forests

MDPI

Article

Forest Certification and Country of Origin: Choice Experiment Analysis of Outdoor Decking Material Selection in E-Commerce Market in Finland

Jani Holopainen [1,*], Anne Toppinen [1], Katja Lähtinen [2] and Mika Rekola [1]

[1] Department of Forest Sciences, University of Helsinki, 00100 Helsinki, Finland; anne.toppinen@helsinki.fi (A.T.); mika.rekola@helsinki.fi (M.R.)
[2] Department of Marketing, University of Vaasa, 65200 Vaasa, Finland; katja.lahtinen@uva.fi
* Correspondence: jani.m.holopainen@helsinki.fi; Tel.: +358-50-376-6392

Received: 31 August 2017; Accepted: 7 November 2017; Published: 11 November 2017

Abstract: Since the early 1990s, there has been hope that the uptake of certified forest products would ensure more sustainable forest management and also deliver business benefits along the value chain. Our study applies a Discrete Choice Experiment (DCE) to model an e-commerce purchase in the case of multiple products with various attribute and certification combinations in the Finnish retail outdoor decking material market. We received 2772 responses from 231 participants in an online survey. Applying conditional logit and latent class models, we were able to assess the relative importance of attributes, identify various consumer segments, and simulate various scenarios for communicating the certification and origin of forest products and competing materials. Our results show that the most important attribute for consumer decision-making was the outdoor decking material followed by price, origin, and certification. Some consumer segments showed a habit of only choosing certain materials or domestic products, while paying less attention to other product attributes. Simulations for an e-commerce purchase situation also implied that communications concerning intangible product attributes, such as domestic origin and environmental certifications, could be used in the brand building of the forest sector to gain competitive advantage and increased market shares over other sectors. The results suggest that the conventional and constantly developing e-commerce marketing tools should be harnessed also in forest product and more general environmental marketing.

Keywords: e-commerce; consumer choice behavior; choice experiment; certified forest product; environmental communication

1. Introduction

Digital marketing and e-commerce is a rapidly growing field both in practice and research; the 21st-century digital culture is claimed to be the new paradigm in consumption [1,2]. Digital culture has spurred global consumption together with an increased amount of information e.g., on sustainability performance and the origin of products and services. However, the research in the field of origin and sustainability certificates in the digital and e-commerce consumer markets is scarce, with only few existing studies. Examples of these studies include a comparison of market shares based on historical data in the context of a book retailing e-commerce [3], a qualitative case study of sustainable networks and market segments in health and well-being products [4], and an experimental model for sustainable e-commerce packaging for packaging designs [5]. Recently, O'Rourke and Ringer [6] found that sustainability information does not educate or change the online purchase behavior of mainstream consumers if they have no interest in or intention to purchase sustainable products.

Choice experiments (conjoint analysis, discrete choice experiments and related experimental designs) are increasingly applied methods also in general digital marketing and e-commerce

research (e.g., [7–10]), and an especially preferred method in new product design and launches for e-commerce [11,12]. However, digital marketing and e-commerce-targeted choice experiments have not been applied in the field of country-of-origin or sustainability-related certification research.

Sustainable forest management certification and uptake of certified forest products are the most prominent sustainability and environmental performance measurements in the forestry sector [13]. The purpose of forest and chain-of-custody certification is to assess and verify the sustainability impacts of all phases in a production chain, and eventually help consumers to select products from sustainably managed forests. Forest certification is thus one way of conveying information to consumers about product sustainability and country-(or region) of origin. Forest certification was introduced in the 1990s, but only lately has interest in the subject as a tool to promote forest stewardship been regained through the emergence of legality verification of forest products both in the European Union (European Union Timber Regulation, EUTR) and the United States (Lacey Act). Consumers' environmental awareness and engagement in pro-environmental behavior have also been identified as trends behind a growing interest towards forest certification [14]. However, due to the emergence of a myriad of eco-labels and certificates in the markets, the information base for consumer choice has become complex. In addition, the reality in the field of forest product markets shows that the production and trade of certified forest products has increased but without substantial price premiums, and the demand for certified products comes largely from retailers, not from final consumers [15].

Previous literature has shown that there are various consumer segments which preferences and willingness-to-pay for raw material origin and forest certification vary. A meta-analysis by Cai and Aguilar [16] showed that frequently purchased forest products and forest products with lower base prices are more likely to have higher final consumers' willingness-to-pay for raw material origin and forest certification. However, past studies still lack consistent results and have not been comprehensive, including competition from various materials and substitutes for certified forest products. Instead, the origin, material, and/or certification loyalty or habitual purchasing are often studied in the general consumer market literature [17]. However, choice experiments are less used as a method for electing consumer preferences for these attributes.

Here, we chose a choice experiment method called Discrete Choice Experiment (DCE) [18,19]. According to Louviere et al. [18] many studies that claim to be conducting Conjoint Analyses (CA) are actually performing DCE. Louviere et al. [18] show that DCEs are indirect preference elicitations, while CA are more direct. The advantage of DCE over CA is that DCE is based on the random utility theory and behavior theory, while CA are based on conjoint measurement theory. This makes DCE more realistic and consistent with both economic demand and behavioral theories. The random utility theory along with the conditional logit and the latent class models with random components comprise all unidentified factors that impact choices [18]. Unlike CA, DCE, based on the random utility theory, does not require orthogonal design and baseline attribute levels [18].

The DCE in our study is designed to mimic a realistic e-commerce purchase situation, where multiple products with various attribute combinations occur in the Finnish retail outdoor decking material market. The DCE method is also applied in the context of certified forest products in the general offline consumer markets. For example several studies [20–23] have shown that raw material quality and origin have become more important for consumers than certification as such. In terms of different consumer segments, simulations by Aguilar and Cai [20] suggested that a segment of consumers might remain indifferent to higher prices and premiums of forest-certified forest products, while Shoji et al. [23] used the latent class model to identify a segment of consumers preferring wood panels as wall renovation materials, and another segment preferring wallpapers. Despite the digital marketing and e-commerce has exploded in the last decades, there are no e-commerce studies on certified forest products.

While existing studies have shown positive consumer attitudes towards forest certification, suppliers' attitudes towards forest certification have been more mixed in terms of forest certification's capability to improve competitive advantage or gain price premiums [15,24,25]. Therefore the

motivation of our research is to explore consumer markets in a case where origin and forest certification could contribute to competitive advantage and increased market shares in the broader material markets, which is an area lacking prior research.

