and are subject to other risks such as natural disasters. Natural disasters are characterized by a low probability of occurrence but a high probability of significant damage. Natural disasters such as fire (natural and anthropogenic) and storms (tornadoes, hurricanes, wind, sleet, and ice) may occur without warning and severely damage both merchantable and nonmerchantable timber. Such disasters can destroy decades of capital investment overnight. Hurricane Katrina in 2005, for example, damaged 5 million acres, with most of the affected forestlands owned by individuals or families. A 2007 wildfire in southern Georgia destroyed timber worth $65 million on more than 564,450 acres, 19,129 acres of which were nonindustrial private forest (NIPF) land. When such natural disasters happen, the financial losses for NIPF landowners can be catastrophic.

Several risk management tools to reduce potential financial losses attributable to natural disasters are available. Two examples are maintaining fire breaks and control burning to prevent or mitigate losses to arson and wildfire (Amacher, Malik, and Haight, 2005). Purchasing insurance is another possibility. Insurance is routinely employed to protect against unexpected losses or damage to a variety of high-value assets such as businesses, homes, and automobiles. The insured pays a premium fixed ex ante to the insurer for a guarantee that if losses occur, the insurer will reimburse the insured for those losses. Standing timber insurance could protect landowners from financial losses. NIPF landowners, however, rarely purchase standing timber insurance. Furthermore, there are very few insurance underwriters that provide standing timber insurance.[3]

Two issues motivate this study. First, on the supply side of the market for standing timber insurance, very little information about which premium rates are affordable and attractive to landowners is available to insurance companies. For insurers, rates must reflect actual hazard risks, and the risks must be diversifiable either by insuring large numbers or insuring properties across large areas unlikely to experience the same loss events (William, 1949). Chen, Goodwin, and Prestemon (2014) filled in this gap by studying timber insurable on the supply side and proposed associated actuarially fair premium rates. However, evaluating a new insurance product evokes fundamental questions about whether a potential product design sufficiently appeals to the potential clientele to justify its development costs (Shaik et al., 2008). Is there a demand for standing timber insurance? If so, are potential buyers willing to pay the minimum premium rates necessary to make the insurance product profitable for insurance companies? The absence of definitive answers to these fundamental questions contributes to

3 At the time this study was initiated, to the authors' knowledge, Davis-Garvin was the only underwriter providing standing timber insurance in the United States. Outdoor Underwriters entered the market as the study progressed.

the lack of standing timber insurance products currently on the market in the United States.

Second, there is little information available on how landowners' characteristics impact their demand for standing timber insurance. Without such information, insurers are unable to judge which landowners are likely to purchase standing timber insurance and target their insurance products accordingly. In light of the aforementioned issues, we explored landowner willingness to pay (WTP) for standing timber insurance. Our work focused on the key determinants of the demand for standing timber insurance and their effects on WTP.

As far as we know, no study has evaluated WTP for standing timber insurance in the United States. This study constitutes the first significant attempt to do so at a detailed, microeconomic level. We want to ascertain whether landowners are willing to purchase standing timber insurance (i.e., the current lack of standing timber insurance is not because of landowner resistance on grounds other than price) and, if so, find premium rates widely acceptable to landowners. Results of this study should be useful to insurance companies interested in providing standing timber insurance, policy makers considering financial assistance to landowners ex post catastrophic disasters, and landowners searching for protection against natural disasters.

2. Markets for Standing Timber Insurance Worldwide

Standing timber insurance markets exist in a few countries such as Denmark, France, Germany, Japan, Portugal, New Zealand, and Sweden. Worldwide, only approximately 0.5% of commercial forestland is insured (Cottle, 2007; Food and Agricultural Organization of the United Nations, 2001). According to the United Nations Environment Programme Finance Initiative (UNEP FI) Climate Change Working Group and Insurance Working Group (2008), most standing timber insurance markets exist only where there are mature insurance markets. In some such countries, standing timber insurance is common. In Scandinavia, standing timber has been insured against fire and wind losses on a national scale by mutual insurance,[4] with high insured values and relatively low volatility of loss (Cottle, 2007). In Denmark and Sweden, standing timber insurance is widespread where 68% and 90% of NIPF landowners, respectively, have insurance against fire and wind damage (e.g., Angstrm, 1982; Brunette and Couture, 2008). In most other European countries, however, standing timber insurance is not common even in countries where such insurance products exist. In Germany and France, for example, only 2% and 5% of the private forest owners, respectively, are insured against windstorm losses (Brunette and Couture, 2008; UNEP FI Climate Change Working Group and Insurance Working Group, 2008). In the Southeast

4 Mutual insurance is an insurance system owned by the insured persons who share the profits and cover claims with their pooled premiums.

Asian market, except for Japan, standing timber insurance is in its infancy, most of which is sold to oil palm companies that recognize their cash flows depend on their oil palm plantations. In Japan, where natural disasters related to tsunamis and typhoons happen frequently, the standing timber insurance market is relatively mature. A three-part standing timber insurance system consisting of a government-run standing timber insurance component, a private standing timber insurance component, and mutual relief funds for forest damage exists as countermeasures against future risks (Matsushita et al., 1995). The total insurance premium paid in Japan was approximately 2,742 million yen (US$30 million) in 2006, with an insured value of approximately 475,648 million yen (US$5.074 billion) and 386,978 hectares (Statistics Bureau, Ministry of Internal Affairs and Communications, 2008).

In the United States, early efforts to provide standing timber insurance never received serious consideration from either the forestry profession or insurance underwriters (Averill and Frost, 1933). The Phoenix Assurance Company, established in 1912, was the earliest insurance company to solicit standing timber insurance. Yet this first venture lasted only 2 years and was not successful. The current standing timber insurance market is characterized by a lack of demand, limited supply, and little competition. So far as we know, only two insurance companies in the U.S. South are providing such insurance products, and their customers account for only a very small percentage of NIPF landowners. The likely reasons for the lack of a substantial standing timber insurance market are complicated, involving both supply-side and demand-side issues. On the supply side, high exposure to catastrophic losses and accumulation of risk, inadequate forest loss data to set proper pricing levels, insufficient risk management practices, and lack of loss assessment techniques and experts may restrict private insurance firms' ability and willingness to provide standing timber insurance widely. On the demand side, although increased catastrophe risk poses difficult challenges for property owners looking for efficient ways to mitigate their exposure to risks, reasons for the lack of a standing timber insurance market are unclear. Anecdotal reasons cited by landowners include high premiums, cash flow problems over the rotation, tradition, and unfamiliarity with payment mechanisms.

