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Estimating Preferences for Wood Products with Environmental Attributes

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Abstract: Tropical deforestation and forest degradation are serious problems for the global environment; as a result, sustainable forest management and forest certification have become important. In this study, using a choice experiment, we investigated, on the demand side, consumers' preferences and willingness to pay (WTP) for certified wood products that attempt to address public concerns regarding deforestation and forest degradation. Specifically, we investigated how estimates of consumers' preferences and WTP were influenced by product attributes such as quality, certification, and price. To the authors' knowledge, few studies of this kind have been conducted, particularly in Japan. The study's main finding was that Japanese consumers were willing to pay a premium for certified wood products with attributes related to sustainable forest management; most preferred were products with attributes related to preserving biodiversity. These findings indicate that consumers are willing to pay a premium for products that contribute to solving the problems of deforestation and forest degradation.

Keywords: wood products; choice experiments; sustainable forest management; Japan

1. Introduction

Tropical deforestation and forest degradation are serious problems for the global environment. Sustainable forest management (SFM) is one of the schemes believed capable of mitigating these problems. The importance of promoting SFM, which provides co-benefits such as biodiversity conservation, was confirmed at COP 15 in Copenhagen (FCCC/CP/2010/7/Add.1.c.70). Other benefits provided by forests include the provisioning of wildlife habitat and carbon sequestration [1,2]. The FCCC document identifies SFM as one of the mitigating actions and there are co-benefits. The Reducing Emissions from Deforestation and Forest Degradation (REDD+) scheme was developed with the aims of promoting SFM and reducing emissions from deforestation and forest degradation [3,4].

Forest certification, particularly in the wood products industry, which emerged in the late 1980s, was conceived as a scheme to promote awareness of tropical deforestation and forest degradation [5,6]. Forest certification is a market-based tool that helps ensure compliance with SFM practices [7,8], and provides information to consumers, informing their purchasing decisions and empowering them to buy products developed from sustainable materials [9]. A number of certification systems have been developed, with the Forest Stewardship Council's (FSC) system being one of the most widely recognized. The FSC has developed internationally recognized requirements for SFM [5], and its forest management certification confirms that a forest is being managed in a way that preserves its natural ecosystem [10]. Forest certification, whose adoption has expanded globally since the 1990s, is a key element in decision-making on wood products [7], and products with the FSC label are currently being marketed [4]. For example, on the supply side, some leading Japanese companies have recently introduced paper and wrapping paper made using FSC-certified wood [11,12]. Actually, in Japan,

some companies (e.g., Mitsubishi Paper Mills Limited, Tokyo, Japan, Mitsubishi Estate Home Co., Ltd., Tokyo, Japan, Oji Nepia Co., Ltd., Tokyo, Japan, Sumitomo Forestry Co., Ltd., Tokyo, Japan, etc.) are increasingly utilizing certified woods like FSC through sustainable forest management in consideration of biodiversity and CO_2 reduction.

On the demand side, it is important to assess consumers' preferences for wood products that have been certified as part of a forest certification system. In this study, using a choice experiment (CE), we investigated consumers' preferences and willingness to pay (WTP) for certified wood products that address public concerns regarding deforestation and forest degradation. Specifically, we investigated how consumers' preferences and WTP premiums are influenced by product attributes such as quality, certifications (specifically, SFM-related certifications), and price. To the authors' knowledge, few studies of this kind have been conducted, particularly in Japan.

We chose paper (in the form of a notebook) as the certified wood product for our CE survey, because paper is used frequently and purchased more widely than wooden furniture; thus, consumers are familiar with paper, making it easy for them to answer our CE questions. Furthermore, consumers believe that such heavily used wood products have a great impact on the environment [7,13]. With regard to the situation of paper production in Japan, in 2016, the collection rate of old paper was 81.2%, and the share of used paper that was recycled was 64.2%, which is at world-class levels [14].

Finally, previous studies have estimated the WTP for paper (as a wood product) [7,13,15].

A number of studies have investigated consumers' preferences for certified wood products. For example, according to [16], consumers would be willing to pay a roughly 20% price premium for desks made of certified wood; and according to [17], Canadian consumers would be willing to pay a premium for wood products. In [18] it was reported that consumers in the UK would be prepared to pay an additional 1.6% for furniture made of certified wood; and in [7] the authors performed a detailed meta-analysis showing that consumers would be willing to pay a 1–39% price premium for products made of certified wood. According to [16], consumers, both in the US and the UK, were willing to pay an additional 20–39% for wood products, and the results in both [19,20] suggested that some Malaysian consumers were willing to pay price premiums for certified wood products. Finally, in [21], the authors analyzed consumers' preferences for product sustainability in relation to LOHAS (Lifestyles of health and sustainability).