The purpose of our study is (1) assessing the relative importance of intangible and tangible product attributes for consumer choices of outdoor decking materials in digital and e-commerce settings, (2) identifying various consumer segments for habitual purchasing, and (3) studying the effects of raw material origin and various certificates on consumer choices and market shares. For this, our study adopted DCE with conditional logit and latent class models along with market share simulations. Comprehensive and realistic choice tasks are found to be crucial for successful market choice experiments in terms of the reliability and validity of results [26,27]. Therefore our study also considers other competing materials including wood-plastic-composites and concrete terrace tiles available in the outdoor decking material market. Our study is also the first digital and e-commerce consumer market study conducted for the literature on certified forest products. Our results show the most important attributes for consumer decision-making, along with identifying consumer groups and providing simulated scenarios where enhanced communication of origin and sustainability could contribute to competitive advantage based on sustainability.

2. Study Framework

2.1. Model and Method

Our study applied a DCE in the form of conditional logit and latent class models [19,28]. DCE is a stated preference method often modeled with probabilistic discrete choice models such as a conditional logit model, which is also known as a multinomial logit [18]. While the conditional logit model assumes equal utilities (U_i) across the respondents, the latent class model identifies various respondent segments with similar preferences [28,29]. Both conditional logit and latent class models apply the random utility theory and model (U_i), which consists of the observable (V_i) and unobservable (ε_i) components of utility as follows:

$$U_i = V_i + \varepsilon_i \quad (1)$$

$$V_i = \beta' x_i,$$

where U_i is the total utility from product i, V_i is an observable deterministic term, and ε_i is an unobservable random term with a type-I extreme value distribution assumption. x_i is a vector of observed variables including information of respondent demographic characteristics and product (i) attributes (e.g., material, price, certification, origin). β' is a vector of parameters (part-worth utilities).

Probabilities of individuals choosing particular alternatives are governed by a conditional logit model [30] as follows:

$$P(i) = \frac{\exp(\mu\, \beta' x_i)}{\sum_j \exp(\mu\, \beta' x_i)}, \quad (2)$$

where P(i) is the probability of an individual choosing product i instead of any other product j. A general assumption is that scale parameter μ equals 1 and all parameters β' are estimated with the maximum likelihood method [31]. While the conditional logic model assumes equal utilities among all respondents, the latent class model assumes that an individual n belongs to a latent class s, which is unobservable a priori. The joint choice probability of a set of T_i choices is conditional on belonging to segment s can be expressed as follows:

$$P_{n|s}(i_1, i_2, \ldots, T_i \mid S) = \prod_{t=1}^{t=T_i} P_{n|s}(i_t \mid S) = \prod_{t=1}^{t=12} \frac{\exp\left(\mu_s \beta_s' x_{i,t}\right)}{\sum_j \exp\left(\mu_s \beta_s' x_{j,t}\right)}, \quad (3)$$

where β'_s is a vector of parameters (part-worth utilities) and μ_s is scale parameter for segment s.

To build the latent class model, Boxall and Adamowicz [32] and Swait [33] describe a latent membership likelihood function:

$$M_{n|s} = \gamma_s' z_n + \zeta_{n|s}, \quad (4)$$

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 according to a type-I extreme value distribution. The probability function that respondent n belongs to segment s:

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

where λ designates the scale parameter. The following represents the unconditional probability of T_i choices by respondent n in segment s:

$$P_s(i_1, i_2, \ldots, T_i \mid S) = \sum_s P_{n|s} \prod_{t=1}^{t=T_i} P_{n|s}(i_t \mid S) = \sum_s \frac{\exp\left(\lambda \gamma_s' z_n\right)}{\sum_s \exp\left(\lambda \gamma_s' z_n\right)} \cdot \prod_{t=1}^{t=T_i} \frac{\exp\left(\mu_s \beta_s' x_{i,t}\right)}{\sum_j \exp\left(\mu_s \beta_s' x_{j,t}\right)}, \quad (6)$$

2.2. Building the Survey

To improve the reliability of models, McFadden [30] and Ashok et al. [27] highlight the consideration of all various latent norms, values, and attitudes when building the hypotheses and the survey framework. Therefore it is important to look at some previous studies attempting to reveal various latent dimensions related to consumer behavior in the context of sustainable consumption and more specifically in the case of wooden outdoor decking materials. The main body of the consumer choice research in the context of forest products has considered the importance of a single product attribute, such as the presence of forest certification, and only three studies have evaluated forest certification in various contexts through building various scenarios or simulations [20,34,35]. O'Brien and Teisl [34] found that certification is more highly valued among US consumers in the case of domestic or local forest products and in curbing environment pollution. Roos and Nyrud [35] assessed consumer choices and preferences for various wooden outdoor decking materials with different preservative wood treatments (organic pressure treatment, heat treatment, and copper and boron pressure treatment) among Norwegian consumers. Their simulations showed preference and possible premium price for organic and heat-treated materials with certificates. Finally, Aguilar and Cai [20] showed that in the consumer markets of the US and UK, tropical forest products could significantly gain market shares in both markets with sustainable forest management certificates and eco-labels.

However, previous consumer studies have not considered the multi-dimensionality embedded in the sustainability issues. For example, according to Green and Peloza [36], corporate responsibility can provide three forms of value for consumers: functional, emotional, and social. In the context of certified forest products Toppinen et al. [37] found forest certification to be two-dimensional for consumers, including the general sustainability and "product health and safety"-dimensions. According to Toivonen [38], in the forest products context consumers may also relate environmental sustainability as an element of product quality, and consumer valuation of different intangible product attributes (such as origin and environmental friendliness) are consistent among various forest products. More specifically, in the case of wooden outdoor decking materials, Holopainen et al. [39] found that consumers universally valued product-relevant attributes, such as price and material quality, while intangible product attributes, such as information on sustainability and origin, were valued by only some consumer segments. The study also showed that intangible sustainability-related information dimension was characterized by a variety of issues concerning social and environmental sustainability, legal and domestic origin along with information on health effects, while material dimension loaded with product features including durability, quality, and perceived utility.

Based on findings from the literature, and evidence of existing consumer value dimensions in the case of wooden outdoor decking materials [39], we suggest a set of intangible (origin, type of certification) and product-relevant product attributes (material and product price) and different attribute levels to be tested in a DCE survey [40] (Table 1). The material bundle and prices of outdoor decking materials used in our study are from January 2015 and gathered from a single home and building material department store chain based in Finland (e-commerce market place). In our case we include two competing forest certification schemes in Finland [15]: The Programme for the Endorsement of Forest Certification (PEFC) and the Forest Stewardship Council (FSC). Both certification schemes also incorporate elements of environmental, labor, and legal forest product origin-certifications [15]. The relative importance and consumer preferences of each of these certification attributes are tested in the survey.

