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Preferences for certified forest products in Japan: A case study on interior materials

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Abstract

The purpose of this study is to examine the preferences of Japanese consumers for certified forest products and estimate their price premiums using a discrete choice experiment. Although Japanese consumers have almost no opportunity to purchase forest certification products now, except paper and paper-related products, Japan may be a promising market with significant scope for increasing the demands for the forest certification products. Each choice task of our discrete choice experiment contained alternative wall renovation scenarios with interior wood materials showing five attributes. In 2008, 150 respondents living in Sapporo, northern Japan, completed our questionnaire, which contained a series of the choice tasks. To understand heterogeneous preferences and identify consumer segments in a systematic way, a latent class model was applied. The results show that the mean price premium on Forest Stewardship Council certification of interior materials was 40.5% under a ceteris paribus condition. However, two identified consumer segments both placed greater value on other attributes of the interior materials: dimensional stability and/or area of production. The results indicate that, for suppliers of forest products outside of Japan, the merit of forest certification and the demerit of foreign product will cancel each other out in Japan.

1 Introduction

1.1 Forest certification and its price premium

Forest certification is a system for promoting sustainable forest management through certifying forest products from properly managed forests according to a set of guidelines. In recent years, forest certification systems have accomplished global-scale developments, both in terms of the area of certified forests and the number of companies holding certificates. As at December 2012, for example, the forest area worldwide under Forest Stewardship Council (FSC) forest management certification was 169 million ha (FSC, 2012), and under the Programme for the Endorsement of Forest Certification (PEFC) scheme, the area under forest management certificates has expanded to 242 million ha (PEFC, 2012).

In respond to global expansion of forest certification systems, many preceding studies examined consumer preferences for certified forest products (Aguilar and Cai, 2010; Aguilar and Vlosky, 2007; Anderson and Hansen, 2004a, 2004b; Bigsby and Ozanne, 2002; Forsyth et al., 1999; Grönroos and Bowyer, 1999; O’Brien and Teisl, 2004; Ozanne and Vlosky, 1997, 2003; Teisl et al., 2002; Veisten, 2007; Vlosky et al., 1999). These previous studies have two main objectives. The first objective is to evaluate the price premiums for certified forest products. Many previous studies tried to evaluate price premiums not only for certification, but also for other attributes of forest products (e.g. areas of production). Ozanne and Vlosky (1997) evaluated the price premiums of US consumers for various forest products using a questionnaire survey, and they found that the price premiums range from 4.4% to 18.7% of noncertified basic prices. Bigsby and Ozanne (2002) also conducted a questionnaire survey to investigate the importance of the attributes of outdoor wood furniture; they showed that forest certification is the third most important attribute after the timber source (imported or domestic) and the forest type (natural or plantation). Other approaches, not based on questionnaire surveys, also supported positive price premiums, and consumers placed relatively high importance on certified forest products. Anderson and Hansen (2004b) and Teisl et al. (2002) indicated that forest certification influences consumers' choice, based on an experimental approach and a focus group approach, respectively. However, some studies have demonstrated that forest certification is not an important attribute of forest products, compared with other attributes (e.g. Bigsby and Ozanne, 2002; Forsyth et al., 1999).

The second objective is to understand heterogeneous preferences for certified forest products, including identification of consumer segments and specification of the source of heterogeneity. While Grönroos and Bowyer (1999) pointed out the relative low importance of forest certification as an attribute for forest products, they indicated that forest certification is important for some specific consumer segments. That is, even a low price premium does not necessarily mean that forest certification is insignificant for marketing. Instead, forest certification can be considered significant to particular segments in the market. In that case, identification of consumer segments is important for the marketing of certified products. Bigsby and Ozanne (2002), for instance, identified four consumer segments, and showed that one of them regarded forest certification as a key attribute of forest products. Ozanne and Vlosky (1997) identified five consumer segments, and demonstrated that one segment, which gave the highest grade to the forest certification attribute, included more women, liberalists and members of environment conservation groups.

1.2 Valuation method for price premium

Over the past few decades, several approaches have been used to estimate the price premiums of certified forest products. The most basic approach for estimating the price premiums of certified forest products is to directly survey consumers about their price premiums (Forsyth et al., 1999; Ozanne and Vlosky, 1997, 2003). Ozanne and Vlosky (1997), for example, asked respondents their maximum permissible price premium for a noncertified two-by-four piece of lumber with one US dollar. Conjoint analysis has also been used to estimate the price premium of certification (Aguilar and Cai, 2010; Anderson and Hansen 2004a; Bigsby and Ozanne, 2002). Conjoint analysis is a set of techniques for measuring tradeoffs among multiattribute goods and services, and has received considerable academic and industry attention, especially in the marketing field (Green and Srinivasan, 1978; 1990). This approach enables us to compare price premiums across certification and the other attributes of forest products.