3. Standing Timber Insurance Literature

Historically, the literature on standing timber insurance focused on forest fire insurance and supply-side issues. Brown (1926) as well as Kaul (1928) reviewed the history of forest fire insurance in America in the early 1900s. Kaul discussed advantages of forest fire insurance for both the insurer and insured, whereas Brown examined lessons behind early development of standing timber insurance. Both pointed out that the high rates offered by small companies, such as Globe and Rutgers Fire Insurance Company and Timber Lands Mutual Fire

Insurance Company of Portsmouth, were not attractive to large timberland owners. Brown (1928) primarily discussed forest fire actuary from the perspective of insurance companies. Shepard (1939) further discussed factors affecting successful implementation of forest fire insurance in the Pacific Coast region. He noted that hazard factors pertaining to standing timber insurance fall into two distinct categories, causative hazards[5] and contributive hazards,[6] and the misunderstanding that the introduction of insurance would decrease protection programs results from not considering the difference between the two hazard factors. Considering both demand and supply, William (1949) pointed out the underwriting problems and that the effective demand for forest fire insurance across the United States was unknown or minimal. He suggested that high rates, absence of sales promotions, and the undeveloped state of forest enterprises were the most important factors responsible for the lack of demand for forest fire insurance. Moreover, the conditions under which standing timber can be insured at reasonable cost were first noted by Wright (1950) and Shepard (1950). They agreed that forest fire insurance could be organized on a mutual basis and discussed values that should be taken into account when considering insurance of standing timber. There is sparse literature on this topic after the 1950s in the United States. The standing timber insurance market was almost nonexistent during this period.

More recently, Manley and Watt (2009) provided an excellent overview of timber insurance issues and current practices and conditions in New Zealand. Pinheiro and de Almeida Ribeiro (2013) developed models to calculate reasonable insurance premiums for Portugal in light of the dearth of insurance companies willing to provide timber insurance. Recently, some experimental studies on standing timber insurance using small samples of landowners were conducted in Europe (i.e., Brunette, Couture, and Garcia, 2014; Brunette et al., 2013; Stenger, 2008). Stenger (2008) conducted experimental studies to analyze landowner attitudes toward risks and ambiguity under three scenarios: buying insurance, self-insurance, and self-protection.[7] Brunette and Couture (2008) proposed a theoretical model to investigate the influence of public compensation on purchasing standing timber insurance contracts. They concluded that direct public financial assistance programs discourage landowners from purchasing standing timber insurance, whereas public financial assistance programs that are contingent on protection activities make standing timber insurance practices more attractive to forest owners, thereby expanding the pool of potential customers and improving the market viability of timber insurance products.

5 Causative hazards are hazards that influence how fires start (e.g., lightning or arson).

6 Contributive hazards are hazards that influence the severity of the fire once started (e.g., weather, wind direction, and forest terrain).

7 The concepts of self-insurance (actions that reduce the magnitude of losses) and self-protection (actions that reduce the probability of a loss) are introduced by Ehrlich and Becker (1972).

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Brunette et al. (2013) conducted a series of experimental designs that tested theoretical predictions about the impact of public compensation schemes and ambiguity on insurance demand for disaster-type risks. Meanwhile, a small body of literature related to the insurance of carbon credits, which can be considered a derivative of standing timber insurance, emerged (Figueiredo, Reiner, and Herzog, 2005; Subak, 2003). The insurability of carbon credits from the insurer's perspective was summarized by Wong-Leung and Dutchke (2003) (e.g., risk pooling, limited maximum possible losses, accepted insurance premium, etc.), and they also expressed concerns about the profitability and inequity (technical difficulties, adverse selection, and reinsurance) of such an insurance product. Insurance of carbon credits was also demonstrated to encourage greater forestland investment in lands subject to hurricanes (Grover, Bosch, and Prisley, 2005). Brunette, Couture, and Garcia (2014) explored determinants of WTP for insurance against forest fire risk in France. Public assistance, uncertainty about natural disaster–related risks, level of expected loss, and landowner characteristics all impacted WTP. Brunette et al. (2015) developed an actuarial insurance model for multiple natural hazards and applied it to silver fir stands in Slovakia. Gross insurance premiums varied as a function of stand age and size.

However, few studies have examined empirically the demand for standing timber insurance in the United States. Gan, Jarrett, and Gaither (2014) identified factors that influence forestland owners to purchase forest fire insurance in the southern United States, but they did not consider price effects. Before further exploration of the nuances of potential timber insurance vehicles, it is essential to ascertain that the current absence of a viable standing timber insurance market is not because of landowner resistance on grounds other than price.

4. The Correlation between Standing Timber Insurance and Agricultural Insurance

Standing timber insurance is similar to agricultural insurance in at least three dimensions: systemic risk, catastrophic risk, and adverse selection. Similar to agricultural crops, systemic risk to standing timber stems primarily from the impact of geographically extensive unfavorable events, such as wildfires, pest outbreaks, and storms, which induce significant correlation among individual landowner-level losses. Because the insured individual units are not stochastically independent, the pooled risks across landowners are not sufficiently diversified, and insurers may bear substantially higher indemnity compared with other property insurance. Like drought in crops, catastrophe risks to timber arise from events with low probability of occurrence but major and irreversible loss, such as wildfire, which can result in heavy losses for landowners. Insurers facing catastrophe risks have the intertemporal problem of matching a smooth flow of annual premium receipts to a highly variable flow of annual loss payments. Generally, insurers are not willing to cover catastrophe risks without sufficient capital markets, reinsurance markets, or government intervention to share such risks. Adverse selection arises when risks vary across the insured and the insured have asymmetric information about the risks they face. Adverse selection exists in agricultural insurance in particular because of the use of aggregate measures (mostly county levels) to estimate individual yields and rates (Coble and Knight, 2002). Similarly, forest landowners who expected potentially large losses on their standing timber would be more likely to purchase insurance against risks. Adverse selection can distort premium ratings, and mitigating it requires expanded participation to pool risks or more accurate data to classify risks. Despite the features common to both agricultural insurance and standing timber insurance, there are distinct differences between them. Timber is a long-term asset and, in that regard, is very different from annual agricultural crops. For landowners, standing timber insurance may be conceptually more similar to insurance for other real assets such as homeowners insurance than to agricultural insurance. There are other differences as well. Catastrophe risks, for example, may cause a farmer severe cash flow problems and possibly bankruptcy. In contrast, standing timber is rarely a key component of landowners' annual income; thus, landowners are less likely to suffer cash flow problems from timber losses. Also, for many forest landowners, the incentive to own forestland is not profit motivated (e.g., recreation, bequest, and nonmarket values) (U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, 2015). These incentive differences would result in different landowner willingness to adopt risk management strategies among agricultural and timber producers. Moreover, relatively stable prices and crop supplies are important for a stable national economy. To reduce income volatility facing farmers and to avoid crop insurance market failures, adequate government subsidies and reinsurance are provided as a result of the passage of the Federal Crop Insurance Improvement Act of 1980 and the Crop Insurance Reform Act of 1994. Premiums are subsidized, and private insurers are reimbursed for administrative costs and for parts of underwriting losses. Government subsidies decrease prohibitively expensive premiums. New reinsurance agreements between private companies and the government have resulted in companies underwriting widespread crop loss risks. Timber, on the other hand, has a much less direct influence on the stability of the national economy and so has not generated the same support for government subsidies and controls as agriculture. Timber, however, still has substantial impacts on local economies and individual landowners. Because in the event of catastrophic events the aggregate losses to timber insurers could be quite large, it is critically important to understand landowner willingness to purchase standing timber insurance in order to develop insurance products that are attractive to landowners and viable to insurance providers, particularly in light of the absence of government support or subsidies.

