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Consumer willingness to pay for quality attributes of fresh seafood: A labeled latent class model

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ABSTRACT

We applied a labeled choice experiment (LCE) to investigate consumer demand and choice behavior for fresh seafood in a retail market. The LCE was conducted for a large number of seafood alternatives (*i.e.*, seafood species) labeled by the respective seafood name (*e.g.*, cod, salmon, mussels). Consumer heterogeneity in preference was expressed by estimating a labeled latent class model with alternative-specific effects, which varies choice probability and model parameters over seafood alternatives and across classes. The willingness to pay (WTP) for extrinsic attributes (*e.g.*, product form, production method, and country of origin), and the rank ordered-intrinsic value were estimated for each seafood alternative within classes and the entire market. The WTP estimate in our study is expected to be more accurate than those derived from studies based on single product alternatives because the LCE allows respondents to evaluate choice alternatives through both attribute judgment and alternative comparison. Exploring a variety of product alternatives is also meaningful to firms with multiple products (*e.g.*, fresh seafood retailers) or firms with many direct competitors.

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1. Introduction

The objective of this study is to investigate consumer demand and choice behavior for fresh fish and seafood[5] at the retail market. Seafood is an important food supply for the human diet. The contribution of seafood to global diets has reached a record of about 17.8 kg per person on average, supplying over three billion people with at least 15 of their average yearly animal protein intake (FAO, 2009). Annually, capture fisheries and aquaculture supply the world with about 140 million tons of fish, of which nearly half is from aquaculture (FAO, 2012). Seafood has emerged as one of the largest internationally traded commodities in the world, with the 2011 total trade value estimated at US$262.1 billion (FAO, 2014). Seafood products are diversified in species and in product forms.

During the last thirty years, many economic studies have been conducted to measure consumer preference and demand for seafood. Those seafood demand studies may be classified into two streams: total market demand studies (*e.g.*, Eales & Wessells, 1999; Manrique & Jensen, 2001; Thong, 2012; Xie & Myrland, 2011) and multi-attribute demand studies (*e.g.*, Alfnes, Guttormsen, Steine, & Kolstad, 2006; Jaffry, Pickering, Ghulam, Whitmarsh, & Wattage, 2004; Marette, Roosen, Blanchemanche, & Verger, 2008; Quagrainie & Engle, 2006; Wirth, Love, & Palma, 2007). Total market demand studies are based on neoclassical consumer theory assuming that the act of consumption expresses consumer utility in the form of revealed preferences. The assumption does not allow for variations of consumer taste and ignores the intrinsic properties of the good. Since most empirical demand analyses use aggregate market data to estimate the total demand for seafood they have limited managerial implications (Kinnucan & Wessells, 1997). The multi-attribute demand studies are based on Lancastrian consumer theory (Lancaster, 1966) assuming that consumer's utility stems from product properties rather than the products themselves. Thus, multi-attribute demand models can elicit the intrinsic value of the product attributes and have been applied widely in marketing research. However, to the best of

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[5] Throughout this paper, when referring to seafood we actually mean fish and seafood which may be from wild stock or aquaculture.

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our knowledge, most multiattribute demand studies for seafood involve a single seafood species only such as salmon (Alfnes et al., 2006), pangasius (Quagrainie & Engle, 2006), or shrimp (Wirth et al., 2007). The absence of comparisons between alternatives in these studies might lead to overestimate the consumers' willingness to pay (WTP) (Parker & Schrift, 2011; Swait & Adamowicz, 2001), not avoid a positive price bias (Rao & Sattler, 2003), and be of less relevance for firms marketing several products or for situations with several or many direct competitors (Lusk & Hudson, 2004).

Against this background our paper will elicit consumers' WTP for the salient attributes of a variety of fresh seafood species in the retail market. The French retail market has been selected for the study because France is one of the most important markets for seafood in the European Union. We focus on fresh seafood since the product is perceived as having the highest quality among the different product forms of seafood (Olsen, 2004) and in France about 70–80% of seafood is consumed at home (GLITNIR, 2008). We apply a discrete choice experiment (DCE) to accomplish this objective; this method is strongly consistent with economic demand theory (Louviere, Flynn, & Carson, 2010), and is highly flexible with respect to data collection and model specifications. DCE is based on random utility theory (Thurstone, 1927) about individual decision making, and seems realistic in imitating real shopping behavior (Louviere, Hensher, & Swait, 2000; Natter & Feurstein, 2002).

To accommodate the evaluation of choice alternatives through both attribute judgment and alternative comparison, we apply a labeled choice experiment (LCE), where choice alternatives are labeled by the respective names of the seafood (*e.g.*, salmon, cod, mussels, and shrimps). This model for seafood choice behavior is similar to the brand choice models that have been applied widely in marketing research (Boxall & Adamowicz, 2002; Kamakura & Russell, 1989, 1993; Wedel & Kamakura, 2000). However, we differentiate our model specification so that the constant terms, which represent intrinsic value of the alternatives, and attribute parameters are varied both over seafood alternatives and across latent classes.

Applying a LCE to a large number of seafood items our study is expected to overcome some limitations of single species focusing-studies. Our LCE allows respondents to not only judge product attributes but also to compare product alternatives at the same time. Comparative judgment is one of the fundamental dimensions of consumer quality perception because it reflects the interactions between the consumer and the product (Parker & Schrift, 2011; Steenkamp, 1990). Therefore, the WTP to be elicited in our study is expected to be more accurate than studies focusing on single species. In addition, allowing the comparison between alternatives assists us to estimate the intrinsic values of the respective seafood, which reflects that consumers in a real market might be very aware of these differences, for example a species' unique nutritional values (*e.g.*, salmon is rich in omega-3 fatty acid). Another advantage is that the LCE may alleviate the bias of the demand estimates because the labeled products or brands that often add information or product knowledge (Keller, 1993; Louviere et al., 2000) will take at least partly the positive effects of price (Rao & Sattler, 2003). Finally, our study conducted for a variety of products may be more meaningful for multiproduct firms and for firms with many direct competitors in optimization of product lines and development of marketing strategy (Lusk & Hudson, 2004).

The remainder of the paper is organized into five sections. The next section provides a brief outline of the labeled latent class model for seafood choice. The subsequent section describes the LCE design, the choice setting and the data collection process. The results are presented in section four, and are followed by a discussion in section five. The conclusion and limitations are contained in the final section.

2. Model

2.1. Labeled latent class model for seafood choice behavior

Consumers are widely recognized as heterogeneous in their taste and preferences (Wedel & Kamakura, 2000). Among many discrete choice models available, the mixed logit (and random coefficient, scaled-multinomial logit, and generalized-multinomial logit) model and the latent class model (LCM) are known as appropriate approaches for capturing unobserved heterogeneity (see Fiebig, Keane, Louviere, & Wasi, 2010; Greene & Hensher, 2003). We apply a LCM because the model can simultaneously perform market segmentation and segment-specific estimation of model parameters. Thus, the delineated segments exhibit different consumer preference and price sensitivity in connection with additional socio-demographic or attitudinal consumer characteristics which might have importantly managerial implications (Wedel & Kamakura, 2000).