It has been recognized that environmental valuation techniques, such as the contingent valuation method and discrete choice experiment (DCE) in the field of environmental economics, are also powerful approaches for estimating price premiums. The contingent valuation method was developed originally to estimate the monetary valuation of environmental resources, and is frequently applied to estimate nonuse values (Carson and Hanemann, 2005; Mitchell and Carson, 1989). DCE is often regarded as one of a family of conjoint analysis techniques in some cases. However, DCE is characterized by measures of choice, rather than ratings or rankings, and modeled by random utility theory. Therefore, in other cases, DCE is distinguished as being a different method from conjoint analysis in respect to consistency with economic theory (Louviere et al., 2010). The estimated marginal willingness to pay (MWTP) for attributes of forest products by DCE can be defined as compensating variation; therefore, their price premiums can be regarded as consistent valuations in economic theory. This also holds true for estimated willingness to pay using a dichotomous choice CVM (Hanemann, 1984). For example, Veisten (2007) applied CVM and DCE to estimate the willingness to pay for eco-labeled wood furniture and compared their estimates.

1.3 The purpose of this study

The purpose of this study is to understand the preferences for forest products with certification and to evaluate their price premiums using DCE with a latent class model (LCM), which incorporates a membership function into the choice model. This paper distinguishes itself from the above mentioned previous studies by focusing on two distinct points of view. First, this paper takes a different integrated approach from these previous papers toward modeling choice behaviors and identifying segmentation simultaneously. LCM allows us to incorporate not only the attributes of wood products, but also membership variables related to the characteristics of individual respondents, such as psychometric or socioeconomic effects, into choice models.

Second, this paper has important consequences for evaluating the price premium for certified forest products of Japanese consumers. Previous studies have focused mainly on cases in North American, European and Oceanian countries, and little attention has been given to cases in other regions (Aguilar and Cai, 2010). Although Owari and Sawanobori (2007) analyzed the current market trends for certified forest products in Japan by a survey of certified companies, to the best of our knowledge, there has been no study that has tried to value quantitatively the consumers' price premium for certification. Japan is one of the foremost timber-importing countries from all over the world. For example, Japan imported the world's largest amount of plywood and the third-largest amount of sawn wood after China and the US in 2010 (FAO, 2012). To understand worldwide trends in the market for certified forest products, Japanese preferences for forest certification need to be examined. Japanese consumers have almost no opportunity to purchase forest certification products now, except paper and paper-related products. Certified wood and wood-based materials, however, will possibly become popular in the Japanese market in addition to paper and paper-related products with a future shift in policy and consumer preferences.

The remainder of the paper is structured as follows. In Section 2, we outline our estimation models, questionnaire design and survey. In Section 3, we present the descriptive statistics and empirical estimates of our conditional logit model and LCM using our survey data. Finally, Section 4 interprets the estimated results and discusses possible marketing strategies for forest certification in Japan.

2 Methodology

2.1 Literature review on DCE

DCE was initially developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983) and is one option in a family of stated preference approaches (Louviere et al., 2000). DCE allows individual preferences to be assessed by asking respondents to choose among various multiattribute scenarios; the method is widely used in marketing, transportation and environmental valuation and so forth (Adamowicz et al., 1999; Hensher; 1994; Louviere, 1994). Here, we are also concerned with consumer segmentation associated with heterogeneous preferences. Over the past few decades, studies have focused on modeling heterogeneous preferences or identifying consumer segmentation for goods and services (e.g. Wedel and Kamakura, 2000). Among many approaches, LCM in the context of DCE, which estimates the part-worth utility for each segment and the probability that each respondent belongs to each segment, has been receiving increasing attention.

Previous models have attempted to explain choice behaviors and segmentation separately. For example, preceded by a choice model, multivariate cluster analysis of psychometric or socioeconomic characteristics is sometimes applied. Although the choice models estimated separately for each cluster were statistically superior to a model that pools the clusters, there must be a priori knowledge of the elements of heterogeneity. Difficulty in modeling heterogeneous preferences comes from the fact that individual-specific characteristics, which are considered to be the main source of heterogeneous preferences, are constant across choice alternatives. In the context of DCE within a random utility framework, this makes it impossible to obtain coefficient estimates of individual-specific characteristics because all the constants will be canceled out. For this reason, previous studies have introduced clever interaction terms between individual-specific characteristics and choice attributes (e.g., Morey et al., 2002; Arnberger and Haider, 2005). However, these methods are also limited because they require a priori selection of key individual characteristics and attributes, and only involve a limited selection of individual specific variables (Boxall and Adamowicz, 2002). While the random parameter logit model is another option for modeling heterogeneity (e.g., Train, 1998; Layton and Brown, 2001), it is not well suited to explaining the sources of heterogeneity. Ideally, an effective procedure should utilize theory to provide a foundation for possible sources of heterogeneity (Boxall and Adamowicz, 2002). In that respect, LCM not only elicits heterogeneous preferences but also identifies the sources of heterogeneity.

Our model is an attempt to incorporate attitudinal factors into LCM. The concept of this model was first introduced by McFadden (1986), and first applied by Swait (1994). Employing this approach, various studies have been conducted (Boxall and Adamowicz, 2002; Chan-Halbrendt, 2010; Morey et al. 2008). Although there is not any novelty in terms of research methods, this paper contributes to the growing literature on understanding heterogeneous preferences of certified forest products.

