Consumer Willingness to Pay for a Naturally Decay-Resistant Wood Product

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ABSTRACT: *Chromated copper arsenate (CCA) is the most widely used chemical wood preservative in the United States. Concerns about the safety of CCA led to an agreement between the Environmental Protection Agency and the wood treatment industry to withdraw CCA for nonindustrial uses by the end of 2003. In light of the publicity surrounding the withdrawal of CCA, this article evaluates consumers' willingness to pay a premium for products manufactured from naturally decay-resistant wood as opposed to chemically treated wood. We use a national contingent valuation survey to quantify consumer willingness to pay for a children's play structure made from Alaska yellow-cedar, as opposed to an identical play structure made from southern pine treated with ammonial copper quaternary, the likely replacement for CCA. Respondents' estimated mean willingness to pay for the Alaska yellow-cedar play structure is $2,013, compared to $1,000 for the treated southern pine structure. This study shows that manufacturers of products made from naturally decay-resistant wood may be able to capture a substantial premium for their products. West. J. Appl. For. 19(3):160-164.*

Key Words: Contingent valuation methodology, Alaska yellow-cedar, forest economics, wood products.

The dominant chemical used to treat lumber in the United States is chromated copper arsenate (CCA) (Fields 2001). The preservative properties of CCA derive from copper (fungicidal) and arsenic (insecticidal), while chromium fixes copper and arsenic in wood (Stilwell and Gorny 1997). CCA was developed in the 1930s, but it was not until the 1970s that it gained widespread use, primarily because of safety concerns surrounding the main two oil-based wood preservatives [creosote and pentachlorophenol (penta)] in use at the time. Although CCA is considered safer than creosote or penta, it is still potentially toxic (Fields 2001).

All three components of CCA have been shown to be toxic to humans (Seiler and Sigel 1988), but arsenic and chromium are of particular concern. CCA is forced into wood under pressure, where a series of chemical reactions are initiated, beginning with the reduction of chromium from a hexavalent to a trivalent form. This reduction causes precipitation and adsorption fixing the copper, chromium, and arsenic in the wood (Taylor et al. 2001). Concerns about the toxicity of CCA center on the degree to which CCA leaches out of treated wood.

Several researchers have shown that the components of CCA will leach out of wood by aqueous solutions and that the lower the pH of the solution, the greater the degree of leaching (Warner and Solomon 1990). Stilwell and Gorny (1997) studied the contamination of soil under CCA-treated decks in Connecticut. They found elevated levels of copper and chromium, but these levels did not exceed Environmental Protection Agency (EPA) or state limits. However, arsenic levels were found that breached both state and EPA limits. Taylor et al. (2001) studied the effect of deck washes on the leaching of CCA components. They found that washes containing phosphoric acid, citric acid, and oxcilic acid caused copper to be lost at a higher rate. Washes containing oxidizing agents such as sodium hypochlorite and sodium percarbonate converted trivalent chromium to the more soluble and toxic hexavalent chromium. For this reason the authors recommended not using washes of this type on CCA-treated decks.

Concerns about the potential toxicity of CCA led to a voluntary agreement between industry and the EPA to phase out CCA for nonindustrial uses by the end of 2003 (Random Lengths 2002). The phasing out of CCA has focused attention on alternative water-based wood preservatives that do not contain arsenic or chromium. Ammonial copper quaternary (ACQ) is currently the most widely used alternative, and will likely replace CCA as the most common chemical wood preservative.

NOTE: Geoffrey Donovan can be reached at (503) 808-2043; gdonovan@fs.fed.us. This study was partially supported by the University of Alaska Fairbanks Extension Service. The authors would like to thank Rhonda Mazza for her helpful and timely editorial assistance. Copyright © 2004 by the Society of American Foresters.

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The negative publicity surrounding the withdrawal of CCA may provide a competitive advantage to manufacturers of products made from naturally decay-resistant species. A measure of competitive advantage is consumer willingness to pay a premium for products made from naturally decay-resistant as opposed to chemically treated lumber. Furthermore, the withdrawal of CCA may adversely affect consumer perceptions of chemical wood preservatives as a class; therefore, should a naturally decay-resistant premium exist, it may persist beyond the withdrawal of CCA.

This article uses a contingent valuation survey to determine how much more, if anything, consumers are willing to pay for a product made from naturally decay-resistant wood, when compared to an identical product made from chemically treated wood. Contingent valuation is one of several analytical tools, including conjoint analysis that uses stated choice data. While conjoint analysis could be used to analyze consumer preferences for naturally decay-resistant wood products, it does not generate an estimate of willingness to pay. Furthermore, contingent valuation is simpler to administer than a conjoint analysis because it is better suited to mail surveys.