In addition to the existing certification types available in the outdoor decking material market, we also include new certification areas such as "climate/low carbon footprint" and "no health risk chemicals". This overall survey framework allows us to better consider the multi-dimensionality embedded in the sustainability issues and to also identify the most important certification attributes for consumer decision-making and test some possible new areas where forest certification could contribute and add value for the consumers.

Table 1. Discrete Choice Experiment (DCE) survey framework: Intangible and tangible product attributes and various attribute levels.

Intangible	Attribute Levels
Material and production origin	Domestic Imported Unknown
Certification	PEFC FSC Environmental Labor conditions Climate/low carbon footprint No negative health effects No certificates
Tangible	
Material	Pressure-treated pine Heat-treated pine Larch Wood-plastic-composite Concrete terrace tile
Price *	250, 550, 700, 1150 €/10 m^2

* Prices received from a Finnish home and building material department store chain: pressure-treated pine (550 €/10 m^2), heat-treated pine (700 €/10 m^2), larch (700 €/10 m^2), wood-plastic-composite (1150 €/10 m^2), concrete terrace tile (250 €/10 m^2). PEFC: Programme for the Endorsement of Forest Certification; FSC: Forest Stewardship Council.

2.3. Survey, Model Estimation, and Analyses

In the DCE survey, the purchase situation and intention were described to the respondent based on a selection of outdoor decking materials from a home and building material department store e-marketplace. Respondents were asked to complete twelve choice tasks, where each task reflected an actual marketplace choice decision with four different product alternatives available. Two of the choice tasks were fixed-task designs, with real product attributes as they are available in Finnish home and building material department stores. Within a choice task, each product alternative was generated according to the survey framework with "balanced overlap" as a random task generation method [40]. Concrete terrace tiles are the exception, as they cannot have forest certification attribute levels.

Following the choice tasks, respondents were asked to fill out a background information form included in the survey, considering respondent demographics such as gender, age, education, marital status, profession description, annual household income, type of residence, residence ownership, and residential area. A nonparametric Kruskal-Wallis test [41] was used for the analysis of variance, using the SPSS 23 program. All respondent demographic variables were nominal except age, which was categorized into three and four groups for testing.

A pilot survey consisting of 20 respondents was conducted at the IUFRO World Congress 2014 on 5–11 October 2014 in Salt Lake City, UT, USA. The participants at the conference consisted of a variety of practitioners, experts, and scholars from the international forest sector, hence the results of the piloting are biased. However, the main task of piloting was to test the survey form and improve the questions. For these objectives the piloting setting was sufficient, as the piloting results were logical and participant feedback for improving some questions were considered when building the final survey.

The final survey was conducted as a web-based survey, where respondents were invited to participate through marketing letters and the Facebook pages of the two Finnish retail-level hardware store chains following the data collection method introduced by [42]. The target population of the survey were home center customers and potential buyers of outdoor decking materials. Our survey also encouraged participation through the chance of winning a gift voucher from a lottery organized for the survey participants. Such target group sampling techniques [43] have advantages, as the data are more representative of home center customers and the largest group of outdoor decking material consumers (e.g., new construction builders and new home owners) than data representing all Finnish consumers more accurately but collected using a mail or open Internet survey. However, non-respondent rate and bias cannot be calculated, as the participation invitations were only made through the marketing letters and on the Facebook walls, and not sent to a certain group of people. Although our intention is not to generalize findings, the survey demographics and representativeness of the sample data compared to the total population of Finland are presented in Table 2. The SPSS 23 program was used for sample testing e.g., in conducting the one-sample *t*-test for overall means between the sample and the population.

The electronic survey form forced respondents to provide answers so the sample had no missing values. However, respondents who used less than three minutes to complete the survey or respondents who only provided monotonous replies in the choice tasks were omitted from the analysis following the suggested screening rules for DCE data [44]. Also only fully completed surveys were included in the final analyses, as uncompleted ones were screened out following the screening rules.

The DCE survey design, web-based survey, and model estimations were all conducted with the Sawtooth Software [40]. The conditional logit model results indicate relative importance (part-worth utilities) of different product attributes, while the latent class model indicates these part-worth utilities in different segments of respondents with similar preferences. Both models are estimated using the Maximum likelihood estimation method, and we were able to build different simulations from the estimated conditional logit model by applying individual probabilities (Equation (3)) [40]. The segments in the latent class model were labeled based on the significance of the explanatory variables [32,33].

Various simulation scenarios were selected to represent various market situations. Scenario 1 represents the prevailing market situation, where all decking materials, including wood composites, are PEFC-certified and domestic, while concrete terrace tiles have no identified origin or certificates. Scenario 2 represents the same situation but with the FSC certification, while none of the products in Scenario 3 have certificates and all are of domestic origin. In Scenario 4 all products are imported and wooden outdoor decking materials are FSC-certified. In Scenario 5 all products are imported and have no certificates. To test the goodness of fit for the conditional logit model and its simulations vs. The actual choices conducted in the survey, the survey had two fixed tasks that were not included in

the model estimation. By comparing the simulated choices and fixed tasks, the Mean Average Error was calculated for the simulated market shares.

General study limitations of the DCE method include incomprehensive attributes and levels of study designs compared to real market situations [26,27]. According to Hensher et al. [45], the DCE method can lack rigor in experimental designs because of a lack of consumer market information concerning latent values, norms, and attitudes related to the attributes and levels. The DCE also requires econometric models and analysis. However, the literature still lacks consensus on what the best models are [28]. In addition, as the study at hand also tests attribute levels currently not available in the markets (such as "climate/low carbon footprint" and "no health risk chemicals"), it is difficult to assess what type of information they contain, and in what form, if they eventually actually exist in the markets. Analysis of non-existing attribute levels could be further investigated with other research methods, such as qualitative research, to better understand the DCE results as well. Therefore, due to the exploratory nature of the study, our results need to be treated only as indicative, and should not be generalized to other product contexts and geographical areas.

Table 2. The survey demographics of the sample compared to the total population of Finland.