With government providing subsidies and significantly sharing in the underwriting risks, agricultural insurance has participation rates greater than

80% and has enrolled more than 200 million acres (Davidson, 2004). Overall, the agricultural insurance program in the United States over the past 30 years has gained the reputation of being "financially sound on a national scale, properly rated and effectively managed" (Glickman, 2000). Growth of agricultural insurance programs in recent decades has provided researchers with a vast database. Thus, researchers can analyze existing rather than hypothetical agricultural insurance (e.g., Coble and Knight, 2002; Coble et al., 1996; Glauber, 2004; Goodwin, 1993; Serra, Goodwin, and Featherstone, 2003; Smith and Baquet, 1996) to evaluate those insurance programs and improve rating and risk classification methodologies. However, for standing timber insurance, both products and research are in the initial stages. Thus, it is necessary to resort to hypothetical insurance policies with relatively large sample sizes to analyze factors that influence purchase decisions of standing timber insurance in order to provide insight for the potential insurance policies.

5. Conceptual Model

To examine landowner WTP for standing timber insurance, consider landowners who face the risk of a natural disaster impacting their standing timber (e.g., tornado losses) with probability p and potential loss L. The expected utility function without standing timber insurance is shown in equation (1).

$$E_0\left(u\right) = pu\left(y - L, m\right) + \left(1 - p\right)u\left(y, m\right), \tag{1}$$

where $u(.)$ is the utility function, y is income, and m is a vector of demographic characteristics and forest features. It is assumed that a landowner compares expected utility with and without standing timber insurance. With standing timber insurance, the expected utility function is shown in equation (2), in which all losses would be covered by insurance once the disaster happens:

$$E_1\left(u\right) = pu\left(y - c + i, m\right) + \left(1 - p\right)u\left(y - c, m\right), \tag{2}$$

where c is the cost of insurance, and i is indemnity. Following Hanemann (1991), the compensating variation or maximum WTP for the insurance, represented as WTP, is as follows:

$$pu\left(y - \mathrm{WTP} + i, m\right) + \left(1 - p\right)u\left(y - \mathrm{WTP}, m\right) = pu\left(y - L, m\right) + \left(1 - p\right)u\left(y, m\right). \tag{3}$$

The expected utility with or without standing timber insurance should be equal, and the landowner would buy such an insurance product only if the WTP is greater than or equal to the cost of insurance. The value of standing timber insurance in the view of the landowner is equivalently stated in equation (4), which is the dual problem to equation (3):

$$\mathrm{WTP} = f\left(p, y, m, L, E_0\left(u\right)\right) - f\left(p, y, m, L, i, E_0\left(u\right)\right), \tag{4}$$

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where f is the expenditure function. If $E_1(u) > E_0(u)$, then WTP will be positive. That is, landowners who derive positive utility from the protection against loss of standing timber insurance will be willing to pay a premium. This WTP estimate can be compared with premium rates currently available.

Equation (4) provides the rationale for our empirical model. It is easy to see from equation (4) that WTP is driven by landowners' utility function, the probability and magnitude of the potential loss, income, and other characteristics. We designed a survey that provided the necessary data to proxy these variables in our empirical model.

6. Survey Design and Data

6.1. Variant One-and-One-Half-Bounded Approach

We follow the Hite, Hudson, and Intarapapong (2002) and Shaik et al. (2008) variant of Cooper, Hanemann, and Signorello's (2002) one-and-one-half-bounded (OOHB) approach to estimate landowner WTP for standing timber insurance by developing a contingent valuation method (CVM) mail survey. The basic rationale underlying CVMs is that even without a market, there still exists a latent demand curve for the good (Hanemann, 1994). Under the assumptions of CVM, respondents know approximately what they are willing to pay for a given good and will report their true WTP for the good or lower-bound WTP when queried in surveys. In this study, we employ the variant OOHB approach instead of the more traditional single-bounded (Bishop and Heberlein, 1979) and double-bounded (Hanemann, Loomis, and Kanninen, 1991) dichotomous choice models for two reasons. First, the single-bounded approach is limited by its lack of informational efficiency (Alberini, 1995), and the double-bounded approach has been criticized for its inconsistency (Hanemann and Kanninen, 1996; McFadden and Leonard, 1993) and biased responses (Altaf and DeShazo, 1994; Cameron and Quiggin, 1994). The OOHB approach proposed by Cooper, Hanemann, and Signorello (2002) overcomes the problems of informational efficiency and follow-up response bias in those two approaches. In the OOHB approach, respondents are asked a follow-up question only if the second price is consistent with the range of the respondent's valuation of the good. Second, "zero" responses in CVM surveys are not uncommon because of the corner solutions of the consumption of a good. "Zero" values may represent protest behavior, or the good may not contribute to the individual's utility (Kriström, 1997; Strazzera et al., 2003). In traditional referendum-style contingent valuation surveys, respondents are often assumed to be "in the market" during the survey. However, when many respondents with zero WTP are present in the sample, a discontinuity can occur in the WTP distribution, and consequently, traditional estimation of WTP may result in a biased estimate of mean WTP and poorly estimated marginal covariate effects (Haab, 1999). To solve this problem, similar to the well-known spike model (Kriström, 1997), the variant OOHB format (e.g., Hite, Hudson, and Intarapapong, 2002; Shaik et al., 2008) differentiated between zero WTP and positive WTP in the survey and added a term to the interval-censored likelihood function that captured the zero WTP information.

To provide a framework for the WTP questions, respondents were provided a scenario in which a hypothetical insurance product for standing timber was offered. The hypothetical insurance product covered multiple perils landowners may encounter. The scenario was described as follows: "Please assume you are provided a standing timber insurance product that covers standing timber losses due to natural hazards, including fire (natural wildfire or arson), windstorm (hurricane, tornado), insects, disease, sleet, hail, flood, and timber theft. Now given the following deductible level and premium rate, please indicate if you are willing to pay the calculated insurance premium."

In accordance with standing timber insurance contracts in the real world, in this scenario landowners were told to insure all of their forestland in a county if they wanted to purchase any standing timber insurance in order to eliminate adverse selection. Following the format of the variant OOHB approach, landowners were given a single annual premium rate first, and a follow-up question was asked only if the respondent's answer was negative for the first question. In the follow-up question, landowners were asked if they would pay any positive amount for the insurance given a specific coverage level. This follow-up question differentiates between positive WTP responses and zero (or negative) WTP responses and allows for a greater and more definitive delineation of censoring points in the likelihood function (Shaik et al., 2008). Additionally, the convention of coding "Don't know" as a "No" vote, as was done in Hite, Hudson, and Intarapapong (2002) and Shaik et al. (2008), was employed. The referendum-style questions presented in the survey were the following:

Q1: If the deductible level for the product is *a*% and the premium rate is \$*b* per \$1,000, would you be willing to purchase the insurance?
Q2: If your answer to the first question is NO, would you be willing to pay any positive amount for this product with the *a*% deductible level?

Although the main threats to both timber and agricultural crops are natural hazards, timber is typically viewed as an asset rather than a source of annual income, and given that natural hazards occur infrequently but with the potential for severe loss, the deductible level in this study should mirror that of property insurance (i.e., home insurance), which traditionally sets 1% of the property value as the lowest possible deductible value and 5% (or more) as the highest. In contrast, crop insurance traditionally treats 15% to 25% of the total value of crops as the normal deductible level. The deductible level, *a*, was set to 3% of the total standing timber value.