2.2 Experimental design of choice tasks

The survey consisted of two distinct components. The first part used a conventional questionnaire on socio-demographic characteristics, forest- or wood-related attitudinal questions and other questions relating to knowledge of the forest certification system and the type of housing owned by the respondents. Attitudinal questions about forests and wood, which are used for attitudinal variables in the membership function, are also included in this part (Table 1).

Table 1. Attitudinal questions about forests and wood

The second part of the survey contained a series of hypothetical choice tasks. The central part of our DCE survey was dedicated to eliciting a preferred wall renovation scenario from a group of alternative renovation scenarios using materials involving (1) the presence or absence of forest certification, (2) area of production, (3) overall color and grain, (4) dimensional stability and (5) total cost. The presence or absence of certification indicates, in our case, whether or not a wood material for wall renovation has FSC certification. While previous studies have showed that certification organization (or type of certification) was also important for consumers' choice (O'Brien and Teisl, 2004; Teisl, 2002), we assumed that Japanese consumers cannot identify the characteristic of each certification organization because knowledge of forest certification systems was not widespread among Japanese consumers. In this paper, FSC certification is used, because FSC certification dominated certification schemes in Japan; it issued 93% of all certificates in 2005 (Owari and Sawanobori, 2007). When we choose a wood product, area of production is also an important attribute of the products (Aguilar and Cai, 2010; Bigsby and Ozanne, 2002). Recently in Japan, along with vitalizing the local economy, consumers have increasingly purchased local goods and services (e.g. agricultural and fishery commodities). The concept of "local production for local consumption" may be an effective concept also to wood products. We are interested in the differences in preferences across the location of production, and three locations were included (the prefecture of domicile, other prefectures in Japan and foreign countries). Overall, color and grain were deciding factors with respect to the purchasing decision (Broman, 2001; Donovan and Nicholls, 2003; Nicholls and Barber, 2010; Nicholls and Roos, 2006). Our survey used a wall renovation scenario, in which overall color and grain were assumed important attributes.

The three attributes discussed above and the total cost of the wall renovation constituted our original scenario setting. However, some reviewers of our scenario, who run living room renovation businesses, pointed out that consumers place significant emphasis on dimensional stability when they purchase wood products. Therefore, our scenario included dimensional stability of wood products as an attribute of our scenario. Note, however, that dimensional stability is only relevant to appearance, and not relevant to livability (e.g. airtightness and temperature resistance). Therefore, the respondents were instructed that dimensional stability only has an influence on the visual appeal of the materials and has no effect on livability. Finally, the attributes and levels of the available materials were designed as illustrated in Table 2.

Table 2. Attributes and levels of the choice experiment

Before the DCE, our scenario was described carefully using both text and interior images. First, a hypothetical choice situation for respondents was provided regarding the wall renovation of a living room in his/her house. Two types of interior materials for the living room were available: wood materials and nonwood material (wallpaper). For the wood materials, general information on attributes and levels was provided along with an image of the renovated room. Then, each respondent evaluated 24 profiles (alternative wood materials) with different attributes and levels, organized into eight choice sets. A choice set consisted of three profiles using wood materials and one profile using wallpaper. Each respondent selected a preferred profile among the four profiles or the alternative of "I do not want to choose any alternatives in this choice set" (Figure 1). In this study, the profiles were designed using an orthogonal main effect design, which is frequently used in empirical studies (Louviere et al., 2000).

Figure 1. An example of the choice set

2.3 Model

The model is based on random utility theory, which assumed that the utility function is the sum of the deterministic term that can be described as a function of factors that influence respondents' utility and the random term that is unobservable and stochastic for researchers. Utility for a profile i is described as equation:

$$U_i = V_i + \varepsilon_i, \tag{1}$$

where U_i is the total utility for profile i, V_i is an observable deterministic term, and ε_i is an unobservable random term. The probability that profile i is chosen among a choice set C, is equivalent to the probability that U_i is larger than U_j, which is the total utility for any other profile j, as described in the following equation:

$$\begin{aligned}\Pr(i) &= \Pr\left[U_i > U_j\right] = \Pr\left[V_i + \varepsilon_i > V_j + \varepsilon_j\right] \\ &= \Pr\left[V_i - V_j > \varepsilon_j - \varepsilon_i\right] \quad \forall j \neq i, \forall j \in C.\end{aligned} \tag{2}$$

The deterministic term can be described as being linear with respect to the model parameters, $V_i = \beta' x_i$, where x_i is a vector of observed variables and β' is a vector of the parameters. If the error term is assumed to be distributed as a type-I extreme value, the probability that profile i is chosen is given by a conditional logit model (McFadden, 1974) as follows:

$$P(i) = \frac{\exp\left(\mu\beta' x_i\right)}{\sum_{j\in C}\exp\left(\mu\beta' x_j\right)}. \tag{3}$$

Generally, the scale parameter μ is assumed to be equal to 1 (Ben-Akiva and Lerman, 1985), and attributes parameters are estimated by the maximum likelihood method.