Demographics	Variables	Survey Sample		Population
		Mean	SD	
Age		43 years	12.5	
		N	(%)	(%)
Male		90	39	49
Female		141	61	51
Education	Primary school	13	6	26 [a]
	Secondary degree	114	49	42
	Tertiary degree	104	45	31
Professional description	Employed	176	76	88
	Unemployed	25	11	12
	Student	21	9	16
	Retired	27	12	51
Living residence	Apartment	61	26	45
	Row house or duplex	54	23	14
	Detached house	116	50	39
Residence ownership	Renting	45	19	13
	Ownership	181	78	83
Residential environment	Urban area	187	81	69
	Countryside	44	19	30

[a] Including students over 20 years of age working for a degree. SD: standard deviation.

3. Results

3.1. Descriptive Data

The majority of the survey respondents were reached through Facebook. The total Facebook community members of two Finnish retail-level hardware store chains included in the survey is over 70,000 individuals. In total, 352 respondents opened the survey, 231 of which were accepted for the analysis after screening. Table 2 represents the survey demographics and representativeness of the sample compared to the total population of Finland (Official Statistics of Finland 2014). According to the one-sample *t*-test, the overall means between the sample and the total population of Finland are equal at the 95% confidence level. Respondent ages ranged from 20 to 74 years, with a mean of 43 years and a standard deviation of 12.5. While the overall data represents the total population, there are some single over/under-represented segments. For example, females were over-represented in the sample: 61% of respondents were females and 39% were males. A sample rate of 49% was

obtained for respondents with secondary degrees, which represented well the entire population, while the sample rate of 45% for tertiary degree respondents was over-represented. The rate of employed and unemployed were well represented in the sample, while students and retired people were under-represented. People living in apartments were under-represented, while people living in row houses or duplexes and in detached houses were slightly over-represented. In terms of residence ownerships, the sample represented well both tenants and residence owners. Urban inhabitants were slightly over-represented with 81% of respondents living in urban areas, while the remaining 19% were countryside inhabitants and under-represented. Overall, the sample appeared to represent potential consumers in the hardware retail store markets e.g., people with higher education, or living in row and detached houses. However, there is no available data on the demographics and shares of Finnish hardware retail store consumers or more specifically in the case of outdoor decking materials. The sample thus represents the case, and the option of weighting the parameters is not used to generalize the results to the entire Finnish population.

3.2. Conditional Logit and Latent Class Models

The 231 respondents completed a total of 2772 choice tasks. The conditional logit model (Table 3) was found to be statistically significant at the 1% level (Relative Chi-Square 78.200 for 15 degrees of freedom). The single attribute levels for material, price, and origin were statistically significant, while from the certification attribute levels, only FSC was found to be significant at the 1% level (paired *t*-test). The average importances for decking material attributes (ratio of sum of attribute level utilities and total utility) indicate the weights given to various attributes in the decking material choice. The material has the highest importance (32.4%) in the decking material consumer choice, followed by price (28.0%), origin (25.9%) and certification (13.7%). Interactions resulted in no statistically significant results.

For the latent class model (Table 4 the classes were selected according to criteria for selecting the optimal number of classes, including the Bayesian Information Criterion (BIC), the Akaike Information Criterion (AIC), R^2, and the log-likelihood statistics [46] (Table 5). The other criteria improved as the number of classes increased, while the minimum BIC suggested a 6-class model. The classes i.e., consumer groups, were named as follows: consumers looking for (1) origin and price, (2) wood composite, (3) domesticity, (4) concrete tile, (5) material and origin, and (6) heat-treated pine and larch. The six classes (hereafter segments) were named after the highest part-worths in each category. High part-worths, therefore, indicate the consumers' preference to choose these attributes and levels in question (suggesting habitual purchasing behavior), while low or negative part-worths indicate the consumers' avoidance. The latent class model was found to be statistically significant at the 10% level (Relative Chi-Square 23.035 for 15 degrees of freedom).

The segment "1 origin and price" was the largest, consisting of 25% of the total respondents, followed by the segment "5 material and origin" with 22%. The PEFC certificate was preferred in the "1 origin and price"-segment, suggesting that it is a certificate for lowest price-seeking consumers, while the FSC certificate was preferred in the segment of "5 material and origin", suggesting that material-orientated consumers prefer FSC. As these two segments showed preference for a variety of different product attributes, also including both domesticity and forest certificates, segment "3 domesticity" only had preference for domestic products and no particular interest towards certificates. The other three segments, "2 wood composite", "4 concrete tile", and "6 heat-treated pine and larch", were very material-orientated and consumers in these segments preferred to only choose their favorable materials, no matter what the other product attributes were, suggesting habitual purchasing behavior towards the material in question.

In addition, the nonparametric analysis of variance (Kruskal-Wallis test) was applied [41] for the nominal respondent demographics (age was also grouped). The variable 'education' was split into three groups: high (e.g., master's education), medium (bachelor's and vocational), and low education levels (primary and high school). The Kruskal-Wallis test revealed statistically significant differences among the demographic variables only for education level. The latent class 6 (heat-treated pine and larch), with the higher mean rank, was preferred by highly educated respondents, while respondents with medium education levels preferred class 1 (origin and price) and class 2 (wood composite). Respondents with lowest education levels preferred class 3 (domesticity), class 4 (concrete tile) and class 5 (material and origin) (Table 6).

Table 3. The conditional logit model results indicating relative importance (part-worth utilities) of various product attributes.

Product Attribute Levels	Effect	Std. Error	*t*-Ratio	
Heat-treated pine	0.477	0.046	10.354	a
Larch	0.327	0.047	6.943	a
Pressure-treated pine	0.123	0.048	2.542	b
Wood-plastic-composite	−0.305	0.053	−5.764	a
Concrete terrace tile	−0.621	0.062	−9.980	a
250 €	0.631	0.039	16.300	a
550 €	0.170	0.041	4.135	a
700 €	−0.123	0.043	−2.850	b
1 150 €	−0.677	0.050	−13.409	a
Domestic	0.739	0.032	22.873	a
Unknown	−0.331	0.037	−8.944	a
Imported	−0.409	0.038	−10.894	a
FSC	0.221	0.059	3.774	a
PEFC	0.105	0.060	1.754	
Labor conditions	0.035	0.062	0.569	
Environmental	0.028	0.062	0.461	
No negative health effects	−0.018	0.063	−0.283	
Climate/low carbon footprint	−0.009	0.063	−0.146	
No certificates	−0.363	0.068	−5.380	a
Average Importances	Avg. Imp			
Material	32.4			
Price	28.0			
Material and production origin	25.9			
Certification	13.7			

a = statistically significant at $p < 0.01$ level; b = statistically significant at $p < 0.05$ level; Number of respondents in analysis = 231; Relative Chi-Square = 78.200 (statistically significant at $p < 0.01$ level); Degrees of freedom = 15. FSC: Forest Stewardship Council; PEFC: Programme for the Endorsement of Forest Certification; FSC: Forest Stewardship Council.