Using a labeled latent class model (LLCM) for fresh seafood choice behavior, we assume that respondents are asked to choose one fresh seafood alternative from a large but finite number of seafood alternatives within a pre-specified set for their household consumption. A seafood alternative is labeled by its actual common name such as salmon, sole, and mussels. The seafood alternatives may have generic or unique attributes, and the attributes may have different levels. Also, we assume that a finite number of latent classes exist on the market under consideration. It follows that each class includes consumers who are assumed to have very similar part-worth utilities (*i.e.*, preferences) for the respective types of seafood.

The source of consumer heterogeneity in preference and choice can be explained by including the variables of consumer attitudes and perceptions, and individual characteristics in the estimated model (Boxall & Adamowicz, 2002; McFadden, 1986). These variables are called covariates and the model that estimates choice probability and latent classes simultaneously is called LLCM with covariates. Following previous studies (*e.g.*, Boxall & Adamowicz, 2002; Vermunt & Madgison, 2005), we express the unconditional choice probability (P_{itq}.) for seafood i in choice set t by the consumer q in the LLCM with covariates as:

$$P_{itq} = \sum_{c=1}^{C} \left[\frac{\exp\ (\vartheta \gamma^c Z_q)}{\sum_{c=1}^{C} \exp\ (\vartheta \gamma^c Z_q)} \right] \left[\frac{\exp\ (\alpha_i^c + \beta_i^c X_{itq} + \sum_A \gamma_{Ai}^c A_{itq})}{\sum_j (\alpha_j^c + \beta_j^c X_{jtq} + \sum_A \gamma_{Aj}^c A_{jtq})} \right] \tag{1}$$

where $i, j = 1,\ldots, I$ specific seafood alternatives; $t = 1,\ldots, T$ choice sets (replications); $q = 1,\ldots, Q$ respondents; $c = 1,\ldots, C$ latent classes; A = the quality attributes of the seafood; α_i^c is the intrinsic value of the seafood i estimated for consumers in class c; β_i^c is the specific-price effects of seafood i estimated for consumers in class c; γ_{Ai}^c is the specific-effects of attribute A of seafood i estimated for consumers in class c; X_{itq} and A_{itq} are levels of price P (continuous variable) and quality attributes A (nominal variables) of seafood i in choice set t, respectively, given to individual consumer q; Z_q is characteristics (*e.g.*, income and age) of individual q used as covariates; γ^c is vector of estimated parameters of the covariates in class c; ϑ is a scale factor of class membership function.

Now we define:

$$f^c = \frac{\exp\ (\vartheta \gamma^c Z_q)}{\sum_{c=1}^{C} \exp\ (\vartheta \gamma^c Z_q)} \tag{2}$$

in which f^c. represents the likelihood of finding an individual in class c or the class membership probability, and is equivalent to

the class size. The probability of class membership (f^c) is the unconditional probability of belonging to class c and is commonly specified in the form of a logit function with linear relationship (Boxall & Adamowicz, 2002).

Our LLCM differs from the traditional LCM in varying the constant term (α_i^c) and attribute-parameters (β_i^c and γ_{Ai}^c) over the latent classes as well as across the choice alternatives. The model therefore may be referred to as a latent class model with alternative-specific effects. The LLCM is estimated by maximum likelihood procedure; see DeSarbo, Ramaswamy, and Cohen (1995) for the application of the likelihood function to the panel structure of choice experiment data. A scale factor (ϑ) represents the class membership function and c scale factors represent c class's utility functions in Eq. (1). In empirical estimation of the latent class model, all scale factors are set equal to one (Boxall & Adamowicz, 2002).

2.2. WTP calculation

We define WTP for a non-monetary attribute as the price premium that consumers are willing to pay for obtaining a desired attribute level. For instance, if it is expected that consumers prefer wild caught salmon over the farmed alternative, then the WTP for wild salmon is a price premium that consumers are willing to pay for obtaining the wild products instead of choosing farmed ones. If the utility is a linear function of all attributes, the WTP for an attribute level in latent class c is calculated as:

$$WTP_{iA}^c = -\frac{\hat{\beta}_{iA}^c}{\hat{\beta}_{iP}^c} \tag{3}$$

where WTP_{iA}^c is the price premium paid for obtaining a desired level of attribute A of the seafood i in class c, and $\hat{\beta}_{iA}^c$ and $\hat{\beta}_{iP}^c$ are the estimated coefficients of quality and price attributes in Eq. (1).

The overall WTP for the sample is simply the weighted averages of the class WTPs in which the weight equals the probabilities of class membership or class size $\hat{f}^c$ (see Kamakura & Russell, 1993). That is:

$$WTP_{iA_\text{average}} = \sum_{c=1}^{C} \hat{f}^c WTP_{iA}^c \tag{4}$$

2.3. Intrinsic value of seafood alternatives

The estimated intrinsic utility for seafood i within class c ($\hat{\alpha}_i^c$) represents the value assigned to the seafood after adjusting for the impact of the observable attributes (*i.e.*, product form, method, origin, and price). In marketing research, the intercept of the utility function of the brand choice behavior model is viewed as the brand equity for the product (Kamakura & Russell, 1993). Similarly, we assume this parameter ($\hat{\alpha}_i^c$) to be a measure of the intrinsic value of the seafood within a class. An aggregate measure for the intrinsic value of the seafood alternative i for the entire market (IV_i) may be defined as the market-weighted average intrinsic utility across the classes (Kamakura & Russell, 1993) as:

$$IV_i = \sum_{c=1}^{C} \hat{f}^c \hat{\alpha}_i^c \tag{5}$$

The intrinsic value is scaled so that the mean value for all seafood alternatives in the model is zero. Thus, the intrinsic value should be viewed as the rank ordered-intrinsic value of the seafood alternatives, which indicates the position (*i.e.*, image) of the seafood in the consumers' minds and therefore has managerial implication. The rank ordered-value may differ from the choice share or market share. One seafood alternative may be valued high but not chosen frequently by consumers likely because it is unavailable, expensive, or inconvenient.

3. Choice experimental design and data collection

3.1. Choice set design

We chose France for the experimental setting because France is a leading country in seafood consumption with a wide variety of seafood species sold in the market. Fresh seafood, which is defined in this study as live, chilled, or unfrozen finfish, shellfish and crustaceans, is the most favored product for French household consumption (OFIMER, 2011). French consumers can buy fresh seafood in separate stalls in most supermarkets, especially the large ones (*e.g.*, Auchan, Carrefour, Champion, and Intermarché). Fresh seafood is sold in different forms depending on the species (*e.g.*, fillet *vs.* steak for salmon, fillet *vs.* whole for sole, or live *vs.* chilled for mussels), and may be supplied from aquaculture or wild stock that are sourced from domestic producers or imported. As the quality of fresh seafood may deteriorate significantly over a short period of time, we assume that consumers usually purchase a limited quantity that reflects the demand for one meal for their family.