A problem associated with the conditional logit model is that it assumes that the parameters are constant among all respondents. In contrast, LCM assumes that an individual n belongs to a latent class s that is unobservable a priori. The joint choice probability of a set of eight choices conditional on belonging to segment s can be expressed as follows:

$$P_{n|s}\left(i_1, i_2, \ldots, i_8 \mid s\right) = \prod_{t=1}^{t=8} P_{n|s}\left(i_t \mid s\right) = \prod_{t=1}^{t=8} \frac{\exp\left(\mu_s \beta_s' x_{i,t}\right)}{\sum_{j \in C} \exp\left(\mu_s \beta_s' x_{j,t}\right)}, \tag{4}$$

where $\beta_s' x_i$ and μ_s are specific utility and a scale parameter for segment s, respectively[1]. Following Boxall and Adamowicz (2002) and Swait (1994), consider a latent membership likelihood function $M^*_{n|s} = \gamma_s' z_n + \zeta_{n|s}$, where z_n represents the psychometric or socioeconomic characteristics of respondent n, γ' is a vector of parameters, and $\zeta_{n|s}$ is an unobservable random term. The error terms are assumed to be distributed independently across individuals and segments according to a type-I extreme value distribution. The probability that respondent n is classified in segment s is:

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[1] There are also models in which the scale parameter is fitted differently for different respondents to account for diversity of choice determinism. The lower value of μ is associated with a higher utility variance and a lower degree of choice determinism (Campbell et al., 2011; Magidson and Vermunt, 2007).

$$P_{n|s} = \frac{\exp(\lambda \gamma_s' z_n)}{\sum_s \exp(\lambda \gamma_s' z_n)}, \tag{5}$$

where λ is the scale parameter. The unconditional probability of a sequence of choices by respondent n in segment s can be expressed as follows:

$$\begin{aligned} P_n(i_1, i_2, \ldots, i_8 \mid s) &= \sum_s P_{n|s} \cdot \prod_{t=1}^{t=8} P_{n|s}(i_t \mid s) \\ &= \sum_s \frac{\exp(\lambda \gamma_s' z_n)}{\sum_s \exp(\lambda \gamma_s' z_n)} \cdot \prod_{t=1}^{t=8} \frac{\exp(\mu_s \beta_s' x_{i,t})}{\sum_{j \in C} \exp(\mu_s \beta_s' x_{j,t})}. \end{aligned} \tag{6}$$

In this research, z_n are factor scores. The factor scores are estimated by principal component analysis using a Varimax rotation for eight attitudinal variables measured on a five-point Likert scale (Table 1). Principal component analysis is useful when one is faced with high-dimensional observed variables and wishes to represent them as lower-dimensional and tractable artificial variables. Varimax rotation is the most common orthogonal rotation (change of coordinates). Orthogonal rotation, which assumes no correlation among the factors, is useful in this case, because the factor scores are used for explanatory variables in the LCM.

In the LCM estimation, the number of segments is an arbitrary scalar that the researcher needs to specify. To avoid arbitrariness, it is common practice to compare the information criteria of the models, such as AIC or BIC (e.g. Boxall and Adamowicz, 2002; Gupta and Chintagupta, 1994; Kamakura and Russell, 1989; Swait, 1994). Andrews and Currim (2003a, b) reported that AIC3 (Bozdogan, 1994), which is AIC with a penalty factor of 3, better identifies the optimal number of segments. Additionally, crAIC is also used as an information criterion because AIC runs the risk of overfitting the data (e.g. Hynes et al., 2008; Kuriyama et al., 2010).

2.4 Data

An email-based questionnaire survey was conducted in Sapporo, Hokkaido, Japan. The city of Sapporo, with a population of 1.9 million, is the largest city in Hokkaido and a key consuming region for forest products from the Hokkaido prefecture. A consumer research company sent invitation emails with the questionnaire to 150 registered respondents with a 500 JPY incentive in May 2008; all responded to the questionnaire. Before the choice tasks, we asked the following question: “Would you consider the use of interior wood materials when undertaking a wall renovation?” Seven respondents who chose the option “I would like to consider nonwood materials” were excluded from the DCE analysis (we instructed them to skip our choice experiment). Serial nonparticipants (two respondents) who always chose nonwood alternatives in their choice tasks, and a respondent who always selected “I do not want to choose any alternatives in this choice set” in his/her choice tasks were also excluded. In addition, some respondents chose the alternative “I do not want to choose any alternatives in this choice set”, so 111 choice observations are not available. Finally, our empirical analysis focuses on 1009 choices made by these 140 individuals.

The selection of respondents was based on stratified random sampling. Only individuals registered as housewives or househusbands of workers’ households received the invitation emails, as these are the individuals most likely to be considering home renovation as a financially viable possibility. Thus, the results from this questionnaire survey have to been interpreted carefully.