Contingent valuation has been used to estimate consumer willingness to pay for a variety of environmental goods (Hutchinson and Chilton 1999, Loomis et al. 2000). Researchers outside environmental economics have used contingent valuation to estimate willingness to pay for attributes of various market goods. Shin et al. (1992) used contingent valuation to estimate willingness to pay for safer food products. The wood products literature also contains examples of the use of contingent valuation. Ozanne and Vlosky (1997) and Veisten (2002) used this technique to estimate consumer willingness to pay for eco-labeled wood products. Ozanne and Vlosky found consumers were willing to pay between 4.4 and 18.7% more, depending on the product. Veisten estimated willingness to pay for ecolabeled furniture in Norway to be 1% greater than nonlabeled furniture and 1.6% more in Britain. To control for potential upward bias, Veisten asked respondents a secondary question concerning the certainty of their response. Only respondents who were "absolutely sure" of their response were included in the analysis.

Methods

A contingent valuation survey was used to estimate how much more, if anything, consumers were willing to pay for a product made from naturally decay-resistant wood, when compared to an identical product made from chemically treated wood. The survey was administered by mail during Aug. and Sept. 2002. Respondents were selected using a randomly generated national phone list. At the initial phone contact, respondents were asked if they would answer a follow-up mail survey concerning their preferences for naturally decay-resistant versus chemically treated wood. Of those contacted, 125 agreed to receive a follow-up survey (sample size was limited by budget).

Following Dillman (2000), a four-contact methodology was used. After the initial phone contact, respondents were mailed a survey. One week later, a reminder postcard was mailed. Three weeks after the initial mailing, nonrespondents were mailed a duplicate survey.

Concerns about the safety of CCA have centered on products with a significant amount of direct human contact (Fields 2001). The potential exposure of children to arsenic and chromium resulted in CCA-treated children's play structures receiving particular attention in the media. Therefore, a children's play structure was used in the survey to compare consumer preferences for naturally decay-resistant versus chemically treated wood products. Common design features from several different manufacturers of children's play structures were used to design the play structure shown in Figure 1. All components in Figure 1 are wood except the slide, roof, swings, and fasteners.

Respondents were told that the play structure pictured in Figure 1 was available in two materials, Alaska yellow-cedar *(Chamaecyparis nootkatensis)* (a naturally decay-resistant species) or southern pine treated with ACQ. Furthermore, respondents were informed that ACQ had been accepted by the BPA as a wood preservative. Given the pending withdrawal of CCA, ACQ was deemed to be a more appropriate choice of preservative for the survey

Having introduced the two possible sources of lumber, a dichotomous choice question was posed asking respondents to choose between the two products. The treated southern pine play structure was always priced at $1,006, while the price of the Alaska yellow-cedar play structure varied between $1,050 and $3,000 for different versions of the survey. In addition, respondents were asked whether they owned or planned to buy a children's play structure, as well as demographic questions on age, household income, gender, and number of children living in the household.

To calculate the appropriate price for the play structure when made from southern pine, it was necessary to determine how much manufacturers charge per board foot for a finished play structure. Five representative southern pine play structures were selected from different manufacturers. The dimensions provided by the manufacturer were used to calculate the amount of lumber in each structure. The cost of all accessories such as fasteners, slides, swings, etc. were

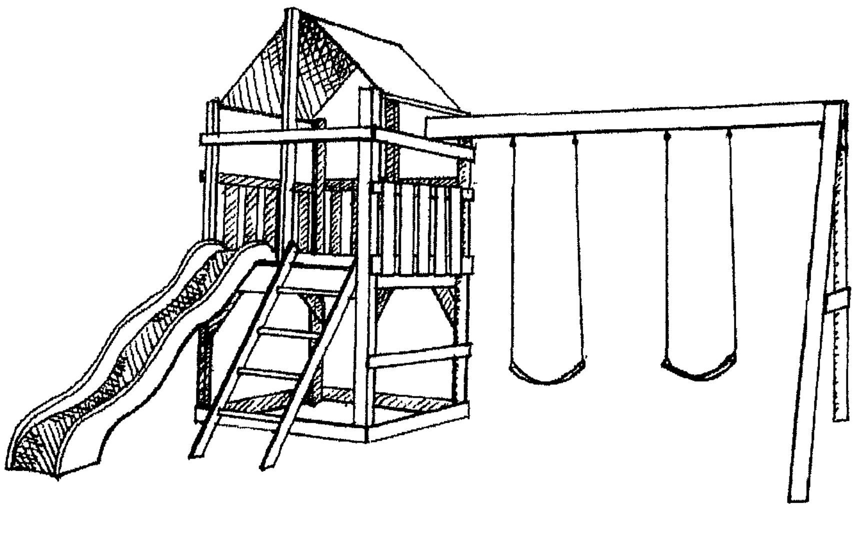

Figure 1. Children's play structure used in the contingent valuation survey. All components in the structure are wood except the slide, roof, swings, and fasteners.

subtracted from the retail price, allowing a per board foot estimate to be calculated. The mean price per board foot was \$2.45. The play structure used in the survey uses 276 bd ft of lumber. The price of the lumber plus the price of accessories resulted in a total cost of \$994 (rounded to \$1,000 in the survey).