The marketplace offers numerous fresh seafood items, which differ in biological nature, product forms and sources of supply. We selected 12 of the most popular types of seafood which are consumed frequently by French consumers to form a "representative basket" of fresh seafood items for the choice experiment. These 12 seafood alternatives account for 64% of total volume or 60% of the total value of fresh seafood products sold in French supermarkets in 2010 (OFIMER, 2011). The seafood alternatives include 8 finfish and 4 shellfish species and they represent high price species (*e.g.*, tuna, sole, langoustine, and monkfish) as well as low price species (*e.g.*, mussels, pangasius, and oyster) (Table 1).

For each seafood alternative, the attributes and attribute levels were considered carefully to ensure that the scenarios in the experiment closely resemble the reality of the market and that potential respondents are familiar with them. We included price, product form, production method, and origin into our choice experiment because the consumers are typically confronted with them in the marketplace. In addition, the attributes have been mentioned in previous studies (*e.g.*, Jaffry et al., 2004; Luomala, 2007; Mueller Loose, Pesche, & Grebitus, 2013; Pouta, Heikkilä, Forsman-Hugg, Isoniemi, & Mäkelä, 2010; Roheim, Asche, & Santos, 2011; Roheim, Gardiner, & Asche, 2007; Tempesta & Vecchiato, 2013).

The price for each seafood alternative was presented on three levels. The middle level reflects the average retail price of the respective species for 2010 (OFIMER, 2011), and the two other price levels are set at 30% above and 30% below that average price. Most extrinsic attributes across species have two levels, and they were checked carefully by observations in the real market and through statistical analysis of various data sources from FAO, FISHBASE, and EUROSTAT. Several attributes only have one level for some species, reflecting the actual market situation. For instance, monkfish can only be wild as it is not yet farmed; pangasius has one level of origin because it is imported to France exclusively from foreign countries (*e.g.*, Vietnam).

To generate labeled choice sets, we followed suggestions of Louviere et al. (2000), Batsell and Louvier (1991), and Kuhfeld (2010). First, a set of factors was formulated by combining each attribute with every seafood alternative (Table A.1). Then a factorial design was created for this set of factors. The total number of factors used in the design was 43 because of the alternative-specific nature of the design. The attributes of production method and country of origin only have one level for some seafood alternatives (*e.g.*, saithe, pangasius, monkfish, and tuna) and therefore they were not part of the statistical design. One extra level was added to each price attribute in order to determine if a given

Table 1
Seafood alternatives and attributes for labeled choice experiment.

No.	English name	French name	Product forms		Production method		Country of origin		Price		
1	Salmon	Saumon	Fillet	Steak	Farmed	Wild catch	French	Imported	11.10	15.90	20.70
2	Cod	Cabillaud	Fillet	Steak	Farmed	Wild catch	French	Imported	10.40	14.90	19.40
3	Sole	Sole	Fillet	Whole fish	Farmed	Wild catch	French	Imported	14.60	20.90	27.20
4	Seabream	Dorade	Fillet	Whole fish	Farmed	Wild catch	French	Imported	9.00	12.90	16.80
5	Saithe	Lieu Noir	Fillet	Steak	Wild catch		French	Imported	7.60	10.90	14.20
6	Pangasius	Pangas	Fillet	Steak	Farmed		Imported		5.50	7.90	10.30
7	Monkfish	Baudroie	Fillet	Tail	Wild catch		French	Imported	13.90	19.90	25.90
8	Tuna	Thon	Loin	Steak	Wild catch		French	Imported	12.50	17.90	23.30
9	Oyster	Huitre	Live	Chilled	Farmed	Wild catch	French	Imported	5.50	7.90	10.30
10	Mussel	Moule	Live	Chilled	Farmed	Wild catch	French	Imported	2.70	3.90	5.10
11	Languostine	Languostine	Raw	Cooked-shell on	Farmed	Wild catch	French	Imported	12.50	17.90	23.30
12	Crab	Tourteau	Live	Chilled	Farmed	Wild catch	French	Imported	6.20	8.90	11.60
	Coding		1	2	1	2	1	2	1	2	3

product was supposed to be absent or present in a choice set, which at the same time permits the estimation of possible cross-effect (Kuhfeld, Tobias, & Garratt, 1994; Lazari & Anderson, 1994); hence choice set size varied. The seafood alternative with the 4th level of price is absent in the choice set. Therefore, each seafood alternative was present in three of every four choice sets.

We used SAS macros (Kuhfeld, 2010) to create and evaluate the $2^{31}\ 4^{12}$ fractional factorial design. The SAS macro suggested that the smallest saturated design consisted of 68 choice sets, but the smallest orthogonal design required 96 choice sets. Given the advantages of an orthogonal design, in which every alternative, attribute, and attribute level appears equally in the choice sets and is independent of the others, we applied this design. The size of the choice sets varies from 5 to 12 alternatives, plus a base alternative with "No choice".

The 96 choice sets were divided randomly into 16 blocks (the design is available from the lead author on request), which is a common practice with too many choice sets in a single experiment (Kuhfeld, 2010; Montgomery, 2008). Each respondent faced 7 choice sets, in which the first one was a common choice set used for practice. The design is sufficient to estimate many complex models in that the number of parameters can be up to 864.[6]

In each choice set (see Fig. 1), the respondents were asked to choose from the "basket" of fresh seafood one alternative for one normal household dinner. The base alternative allowed respondents to indicate if none of the offered alternatives was acceptable (Parker & Schrift, 2011). Such a base alternative arguably leads to more evaluative judgments during the consumers' decision-making process (Parker & Schrift, 2011).

After a respondent had completed the first choice, the chosen alternative disappeared from the screen and the respondent was asked "If the product you chose would NOT be available in the basket, what alternative would you choose now?" If the respondent chose the "No choice" for the first choice, it was assumed that the second choice would also be the "None-option", and therefore no second choice was presented. We use this second response for a reliability test.

3.2. Data collection

The choice experiment was one part of the survey. The questionnaire included other questions about the household's food consumption pattern. The survey included the question "In your family, who makes the decision of buying food for consumption at home?" If the respondent answered that he/she is mainly or partly (*i.e.*, sharing the job with the spouse) responsible for food shopping, he/she was an appropriate person to continue the survey. Thus, the respondents in the survey were all familiar with shopping for food for household consumption.

The questionnaire was pre-tested with a small sample of individuals (40) with the aim of assessing the properties of the experimental design and the overall understanding of the survey format by the consumers. The pre-tested and official surveys were conducted by means of a web-based survey administered by a commercial research agency based in Paris (Ipsos-International Market Research Company). The company distributed the questionnaire to members of its consumer panel. Respondents who completed the survey were rewarded with an actual monetary deposit into their account at the research company, with the idea that such an incentive would increase the response rate. One big advantage of the web-based survey is that the survey administrator can continue to distribute invitations to the survey among the panel, until the predetermined quota is reached, and can at the same time also control for an equal distribution of the blocks of the choice experiment. Finally, the order of alternatives in each choice set was randomized for each respondent.

The survey was conducted in France during August 2011. The data were "cleaned" by removing respondents who completed the whole questionnaire too fast, *i.e.*, lesser than 15 min compared to the average of 30 min. Consequently, 40 respondents who violated the time restriction and 17 respondents who exceed the quota were removed from the total sample of 1017 respondents, accounting for 5.6% attrition. The final sample of 960 respondents was used for analysis. Table 2 describes the sample, indicating a good representation of the population over five demographic variables.