3 Results

3.1 Descriptive statistics

Table 3 presents the descriptive statistics of the respondents. Almost all the respondents were females. Most housework is still performed by females in Japan, especially for the older generations; thus, it is not surprising to have a disproportionate number of female respondents. Almost 80% of respondents were aged between 20 and 49[2]. The average annual household income for Sapporo was marginally higher than the average for the Hokkaido prefecture; this reflects the fact that the city of Sapporo is the economic center of Hokkaido. About a half of respondents lived in single-family houses (44.7%), and about a half of respondents lived in wooden houses (50.7%) regardless of house types. In addition, 38.0% of respondents selected

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[2] The main reason for the higher percentage of younger respondents is the constraints on samples (i.e. housewives or househusbands of workers' households). Some in their twenties and quite a few aged over 60 years in our initial samples were students and pensioners respectively; thus, we did not send them invitation emails. In addition, the tight constraints also led to the research company having a shortage of potential respondents in their fifties.

interior wood materials. Only three respondents were forest owners, as most of the respondents lived in residential districts.

Table 3. Descriptive statistics of the respondents

Our survey also contained questions on knowledge of the forest certification system and forest-related issues. Almost all the respondents (98.7% and 84.0%) understood the meaning of the words “global warming” and “ecosystem”. In addition, 92.6% of respondents understood the meaning of “sick-building syndrome”, even though the expression is specialized terminology. In contrast, only half of the respondents (51.3%) understood the meaning of the expression “local production for local consumption”. In addition, only 12 respondents (8.0%) knew the meaning of “forest certification system”. After being provided with a description of forest certification system, however, 96 respondents (64.0%) considered the system to be “very important” or “important” on a 5-point Likert scale.

3.2 Conditional logit result

The estimates of the conditional logit model, which measure the preferences of the mean respondents, are shown in Table 4. All attributes, except the total cost, were effects coded (Holmes and Adamowicz, 2003; Louviere et al., 2000). The parameter value of arbitrarily omitted level is defined as the negative sum of the other levels of parameters. For example in "Area of production", the parameter of "Foreign countries": –0.828 can be calculated by –(0.501 + 0.327), which are parameters of "Hokkaido" and "Japan (other than Hokkaido)", respectively. The significant parameter estimates with positive signs mean that the attributes or levels affect respondents' utility positively, and those with a negative sign affect utility negatively. For example, "FSC certified" influences the respondents' utility positively, and "Total cost" influences the respondents' utility negatively. Insignificant parameter estimates indicate that the hypothesis that these particular attributes or levels do not affect respondents' utility cannot be rejected. Note, however, that the significance of the estimated parameters of the effect-coded variables depends on arbitrarily omitted levels.

Table 4. The conditional logit model

Using the estimated parameters, we can estimate the MWTPs. For example, the influence of "FSC certified" on respondents' utility was 0.420, as shown in Table 4. The effect of the payment of one JPY on respondents' utility (marginal utility of income) is also calculated. The MWTP for "FSC certified" is obtained by dividing the parameter of "FSC certified" by the marginal utility of income, taking into account their signs. The formula for the calculation of MWTP is:

$$MWTP = -\frac{dV}{dx_{kl}} \bigg/ \frac{dV}{dx_{tc}} = -\beta_{kl} / \beta_{tc} , \tag{7}$$

where x_{kl} is level l of the attribute k , x_{tc} is the “Total cost”, and β_{kl} , β_{tc} are the estimated parameters for each variable, respectively.

The price premium for FSC certification is defined as the percentage by which a willingness to pay (WTP) for a wall renovation with FSC-certified wood materials (WTP_{crtf}) exceeds a benchmark WTP for that without FSC-certified wood materials ($WTP_{non\text{-}crtf}$), ceteris paribus, as follows:

$$\text{Price Premium}(\%) = \left[\left(WTP_{crtf} \text{ -} WTP_{non\text{-}crtf} \right) \big/ WTP_{non\text{-}crtf} \right]. \tag{8}$$

If the benchmark $WTP_{non\text{-}crtf}$ for a typical wall renovation without certified wood materials (hokkaido, dark color and flat grain, and detectably warped) is 100,000 JPY, the results show that the WTP for a wall renovation with FSC-certified wood materials is 140,476 JPY, ceteris paribus. Since the difference of MWTPs between “FSC-certified” and “Noncertified” is 20,238 – (–20,238) = 40,476 JPY. Therefore, the percentage of the price premium that relates to FSC certification is 40.5%.

3.3 Factor analysis

Two components were identified by our factor analysis (Table 5). The first component relates to “nonextractive values” because of the high scores for “Forests absorb carbon dioxide and contribute to the prevention of global warming”, “Forests contribute to biodiversity conservation”, “Forests contribute to the prevention of landslide disasters” and “Forests provide a comfortable living environment”. These statements suggest that value comes from the forests themselves, rather than the timber in the forests. Analogously, the second component represents “extractive values” because of the high scores for “Wood is an alternative to fossil fuels and contributes to the prevention of global warming”, “Wood is a natural material and provides a healthy and comfortable dwelling space” and “Forestry activities vitalize the local economy”. These statements have features in common, in that their values come into existence from extractive uses of forests. Although the service of recreational activities is defined as a nonextractive value of forests by Field (2008), the results show that respondents assess the statement in much the same fashion as for extractive values.