A discrete choice logit regression model was used to analyze survey data and estimate willingness to pay (Hanemann 1984). A significance level of 90% was the criteria used for including independent variables in the model. Mean willingness to pay is a function of estimated regression coefficients and independent variable means (Loomis 1998) as represented in Equation 1:

$$MeanWTP = \frac{B_0}{-B_1} \qquad (1)$$

where B*o* is either the estimated constant if there are no additional independent variables, or the sum of the estimated constant plus the product of all other independent variables multiplied by their means, and B*o* is the estimated coefficient on the bid amount *\$X.*

Equation 1 shows that mean willingness to pay is a function of estimated regression coefficients that have associated variance. Therefore, confidence intervals around estimates of mean willingness to pay cannot be calculated conventionally. We use the simulation approach developed by Park et al. (1991). The variance covariance matrix of estimated regression coefficients *(*Bo, B1, etc.) was used to define a multivariate normal distribution. A total of 1,000 draws were made from this distribution, allowing the calculation of 1,000 willingness-to-pay estimates and associated confidence intervals.

Several authors have noted the importance of determining optimal bid amounts for dichotomous choice contingent valuation surveys (Cooper 1993, Judez et al. 2000). We followed the method developed by Boyle et al. (1988). First, in a pretest sample, individuals were asked the following open-ended question: "If the treated southern pine play structure cost \$1,000, how much would you be willing to pay for the Alaska yellow-cedar play structure?" Responses to this question were used to generate a cumulative distribution function showing what proportion of the sample were willing to pay progressively higher premiums for the Alaska yellow-cedar play structure. This cumulative distribution function was used to transform 125 random numbers, generated on the interval 0-1, into bid amounts for different versions of the survey. The term "bid amount" is used to denote the difference between the price of the treated southern pine play structure (always \$1,000) and the price of the Alaska yellow-cedar play structure.

Nonresponse bias is a common concern when dealing with survey data. Nonresponse bias occurs when the subsample of the population that did not respond to the survey is significantly different to the subsample of the population that did respond. Given that data from nonrespondents are not available, a common strategy is to use late respondents as a proxy for nonrespondents (Armstrong and Overton 1977). Demographic data from first-wave and second-wave respondents were compared; no statistically significant difference was found at the 95% level. However, there is an additional aspect of nonresponse bias that we were unable to address. Over 700 phone numbers were used to generate the final sample size of 125. Most of the nonresponse was due to getting no answer. However, a significant number of people did not wish to answer a follow-up mail survey. The survey was administered by the University of Alaska Fairbanks Extension Service, which, if anything, encouraged people to reply, as people were curious about why they were receiving a call from Alaska. There is no way of determining whether those people who agreed to receive a survey were self-selecting and had different preferences for naturally decay-resistant wood products than the rest of the sample. Therefore, when interpreting the results it should be acknowledged that the sample may have a greater interest in naturally decay-resistant wood products than the general population.

Results

Of the 125 surveys mailed, 67 responses were received from the first wave, with a further 19 responses from the second wave, resulting in an overall response rate of 69%. Table 1 contains the bid amounts for the 125 surveys mailed, the 86 surveys returned, and whether the respondent was willing to pay the bid amount.

In addition to the data in Table 1, demographic data were collected: mean age was 46, 57% of the sample was male, mean household income was \$52,000, mean number of children in the household was 0.8, and 19% of the sample owned a children's play structure. These data were analyzed using a logit regression model. The dependent variable was the binary response to the willingness-to-pay question (1 if the respondent was willing to pay the price premium for the Alaska yellow-cedar play structure and 0 otherwise). Regression results appear in Table 2.

Stepwise elimination of variables resulted in a model with two independent variables (at a 90% significance level): bid amount and number of children (Table 3).

Substitution of regression coefficients from Table 3, and mean number of children in the sample into Equation 1 yields Equation 2:

Table 1. Bid amounts for surveys mailed, surveys returned, and willingness to pay bid amount.

Bid amount (\$)	No. in mailed surveys	No. in returned surveys	No. of respondents willing to pay bid
50	28	20	18
100	15	10	9
250	17	12	10
300	14	9	4
400	18	12	10
500	12	7	3
1,000	9	7	3
1,500	7	6	1
2,000	5	3	1

Table 2. Regression results, bid amount, and demographic data on likelihood of choosing the Alaska yellow-cedar play structure.