Thus, as can be seen from the examples above, many studies have confirmed consumers' willingness to pay a premium for certified wood products, indicating increasing consumer support for certified wood products [7]. In addition, there is a high WTP for frequently purchased wood products such as paper, and for wood products with low prices [7,13].

We designed a CE in which consumers chose between hypothetical certified wood products (notebooks). As noted above, a notebook was selected due to frequency of use and consumer familiarity. In this research, CE was applied, since it is still valuable to investigate WTP, which could lead to beneficial factors of consumers' potential preference in order to obtain detailed preference information according to product attributes, even though paper notebooks are common at the market.

A CE with the following attributes included in its hypothetical scenario was designed for the study. The first notebook attributes selected were Quality and Price, which are traditional product attributes. The other selected attributes, which can both be seen as being related to SFM, were the respective extents to which a given notebook purchase contributed to global warming prevention (the degree of CO_2 emission reduction), or to biodiversity conservation. This information referred to Japanese companies who engage with these issues, for example, Nippon Paper Industries Co., Ltd., Website (www.Nipponpapergroup.com). The CE scenario assumed that the notebook paper was made from materials produced in accordance with SFM practices. Thus, the CE was designed with a total of four product attributes.

2. Materials and Methods

As discussed, we used a CE for the investigative purposes of the study. Widely used in the fields of marketing and environmental valuation, a CE is a method that closely resembles conjoint analysis (developed in marketing), and is ideal for studies like ours, which investigate the degree of consumer preference for product attributes by measuring preferences through product selection [22–24]. In a CE, several product profiles, which are hypothetically described in terms of the selected attributes (and the levels of these attributes), are presented to subjects for evaluation; and the subjects choose the alternative they most prefer [25]. The responses are then statistically processed [25].

The utility function used in the random utility theory is expressed by a defined term V and a random term ε (the suffix n, which indicates an individual n, is omitted from the equation):

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

Using j as an element of the choice set that is not i, the probability P_i of a person n choosing i from the choice set is given by:

$$P_i = P(U_i > U_j) = P(V_i + \varepsilon_i > V_j + \varepsilon_j). \tag{2}$$

The following conditional logit model is derived assuming the Gumbel distribution for the random term [26]:

$$P_i = exp(\lambda V_i)/(\Sigma exp(\lambda V_j)) \tag{3}$$

where λ is a scale parameter and usually normalized to 1.

A linear utility function is assumed for the defined term V, and the maximum likelihood method, using a log-likelihood function, is used to estimate the factor β.

X_i is an attribute vector and contains a monetary attribute:

$$V = \Sigma \beta_i X_i. \tag{4}$$

WTP is given by the following equation [27], where V' indicates the state after the change in an attribute and V indicates the state before the change:

$$WTP = -1/\beta \, (ln(\Sigma exp(V_i') - \Sigma exp(V_i))). \tag{5}$$

As mentioned above, the wood product to be evaluated was a notebook (actually a set of five notebooks) made from materials produced in accordance with SFM practices, and four attributes were selected for our CE's hypothetical scenario. The attribute levels are shown in Table 1, with most described qualitatively rather than quantitatively.

Table 1. Attributes and attribute levels in CE survey.

Attributes	Level 1	Level 2	Level 3
Quality	Good	Normal	Poor
Reducing CO_2 Emissions	High	Medium	Low
Conserving Biodiversity	High	Medium	Low
Price (Yen)	400	600	800

This approach was taken primarily to help ensure respondent comprehension. In particular, the public is not generally familiar with the characteristics of ecosystem services (or passive use values of forests), such as CO_2 absorption effects (CO_2 emission reduction) and biodiversity preservation [28]. We conducted two focus group meetings to examine product attributes and their levels. In the first focus group meeting, many members noted that the attribute levels for Conserving Biodiversity, then shown as percentages, were too difficult to understand. Therefore, despite qualitative descriptions being

somewhat less exact than quantitative descriptions, a qualitative scale (i.e., High, Medium, and Low) was adopted for most attribute level descriptions, making it easier for subjects to answer attribute level-related questions.

In light of the foregoing, all attribute level descriptions, including those related to Reducing CO_2 Emissions, were kept as simple as possible; and we note that other CE studies have used such qualitative attribute level descriptions [29–31]. Although comprehension problems related to using quantitative descriptions may be mitigated by providing thorough explanations in a face-to-face survey, it has been shown that in actual face-to-face surveys, the geographical area that can be covered by the survey is limited, and bias occurs due to subtle differences in the speaking styles of respective interviewers, affecting survey results [25].

Using the selected attributes and their levels, 3^5 hypothetical product profiles were generated. As it would be laborious to present all of these to the respondents and have them make a choice in each case, the orthogonal design approach is typically used in CE surveys, to reduce the number of profiles [26,32]. In the present study, we also adopted this approach, and using combinations of the profiles thereby generated, we created several multiple-choice questions in which the respondents were asked to choose one preferred profile from three profiles (an example of one such question is shown in Appendix A).