4. Results

4.1. Classification

Several alternative-specific attribute effect models were estimated to find the best solution, including LLCM and the labeled multinomial logit model (LMNL) with availability effects, measuring the effects of presence or absence of one alternative to the choice of others, and price cross-effects. Five demographic variables were used as covariates: income, gender, education, age, and with/without children. We chose a labeled latent class model with four classes (4-LLCM) as the best solution, based on the minimum value of Bayesian Information Criterion (BIC). The BIC is a traditional statistic and was used commonly in previous studies (Green & Hensher, 2003; Vermunt & Madgison, 2005) (Table A.2).

[6] The number of 864 parameters is the most complex model allowed, because: the number of times a seafood item present in choice sets * (the number of alternatives in a choice set − 1) = (3/4) * 96 * (13–1) = 864.

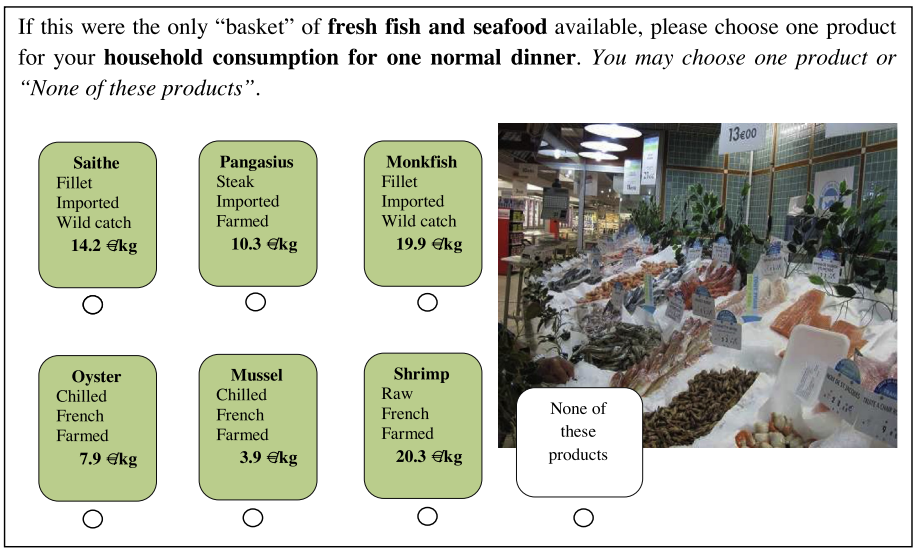

Fig. 1. Example of seafood choice set.

Table 2
Sample description.

Demographic variables		% sample	% census*
Gender	Men	49.2	49.3
	Women	50.8	50.7
Age	18–24 age	14.0	14.3
	25–34 age	21.1	20.1
	35–44 age	23.4	22.4
	45–59 age	33.6	32.8
	60–64 age	7.8	10.4
Education	Secondary school/lower	12.1	18.2
	High school	30.0	41.5
	Lower college/ University level	26.8	20.1
	College/ University level	18.4	9.9
	Post-graduate level	12.7	10.2
Income	<12000€/year	17.7	16.7
	12,000–21,000 €/year	23.1	38.3
	21,000–36,000 €/year	31.2	32.0
	>36,000 €/year	18.6	13.0
	Undisclosed	9.5	
With children (<18 age)	No	41.3	49.0
	Yes	58.7	51.0

* Source: Eurostats.

4.2. Reliability and validity

We used the responses to the first and second choices to test the reliability of the experimental data. For that purpose, the 4-LLCM was estimated with the first and second choice separately, and thereafter the individual choice probability and the individual coefficients were obtained by posterior mean procedure (see Green & Hensher, 2003; Vermunt & Madgison, 2005). The goodness-of-fit of the model derived from the second choice is poorer (*e.g.*, pseudo $R^2 = 0.161$, hit rate = 0.35) than those for the model from the first choice. However, the correlations of individual coefficients (species, product form, method, origin, and price) were all statistically significant at the 1% level. The correlation of choice probabilities of all alternatives obtained by the two estimates is 0.516 and significant at the 5% level. The correlation of the probabilities of the first choices predicted by the two estimates is 0.43 but also significant at the 1% level. The results indicate the consistency of our choice experiments.

We re-tested the reliability by using a conventional method named the jackknife approach (Malhotra, 1982). We withdrew randomly 1, 2 and 3 choice sets from the original sample and then re-estimated the model with the retained choice sets. The relative importance of the attributes and the standard errors of the estimated parameters of the reduced samples were compared with those from the original model. The results indicate that our choice experiment design is structurally stable until half of the choice sets were withdrawn.

We are not aware of any other studies applying the second choice response for testing reliability. However, the approach is somewhat similar to the approach in conjoint analysis that correlates the rank order of preference estimated from some duplicate profiles or holdout sample with the original sample (Green & Srinivasan, 1990; Rao & Sattler, 2003; Volckner, 2008). In using second choice responses to test reliability we assume that the respondent is consistent in her or his preference and her or his choice is rational. Therefore, the individual part-worth utilities and choice probabilities between the two judgments for a given choice set must be in accordance with each other. The use of first and second choice responses to test reliability has an advantage over the duplicate profiles or holdout samples as the second choice response may be added to every choice scenario and passed to all respondents. The reliability test, therefore, was conducted over all choice sets involving the full sample.

To test the predictive power of the choice model, the hit rate (*i.e.*, the percent of correct prediction for the observed choice) is used as indicator of internal validity (*e.g.*, Rao & Sattler, 2003; Theysohn, Klein, Völckner, & Spann, 2013; Volckner, 2008). The hit rate is calculated for only first choice responses in a common way. The hit rate of the 4-LLCM is 0.41, which is considerably higher than that of the one class model with 0.27 (Table 3), indicating the superiority in predictive power of the LLCM.

4.3. Estimated parameters

The final 4-LLCM is presented in Table 3. We report the estimated coefficients and the corresponding *z*-values. The statistics of goodness-of-fit are also reported, including log-likelihood, BIC, hit rate, *pseudo* R^2 of overall model. The table also includes the Wald statistic, which is used to test for the equality of the effects between classes. The *p*-value of the Wald (=) test of less than 5% indicates the insignificant difference of the effects between classes. Consequently, these effects were set to be class independent or equal between classes. In addition, several parameters that were

Table 3
Estimates of fresh seafood choice behavior model.