Table 4. Results of the latent class model.

	Segment 1 (Size 24.6%)	**Segment 2 (Size 7.9%)**	**Segment 3 (Size 20.6%)**	**Segment 4 (Size 10.1%)**	**Segment 5 (Size 21.8%)**	**Segment 6 (Size 14.9%)**
	Origin and Price	**Wood Composite**	**Domestic**	**Concrete Tile**	**Material and Origin**	**Heat-Treated Pine and Larch**
	Part Worth [c]	**Part Worth [c]**	**Part Worth [c]**	**Part Worth [c]**	**Part Worth [c]**	**Part Worth [c]**
Heat-treated pine	28.806 (0.116) [a]	−3.059 (0.255)	46.406 (0.143) [a]	−73.948 (0.184) [a]	81.131 (0.124) [a]	91.793 (0.169) [a]
Larch	4.563 (0.12)	28.746 (0.22) [a]	4.128 (0.149)	2.455 (0.151)	23.493 (0.127) [a]	130.379 (0.186) [a]
Pressure-treated pine	6.163 (0.118)	−44.771 (0.317) [a]	−12.263 (0.153)	8.118 (0.152)	95.555 (0.122) [a]	−47.223 (0.22) [a]
Wood-plastic-composite	−1.212 (0.12)	115.168 (0.293) [a]	−20.418 (0.148)	−41.791 (0.164) [b]	−96.669 (0.22) [a]	−87.078 (0.287) [a]
Concrete terrace tile	−38.319 (0.147) [a]	−96.084 (0.5) [a]	−17.852 (0.167)	105.165 (0.146) [a]	−103.51 (0.249) [a]	−87.872 (0.291) [a]
250 €	99.844 (0.188) [a]	27.321 (0.194) [a]	27.144 (0.127) [a]	42.331 (0.121) [a]	22.549 (0.101) [a]	32.279 (0.142) [a]
550 €	46.919 (0.181) [a]	22.07 (0.196) [b]	0.038 (0.123)	5.291 (0.13)	5.596 (0.103)	17.119 (0.146) [b]
700 €	−0.868 (0.196)	−12.344 (0.213)	12.441 (0.124)	−6.466 (0.131)	−1.803 (0.103)	13.686 (0.144)
1150 €	−145.895 (0.493) [a]	−37.047 (0.234) [a]	−39.623 (0.136) [a]	−41.156 (0.139) [b]	−26.342 (0.112) [a]	−63.083 (0.18) [a]
Domestic	27.681 (0.084) [a]	43.844 (0.186) [a]	142.778 (0.119) [a]	24.466 (0.103)	48.88 (0.085) [a]	39.503 (0.124) [a]
Unknown	−12.488 (0.086) [a]	−31.044 (0.191) [a]	−71.38 (0.143) [a]	7.861 (0.104)	−18.572 (0.088) [a]	−25.075 (0.126) [a]
Imported	−15.192 (0.086) [a]	−12.8 (0.169)	−71.398 (0.143) [a]	−32.326 (0.11) [b]	−30.308 (0.091) [a]	−14.428 (0.124) [b]
PEFC	19.307 (0.148) [a]	7.842 (0.27)	19.348 (0.179)	−23.6 (0.222)	4.499 (0.141)	−11.495 (0.209)
FSC	−0.61 (0.146)	28.126 (0.274) [b]	21.441 (0.18)	21.877 (0.196)	24.847 (0.141) [a]	10.315 (0.204)
Labor conditions	−2.368 (0.153)	−13.433 (0.32)	−20.58 (0.193)	37.312 (0.176)	8.941 (0.155)	−6.998 (0.218)
Environmental	3.345 (0.148)	0.102 (0.303)	3.618 (0.187)	4.294 (0.189)	3.37 (0.151)	2.411 (0.21)
No negative health effects	6.183 (0.15)	−7.322 (0.305)	11.008 (0.18)	−43.298 (0.199)	10.133 (0.157)	7.191 (0.222)
Climate/low carbon footprint	−0.901 (0.152)	6.052 (0.304)	−4.044 (0.187)	28.315 (0.177)	−3.779 (0.166)	6.98 (0.219)
No certificates	−24.957 (0.167) [a]	−21.367 (0.319)	−30.792 (0.197) [b]	−24.9 (0.196)	−48.01 (0.181) [a]	−8.405 (0.224)

[a] = statistically significant at $p < 0.01$ level; [b] = statistically significant at $p < 0.05$ level; [c] = Part-worth Utilities Rescaled for Comparability Standard errors in parantheses; Number of Respondents = 231; Relative Chi-Square = 23.035 (statistically significant at $p < 0.1$ level); Degrees of freedom = 15.

Table 5. Criteria for selecting the optimal number of latent classes.

Number of Classes	Log-Likelihood	R^2	AIC	BIC
1	−2615.841	0.183	5261.683	5347.858
2	−2469.652	0.229	5001.303	5179.398
3	−2339.097	0.270	4772.195	5042.210
4	−2255.806	0.296	4637.613	4999.548
5	−2176.944	0.320	4511.888	4965.743
6	−2108.185	0.342	4406.370	4952.146
7	−2058.476	0.357	4338.953	4976.648
8	−2021.470	0.369	4296.940	5026.555

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion.

Table 6. Kruskal-Wallis test for education and latent class segments (6 groups).

Segment Number and Name		*N*	Mean Rank
1	Origin and price	54	119.491
2	Wood composite	18	124.306
3	Domestic	48	109.094
4	Concrete tile	23	98.196
5	Material and origin	54	104.926
6	Heat-treated pine and larch	34	145.441
	Total	231	

Chi-Square = 13.240; Asymp. Sig. 0.021 = statistically significant at $p < 0.05$ level; Degrees of freedom = 5.