Premium rates reflect the insurer's forecast of the risk exposure on the policy and are typically derived from historical payouts on similar policies in the region, coverage level, and various other classification variables used for risk classification. The literature provides very little guidance on appropriate premium rates for standing timber insurance covering multiple hazards in the United States. Holecy and Hanewinkel (2006) proposed an insurance model to calculate risk premiums for insuring coniferous stands in southwest Germany against storm damage, in which the computed premium rate ranged from €0.77/ha to €4,429/ha (US$0.44/ac. to US$2,525/ac.). Brunette et al. (2015) computed actuarially fair premium rates for fir stands in Slovakia covering multiple hazards ranging from €5.62/ha to €6,312.81/ha (US$3.21/ac. to US$3,607.32/ac.). Chen, Goodwin, and Prestemon (2014) estimated actuarially fair premium rates based on Florida timberlands for fire hazards only, which ranged from means of $20.41/ac. to $35.41/ac. depending on the model specifications. However, in this study, considering that the value of standing timber varies with total acres, site quality, tree species, and tree size, the insurance premium rate is expressed in dollars per $1,000 of insured value for survey simplicity. In the survey, $1.00 per $1,000 was the lower bound on premium rates presented to respondents. To our knowledge, Davis-Garvin, a firm that did offer standing timber insurance covering multiple perils (e.g., fire, wind, flood, ice, and theft) at the time of this study, had a maximum rate of $12.50/$1,000 for standing timber insurance in previous years. Hence, $14.00/$1,000 was designated as the maximum of premium rate offered, which should capture the upper bound for WTP of most landowners. In 2006, the average premium rate for standing timber insurance in Japan was ¥5.60/¥1,000 (Statistics Bureau, Ministry of Internal Affairs and Communications, 2006); therefore, US$6.00/US$1,000 was utilized as the benchmarked median premium rate in the survey. The premium rate, b, was varied from $1.00 to $14.00, and landowners randomly received a survey with one of the following rates: $1.00, $2.00, $3.00, $4.00, $5.00, $6.00, $8.00, $10.00, $12.00, or $14.00 per $1,000.

6.2. *Empirical Setting*

Obviously, WTP for standing timber insurance is a function of not only product-specific attributes but also landowner characteristics such as risk perception, risk aversion, and the ability to manage risk with other mechanisms. Factors included in the analyses were landowners' level of risk perception, degree of risk aversion, importance of risk management as an alternative to standing timber insurance, participation in liability insurance for forestland, loss experience, and impact of governmental programs. Additional factors included forestland characteristics, such as ownership size and species, and demographic factors, such as age, land tenure, and income (a copy of the survey is available upon request). These variables are described subsequently.

6.2.1. Risk Perception and Risk Aversion

Expected utility theory implies that WTP for insurance depends primarily on a combination of the individual's level of risk perception and the individual's degree of risk aversion (Pennings et al., 2002). Risk perceptions reflect a landowner's belief about the probability of certain hazards actually occurring, whereas risk aversion reflects a landowner's willingness to accept, or comfort with, risk. Landowners perceiving greater levels of insurable risk and being more risk averse are expected to have greater demand for standing timber insurance. Risk perception and risk aversion were measured using a Likert-scaling procedure because of the simplicity of measurement.[8] Such self-assessed strength of rating scales are reliable and valid and thus are most commonly used (e.g., Pennings and Garcia, 2001; Pennings and Smidts, 2000). For measures of risk perception, respondents were asked to rate their concern for three types of risk on a 5-point scale ranging from 1 (not concerned) to 5 (extremely concerned). Those types of risk were (1) risks because of physical natural disasters such as fire, hurricanes, tornadoes, ice storms, drought, or flood; (2) risks because of biological natural disasters such as insects, disease, or animal damage; and (3) risks because of liability associated with timberland ownership such as hunting-related liability, liability for personal injury to those on your land, liability for escaped control burns, and so forth. These three questions reflected landowners' risk perception associated with forest management/investments as related to natural disasters and liability, respectively. For risk aversion measurements, respondents were asked to rate their level of agreement for the following five statements on a Likert scale of 1 (strongly disagree) to 5 (strongly agree): (1) In the conduct of business, I prefer certainty to uncertainty; (2) I am willing to accept the risks of timber ownership, including fire, hurricanes, tornadoes, ice storms, insect and disease, timber theft, and liability; (3) I am willing to take higher financial risks in order to realize higher than average returns; (4) I am reluctant to adopt new ways of doing things until I see them working for others; and (5) I am more concerned about large losses to my forest investment than about missing a substantial gain. Note that answers to questions (2) and (3) had to be coded in reverse for the analysis, so that a 1 (strongly disagree) on items (2) and (3) is associated with risk aversion and a 5 (strongly agree) is associated with risk seeking. The average overall scores for both the risk perception and risk aversion questions are used instead of using the specific score of each question, with higher scores indicating more risk perception and more risk aversion. The use of a composite score is supported by prior studies that combined a set of response-scale questions into a single indicator of risk attitudes and perception (e.g., Pennings and Garcia, 2001; Pennings, Wansink, and Meulenberg, 2002; Sherrick et al., 2004; Smidts, 1997). For the analysis, the

8 Other researchers have used more detailed experimental methods to measure landowners' risk perception and risk preference (e.g., Andersson and Gong, 2010; Brunette et al., 2013), but the Likert scales used in this study are easy to employ and provide valid measures.

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average overall scores for risk perception and risk aversion measurements are further reduced to two dummy variables, with "1" indicating that the perceived risk was high or that the respondent was highly risk averse and "0" indicating the perceived risk was low or that the respondent was not risk averse.

6.2.2. *Risk Management Alternatives*

NIPF landowners have several timber management practices available that are likely to mitigate the risk of natural disasters. Landowners' opinions about the effectiveness of these alternative risk management strategies may influence their demand for standing timber insurance. Landowners who engage in timber management practices that mitigate their susceptibility to natural disasters may be less likely to purchase standing timber insurance because their risk has been reduced by their actions; conversely, their willingness to engage in risk management activities may indicate a willingness to engage in all types of risk management, including buying insurance. In the survey, risk management activities involved two instruments: (1) thinning to reduce the susceptibility to forest insects and diseases and (2) control burning to reduce the amount of fuels available in case of a wildfire. The landowners were asked to rate the effectiveness of these risk management strategies on a Likert scale of 1 (not effective) to 5 (extremely effective). Although there are more timber management options available that landowners may use to mitigate risk, we only include these two as general indicators of the effect of such timber management practices on WTP. The benefits of control burning and thinning are generally well known and thus serve as good proxies for alternative risk management strategies in general. Practices to reduce damage from ice storms or loss from timber theft, for example, are less commonly applied and thus less suitable as proxies.

6.2.3. *Liability Insurance*

Liability coverage is protection against injury or damage claims made by third parties against the forest ownership and is not related to standing timber insurance (i.e., hunting insurance or timberland insurance).[9] Having liability insurance may be correlated with demand for standing timber insurance. Some landowners may be concerned about financial losses in general and not specifically concerned about the cause. If such landowners own liability insurance, it may indicate a willingness to purchase insurance that would include standing timber insurance if it were available. In contrast, purchasing liability insurance for forestland may negatively impact the probability of purchasing standing timber insurance by reducing the funds available for other forestry-related insurance.