Effects		Labeled MNL		4-Labeled latent class model (4-LLCM)								
				Class 1		Class 2		Class 3		Class 4		Wald *p*-value
		Coefficients	*z*-Value	Coefficients	*z*-Value	Coefficients	*z*-Value	Coefficients	*z*-Value	Coefficients	*z*-Value	
Species effect (baseline: No-choice)												
	Cod	2.375	13.787	3.613	10.195	3.170	7.925	0.229[ns]	0.327	3.326	4.324	0.000
	Crab	0.526[ns]	1.735	1.205	3.284	0.812[ns]	1.737	−0.378[ns]	−0.885	0.230[ns]	0.379	
	Languostine	1.212	4.304	2.493	4.178	0.922	3.626	1.458[ns]	1.326	−0.492[ns]	−0.914	
	Monkfish	1.987	4.951	3.053	5.533	3.083	5.662	−5.573[ns]	−0.719	1.522[ns]	1.666	
	Mussels	1.291	7.559	1.580	3.962	0.956	3.429	0.774	7.287	3.095	4.587	
	Oyster	−0.216[ns]	−0.696	0.810	2.133	0.906	2.052	−1.058	−2.739	−0.736[ns]	−0.989	
	Pangasius	0.447	1.773	−1.152	−3.565	−0.361[ns]	−1.039	−2.734	−7.307	4.826	8.288	
	Saithe	1.857	10.636	2.835	9.058	2.388	4.157	1.200[ns]	1.383	4.676	6.087	
	Salmon	2.449	13.630	2.583	6.515	3.919	10.216	2.864	3.210	6.946	5.169	
	Seabream	1.853	9.402	2.998	11.487	2.751	8.631	−0.137[ns]	−0.403	2.276	6.057	
	Sole	1.792	7.395	1.867	4.914	3.415	10.070	−0.210[ns]	−0.521	1.414	2.704	
	Tuna	1.540	6.416	1.757	4.862	3.416	9.964	−0.289[ns]	−0.804	1.039	2.139	
Alternative specific price effect (continuous variables)												
	Cod	−0.118	−10.107	−0.176	−7.346	−0.078	−3.478	−0.101	−2.167	−0.167	−3.068	0.029
	Crab	−0.145	−4.139	−0.136	−3.661	−0.136	−3.661	−0.136	−3.661	−0.136	−3.661	a
	Languostine	−0.104	−6.300	−0.176	−4.962	0.000		−0.223	−3.114	0.000		0.000
	Monkfish	−0.179	−7.680	−0.185	−7.399	−0.185	−7.399	−0.185	−7.399	−0.185	−7.399	a
	Mussels	−0.141	−3.353	−0.227	−2.416	0.000		0.000		−0.470	−2.737	0.016
	Oyster	−0.070	−1.807	−0.096	−2.350	−0.096	−2.350	−0.096	−2.350	−0.096	−2.350	a
	Pangasius	−0.093	−2.930	0.000		0.000		0.000		−0.265	−4.173	a
	Saithe	−0.114	−7.200	−0.096	−3.875	−0.115	−2.596	−0.296	−3.094	−0.346	−4.461	0.001
	Salmon	−0.122	−10.532	−0.116	−4.816	−0.111	−5.411	−0.297	−4.172	−0.471	−4.345	0.001
	Seabream	−0.125	−8.070	−0.135	−7.818	−0.135	−7.818	−0.135	−7.818	−0.135	−7.818	a
	Sole	−0.101	−8.202	−0.102	−7.604	−0.102	−7.604	−0.102	−7.604	−0.102	−7.604	a
	Tuna	−0.101	−7.210	−0.111	−7.454	−0.111	−7.454	−0.111	−7.454	−0.111	−7.454	a
Alternative specific form effect (dummy coding)												
Live	Crab			0.790	3.235	0.000		0.000		0.000		0.001
Live	Mussels	0.305	3.803	0.652	3.507	0.000		0.456	2.774	0.000		0.000
Live	Oyster	0.517	3.376	0.522	3.275	0.522	3.275	0.522	3.275	0.522	3.275	a
Fillet	Pangasius	0.327	2.662	0.456	2.707	0.456	2.707	0.456	2.707	0.456	2.707	a
Fillet	Saithe	0.215	2.580	0.243	2.573	0.243	2.573	0.243	2.573	0.243	2.573	a
Fillet	Salmon	0.260	3.015	0.244	2.548	0.244	2.548	0.244	2.548	0.244	2.548	a
Alternative specific method effect (dummy coding)												
Wild	Cod	0.484	5.781	0.773	4.410	0.000		0.853	2.491	0.000		0.000
Wild	Languostine	0.510	3.648	0.491	3.304	0.491	3.304	0.491	3.304	0.491	3.304	a
Wild	Mussels	0.149	1.855	0.470	2.625	0.000		0.000		−0.843	−2.577	0.011
Wild	Salmon	0.308	3.560	0.352	3.663	0.352	3.663	0.352	3.663	0.352	3.663	a
Wild	Seabream	0.562	5.841	0.996	6.190	0.000		0.000		0.000		0.000
Wild	Sole	0.241	2.050	0.310	2.389	0.310	2.389	0.310	2.389	0.310	2.389	a
Alternative specific origin effect (dummy coding)												
Domestic	Cod	0.786	9.265	1.917	8.103	0.000		0.990	2.817	0.000		0.000
Domestic	Crab	0.719	4.673	1.521	5.494	0.000		0.000		0.000		0.000
Domestic	Languostine	0.707	4.893	2.171	4.408	0.000		0.000		0.000		0.000
Domestic	Monkfish	1.337	6.231	2.440	4.041	0.000		0.000		0.000		0.000
Domestic	Mussels	0.696	8.481	2.059	7.939	0.000		0.000		0.000		0.000
Domestic	Oyster	0.902	5.603	1.587	4.571	0.000		0.984	2.238	0.000		0.000
Domestic	Saithe	0.695	8.189	1.289	7.945	−0.546	−2.173	0.000		0.000		0.000
Domestic	Salmon	0.567	6.498	1.807	6.970	0.000		0.000		0.000		0.000
Domestic	Seabream	0.897	9.006	1.529	8.077	0.000		0.000		0.000		0.000
Domestic	Sole	0.659	5.378	2.2588	4.777	0.000		0.000		0.000		0.000

Domestic	Tuna	0.865	7.045	2.5838	5.280	0.000		0.000		0.000		0.000
Covariates												
	High Age			0.283	2.290	−0.064^{ns}	−0.490	0.051^{ns}	0.381	0		
	High Education			0.798	2.643	0.858	2.723	0.685	2.081	0		
	Gender (Male)			0.052^{ns}	0.189	0.451^{ns}	1.548	0.340^{ns}	1.124	0		
	High Income			0.443	2.294	0.449	2.204	−0.103^{ns}	−0.481	0		
	Without children			0.680	2.342	0.420^{ns}	1.386	0.056^{ns}	0.178	0		
Log-likelihood (LL)		−11690.305						−9842.984				
Degrees of freedom (df)		914						752				
Latent class probability (class size)				0.418		0.294		0.186			0.102	
BIC		23746.98						22907.29				
Pseudo R^2		0.066						0.183				
Hit rate		0.270						0.410				

"a" refers to the parameters set to be class independence.
^{ns} Indicates the coefficient is not significant at 5% level.

not statistically significant at the 5% level were set to be zero in the final model. Hence, the model is named a restricted model (Vermunt & Madgison, 2005).

We use the restricted model for several reasons. First, the insignificant effects of some attributes imply that consumers did not evaluate its levels differently. The WTP for these attributes are zero and do not need to be calculated. Second, including insignificant effects adds 'noise' to the calculation of WTP at the individual level. For example, too small or insignificant coefficients of price will inflate the individual WTP of the corresponding attributes. Third, excluding the insignificant effects could increase accuracy of the estimate due to increasing degrees of freedom and avoiding possible multicollinearity problems (Vermunt & Madgison, 2005). The non-significant effect of price is an unexpected result that may stem from the problem of the choice of price levels or the nature of choice behavior. We reserve this result as one of our study weakness.