Table 5. Factor loadings by principal component analysis with varimax rotation

3.4 Latent class model

To specify the appropriate number of segments, the information criteria of the models with different segmentations were compared (Table 6). As shown in Table 6, AIC and AIC3 indicate that the model with five and four segments are optimal among the five models, respectively; however, crAIC and BIC indicate that the model with two segments is optimal. That is, we cannot select the optimal model based solely on the information criteria. Therefore, we next examine the increases in the maximum log-likelihood as the number of segments increases. The results shown in Table 6 demonstrate that the increase in the log-likelihood is highest when we move from the one-segment model to the two-segment model; thus, it seems reasonable to employ the two-segment model[3].

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[3] The decision of which model to use also involves the discretion of the researcher (Hynes et al., 2008; Scarpa and Thiene, 2005). The researcher's judgment, interpretability of the model, and the overall "parsimony" of the model along with its matching with prior information (theoretical and otherwise) are key factors which also come into play in selecting the appropriate number of segments (Ruto et al., 2008).

Table 6. The number of segments and information criteria

The results of LCM with two segments are shown in Table 7. To facilitate interpretation of the result, β_{tc} is assumed to be the same value between the segments. The log-likelihood ratio index shown in Table 4 and 7 is an index of explanatory power, for the LCM is larger than that of the conditional logit model. Thus, the model specification of LCM is better than that of the conditional logit model. The larger segment (segment 1) consists of 79.8% of the respondents, and the other, smaller, segment (segment 2) contains the remaining 20.2%. The interpretation of the estimated parameters is the same as for the conditional logit model except for the membership parameters. Note that the membership parameters for segment 2 are equal to 0 due to their normalization. Therefore, the membership parameters of segment 1 are described relative to the segment 2. This interpretation is the same as for a multinomial logit model, which is a choice model using individual-specific attributes. Both of the two membership parameters of segment 1 are statistically significant; therefore, both segments are characterized by two factors as shown in Table 5. Segment 1 places a lower weight on " Nonextractive values", and a larger weight on "Extractive values" of forests or wood.

Table 7. The latent class model

4 Discussion

4.1 Mean preferences for choice attributes

First, as shown in Table 4, the MWTP or the price premium demonstrates that respondents positively valued FSC certification as an attribute of wood products. Yet, the 40.5% price premium was considerably higher than the estimated price premiums in previous studies[4]. For example, Ozanne and Vlosky (1997; 2003) estimated price premiums for kitchen renovation with certification of 11.0% in both 1995 and 2000. One possible reason for the higher price premium is the nature of our samples, which include a considerable number of housewives. As mentioned above, Ozanne and Vlosky (1997) found that women valued forest certification most highly. Another possibility is the difference in valuation methods. However, the effect of such differences awaits future studies since there exist no comparable study in Japan. The reason for our higher price premium must be discussed further. Aside from the size of our price

[4] It may be inappropriate to compare our price premium directly with that of previous studies, since our price premium depends heavily on an arbitrary benchmark WTP for a wall renovation.

premium, the fact that Japanese consumers' price premium for certified wood products is positive is important because certified wood products are not yet common in Japan.

Second, compared with the MWTPs for other attributes, that for FSC certification is not large. In this case, it may be more useful to consider the possible ranges of the MWTPs instead of the MWTP values themselves. The impact on utility of the attribute "FSC certified" was larger than that for "Overall color and grain", yet smaller than that for "Dimensional stability" and "Area of production". In particular, the values of "Foreign countries" and "Detectable warped" had large negative effects on utility; therefore, respondents had a strong tendency toward avoidance of alternatives including such levels.

Table 4 also reveals that the alternative specific constant (ASC) is positive and significant. This parameter indicates a preference for a wall renovation using nonwood materials and a total cost of 50,000 JPY (Figure 1). Thus, the results show that a cheaper renovation with wallpapers is preferable to a renovation with wood materials in general.

4.2 Two types of consumers of wood products

The discussions above relate to the conditional logit model and reflect the preferences of the average respondent. As mentioned before, however, respondents have heterogeneous preferences for wood products; hence, the LCM are more relevant. Hereinafter, we discuss the LCM results using the estimated parameters.

First, the results for segment 1 are similar to that of the conditional logit result in Table 4, since segment 1 contains 79.8% of respondents. However, compared with the mean respondent, segment 1 has negative and significant parameters for the ASC. Accordingly, while the results for segment 1 are similar to that for the mean respondents, the members of the segment are different from mean respondents in that the segment 1 respondents are a cluster of consumers who prefer a renovation with wood materials to a cheaper renovation with wallpaper.

In contrast, the results for segment 2 are different from those of the conditional logit model. Although the parameter for “FSC certification” is still significant, the attribute “Area of production”, which had a large impact on utility in the conditional logit model, is not significant. In addition, the attribute “Overall color and grain” becomes more important, and “White and vertical grain” is now an important factor for consumer choices. Moreover, the parameter of ASC is positive and significant; thus, in contrast, consumers prefer a cheaper renovation with wallpaper to a renovation with wood materials.