9 Timberland insurance provides coverage that "the insured would become legally obligated to pay because of bodily injury or property damage caused by an occurrence arising out of the ownership or use of the designated timberland" (from a Davis-Garvin Insurance Agency policy).

6.2.4. Loss Experience

Previous experience with significant timber losses may also affect landowner willingness to purchase timber insurance. Landowners were asked whether they had experienced losses of more than 5% of their total timber value in the past 10 years because of natural disasters. Such past losses clearly demonstrate that forest investments are risky and losses can be significant, thereby increasing the probability of purchasing insurance. The gambler's fallacy, however, suggests that some who have experienced losses in the past may believe that they are thus less likely to suffer losses in the future. Such individuals would be less likely to purchase insurance.

6.2.5. Perceived Public Programs

The impact of public programs on NIPF landowner decisions to purchase an insurance product for windstorm coverage and other natural events was analyzed by Brunette and Couture (2008). They concluded that providing public financial assistance to NIPF landowners after natural disasters may reduce their incentive to purchase insurance. Therefore, effects of public programs on NIPF landowner willingness to purchase standing timber insurance are also explored. One question related to public programs is considered: whether landowners themselves or other landowners they personally know have ever received financial or technical assistance from public agencies after timber losses in the past. However, we need to point out that although some landowners claimed to be aware of government financial aid programs, in fact, no such financial programs exist. We actually test whether the illusory expectation of governmental financial aid influences landowner insurance behavior.

6.2.6. Forestland Features

Three variables were used to represent forestland characteristics: ownership size, forest type, and location. Ownership size is expected to be positively correlated with the likelihood of purchasing standing timber insurance, as in general, larger land holdings represent greater values at risk. Of the several forest types considered, pine plantations represent greater out-of-pocket investments, primarily in establishment costs, compared with other forest types; thus, the need to protect the investment is more obvious and likely to increase WTP for standing timber insurance. Forestland located in the coastal region of Mississippi is more frequently impacted by hurricanes, forestland located in the north is more frequently impacted by sleet and ice storms, and forestland located in the central portion of the state is affected by both of these factors but to a lesser extent. A priori, it is hard to predict in which location landowners would be more willing to buy standing timber insurance. Highway 84 and Highway 82 are major east–west highways in Mississippi and were used as boundaries for these three regions for the purpose of this survey.

6.2.7. *Landowner Characteristics*

Landowner demand for standing timber insurance is likely influenced by ownership characteristics, which were represented by two variables: ownership objectives and length of ownership. Landowners were asked to identify their primary objective for their forestland property from the following list: timber production, land investment, hunting, recreation, or bequest. Those interested in timber production or investment value likely have more invested in their timber and have greater expectations for timber income, and thus greater demand for standing timber insurance than landowners with other objectives for their forestland. For the analysis, answers to the ownership objective question were reduced to a dummy variable, with "1" indicating timber production and land investment and "0" indicating others. The impact of length of ownership on WTP for standing timber insurance is ambiguous. The longer landowners own forestland, the more likely they are to have experienced losses because of natural disasters. In contrast, they may become more experienced with alternative risk mitigation strategies such as thinning or control burning. A number of other socioeconomic variables (i.e., age, race, residence, education level, income, form of ownership, etc.) may influence landowner demand for standing timber insurance. Of these, only age and income were employed in the model. All variables used in the analysis, with expected signs, are presented in Table 1. The survey is available online (http://www.cfr.msstate.edu/forestry/docs/insurance_wtp.pdf).

7. Estimation Procedures

A mail survey of Mississippi forest landowners was implemented in the fall of 2010 to generate the necessary data. Before administration of the full survey, pretests of the initial survey were conducted with NIPF landowners attending Mississippi Forestry Association meetings for question clarity and appropriateness. The pretests were also conducted to make sure the survey format was incentive compatible (i.e., respondents would act on the stated intention) and that landowners took the questions seriously. Appropriate adjustments to the survey instrument were made. To eliminate as many nonforestry holdings as possible, the sample frame was limited to landowners who owned at least 100 acres of forestland in Mississippi. This yielded a list of approximately 20,000 owners. Among them, a random sample of 2,000 landowners was selected and used in the mail survey. Following Dillman's (2000) total design method, a presurvey letter announcing the upcoming study was mailed to the selected landowners 1 week before the initial mailing. A reminder card was sent to all landowners 2 weeks after the initial mailing. A second mailing was sent after a month to those who did not respond to the first mailing. A third (final) mailing was sent after another month to landowners who did not respond to the second mailing.

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Table 1. Definition of Variables Used in the Analysis and the Expected Sign

Variables	Definitions	Expected Sign
Dependent variables		
Premium rate	\$1.00, \$2.00, \$3.00, \$4.00, \$5.00, \$6.00, \$8.00, \$10.00, \$12.00, \$14.00	
Vote	Response to the first referendum (0 = "No"; 1 = "Yes")	
Pay_any	Respondent not willingness-to-pay (WTP) predetermined premium rate, but WTP some positive amount (0 = "No"; 1 = "Yes").	
Independent variables		
Acreage	Logarithm of total forestland acreage owned	?
%Cutover	Percentage of natural pine to total acreage owned	–
%Natural pine	Percentage of hardwood to total acreage owned	–
%Hardwood	Percentage of mixed pine and hardwood to total acreage owned	–
%Mixed	Percentage of cutover land to total acreage owned	–
%Planted pine	Percentage of planted pine to total acreage owned	Base
Risk perception	Dummy = 1 if the average response to questions designed to measure landowner concern was >3. Landowners rated concerns about the impact of various types of forest-related risk on a five-point scale: 1 = not concerned to 5 = extremely concerned.	+
Risk aversion	Dummy = 1 if the average value to questions designed to measure landowner risk aversion was >3. Landowners rated their risk aversion based on five-point scale: 1 = not risk averse to 5 = very risk averse.	+
Alternatives	Dummy = 1 if the average value to questions designed to measure landowner belief in the effectiveness of management practices to reduce risk was >3. Landowners indicted the effectiveness of practices in reducing natural risks on five-point scale: 1 = not effective to 5 = very effective.	–
Program	Dummy = 1 if the landowner claimed to be aware of any public disaster relief program for timberland owners; 0 otherwise	–
Liability	Dummy = 1 if the landowner has purchased any kind of liability insurance related to forestry; 0 otherwise	+
Loss	Dummy = 1 if the landowner has experienced losses >5% of the standing timber over the past 10 years; 0 otherwise	+
South	Dummy = 1 if forestland is in south Mississippi; 0 otherwise	?
North	Dummy = 1 if forestland is in north Mississippi; 0 otherwise	?
Central	Dummy = 1 if forestland is in central Mississippi; 0 otherwise	Base
Goal	Dummy = 1 if the landowner's primary goal is timber production; 0 otherwise	+
Years	Dummy = 1 if years of landownership is >30; 0 otherwise	?
Age	Landowner age in years	?
Income	Ordered categorical from 1 to 11 (1 = <\$30,000; 11 = >150,000, with \$10,000 as interval)	?