	Coefficient	SE	Z ratio	*P*
Intercept	2.27	1.43	1.59	0.110
Age	0.00425	0.0246	0.172	0.863
Bid	-0.00245	0.000734	-3.34	
Gender	-0.751	0.608	- 1.24	0.216
Income	1.05E-05	1.24E-05	0.852	0.394
No. of kids	-0.514	0.322	-1.60	0.110
Own a play structure	0.918	0.913	1.01	0.315
McFadden R^2	0.282			

Table 3. Regression results, bid amount, and number of children on likelihood of choosing the Alaska yellow cedar play structure.

	Coefficient	SE	Z ratio	*P*
Intercept	1.98	0.457	4.33	0
Bid	-0.00167	0.00051	-3.27	0.001
No. of children	-0.361	0.214	-1.69	0.091
McFadden R^2	0.136			

$$MeanWTP = \frac{B_0 + (children * B_2)}{-B_1}$$

$$MeanWTP = \frac{1.98 + (0.8* - 0.361)}{0.00167} \qquad (2)$$

$$MeanWTP = \$1{,}013,$$

where *Bo* is the estimated constant, B_1 is the estimated coefficient on the bid amount, B_2 is the estimated coefficient on the number of children, and *children* is the mean number of children in the sample. It is important to note that $1,013 is a price premium in addition to the price of the treated southern pine play structure. Therefore, the mean willingness to pay for the Alaska yellow-cedar play structure is $2,013.

The variance covariance matrix of the variables in Table 3 was used to estimate 95% confidence intervals for the Alaska yellow-cedar play structure over the treated southern pine play structure. The lower confidence bound for the price premium is $433, the upper $1,593.

Discussion

We used contingent valuation techniques to estimate consumer willingness to pay a premium for a children's play structure made from Alaska yellow-cedar over an identical play structure made from treated southern pine. Respondents were willing to pay an additional $1,013 for the Alaska yellow-cedar over the base price of $1,000 for treated southern pine.

The negative coefficient on bid amount is consistent with economic theory and other contingent valuation studies (Loomis 1988). Economic theory does not predict the sign of the coefficient on number of children. However, the negative coefficient may be interpreted as a reflection of the higher disposable income of households without children.

Recent media coverage has raised public awareness concerning the potential toxicity of CCA. However, as ACQ was specified in the survey, it seems reasonable to conclude that consumers have negative perceptions about chemical wood preservatives as a class. If CCA had been used instead of ACQ, the interpretation of a willingness-to-pay estimate for Alaska yellow-cedar would be problematic; that public awareness of CCA would make it inappropriate to generalize such a result to other preservatives. Given the imminent withdrawal of CCA, a CCA-specific result would be of limited interest. In contrast, we assume that public awareness of the potential toxicity of ACQ is low. Therefore, it would seem reasonable to generalize such a result to other preservatives. Furthermore, it is likely that this preference for Alaska yellow-cedar products over chemically treated products extends to other naturally decay-resistant species such as redcedar and redwood.

The estimate of willingness to pay a premium should be treated with some caution, however, given that values were derived from stated as opposed to observed preferences, and may be biased upwards. However, upward bias is less critical in this study than studies of consumer willingness to pay for environmental goods. These studies are often based on cost benefit analyses, comparing total consumer willingness to pay for an environmental good to the cost of its provision. In these cases, projects that should not pass the cost benefit, test may do so because of upward bias in estimated consumer willingness to pay. However, upward bias in this study would not alter study conclusions. Consumers are willing to pay a significant premium for products made from naturally decay-resistant species; therefore, manufacturers should emphasize natural decay resistance in their marketing efforts. The use of ACQ as opposed to CCA in the survey suggests that respondents were averse to chemical preservatives in general.

The estimated price premium consumers are willing to pay for Alaska yellow-cedar is orders of magnitude larger than the price premium consumers are willing to pay for eco-certified wood products (Veisten 2002, Ozanne and Vlosky 1997), but is of a similar magnitude to the premiums observed for clear wood (Waggener and Fight 1999). This suggests that consumers are willing to pay more for tangible attributes of wood products.

The results from this study are consistent with increasing concern among consumers regarding exposure to chemicals in food, water, and the workplace. Therefore, it seems likely that consumer demand for naturally decay-resistant wood products will persist and possibly increase over time. Given a substantial and persistent price premium for naturally decay-resistant wood products, forest mangers might consider planting more naturally decay-resistant species and more intensively managing existing stands. Because forestry is so time-intensive, forest mangers cannot respond as quickly to changes in consumer demand as mangers can in other industries. Therefore, those mangers that are the first to identify and respond to emerging trends in the demand for forest products will have a competitive advantage over those that do not.

While this survey was limited by the number of contacts, our research suggests that further exploration into willingness to pay for naturally decay-resistant wood products would be worthwhile. Future research can focus on results from a greater number of respondents, or on geographic areas with potentially higher demand for nontreated products.

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