3.3. Simulations

The simulations (Figure 1) for the conditional logit model (Table 3) showed the prevailing market situation, where all forest products including wood composites are PEFC-certified and domestic, while concrete terrace tiles have no identified origin and no certificates (Scenario 1). FSC certification for wooden outdoor decking materials slightly improves the market shares (Scenario 2). Scenario 3, where none of the products have certificates and all are domestic, improves the relative market share for concrete terrace tiles. The market share for concrete terrace tiles is further improved when all products are imported and wooden outdoor decking materials are FSC-certified (Scenario 4). Scenario 5, where all products are imported with no certificates, had the highest share for concrete terrace tiles. The results imply that wooden outdoor decking materials with domestic origin and certification could gain competitive advantage over other materials such as concrete terrace tiles. Table 7 shows the goodness of fit for the conditional logit model and its simulations vs. The actual choices conducted in the survey. The Mean Average Error for the simulated market shares is reasonably small, 1.9%.

Table 7. Actual (fixed tasks) and simulated choice shares.

Product	Actual Choice Shares %	Simulated Choice Shares %	Absolute Error
Pressure-treated pine, 550 €, Imported PEFC	38.5	39.9	1.4
Wood-plastic-composite, 1150 €, Domestic, PEFC	10.8	11.2	0.4
Concrete terrace tile, 250 €, Unknown, No certificates	11.7	6.5	5.2
Heat-treated pine, 700 €, Domestic, PEFC	39	42.4	3.4
Pressure-treated pine, 550 €, Imported, No certificates	35.5	33.2	2.3
Wood-plastic-composite, 1150 €, Imported, No certificates	9.1	9.3	0.2
Concrete terrace tile, 250 €, Unknown, No certificates	27.3	27.1	0.2
Larch, 700 €, Imported, No certificates	28.1	30.4	2.3

Mean Average Error = 1.9%, is the mean of absolute errors.

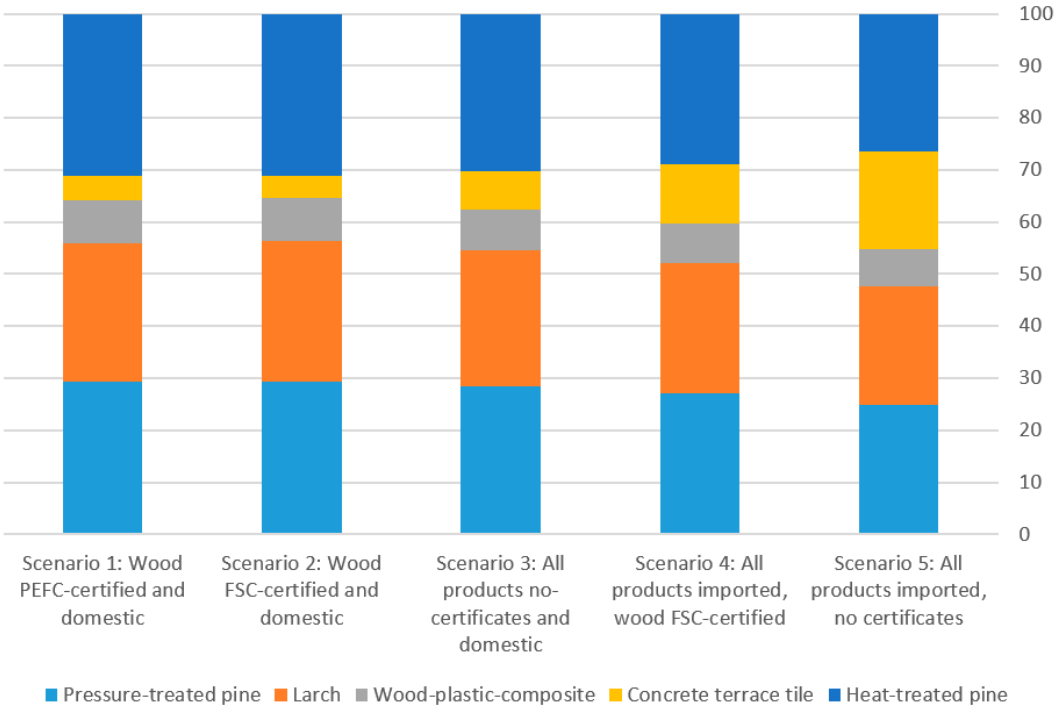

Figure 1. Simulation results: the right axis represents the simulated market shares (%) under the different scenarios.

4. Discussion and Conclusions

The DCE applied in our study is a relatively new method, and apart from Aguilar and Cai [20], Cai and Aguilar [16], Sakagami et al. [22], and Shoji et al. [23], has seldom been applied in raw material origin and forest certification -related consumer studies. The advantage of the DCE over traditional conjoint analysis methods is that it better mimics a realistic purchase situation where a respondent has to select one product from multiple products with different attribute combinations occurring in the market. The study at hand contributes to the DCE literature of the raw material origin and forest certification consumer studies, but also introduces a new research context of digital marketing and e-commerce. Most importantly, our study sheds light on how origin and certification can contribute to the forest sector's competitiveness against other material sectors, an area that lacks research. This is also an area concerning the forest industry and which has affected their attitudes in terms of forest certification's capability to improve competitive advantage and gain price premiums [15,25].

The existing DCE forest certification consumer studies [16,20,22,23] have shown that raw material quality and origin have become more important for consumers than certification. Moreover, Cai and Aguilar's [16] meta-analysis on overall forest certification consumer studies concluded that there are cases where a significant percentage of some consumer segments showed willingness-to-pay for forest certification, and this is more likely to happen with frequently purchased forest products and forest products with lower base prices. O'Rourke and Ringer [6] found that in general, sustainability information in the consumer e-commerce market does not educate or change the mainstream consumers' online purchase behavior if they have no interest or intension towards sustainability.

Our results for mimicking the e-commerce purchase situation show similarity to previous forest certification consumer DCE studies (e.g., [16,20,22,23]) suggesting that material and price are the most important choice attributes, but also that certification and origin in particular have a significant impact on consumer choices and product markets shares. This finding is also in line with many existing CA studies [47]. In terms of consumer segments, our study confirmed that certification matters for some consumer groups, but this is often linked with domestic production, which was also the case

in the US [34]. As a new finding, low price-seeking consumers looked for PEFC certificates, while material-orientated consumers preferred FSC. The latter consumer segment consisted of more highly educated people, who in general preferred higher quality wooden materials. Some segments showed a habit of choosing only wood composites, concrete tiles, heat-treated pine or larch, and paying less attention to other product attributes. Such habitual purchasing and consumer segments not changing their environmental behavior is in line with the results of Shoji et al. [23] and O'Rourke and Ringer [6]. However, this confirms well with the results that material and price were found to be the dominant factors for consumer choice, while origin and certificates can only give additional value.