To analyze the responses to the aforementioned contingent valuation questions, we employed a modified version of the interval-censored model (Cameron, 1988; Cameron and James, 1987) that allowed for uncensored values of zero WTP for those respondents who answered "No" to the first question. We assumed that a landowner has a latent WTP*, which can be expressed as follows:

$$\text{WTP}^* = x\beta + \varepsilon, \tag{5}$$

where x is a vector of explanatory variables, β is a conformable vector of coefficients, and ε is an independently and identically distributed normal error with mean zero and variance σ^2. Rather than directly observed WTP*, what is actually observed from the data is whether a respondent indicated a WTP greater than or less than the particular designated premium rate, c. For a fixed coverage and predetermined premium rate level, there are three possible outcomes: (1) The respondent replies "Yes" to the first question, which indicates that the presented premium rate is the lower bound for the distribution of the WTP, while infinity marks the upper bound. The WTP falls in the range of $(c, +\infty)$. (2) The respondent replies "No" to the first question and "Yes" to the second question, which indicates that zero is the lower bound, and the prespecified premium rate is the upper bound, for a range of $(0, c)$. (3) The respondent replies "No" to both of the questions, which indicates that the WTP for the standing timber insurance policy is zero. Although Shaik et al. (2008) argued that in case (3) the lower bound of the possible distribution of WTP is negative infinity and zero is the upper bound, such a range is not adopted in this study. A negative WTP can be ruled out on theoretical grounds in that insurance is an existing and well-known market commodity readily available for purchase as opposed to nonmarket goods. This interval-censored model is also called a partial-censored model because one point of the distribution corresponding to individuals with zero WTP is not censored (Hite, Hudson, and Intarapapong, 2002). The original log-likelihood function (LLF) is given in Cameron (1988) and is modified as equation (6):

$$\begin{aligned}\text{LLF} = \sum_{i \in I_1} \ln \Phi\left(\frac{x_i\beta - c_j}{\sigma}\right) + \sum_{i \in I_2} \ln \left[\Phi\left(\frac{c_j - x_i\beta}{\sigma}\right)\right. \\ \left. - \Phi\left(\frac{-x_i\beta}{\sigma}\right)\right] + \sum_{i \in I_3} \ln \frac{1}{\sigma}\phi\left(\frac{-x_i\beta}{\sigma}\right),\end{aligned} \tag{6}$$

where ϕ is the probability density function and Φ is the cumulative distribution function of a normal distribution, respectively; c_j is the premium rate presented to a landowner, and x_i represents a row vector of explanatory variables for the ith respondent; and β is a vector of parameters to be estimated, and σ is the standard error. Cameron (1988) showed that coefficient estimates from the interval-censored model above can be interpreted loosely as the marginal effect of x on WTP. Duffield and Patterson (1991) noted that the interval-censored formulation is simply a reparameterization of the typical logit or probit models discussed in Hanemann (1984), which makes mean WTP and confidence intervals (CIs) easily calculated. Hence, the mean WTP value is simply:

$$E\,(\text{WTP}) = \bar{x}\beta, \tag{7}$$

where $\bar{x}$ is a vector of the sample average of the independent variables, and the CI is suggested by Cameron and Quiggin (1994):

$$\text{CI}_{1-\alpha}\,[E\,(\text{WTP})] = \bar{x}\hat{\beta} \pm t_{\alpha/2}\sqrt{\bar{x}\Omega\bar{x}'}, \tag{8}$$

where Ω is the variance-covariance matrix of the parameter estimates. To make the results more robust, the 95% CI for the mean WTP was also estimated by Krinsky and Robb (1986) bootstrapping methods with 5,000 repeated subsamples.

The rigorous assumption of a specific normal distribution of the error term in parametric econometric models when explaining landowner purchase behavior led us to consider estimating WTP using nonparametric methods. The basic idea is that a priori there is no reason why landowner purchase decisions should necessarily follow a normal distribution. The most straightforward nonparametric model is based on the idea that the demand curve should be nonincreasing in price. In order to compare the mean WTP calculated without an error term assumption with the parametric estimate, we use the Turnbull (1976) estimator as the benchmark. One of the advantages of the Turnbull estimator over other nonparametric estimators is its ease of use. Only a table including the range of bids and the number of "Yes" and "No" responses is required. Following Haab and McConnell (2002, pp. 60–112), only responses to the first question were used, which was treated as a single-bounded format. The Turnbull approach estimates WTP $E(\text{LB}_{\text{WTP}})$ as a lower-bound approximation to expected WTP.

8. Results

The final sample size was 1,826, after accounting for incorrect addresses, property sales, and landowner deaths. A total of 547 questionnaires were returned, for a 30% response rate. However, because of missing data on variables of interest to this study, 30 questionnaires were unusable, yielding a usable sample size of 517. The sample included landowners with properties in all 82 Mississippi counties. Given that the survey was unusually long (8 pages) with detailed financial questions, this response rate was better than expected. To assess potential nonresponse bias, we conducted three tests. First, mean demographic characteristics of the respondents were compared with those Mississippi landowners in the 2005 National Woodland Owner Survey (U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, 2015). We compared the means of key demographic variables in our sample with those

Table 2. Descriptive Statistics of Variables Used in the Analysis

Variables	Mean	Standard Error
% Response of WTP questions (Yes Yes)	0.289	0.454
% Response of WTP questions (No No)	0.382	0.483
% Response of WTP questions (No Yes)	0.329	0.510
Acreage	5.472	1.091
%Cutover	0.073	0.211
%Natural pine	0.124	0.226
%Hardwood	0.210	0.319
%Mixed	0.186	0.285
%Planted pine	0.408	0.369
Risk perception	0.696	0.460
Risk aversion	0.634	0.482
Alternatives	0.327	0.470
Program	0.141	0.349
Liability	0.298	0.458
Loss	0.544	0.499
South	0.240	0.427
North	0.309	0.463
Central	0.451	0.498
Goal	0.594	0.492
Years	28.483	16.504
Age	65.389	12.344
Income	7.669	4.625

Note: WTP, willingness to pay.

of Mississippi landowners as reported in the National Woodland Owner Survey and found that population risk perception,[10] age, and land tenure did not differ significantly between them.[11] Second, we tested for differences in WTP, total acreage, and forested acreage between surveys returned after each mailing and found no significant differences in WTP, total acreage, and forested acres between mailings. Finally, we tested for differences in total acres and forested acres owned by respondents and nonrespondents and found no significant differences. In combination, these tests indicate that response bias is not a concern.

Descriptive statistics of variables used in the estimation of empirical models of landowner willingness to purchase standing timber insurance are reported in Table 2. Of the 517 respondents, 28.9% were willing to pay the designated premium rate for the standing timber insurance, and 32.9% were willing to pay

10 We limited the range of ownership of the National Woodland Owner Survey from 100 acres to 10,000 acres given that our survey was truncated at 100 acres at the lower end and the largest ownership size in our sample was 8,500 acres. The risk perceptions in the National Woodland Owner Survey included fire, insects, or plant diseases and wind or ice storm.

11 The mean value of age was 67.5, land tenure was 31.2, and perception was 0.68 from the National Woodland Owner Survey. The results of *t*-tests show that there is no significant difference of the variables from those of our respondents.