A questionnaire format was also designed. First, the introductory portion of the CE questionnaire provided a basic explanation of global forest degradation and deforestation. The summary of the introductory portion is: 'Deforestation and forest degradation are global problems. Sustainable forest management is expected to be one of the schemes to mitigate these problems and will give an impact on the production of wood products. For example, conservation of the forest ecosystem and reducing the emission of carbon dioxide, etc. may be reflected in the following paper-based product (notebook) as well. In this case, what notebook would you prefer to buy? Please select your answer from the choice.' And then provided a hypothetical scenario concerning the purchase of wood products produced in accordance with SFM practices. Next, the questionnaire explained how to answer the CE questions, by selecting the notebook type the respondent would prefer to purchase given the hypothetical choices provided (three alternatives—A, B, and C—were presented, with D corresponding to No Choice). After that, product attributes and attribute levels were briefly described as shown in the Introduction, and respondents were asked to serially answer six CE questions. Finally, respondents were asked to provide demographic-related information.

The profiles (alternatives) of notebooks were presented to the persons as shown in Appendix A (not using a picture). They were presented three profiles of notebooks at once, and were asked to choose one notebook, as shown in Appendix A. The language used for this CE survey was Japanese. We did not use emotional expression, but used simple words, so as not to be misunderstood by subjects. In focus group meetings, we confirmed that there was a common view about a set of five notebooks, because they are very common goods and many Japanese people had often bought them previously, especially in elementary school. Therefore, we didn't add a detailed explanation of the notebook and its picture.

From the survey summary shown in Table 2, we can see that the percentage of male respondents was 52.6%; and in terms of age, the majority of respondents were in their 30s and 40s. The survey was conducted by a research company as a CE web survey in August 2011, in Japan. The survey's high response rate (over 90%) was due to the research company using survey panels of subjects, with random sampling. The research company selected the subjects from their own existing pool of potential subjects for their own business. We requested that subjects be selected without gender and generational bias.

Table 2. Summary of the CE survey.

	% Japan (*n* = 604)
SEX	
Male	52.6
Female	47.4
AGE	
10–19	1.0
20–29	12.8
30–39	26.7
40–49	29.7
50–59	17.8
60+	11.9

3. Results

The results of our estimation showed ethical factors to be significant in all of the attributes (Table 3). The Conserving Biodiversity (in the tables: BIO) attribute, at High level, was regarded as the most important (1.35), followed by the Quality (QUA) attribute at High level (1.15). Quality at Medium level ranked more highly than Reducing CO_2 Emissions (CO_2) at High level.

Table 3. Estimation results of conditional logit model.

	Coefficient	S.E.	*t*-Value
Constant	−0.17	0.12	−1.42
CO_2high	0.84	0.10	7.84 *
CO_2medium	0.67	0.09	7.16 *
BIOhigh	1.35	0.11	11.49 *
BIOmiddle	0.77	0.07	10.43 *
QUAhigh	1.15	0.14	8.22 *
QUAmedium	1.00	0.08	12.05 *
Price	−0.00	0.00	−30.22 *
Log Likelihood: −2092.07			
R^2: 0.3			

* Estimated parameter (coefficient) is at the 1% level of significance.

We conducted a further analysis, this time with parameter heterogeneity using a random parameter logit model, as it is typically difficult to reveal consumer preference heterogeneity using a conditional logit model (as was used in the initial analysis, whose results are described above). The results obtained using the random parameter logit model are shown in Table 4, and the estimated parameters were very similar to the results obtained using the conditional logit model. It was found that the attribute variance (standard deviation (SD)) was high and significant for Reducing CO_2 Emissions at High level and for Conserving Biodiversity at High level. In contrast, the attribute variance for Quality was low and not significant. It is supposed that, with respect to traditional product attributes such as Quality, consumer preference was not especially varied; that is, there was no preference heterogeneity. It is further supposed that awareness related to (and thus preference for) Reducing CO_2 Emissions varied widely among consumers.

Table 4. Estimation results of random parameter logit model.

	Coefficient	S.E.	*t*-Value
Constant	−0.20	0.12	−1.56
CO_2high	0.83	0.11	7.30 *
CO_2medium	0.67	0.09	6.99 *
BIOhigh	1.46	0.12	11.33*
BIOmedium	0.83	0.08	10.28 *
QUAhigh	1.22	0.14	8.32 *
QUAmedium	1.05	0.09	11.53*
Price	−0.00	0.00	−26.12 *
SD CO_2high	0.58	0.14	4.12 *
SD CO_2medium	0.10	0.13	0.80
SD BIOhigh	0.35	0.16	2.17 *
SD BIOmedium	0.09	0.29	0.31
SD QUAhigh	0.28	0.18	1.54
SD QUAmedium	0.00	0.11	0.08
Log Likelihood: −2086.6			
R^2: 0.31			

* Estimated parameter (coefficient) is at the 1% level of significance.