Several studies on forest certification in consumer markets have investigated the origin and certification effects on market shares, but focused only on wood products (e.g., [20,21]), neglecting the broader material markets. However, inclusion of more realistic and comprehensive choice tasks is crucial in terms of results reliability and validity [26,27]. In terms of origin and certification contributing to the competitive advantage of forest products against other materials, the conditional logit model simulations suggests that the popularity and market shares for forest products are greater when the products are domestic and carry environmental certificates. The concrete terrace tiles, on the other hand, gain market shares when wooden outdoor decking materials are imported and non-certified. When the origin and certification attributes are equivalent or not reported at all, the share for concrete terrace tiles drastically improved. By implication, domestic and certified forest sector products gain competitive advantage against other material sectors. Some limitations regarding the simulations and markets shares exist in terms of the model's incapability to reveal any interaction effects, e.g., between origin/certificates and various materials. This reduces the validity of simulation market shares, however, the statistically significant conditional logit model and low Mean Average Error for simulated choice shares suggest reliability of the overall results, i.e., relative order and sensitivity of different product market shares under various scenarios.

The study results suggest that raw material origin and certification can improve the demand and market share of forest sector products especially in larger and substituting material markets. Several studies and observations also suggest that many certifications and eco-labels, particularly in the case of forest sector, do not significantly increase the demand and price premiums (see e.g., Chen et al. [24] Räty et al. [15], Korhonen et al. [48]). However, the simulations of our study imply (for one specific case product and country) that these results may not be valid if broader material markets are considered. The overall sectoral image concerning origin and sustainability may give a competitive advantage over other sector products, and therefore the study results supports the integrated and harmonized communication efforts across the sector value chains for improved sectoral image and brand building such as in the case of forest products. The digital and e-commerce markets, enabling more information and comparisons of product variety, hold a new significant potential for the communication of these intangible product attributes.

Our results and findings encourage future research targeting more comprehensive consumer markets, where realistic choice experiments can be achieved only by including various materials and substitutes along with considering various latent norms, values, and attitudes [27]. Moreover, this requires better understanding of the role of various kinds of values and psychological information processing by consumers in different choice and purchase situations, which is a research vein completely absent from forest product consumer markets. In this regard, also understanding the customer journey, e.g., the role of e-commerce market place communication and cues in eventual certified forest product purchasing could be better understood.

Acknowledgments: This work was financially supported by Niemi Foundation, Foundation for Economic Education and Academy of Finland grant #278363.

Author Contributions: J.H. conceived and designed the experiments, performed the experiments, analyzed the data and wrote the article. A.T. contributed to the writing and analysis. M.R. and K.L. contributed to the design of experiments.

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

References

1. Klein, L.R.; Ford, G.T. Consumer search for information in the digital age: An empirical study of prepurchase search for automobiles. *J. Interact. Mark.* **2003**, *17*, 29–49. [CrossRef]
2. Deuze, M. Participation, remediation, bricolage: Considering principal components of a digital culture. *Inf. Soc.* **2006**, *22*, 63–75. [CrossRef]
3. Xu, M.; Allenby, B.; Kim, J.; Kahhat, R. A dynamic agent-based analysis for the environmental impacts of conventional and novel book retailing. *Environ. Sci. Technol.* **2009**, *43*, 2851–2857. [CrossRef] [PubMed]
4. Liu, J.Y.; van Ginkel, S.N. Chiropractic marketing: Market segmentation & growth strategy. *J. Int. Acad. Case Stud.* **2011**, *17*, 55–70.
5. Santarelli, G.; Regattieri, A.; Bortolini, M.; Cascini, A.; Mora, C. Packaging design for e-Operations: A reference framework and experimental evidence. In Proceedings of the International Conference on Production Research (ICPR), Iguazu Falls, Brazil, July 2013.
6. O'Rourke, D.; Ringer, A. The Impact of Sustainability Information on Consumer Decision Making. *J. Ind. Ecol.* **2015**. [CrossRef]
7. Rao, A. Online content pricing: Purchase and rental markets. *Mark. Sci.* **2015**, *34*, 430–451. [CrossRef]
8. Yong, C. Estimating the monetary value of willingness to pay for E-book reader's attributes using partially confounded factorial conjoint choice experiment. *AIP Conf. Proc.* **2013**, *1557*, 495–499.
9. Soga, N.; Okamoto, T. Using choice experiments to value an electronic commerce. In Proceedings of the IEEE/IPSJ 11th International Symposium on Applications and the Internet (SAINT), Munich, Germany, 18–21 July 2011; pp. 568–573.
10. Jin, S.; Li, H.; Li, Y. Preferences of chinese consumers for the attributes of fresh produce portfolios in an e-commerce environment. *Br. Food J.* **2017**, *119*, 817–829. [CrossRef]
11. LoPinto, F.A.; Ragsdale, C.T. Efficient modelling of individual consumer preferences: Facilitating agent-based online markets. *Int. J. Electron. Mark. Retail.* **2010**, *3*, 66–81. [CrossRef]
12. Zufryden, F. An integrated virtual store-based approach for price determination before product launch. *Int. J. Elect. Commer.* **2007**, *11*, 79–99. [CrossRef]
13. Toppinen, A.; Cubbage, F.; Moore, S. Economics of forest certification and corporate social responsibility. In *Handbook of Forest Resource Economics*; Kant, S., Alavapati, J., Eds.; Routledge: London, UK, 2014.
14. Kleinschmit, D.; Lindstad, B.H.; Thorsen, B.J.; Toppinen, A.; Roos, A.; Baardsen, S. Shades of green: A social scientific view on bioeconomy in the forest sector. *Scand. J. For. Res.* **2014**, *29*, 402–410. [CrossRef]
15. Räty, T.; Toppinen, A.; Roos, A.; Nyrud, A.; Riala, M. Environmental policy in the Nordic wood product industry: Insights into firms' strategies and communication. *Bus. Strategy Environ.* **2016**, *25*, 10–27. [CrossRef]
16. Cai, Z.; Aguilar, F.X. Analysis of consumer's willingness-to-pay premiums for certified wood products. *J. For. Econ.* **2013**, *19*, 15–31. [CrossRef]
17. Duhigg, C. *The Power of Habit: Why We Do What We Do in Life and Business*; Random House: New York, NY, USA, 2012.
18. Louviere, J.J.; Flynn, T.N.; Carson, R.T. Discrete choice experiments are not conjoint analysis. *J. Choice Model.* **2010**, *3*, 57–72. [CrossRef]
19. Louviere, J.J. Experimental choice analysis: Introduction and overview. *J. Bus. Res.* **1992**, *24*, 89–96. [CrossRef]
20. Aguilar, F.X.; Cai, Z. Conjoint effect of environmental labeling, disclosure of forest of origin and price on consumer preferences for wood products in the US and UK. *Ecol. Econ.* **2010**, *70*, 308–316. [CrossRef]
21. Cai, Z.; Aguilar, F.X. Consumer stated purchasing preferences and corporate social responsibility in the wood products industry: A conjoint analysis in the U.S. and China. *Ecol. Econ.* **2013**, *95*, 118–127. [CrossRef]
22. Sakagami, M.; Okuda, T.; Lim, H.F. Estimating potential preferences for wood products sourced from forests that are managed using sustainable forest management schemes. *Int. For. Rev.* **2014**, *16*, 301–309. [CrossRef]
23. Shoji, Y.; Nakao, N.; Ueda, Y.; Kakizawa, H.; Hirai, T. Preferences for certified forest products in Japan: A case study on interior materials. *For. Policy Econ.* **2014**, *43*, 1–9. [CrossRef]
24. Chen, J.; Tikina, A.; Kozak, R.; Innes, J.L.; Duinker, P.; Larson, B. The efficacy of forest certification: Perceptions of Canadian forest products retailers. *For. Chron.* **2011**, *87*, 636–643. [CrossRef]
25. Holopainen, J.; Toppinen, A.; Perttula, S. Impact of European Union Timber Regulation on Forest Certification Strategies in the Finnish Wood Industry Value Chain. *Forests* **2015**, *8*, 2879–2896. [CrossRef]
26. McFadden, D. The choice theory approach to market research. *Mark. Sci.* **1986**, *5*, 275–279. [CrossRef]