Table 3 reports the estimates of the 4-LLCM and also the estimates of the LMNL model with one class, providing the opportunities to compare the overall pattern of the effects. In general, most effects are significant at the 5% level across the 12 seafood alternatives. All alternative-specific price effects estimated by the LMNL model are significant at the 1% level and carry the expected sign. In the 4-LLCM, the effects of every attributes are significant at the 1% level in at least one class. Table 4 reports the choice probability of specific seafood of the LMNL and the 4-LLCM. In general, the LMNL and the 4-LLCM consistently reveal that cod, salmon, sea bream, and sole have the largest market share (exceeding 10%).

We also obtained the mean and standard deviation of individual coefficients by following the posterior mean procedure (Table A.3). Notice that consumers are assumed to be consistent in preference, and therefore the individual coefficient of a given attribute is constant over choice sets. In general, the mean of individual coefficients and aggregate coefficients estimated by LMNL have the same pattern. For instance, all price effects are statistically significant at 1% the level and negative.

4.4. WTP for seafood attributes

The WTP for desired seafood attribute levels within a latent class and in the entire market are presented in Table 5. The seafood attributes (*e.g.*, product form, production method, and origin) were coded as dummy variables, and therefore the positive WTP indicates the price premium (in euro) that consumers are willing to pay for the desired attribute level mentioned in the table, whereas the negative value indicates the consumer's preference for the attribute-based level. For some insignificant price coefficients (at the 5% level), the WTP value of the corresponding attributes could not be estimated. These insignificant coefficients (*e.g.*, product form of crab in classes 2, 3, and 4) indicate that consumers are indifferent between the two levels of that attribute, and therefore the WTP is assumed to be zero and they are not presented in Table 5. We also calculated the WTP at the individual consumer level and the result is provided in Table A.4.

In general, consumers' preferences for attribute levels of product forms, production method, and origin vary across seafood alternatives and over classes. Fillet is preferred to steak in several finfish species (*i.e.*, pangasius, saithe, and salmon), and a live product is preferred to the chilled products for shellfish (*i.e.*, mussels and oysters) and crustaceans (*i.e.*, crab). Consumers did not differentiate significantly between the product forms for sole, sea bream, cod, monkfish, tuna, and langoustine (Norwegian shrimp). The consumers' preference for wild caught seafood over the farmed alternative is significant for six out of the eight species offering different production methods. Consumers were indifferent toward production method for oysters and crabs. French consumers valued

Table 4
Predicted choice share.

Species	Labeled MNL	4-Labeled latent class model				
		Class 1	Class 2	Class 3	Class 4	Overall
Cod	0.141	0.148	0.189	0.077	0.106	0.142
Crab	0.011	0.008	0.004	0.034	0.005	0.011
Langoustine	0.021	0.014	0.011	0.058	0.013	0.022
Monkfish	0.087	0.082	0.077	0.134	0.057	0.088
Mussels	0.046	0.030	0.026	0.112	0.029	0.045
Oyster	0.067	0.052	0.039	0.154	0.048	0.067
Pangasius	0.064	0.062	0.059	0.055	0.107	0.064
Saithe	0.085	0.094	0.064	0.034	0.206	0.085
Salmon	0.165	0.139	0.281	0.085	0.088	0.164
Seabream	0.120	0.160	0.076	0.057	0.194	0.119
Sole	0.108	0.144	0.112	0.036	0.093	0.109
Tuna	0.083	0.066	0.063	0.161	0.054	0.082
None	0.002	0.001	0.001	0.006	0.001	0.002
Class size	1.000	0.418	0.288	0.193	0.102	1.000

domestic seafood extremely high, especially the consumers in the class 1.

4.5. Intrinsic value of the seafood alternatives

The rank ordered-intrinsic value of the 12 seafood alternatives predicted by the LMNL model, and the aggregate value predicted by the 4-LLCM are presented in Fig. 2. In general, salmon, cod, and saithe are ranked as the highest valued seafood, whereas oyster, pangasius, and crab are the lowest. The estimates of the 4-LLCM in Table 3 can be used to understand the intrinsic values within classes in a more detail. For instance, cod, saithe, sea bream, and sole are valued high at the market level, but they are valued low by class 3, which accounts for 20% of the sample. Similarly, pangasius has a negatively intrinsic utility in class 1 but a positive value in class 4.

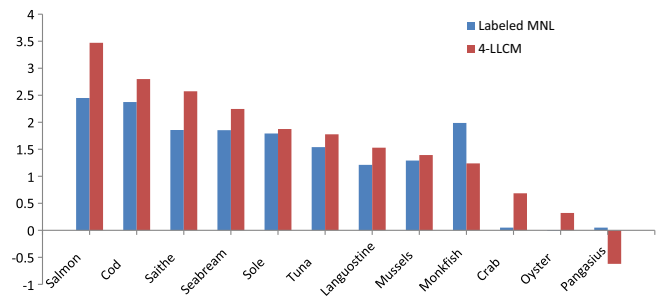

Fig. 2. Rank ordered-intrinsic value of seafood alternatives.

4.6. Class description

The latent classes were defined on the basis of the socio-demographic characteristics as well as the choice behavior and product attributes, providing the results that are more actionable and more directly relevant to management decision making (Swait, 1994; Wedel & Kamakura, 2000). Four out of five covariates have significant coefficients at the 5% level in at least one class. The coefficients of the covariates in Table 3 should be explained by comparison with the baseline class (class 4). A significant coefficient (at the 5% level) with a positive value indicates that the higher the value of the corresponding variable, the higher the probability that a household belongs to that class. For instance, the income coefficients are significant at the 5% level and have positive values in classes 1 and 2, while an negative (albeit insignificant) value in class 3 indicates that higher-income households are more likely to belong to classes 1 and 2; conversely, the lower-income households are more likely to belong to class 3 and 4. Similarly, older respondents without children are more likely to belong to class 1. The same explanation could be applied to other indicators.

Table 5
WTP for quality attributes of seafood (€).