The key point here is whether the preference parameters are consistent with the membership parameters or not. To begin with, we would like to examine the attribute “Area of production”, which had the largest difference in effect between segments 1 and 2. A feasible interpretation for this result is that segment 2 attached too much importance to nonextractive values. Table 5 shows that the mean scores of the four items with respect to nonextractive values were in excess of 4.5; therefore, most respondents value nonextractive factors highly. Nevertheless, Table 7 shows that there exist differences in views on nonextractive values between segments 1 and 2 of the membership parameter. That is, while respondents in segment 1 attach importance to nonextractive values, those in segment 2 attach much greater importance. The typical respondent in segment 2 assume to be a person who believes forests should be conserved. This interpretation is consistent with the positive and large coefficient on ASC indicating a preference for renovation without wood materials. Although segment 2 values FSC certification positively, it could also be interpreted as follows. As suggested by the parameters of the membership function and ASC, respondents in segment 2 view the forestry industry negatively. However, if faced with a choice among wood products, respondents in segment 2 would unsurprisingly choose those with FSC certification. This is because wood products provided by properly managed forests according to FSC guidelines are an apparently better alternative than other alternatives without environmental consideration. That is, the respondents in segment 2 do not value FSC certification positively, but rather do not choose noncertified wood products.

4.3 Consumer segments and marketing strategy

Lastly, we would like to discuss one aspect of the forest certification system in Japan. From the discussion above, it is difficult to direct consumer spending toward certified forest products. Only a small proportion of consumers understand the forest certification system (only 8.0% according to our results); thus, forest certification has a limited impact on merchandise choice at present in Japan. Although the respondents value FSC certification positively as shown above, we note that the respondents in this study read our description of the forest certification system, then completed our questionnaire.

Even if the Japanese consumers' understanding of the forest certification system improved, we still need to consider the following. The Japanese consumers included in segment 2 are consumers who prefer nonwood materials rather than wood materials. That is, some part of Japanese consumers will not choose wood products in the first place. Even if they do, the attributes of overall color and grain or dimensional stability are more important than that of forest certification. On the other hand, the consumers included in segment 1 prefer wood products; however, area of production and dimensional stability are still regarded as more important attributes than forest certification. Especially for suppliers of forest products outside of Japan, the merit of forest certification and the demerit of foreign product will cancel each other out. Therefore, even the respondents in segment 1 may not prefer a certified foreign forest product. Meanwhile, the basic attributes of forest products such as overall color and grain and dimensional stability (i.e. tree species with fine grain and good seasoning condition) remain important factors for Japanese consumers. Foreign suppliers outside of Japan have advantages at present (e.g. all Japanese saw mills are not equipped with seasoning facilities); thus, emphasis on these attributes instead of forest certification seems to be a good policy to meet Japanese consumers' needs. On the contrary, appreciation of domestic forest products by Japanese consumers is good news for domestic suppliers of forest products in Japan. The forest certification labeling would allow a price premium as long as domestic products are of the same quality as foreign products.

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Table 1. Attitudinal questions toward forest and wood

Statements*
Forests absorb carbon dioxide and contribute to the prevention of global warming.
Forests contribute to biodiversity conservation.
Forests contribute to the prevention of landslide disasters.
Forests provide a comfortable living environment.
Forests provide recreational activities.
Wood is an alternative fossil fuel and contributes to the prevention of global warming.
Wood is a natural material and provides a healthy and comfortable dwelling space.
Forestry activities vitalize the local economy.

* Each statement is measured on a 5-point Likert scale from strongly agree (5) to strongly disagree (1).

Table 2. Attributes and levels of the choice experiment

Attributes Levels
Forest certification
FSC certified; Noncertified
Area of production
Hokkaido prefecture; Japan (other than Hokkaido); Foreign countries
Overall color and grain
White and vertaical grain; White and knotted; Dark and flat grain
Dimensional stability *
Unwarped; Warped but hardly detectable; Detectably warped
Total Cost
50,000; 75,000; 100,000; 125,000; 150,000 JPY**

* We explained to respondents that the degree of warping only has an influence on the visual appeal of materials and makes no difference to livability (e.g. airtightness).

** USD/JPY = 92.75, EUR/JPY = 123.96 on 9 February 2013.

Table 3. Descriptive statistics of the respondents

Male/Female
134 females (89.3%); 15 males (10.0%); 1 missing value (0.7%)
Age
14 twenties (9.3%); 54 thirties (36.0%); 50 forties (33.3%);
19 fifties (12.7%); 7 sixties (4.7%); 6 over seventies (4.0%)
An average annual income of the household*
5.57 million JPY**
Type of respondents’ housing
67 respondents (44.7%) were living in a single-family house
83 respondents (55.3%) were living in a condominium or an apartment
Respondents who live in a wooden house
76 respondents (50.7%)
Respondents who have a room with interior wood material
57 respondents (38.0%)

* An average annual income of a household in Hokkaido prefecture, Japan was 4.67 million JPY in 2009.