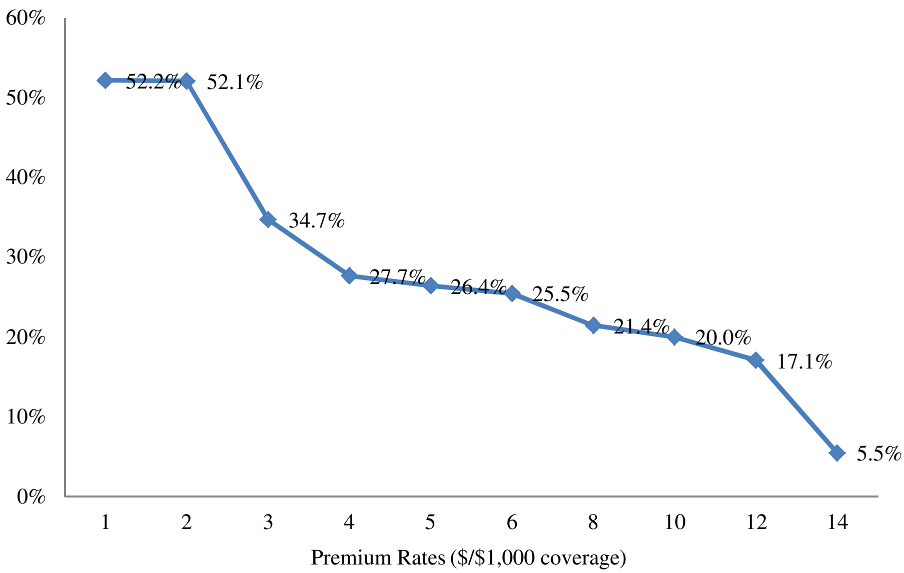

Figure 1. Percentage of Respondents Indicating They Were Willing to Purchase Standing Timber Insurance at Designated Premium Rates (i.e., those who responded "Yes" to the offered bid value in their survey)

some positive amount for this product but less than the designated premium rate. The percentage of respondents willing to purchase standing timber insurance with the designated premium rates is illustrated in Figure 1. Consistent with our expectations, the percentage of respondents willing to purchase insurance decreased with the increasing premium rates from 52.2% for $1 per $1,000 to 5.5% for $14 per $1,000.

Respondents were 65 years old on average and had median household incomes of approximately $80,000. Because we only surveyed landowners having more than 100 acres of forestland, the average ownership size was 238 acres. More than 40% of the land was planted with pine. For 59.4% of the survey respondents, the primary goal of timber ownership was revenue generation. More than half of respondents (54.4%) had previously experienced loss greater than 5% of the standing timber value or knew someone who had. Almost 70% of respondents were very or extremely concerned about the risks associated with standing timber. Slightly more than 63% of respondents indicated they were risk averse. Only 14% respondents indicated awareness of government programs that provided financial or technical assistance to landowners who suffered losses to standing timber because of natural disasters. Thirty-two percent of respondents believed risk-reducing management practices were effective. All these facts implied that the potential for a substantial standing timber market exists.

Table 3. Interval-Censored Estimates of Landowners' Willingness to Pay for Standing Timber Insurance

Parameters	Estimated Coefficient	Standard Error
Constant	0.524	1.431
Acreage	0.049	0.181
%Cutover	– 1.471*	0.797
%Natural pine	– 1.340*	0.798
%Hardwood	– 0.999	0.622
%Mixed	– 0.805	0.659
Risk perception	2.001***	0.382
Risk aversion	0.914***	0.356
Alternatives	– 2.071***	0.376
Program	0.317	0.492
Liability	0.663*	0.404
Loss	0.875**	0.363
South	– 0.132	0.437
North	0.378	0.396
Goal	0.865**	0.376
Years	0.027**	0.011
Age	– 0.014	0.016
Income	0.078*	0.042
σ	3.353	0.134
−2Log likelihood	– 1,661.883	

Note: Asterisks (∗, ∗∗, and ∗∗∗) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Estimation results of the parametric model, which included all relevant factors for landowners' WTP for standing timber insurance, are reported in Table 3. We also estimated a model that only included a constant term. The results for that model implied that the "average" landowner was willing to pay \$3.087 for standing timber insurance disregarding all explanatory variables. The estimated coefficients for the model reported in Table 3 were estimated using an interval-censored model and can be interpreted similarly to those in the standard probit model proposed by Cameron and James (1987).[12] The coefficients can be interpreted as marginal contributions to WTP in dollars for those variables. Consistent with prior expectations, both risk perception (\$2.001) and risk aversion (\$0.914) were significant determinants of landowner WTP for timber insurance. Belief in the effectiveness of forest management activities to reduce risk decreased WTP (\$−2.071) for standing timber insurance. Previous loss experience (\$0.875) and income (\$0.078) were positively related to WTP, whereas the perception that government programs were available to offset losses to natural disasters was not significant. Landowners whose

12 Following Hite, Hudson, and Intarapapong (2002), all the numbers in the parentheses represent marginal willingness-to-pay increase or decrease of the variables.

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Table 4. Estimated Mean Willingness-to-Pay (WTP) Premium ($/$1,000) for Standing Timber Insurance

Methods	Estimated Mean WTP
Interval-censored survival model	
Mean WTP point estimate	$3.20
95% Confidence interval	[$2.74, $3.62]
95% Krinsky-Robb confidence interval	[$2.80, $3.60]
95% Bootstrapping confidence interval	[$2.67, $3.73]
Turnbull nonparametric estimate	
Lower-bound mean WTP	$2.63
Upper-bound mean WTP	$4.06

primary objective was to generate revenue directly from their timber (timber production and land investment) were willing to pay a higher premium ($0.865) than landowners whose primary objective was not financial. Years of forest management experience was also positively related to WTP ($0.027). Forest types, where significant, had the expected signs. Increasing shares of natural pine stands ($−1.340) and cutover land ($−1.471) at the expense of pine plantations decreased WTP. Mixed pine hardwood and hardwood stands were not significantly different than pine plantations. Previous purchases of liability insurance, ownership size, age, and region of the state were not significantly related to WTP.

Estimated WTP values and CIs for standing timber insurance based on both the interval-censored survival method and the Turnbull method are reported in Table 4. The estimated mean WTP premium for standing timber insurance was $3.203 per $1,000 based on the parametric results. The 95% Krinsky-Robb CI was between $2.80 and $3.60, and the bootstrapping interval was between $2.67 and $3.73. The Turnbull lower-bound estimate of the mean WTP for standing timber insurance was $2.63 (and $4.06 as higher-bound mean WTP). Thus, on average, respondents were willing to pay between $2.67 and $4.06 per $1,000 for standing timber insurance, approximately half of the actual premium rate of $6.00 per $1,000 currently available.