Species	Labeled MNL	4-Labeled latent class model				
		Quality conscious consumers 41.80%	Species expensive consumers 28.80%	Species familiar consumer 19.30%	Price sensitive consumers 10.20%	Market Aggregation
Live crab	0.00	5.81	0.00	0.00	0.00	2.39
Live mussels	2.17	2.87	*ne*	*ne*	0.00	*ne*
Live oyster	7.36	5.46	5.46	5.46	5.46	5.46
Fillet pangasius	3.52	*ne*	*ne*	*ne*	1.72	*ne*
Fillet saithe	1.89	2.52	2.10	0.82	0.70	1.88
Fillet salmon	2.13	2.10	2.19	0.82	0.52	1.72
Wild Cod	4.11	4.39	0.00	8.49	0.00	3.45
Wild Languostine	4.89	2.78	*ne*	2.20	*ne*	*ne*
Wild Mussels	1.06	2.07	*ne*	*ne*	−1.79	*ne*
Wild Salmon	2.52	3.03	3.16	1.18	0.75	2.48
Wild Seabream	4.51	7.41	0.00	0.00	0.00	3.05
Wild Sole	2.40	3.03	3.03	3.03	3.03	3.03
Domestic Cod	6.68	10.89	0.00	9.85	0.00	6.38
Domestic Crab	4.95	11.19	0.00	0.00	0.00	4.60
Domestic Languostine	6.78	12.31	*ne*	0.00	*ne*	*ne*
Domestic Monkfish	7.47	13.17	0.00	0.00	0.00	5.42
Domestic Mussels	4.94	9.07	*ne*	*ne*	0.00	*ne*
Domestic Oyster	12.82	16.60	0.00	10.29	0.00	8.82
Domestic Saithe	6.11	13.39	−4.74	0.00	0.00	4.11
Domestic Salmon	4.64	15.58	0.00	0.00	0.00	6.41
Domestic Seabream	7.20	11.37	0.00	0.00	0.00	4.68
Domestic Sole	6.55	22.10	0.00	0.00	0.00	9.09
Domestic Tuna	8.61	23.38	0.00	0.00	0.00	9.62

The positive value indicates the amount of euro that consumers are willing to pay to obtain the associated attribute (mentioned in front of species name) while the negative indicates the consumer's WTP for the based attribute level. '*ne*' indicates the value is not estimated due to insignificant price coefficient.

Class 1 (41.8%) was named *"quality conscious consumers"* and comprises consumers who are older, have high levels of education, large incomes and no children. This class is the most conscious of the seafood quality and is willing to pay a high price premium for most quality attributes *e.g.*, live, wild caught, and domestic seafood. Classes 2 (28.8%) was called *"species expensive consumers"* and consists of consumers who have high levels of education and large incomes. This younger consumer group evaluated highly positive for high priced seafood alternatives *e.g.*, cod, salmon, sole, and tuna. Class 3 (19.3%) was labeled *"species familiar consumers"* and includes consumers who are younger, lower income and have children. This group prefers quality attributes but they are more likely to choose alternatives that French consumers are most familiar with, such as monkfish, mussels, oyster and tuna (see Table 3). Class 4 (10.2%) was called *"price sensitive consumer"* and differs from the other classes with low education levels, low incomes and having children. This class is more likely to select the low priced seafood alternatives *e.g.*, pangasius and saithe, and less willing to pay a price premium for quality attributes.

5. Discussion

Applying a LCE containing a total of 12 seafood alternatives allowed us to estimate a LLCM, which in turn made it possible to estimate the WTP for seafood quality attributes specific to each seafood alternative and within latent market segments. The results are considered to be more accurate than the results from studies focusing on a single seafood species for at least two reasons. First, our study clearly showed that a specific seafood attribute may be a quality cue for a given seafood alternative but not for all seafood species, and be a determinant of the choice for a given consumer group but not for the whole population. Such simultaneous insights cannot be obtained by studies using unlabeled choice experiments. Second, the LCE allowed respondents to evaluate choice alternatives through both attribute judgment and alternative comparison, and the choice alternatives labeled by the name of the seafood are expected to also alleviate the positive effect of price (see Rao & Sattler, 2003; Volckner, 2008). The statistically significant effects of intrinsic utilities (*i.e.*, alternative specific constants) in both the aggregate and the latent class model satisfy these expectations. Last, the composition of the choice sets was varied between 6 and 12 seafood alternatives, which means not all products were available all the time. Therefore, the preference order between various species may be more realistic and the varying composition of the choices may help to avoid a systematic order bias by each respondent.

The intrinsic values of the seafood, which consumers in a real market might be very aware of, were estimated inconsistently by Roheim et al. (2007) and Ahmad and Anders (2012), who fitted hedonic price models to scanner data. Our study found that salmon, cod and saithe have highly rank ordered-intrinsic values in the French market, whereas oyster, pangasius, and crab received a low evaluation. Apart from differences in methods and databases applied by the studies, the differences in intrinsic values of the seafood may be due to differences in consumer preferences and consumption habits in these different markets.

Consumers' preferences for a specific product form (*e.g.*, preparation format) or a specific production method (*e.g.*, farmed vs. wild caught) may stem from the associations of these attributes with perceived quality and convenience (Brunsø et al., 2008; Olsen, 2004; Thong & Olsen, 2012). Consumers in our study are willing to pay a price premium for fillet in three out of eight finfish species under consideration. Consumers are willing to pay a high price premium for live mussels, oysters, and crabs, whereas they have no preference for chilled versus cooked-shell on langoustines (Norwegian shrimp). Previous studies (*e.g.*, Solgaard & Yang, 2011; Sveinsdóttir et al., 2009; Verbeke, Vermeir, & Brunsø, 2007) found consistently that consumers prefer wild caught seafood to the farmed alternatives. Our study confirms consumers' WTP for the attribute wild caught for six out of eight seafood alternatives under consideration. The seafood alternatives carrying a high price premium for the wild caught attribute are sea bream, salmon, and cod.

A high WTP for the domestic origin in our study might stem from consumers' perception that French seafood is safer or might be a result of consumers' ethnocentrism (Luomala, 2007; Verlegh & Steenkamp, 1999). However, only 41.8% of the sample in class 1 preferred the domestic products across all twelve seafood alternatives included in the experiment. This finding may provide important information to the importers of seafood because about 58.2% of the sample did not consider the difference between the domestic and imported origin for many seafood alternatives.

6. Conclusion and limitations

Applying a LCE to a number of fresh seafood species allows us not only to understand consumers' evaluation of seafood attributes within a product but also to compare seafood alternatives. Overall, many of the intrinsic values of the seafood options emerged as important determinants of consumer choice. Furthermore, consumer preferences between species differed significantly, as salmon, cod, and saithe were ranked high, while pangasius, oyster, and crab were ranked low, which reflects an intuitively correct preference ordering that also influenced the characteristic of the latent classes significantly. The available quality cues of fresh seafood in the retail market are significant determinants of the choice for a number of seafood alternatives but not for all alternatives. In addition, the LLCM shed light into the market and uncovered that a given quality cue may be of major importance for a specific consumer group but not for the whole population. In general, fillet is preferred to other forms for pangasius, saithe, and salmon, but not for seabream, sole, tuna, and monkfish; live form is important attributes of crab, mussels and oyster. Similarly, consumers considered products caught in the wild as an important cue of the quality for cod, langoustine, mussels, salmon, seabream, and sole, but not as an important cue for oyster and crab. Only *"quality conscious consumers"* class (41.8% of the sample) indicated that they preferred domestic seafood to imported alternatives across all seafood alternatives.

Our study has implications for producers and retailers. For example, with information on marginal cost in hand retailers can optimize their product lines by maximizing the firm's profit function (see Theysohn et al., 2013 for the profit function). Producers and retailers may consider both the rank ordered-intrinsic values and the market share to determine the market potential or risk associated with their products. Finally, producers may use the results to identify a market niche and develop a marketing strategy for the respective seafood alternatives.