27. Ashok, K.; Dillon, W.; Yuan, S. Extending discrete choice models to incorporate attitudinal and other latent variables. *J. Mark. Res.* **2002**, *39*, 31–46. [CrossRef]
28. Greene, W.H.; Hensher, D.A. A latent class model for discrete choice analysis: Contrasts with mixed logit. *Transp. Res. Part B Methodol.* **2003**, *37*, 681–698. [CrossRef]
29. DeSarbo, W.S.; Wedel, M.; Vriens, V.; Ramaswamy. Latent Class Metric Conjoint Analysis. *Mark. Lett.* **1992**, *3*, 273–288. [CrossRef]
30. McFadden, D. Conditional logit analysis of qualitative choice behavior. In *Frontiers in Econometrics*; Zarembka, P., Ed.; Academic Press: New York, NY, USA, 1974.
31. Ben-Akiva, M.; Lerman, S.R. *Discrete Choice Analysis*; The MIT Press: Cambridge, UK, 1985.
32. Boxall, P.C.; Adamowicz, W.L. Understanding heterogeneous preferences in random utility models: A latent class approach. *Environ. Resour. Econ.* **2002**, *23*, 421–446. [CrossRef]
33. Swait, J. A structural equation model of latent segmentation and product choice for cross-sectional revealed preference choice data. *J. Retail. Consum. Serv.* **1994**, *1*, 77–89. [CrossRef]
34. O'Brien, K.A.; Teisl, M.F. Eco-information and its effect on consumer values for environmentally certified forest products. *J. For. Econ.* **2004**, *10*, 75–96. [CrossRef]
35. Roos, A.; Nyrud, A.Q. Preferences for pressure-treated wooden deck materials. *Wood Fiber Sci.* **2008**, *40*, 436–447.
36. Green, T.; Peloza, J. How does corporate social responsibility create value for consumers? *J. Consum. Mark.* **2011**, *28*, 48–56. [CrossRef]
37. Toppinen, A.; Toivonen, R.; Valkeapää, A.; Rämö, A.K. Consumer perceptions of environmental and social sustainability of wood products in the Finnish market. *Scand. J. For. Res.* **2013**, *28*, 775–783. [CrossRef]
38. Toivonen, R. Dimensionality of quality from a customer perspective in the wood industry. *Dissertat. For.* **2011**. [CrossRef]
39. Holopainen, J.; Häyrinen, L.; Toppinen, A. Consumer value dimensions for sustainable wood products: Results from the Finnish retail sector. *Scand. J. For. Res.* **2014**, *29*, 378–385. [CrossRef]
40. Manual of Sawtooth Software. *CBC/HB v5: Software for Hierarchical Bayes Estimation for CBC Data*; Sawtooth Software, Inc.: Sequim, WA, USA, 2009.
41. Metsämuuronen, J. *Tutkimuksen Tekemisen Perusteet Ihmistieteissä 4*; Jyväskylä, Gummerus Kirjapaino Oy: Jyväskylä, Finland, 2009.
42. Munnukka, J.; Karjaluoto, H.; Tikkanen, A. Are Facebook brand community members truly loyal to the brand? *Comput. Hum. Behav.* **2015**, *51*, 429–439. [CrossRef]
43. Macri, E.; Tessitore, C. Facebook sampling method: Some methodological proposals. In Proceedings of the NTTS 2011—New Techniques and Technologies for Statistics 2011, Luxembourg, Luxembourg, 22–23 September 2011.
44. Johnson, R.M.; Orme, B.K. *A New Approach to Adaptive CBC*; Research Paper Series; Sawtooth Software, Inc.: Orem, UT, USA, 2007.
45. Hensher, D.A.; Rose, J.M.; Greene, W.H. *Applied Choice Analysis: A Primer*; Cambridge University Press: Cambridge, UK, 2005.
46. Swait, J. Advanced choice models. In *Valuing Environmental Amenities Using Stated Choice Studies*; Kanninen, B.J., Ed.; Springer: Amsterdam, The Netherlands, 2006.
47. Macias, N.; Knowles, C. Examining the effect of environmental certification, wood source, and price on architects' preferences of hardwood flooring. *Silva Fenn.* **2011**, *45*, 97–109. [CrossRef]
48. Korhonen, J.; Toppinen, A.; Kuuluvainen, J.; Prestemon, J.; Cubbage, F. Recycling, certification, and international trade of paper and paperboard: Demand in Germany and the United States. *For. Sci.* **2017**, *63*, 449–458.