9. Discussion

Our results clearly demonstrate that landowners have "effective" interest in standing timber insurance, but the mean WTP premium rate was well below the existing premium rate currently available. However, in addition to knowing the mean WTP premium rate, standing timber insurance providers may also be interested in identifying landowners who are most likely to purchase insurance and are willing to pay the desired insurance premium rates. To illustrate the importance of certain characteristics, the impact of three counterfactual scenarios

Table 5. Predicted Mean Willingness to Pay (WTP) of Standing Timber Insurance for Landowners by Selected Characteristics

		Base		Scenario 1		Scenario 2		Scenario 3	
Variables	$\hat{\beta}$	$\bar{X}$	$\bar{X}\hat{\beta}$	$\bar{X}$	$\bar{X}\hat{\beta}$	$\bar{X}$	$\bar{X}\hat{\beta}$	$\bar{X}$	$\bar{X}\hat{\beta}$
Forestland features									
Acreage	−0.049	5.472	0.269	5.472	0.269	5.472	0.269	5.472	0.269
%Cutover	−1.471	0.073	−0.108	0.073	−0.108	0.073	−0.108	0.173	−0.255
%Natural pine	−1.340	0.123	−0.164	0.123	−0.164	0.123	−0.164	0.223	−0.298
%Hardwood	−0.999	0.210	−0.209	0.210	−0.209	0.210	−0.209	0.210	−0.209
%Mixed pine	−0.805	0.186	−0.150	0.186	−0.150	0.186	−0.150	0.186	−0.150
Landowner attributes									
Year	0.027	28.483	0.769	28.483	0.769	28.483	0.769	28.483	0.769
Age	−0.014	65.389	−0.942	65.389	−0.942	65.389	−0.942	65.389	−0.942
Income	0.078	7.669	0.601	7.669	0.601	7.669	0.601	7.669	0.601
Risk perception	2.001	1	2.001	1	2.001	0	0.000	0	0.000
Risk aversion	0.914	1	0.914	1	0.914	0	0.000	0	0.000
Alternatives	−2.071	0	0.000	0	0.000	1	0.000	1	0.000
Program	0.317	0	0.000	0	0.000	0	0.000	0	0.000
Liability	0.663	0	0.000	0	0.000	0	0.000	0	0.000
Loss	0.875	1	0.875	0	0.000	0	0.000	0	0.000
South MS	−0.132	0	0.000	0	0.000	0	0.000	0	0.000
North MS	0.378	0	0.000	0	0.000	0	0.000	0	0.000
Goal	0.865	1	0.865	0	0.000	0	0.000	0	0.000
Constant	0.524	1	0.524	1	0.524	1	0.524	1	0.524
Simulated WTP			\$5.245		\$3.505		\$0.520		\$0.309
Predicted WTP at the mean			\$3.203		\$3.203		\$3.203		\$3.203

was simulated (Table 5). The "base case" scenario used the mean values of the continuous explanatory variables and the most frequent values for interval and dummy explanatory variables to represent the typical NIPF landowner. Thus, the base case NIPF landowner was "65 or more" years old, had a household income approximately \$80,000, targeted timber revenue (Goal = 1), did not expect government help after disasters (Program = 0), experienced loss before (Loss = 1), believed that forest management was not effective in reducing risk (Alternatives = 0), perceived greater levels of insurable risk (Risk perception = 1), and was risk averse (Risk aversion = 1). This typical landowner owned 238 acres in the central portion of Mississippi that was 40% planted pine, 18% mixed pine, 21% hardwood, 12% natural pine, and 7% cutover land. With these characteristics, the estimated mean WTP of standing timber insurance was \$5.245, close to the actual insurance premium rate provided in the market.

The three counterfactual scenarios illustrated the importance of targeting specific landowners. The first scenario illustrated the impacts of ownership objectives and previous loss experience. Information about ownership objectives

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and previous loss experiences can easily be ascertained by simple surveys and thus provides a way to segment the landowner clientele. The simulation involved changing the primary goal from timber revenue to others (i.e., changing Goal from 1 to 0) and invoking a lower past loss experience (changing Loss from 1 to 0). All else being equal, this change reduced the mean WTP of standing timber insurance premium rate from $5.245 to $3.505.

In scenario 2, we simulated the effects of landowners' risk attitudes and risk management alternatives in addition to the changes specified in scenario 1, redefining the typical landowner so that risk aversion and belief in risk management alternatives were no longer constraining factors (i.e., setting Risk perception = 0; Risk aversion = 0, and Alternatives = 1). This resulted in a cumulative reduction of mean WTP to $0.520. Finally, scenario 3 illustrated the simultaneous impact of targeting characteristics based on scenario 1 and scenario 2, which involved changing forestland features (i.e., increase cutover and natural pine land by 10% each), decreasing length of ownership by 1 year, and decreasing income by $10,000. The mean WTP was then only $0.309. These simulation results suggested that to better develop a standing timber insurance market, it is important that insurance providers target landowners who have more planted pine, higher income, a long history of forestland ownership, and timber revenue as a their primary goal, as well as having previously experienced loss and having fewer risk management alternatives.

10. Conclusions and Implications

This study is the first significant attempt to answer the fundamental question of whether standing timber insurance sufficiently appeals to the potential clientele to justify its development costs. This study provides a wealth of information with potential uses in a broad range of applications. After conducting an extensive survey of landowners' WTP for an insurance product covering standing timber loss, we found that landowners have an "effective" interest in insurance—that is, approximately 61% of them are willing to pay some positive value for the product. Using standard WTP techniques, we assessed the premium rates for a hypothetical standing timber insurance product with 3% deductible level and multiple perils. Landowners were willing to pay a higher premium rate if their primary goal for timberland ownership was timber revenue, they were risk averse and had substantial income, they had previously experienced a loss, and they were concerned about risks to standing timber. Factors that decreased landowners' WTP for a higher premium rate included a greater proportion of cutover land and natural planted pine. However, in contrast to our hypothesis, known government programs did not appear to significantly influence landowners' WTP. In general, landowners were willing to pay premium rates of $3.203 per $1,000 value of standing timber. The results of our survey confirmed the existence of a significant, positive demand for standing timber insurance, but the mean WTP was well below the existing premium rates provided by insurance companies. This partially explains the underinsurance phenomenon for natural disaster risks among landowners. However, despite the fact that the current premium rate is well above the mean WTP, the market for standing timber insurance is still attractive. More than 20% of the respondents presented with an $8 or $10 per $1,000 premium rate indicated that they were willing to pay that amount. Considering that in Mississippi there are more than 25,000 landowners with properties larger than 100 acres, even if a small proportion of landowners are willing to pay the required premium rates, there would be a substantial market for standing timber insurance. Our study also provided strong evidence that insurers should target landowners with certain characteristics to generate the desired premiums (e.g., landowners who are more risk averse and have experienced a large loss).

Although the sample is geographically restricted to Mississippi NIPF landowners, it is important to note that they have forestland features and landowner characteristics similar to other landowners across the southern United States. With minor modifications, the landowner survey and analysis methods conducted for Mississippi can provide the basis for a continuing study of the standing timber insurance market in the United States. A number of issues still need to be addressed. First, testing of the relationships between WTP for standing timber insurance and its product attributes (i.e., different deductibles, insured perils, insurance providers, etc.) in other empirical settings is necessary in order to tailor insurance policies to landowners' preferences and thus make standing timber insurance more popular. Second, it would be worthwhile to identify homogeneous consumer segments with respect to their preferences for standing timber insurance attributes to allow targeting specific landowner groups. Third, like crop insurance, further investigation is warranted to determine the effects of government subsidies on premium rates of standing timber insurance in the United States. Such studies will provide useful information for the future development of the standing timber insurance market.

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