Despite the apparent advantages associated with a multi-product approach, our paper also carries a number of limitations. Firstly it is based on a purely hypothetical choice experiment in which the consumer choice may not be consistent with actual choices in the real market. Therefore, the results of WTP may be overestimated. Several methods or techniques can be used to reduce the gap between hypothetical and real choice such as experimental auction (Alfnes et al., 2006), best-worst scaling (Louviere & Woodworth, 1991) or including a cheap-talk script (Lusk, 2003) in the choice experiment.

A second weakness is associated with the actual response task selected for the choice experiment. In our response task we asked consumers to imagine that they were shopping for fresh seafood to

be consumed on that day (*i.e.*, without storage), and therefore asked them to select one single (seafood) product only from each of the choice sets provided. With this simplification of the purchasing process we effectively eliminated the complexity of purchasing multiple goods. We acknowledge of course that in the real world consumers may shop only one or two times a week, and therefore may purchase a second option of fresh seafood for the next day, and will likely also purchase a number of packaged and possibly frozen other seafood products. Finally we acknowledge that the framing our choice task did not consider the availability of other substitutes for seafood, especially meat and poultry. Future studies may replicate our study design by extending the model to capture bundle purchase behavior (Seetharaman et al., 2005) or the quantity aspects of demand (Chintagunta & Nair, 2011).

One further weakness in our study is associated with not including all potential quality attributes such color, freshness, and texture that previous studies (Alfnes et al., 2006; Olsen, 2004; Thong & Olsen, 2012) because we assumed that these attributes' effects on consumers' choices worked via the alternative specific-effects. Moreover, including more attributes would have increased the complexity of the choice task, which might have shifted the choice behaviors toward the choice of the "Non-option" rather than evaluating the attributes in the experiment (Swait & Adamowicz, 2001). Furthermore, our study did not include any psychographic variables; instead, the segmentation is purely based on demographic variables and the product attributes. Future studies should use behavioral and cultural variables, *e.g.*, attitude, motivation, and situations to characterize the segment because food choice is influenced by many interrelating factors of product attributes, person, and cultural and social environment (Furst, Connors, Bisogni, Sobal, & Falk, 1996).

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Appendix .

Table A.1
Set of factors formulated by combining attributes with alternatives.

Factor	Species	Attribute	Level	Factor	Species	Attribute	Level
1	Salmon	Form	1,2	23	Sole	Origin	1,2
2	Cod	Form	1,2	24	Seabream	Origin	1,2
3	Sole	Form	1,2	25	Saithe	Origin	1,2
4	Seabream	Form	1,2	26	Monkfish	Origin	1,2
5	Saithe	Form	1,2	27	Tuna	Origin	1,2
6	Pangasius	Form	1,2	28	Oyster	Origin	1,2
7	Monkfish	Form	1,2	29	Mussel	Origin	1,2
8	Tuna	Form	1,2	30	Languostine	Origin	1,2
9	Oyster	Form	1,2	31	Crab	Origin	1,2
10	Mussel	Form	1,2	32	Salmon	Price	1,2,3,4[a]
11	Languostine	Form	1,2	33	Cod	Price	1,2,3,4
12	Crab	Form	1,2	34	Sole	Price	1,2,3,4
13	Salmon	Method	1,2	35	Seabream	Price	1,2,3,4
14	Cod	Method	1,2	36	Saithe	Price	1,2,3,4
15	Sole	Method	1,2	37	Pangasius	Price	1,2,3,4
16	Seabream	Method	1,2	38	Monkfish	Price	1,2,3,4
17	Oyster	Method	1,2	39	Tuna	Price	1,2,3,4
18	Mussel	Method	1,2	40	Oyster	Price	1,2,3,4
19	Languostine	Method	1,2	41	Mussel	Price	1,2,3,4
20	Crab	Method	1,2	42	Languostine	Price	1,2,3,4
21	Salmon	Origin	1,2	43	Crab	Price	1,2,3,4
22	Cod	Origin	1,2				

[a] Seafood alternative with price at the level 4 will be absent in the choice set.

Table A.2
Class information (unrestricted model).

Model	LL	BIC(LL)	CAIC(LL)	L^2	Class. Err.	$R^2(0)$
1-Class choice	−11684.65	23746.98	23801.98	15539.70	0.00	0.07
2-Class choice	−11221.50	23205.23	23316.23	14613.40	0.06	0.12
3-Class choice	−10988.33	23123.44	23290.44	14147.07	0.06	0.15
4-Class choice	***−10769.12***	***23069.58***	***23292.58***	***13708.65***	***0.11***	***0.19***
5-Class choice	−10583.68	23083.24	23362.24	13337.77	0.11	0.22

Table A.3
Mean and standard deviation of individual specific-coefficients.

Species	Species		Price		Form		Method		Origin	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Cod	2.93	1.02	−.13	.04	.0[a]	.0[b]	−.38	.34	.84	.76
Crab	.83	.68	−.14	.0[b]	.22	.41	.00	.0[b]	.66	.67
Langoustine	1.13	1.08	−.09	.08	.0[a]	.0[b]	−.54	.0[b]	.99	1.00
Monkfish	1.92	2.08	−.19	.0[b]	.0[a]	.0[b]	ne	ne	1.02	1.03
Mussels	1.34	1.02	−.12	.08	.35	.31	−.16	.18	.90	.91
Oyster	.12	1.41	−.08	.0[b]	.55	.0[b]	.0[a]	.0[b]	1.14	1.55
Pangasius	−.50	1.87	−.04	.06	.31	.0[b]	ne	ne	ne	ne
Saithe	2.66	.86	−.17	.09	.25	.0[b]	ne	ne	.44	.70
Salmon	3.37	1.04	−.17	.08	.29	.0[b]	−.34	.0[b]	.77	.79
Seabream	2.25	1.22	−.13	.0[b]	.0[a]	.0[b]	−.44	.45	.70	.71
Sole	1.98	1.10	−.10	.0[b]	.0[a]	.0[b]	−.29	.0[b]	1.04	1.06
Tuna	1.80	1.14	−.11	.0[b]	.0[a]	.0[b]	ne	ne	1.16	1.18

ne – means not estimated because the attribute has only one level.
[a] Insignificant effect at the 5% level was removed.
[b] Standard deviation equals zero because the effect was set class independent.

Table A.4
Mean and standard deviation (Std.D) of WTP estimated at individual specific parameters (€).

Species	WTP for desired product form[*]		WTP for wild seafood		WTP for domestic seafood	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Cod	0.00	0.00	2.77	2.50	5.80	4.80
Crab	1.56	2.91	0.00	0.00	4.66	4.74
Languostine	0.00	0.00	5.29	8.91	7.43	6.08
Monkfish	0.00	0.00	ne	ne	5.49	5.57
Mussels	2.41	4.90	1.08	1.06	6.04	5.26
Oyster	6.50	.00	0.00	0.00	13.62	18.53
Pangasius	2.10	5.13	ne	ne	ne	ne
Saithe	1.96	.82	ne	ne	4.89	7.51
Salmon	2.07	.72	2.43	.85	6.48	6.91
Seabream	0.00	0.00	3.33	3.38	5.27	5.33
Sole	0.00	0.00	2.82	.00	9.96	10.14
Tuna	0.00	0.00	ne	ne	10.34	10.52

ne – means not estimated attribute has only one level.
[*] Desired product forms are filleted finfish and live shellfish.

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