** USD/JPY = 92.75, EUR/JPY = 123.96 on 9 February 2013

Table 4. The conditional class model

Attributes Levels	Coefficient	(t value)	MWTP
Forest certification			
FSC certified	0.420	(9.404) ***	20,238
Noncertified†	–0.420		–20,238
Area of production			
Hokkaido	0.501	(7.335) ***	24,132
Japan (other than Hokkaido)	0.327	(4.507) ***	15,771
Foreign countries†	–0.828		–39,904
Overall color and grain			
White and vertical grain	0.223	(3.725) ***	11,228
White and knotted	–0.029	(–0.441)	–1,384
Dark and flat grain†	–0.204		–9,844
Dimensional stability			
Unwarped	0.537	(4.630) ***	25,887
Warped but hardly detectable	0.438	(3.510) ***	21,106
Detectably warped†	–0.975		–46,992
Total cost (10^{-5})	–2.074	(–14.646) ***	
Alternative specific constant	0.692	(2.467) **	
Observations	1009		
Log-likelihood (0)	–1105.11		
Log-likelihood (max)	–1398.77		

Log-likelihood ratio index[††]	0.21

*** $p < .01$, ** $p < .05$, * $p < .10$

[†] Baseline level of effect-coded variables.

[††] Log-likelihood ratio index is estimated as: 1– [Log-likelihood (max)/ Log-likelihood (0)].

Table 5. Factor loadings by principal component analysis with varimax rotation

Statements	Mean* (std. dev.)	Factor loadings	
		Factor 1	Factor 2
Forests absorb carbon dioxide and contribute to the prevention of global warming	4.513 (0.673)	0.827	0.255
Forests contribute to biodiversity conservation	4.500 (0.740)	0.821	0.182
Forests contribute to the prevention of landslide disasters	4.500 (0.712)	0.830	0.299
Forests provide comfortable living environments	4.607 (0.623)	0.881	0.264
Forests provide recreational activities	3.633 (1.064)	0.227	0.743
Wood is an alternative fossil fuel and contributes to the prevention of global warming	3.753 (1.016)	0.194	0.851
Wood is a natural material and provides healthy and comfortable dwelling spaces	3.967 (0.986)	0.290	0.847
Forestry activities vitalize the local economy	3.620 (1.060)	0.251	0.816
Eigenvalue		4.615	1.361

* Each statements was measured on a 5-point Likert scale from strongly agree (5) to strongly disagree (1).

Table 6. The number of segments and information criteria

The number of segments	$LL(0)$	$LL(\max)$	AIC*	AIC3**	crAIC†	BIC††
1	–1398.77	–1105.11	2228.22	2237.22	2212.22	2272.47
2	–1398.77	–1000.520	2041.04	2061.04	2019.80	2139.37
3	–1398.77	–977.667	2017.33	2048.33	2022.48	2169.75
4	–1398.77	–969.122	2022.24	2064.24	2103.02	2228.75
5	–1398.77	–951.655	2009.31	2062.31	2233.42	2269.90

* AIC: $-2LL(\max) + 2k$ (k: the number of parameters)

** AIC3: AIC3: $-2LL(\max) + 3k$

† crAIC: AIC + $2k(k+1) / (n-k-1)$ (n: the number of observations)

†† BIC: $-2\,LL(\max) + k\ln(n)$

Table 7. The latent class model

Attributes and levels	Segment 1				Segment 2			
	Coefficient	(*t* value)		MWTP	Coefficient	(*t* value)		MWTP
Forest certification								
FSC certified	0.437	(8.725)	***	19,927	0.282	(2.628)	***	10,683
Noncertified†	–0.437			–19,927	–0.282			–10,683
Area of production								
Hokkaido	0.605	(7.639)	***	27,550	0.114	(0.813)		4,407
Japan (other than Hokkaido)	0.393	(4.677)	***	17,889	0.121	(0.815)		3,329
Foreign countries †	–0.997			–45,438	–0.235			–7,735
Overall color and grain								
White and vertical grain	0.201	(2.862)	***	9,161	0.433	(2.922)	***	15,937
White and knotted	0.002	(0.022)		74	–0.249	(–1.611)		–8,341
Dark and flat grain †	–0.203			–9,234	–0.184			–7,596
Dimensional stability								
Unwarped	0.654	(4.494)	***	29,816	0.444	(2.012)	**	13,409
Warped but hardly detectable	0.542	(3.547)	***	24,710	0.428	(1.731)	*	11,262
Detectably warped †	–1.197			–54,526	–0.871			–24,671
Total cost (10^{-5})	–2.195	(–15.538)	***		–2.195	(–15.538)	***	
Alternative specific constant	–1.086	(–2.319)	**		1.710	(3.205)	***	
Membership function								
Constant	1.514	(4.943)	***					
Nonextractive values (factor 1)	–0.735	(–3.205)	***					

Extractive values (factor 2)	0.734	(3.204) ***
Observations	1009	
Log-likelihood (0)	–1000.52	
Log-likelihood (max)	–1398.77	
Log-likelihood ratio index††	0.29	

*** $p < .01$, ** $p < .05$, * $p < .10$

† Baseline level of effect-coded variables.

†† Log-likelihood ratio index is estimated as: 1– [Log-likelihood (max)/ Log-likelihood (0)].