We also performed an analysis to calculate WTP (results shown in Table 5, Figure 1). The Conserving Biodiversity attribute at High level had the highest WTP value (261.8 yen), followed by Quality at High level (217.9 yen), and then Quality at Medium level (187.5 yen). It was revealed that consumers were willing to pay an additional 261.8 Japanese yen for wood products that positively address global environmental issues (e.g., Conserving Biodiversity), and pay roughly an additional 217.9 yen for notebooks with high-quality paper. It was found that consumers put a premium on wood products that contribute, by adhering to SFM practices, to addressing global environmental issues such as deforestation and forest degradation; and that consumers also value traditional product attributes such as Quality.
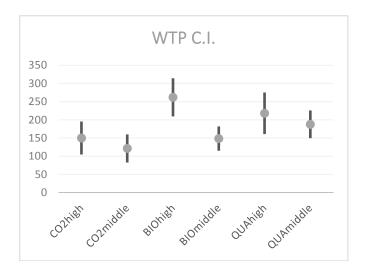

Figure 1. WTP Confidence Intervals (CIs).

Table 5. Results of WTP.

WTP	Japan Yen
GWhigh	149.9
GWmedium	121.3
BIOhigh	261.8
BIOmedium	148.4
QUAhigh	217.9
QUAmedium	187.5

4. Discussion

We revealed that Japanese consumers are willing to pay a premium for certified wood products with SFM-related attributes. In the results obtained using the random parameter logit model, there was no heterogeneity of preference for the Quality product attribute, but there was heterogeneity of preference for Reducing CO_2 Emissions (as a product attribute related to SFM).

The analysis in [31], which used a random parameter logit model, revealed a 7.4% probability that consumers would have a reverse preference for Reducing CO_2 Emissions. In terms of the evaluation of SFM-related product attributes, Conserving Biodiversity was considered most important, followed by Preventing Global Warming. For example, learning that buying a product contributes to biodiversity conservation would increase consumer willingness to purchase that product, more so than learning that purchasing the product would help prevent global warming. It is also interesting that the preference for the Conserving Biodiversity attribute was higher than the preference for the traditional product attribute of Quality.

To better express our study's WTP results (shown above in greater detail), let us assume two hypothetical wood products: a certified wood product with materials produced in accordance with SFM practices, and an ordinary wood product. Both products are of the same quality, and the price of the ordinary wood product is 400 yen. The WTP results showed that consumers would be willing to buy the product with materials produced in accordance with SFM practices (and thus contributing to biodiversity conservation), as long as the price did not exceed the price of the ordinary wood product by more than 261 yen.

5. Conclusions

Despite the limitations that might be attributed to the CE, this study helped to highlight the influence of the perception of sustainable forest management on consumers' decisions. We investigated consumers' preferences for certified wood products, and confirmed that consumers were willing pay a premium for products that contribute to solving environmental issues. It was revealed that the Conserving Biodiversity attribute at High level was regarded as the most important, followed by the Quality attributes (at High and Medium level) and Reducing CO_2 Emissions at High level. Quality at Medium level ranked more highly than Reducing CO_2 Emissions at High level. It was also found that consumers were willing pay a premium for traditional product attributes such as Quality.

We found that consumers were more attracted to certified wood products produced in accordance with SFM practices than they were to other, more ordinary wood products. Furthermore, another study has shown that consumers who believe certified products contribute to reducing tropical forest deforestation are potentially willing to pay a premium for such products [5].

Our study will contribute to the literature on consumer preferences regarding wood products. However, stated preference studies such as ours typically have limitations. First, a CE survey is based on hypothetical rather than actual purchasing behavior, and there may be discrepancies between the two behaviors [5]. Second, web surveys, which are usually conducted without interviewers, do not always reveal how well respondents understand the questionnaire [25], and methodological misspecification bias may result if respondents do not understand questionnaire content in the way the researcher(s) intended [25,33]. Therefore, CE surveys should be carefully conducted.

Author Contributions: Sakagami conceived, designed and performed the experiments; Sakagami also analyzed the data; Sakagami and Sakaguchi grasped the implication of results; Sakaguchi considered about sustainable forest management and certification.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. CE Question Example

Please select the type of notebooks (five notebooks per set) that you would be willing to buy, from the hypothetical alternatives (A, B, and C).

If you would not be willing to buy any of these notebooks, please select D (No Choice).

Table A1. An example of the CE question.

	Alternative A	Alternative B	Alternative C	Alternative D
Quality	Good	Good	Poor	
Reducing CO_2 Emissions	Medium	Medium	High	No Choice
Conserving Biodiversity	High	High	Medium	
Price (Yen)	800	600	600	

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