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Estimating the Public's Preferences for Sustainable Aquaculture: A Country Comparison

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Abstract: Integrated Multi-Trophic Aquaculture (IMTA) is an alternative to the monoculture of fin fish species, in which several species are combined in the production process. This can have environmental advantages such as a lower environmental impact through nutrient cycling and natural filters; and can have economic advantages consisting of increased efficiency, product diversification and potential price premiums. In this paper, a choice experiment (CE) was conducted through an online survey in Ireland, the UK, Italy, Israel and Norway, to assess how the public makes decisions on what type of salmon or sea bream to buy based on the attributes of the product. Analysis assessed the Willingness-to-Pay (WTP) for more sustainable produced seafood using a Latent Class multinomial logit modelling approach. In the experiment, an ecolabel was used to distinguish between regularly produced (monoculture) products and sustainably produced (IMTA) products. The general public in each country showed a positive attitude towards the development of such an ecolabel and towards the payment of a price premium for the more sustainably produced salmon or sea bream.

Keywords: aquaculture; IMTA; ecolabel; choice experiments; latent class; WTP

1. Introduction

Seafood production is increasingly challenged in the context of human population growth, increasing global per capita seafood demand and diminishing wild fish stocks [1–3]. Aquaculture is viewed by many as an alternative to wild fisheries and in recent years the aquaculture industry has shown considerable growth. However, in 2014 the annual European aquaculture industry increased by 0.5 percent against a growth of 7 percent globally [4]. Due to the international character of the seafood market, the EU is currently looking into the marketing of the seafood industry at the transnational level through educating the public and stimulating producers to shift towards sustainable production methods. One of the proposed strategies is the use of an ecolabel for seafood products that indicates the degree of sustainability of the production of the seafood product [5].

Integrated Multi-Trophic Aquaculture (IMTA) has also been proposed by academics and policy and industry actors to reach the dual aim of economic growth and environmental sustainability [6–8]. Multiple experiments have been conducted with IMTA; in the Far East, aquatic species have traditionally been co-cultured for centuries and in recent years IMTA has been implemented experimentally in modern industrial forms in Canada [9], Israel [10] and the Netherlands [11]. However, despite this call for IMTA integration in the European industry, IMTA has not been adopted on an industrial scale. In an IMTA system, multiple species from different trophic levels are combined in the production process. The species are selected based on their function in the ecosystem and economic value. Combining them has the advantage of allowing for nutrient cycling in the production process. On the one hand, this allows for environmental benefits, as the added species extract organic and inorganic wastes that would otherwise be discarded from the fed finfish cages [12–15]. Additionally, bivalves consume sea lice copepods [16], the main parasitic infection contributed to intensive salmon farming [17]. The inclusion of bivalves in an aquaculture production system could contribute to the mitigation of such parasites thereby limiting the environmental impact of the farm. On the other hand, IMTA has potential economic benefits, as nutrient cycling may reduce feed costs per unit biomass. Some research results suggest that IMTA systems may have higher growth rates for the lower trophic species [15].

In addition, products from an IMTA system can produce higher profits than monoculture products as the public may have willingness-to-pay (WTP) for products from an IMTA farm as opposed to a monoculture farm. Research has indicated that the public indeed values an IMTA approach to fish farming [18–21]. A small-scale study in New York concluded that IMTA produce outperformed monoculture salmon on the main seafood purchase determinants of product quality, freshness and taste [18]. Regarding the public's preferences for IMTA produce, several studies identified a positive WTP for salmon produced in an environmentally friendly manner in Scotland [21], the US Pacific Northwest [19] and Canada [20]. Higher marginal WTP should translate to additional revenue, which could function to cover potentially additional costs to IMTA production practices, particularly in the short run, as opposed to monoculture production [12,15,22].

However, an essential element in the valuation of IMTA products is the public's ability to distinguish between monoculture and IMTA products [18,23]. Both industry and non-industry actors have proposed eco-labelling to create bottom up pressure to reform production systems to prevent the over-exploitation of natural stocks [24]. Eco-labelling is an increasingly used tool that can change purchasing behaviour by educating the public on the environmental impact of purchasing decisions. Eco-labelled seafood has been found to be preferred over unlabelled seafood in several studies [24–31]. Despite aquaculture products being perceived distinctly different from wild-caught products [28], according to our knowledge, research on preferences specifically for aquaculture ecolabels is limited to Roheim [28] and Yip et al. [19]. Individuals prefer wild products over farmed products, even when these farmed products are certified [28]. Yet within the aquaculture market, products produced in CC (Closed Containment) and IMTA systems are preferred over monoculture production, with strongest preferences expressed for IMTA [19]. Further research on public preferences for aquaculture labelling and production methods is essential if environmental labelling is to be used as a tool to internalize any external costs from the aquaculture industry.

In this paper, we explore the market potential of IMTA across five countries, Ireland, UK, Norway, Italy and Israel, by estimating the public's preferences for the products of sustainable aquaculture. Specifically, we answer the question: is the public willing to pay a price premium for fish cultured sustainably in European and Israeli farms? If so, then part of the European marketing strategy [5] should include the promotion of the sustainability and production location attributes. In this study, preferences are elicited using a choice experiment (CE) that asked respondents from the five countries to choose from among fish with different levels of sustainability, different locations of production and different prices. The WTP for the sustainability and location attributes was estimated based on the choices. The CE approach was taken due to its capacity to capture diversity among the countries and to enable a cross-country comparison. This adds to the current dearth of multinational research on preferences for IMTA.

Current aquaculture growth is taking place in a context of rising awareness and public concern over food production, specifically on issues such as food safety, food quality, health impacts, environmental sustainability and animal welfare [32]. Against this background, several seafood consumer awareness ecolabels have been developed such as the Earth Island Institute's Dolphin Safe label and Marine Stewardship Council (MSC) labels. Ecolabels consist of a physical label on a product, indicating that it fulfils the criteria defined for sustainable production, thus communicating the environmental effect of production of the good [3]. This differentiates eco-labelled seafood products from unlabelled products, with the aim of stimulating environmentally friendly purchasing behaviour in order to increase demand for certified products, hence decreasing the environmental impact of the fast-growing industry [33].

The economic impact of eco-labelling is influenced by several factors. First, it depends on the degree of one's altruism [34]. Individuals weigh their utility for attributes related to self-interest, such as health, to their utility for attributes outside of their individual interest, such as sustainability [29]. Second, WTP is influenced by an individuals' income. As individuals with a high income have a lower marginal utility for income [35], their price sensitivity will be low and their WTP will be higher [29]. This implies that in the creation of the model and interpretation of model results, the income level of respondents must be taken into consideration to account for the difference in price sensitivity. Third, information plays a role in the value individuals attribute to a sustainability ecolabel. Individuals are more likely to use eco-labelled products when they have a higher degree of environmental awareness, are concerned about the environment and feel a responsibility towards contributing to its maintenance [36]. Lastly, one's WTP for a seafood product with a sustainability ecolabel is influenced by the perception of the product. Individuals will weight a product with their preferred level of sustainability against other products and attributes such as quality and value for money [37]. This has been accounted for in the experiment design deployed in this paper by including an opt-out option in every choice card.

2. Materials and Methods

2.1. Sample, Questionnaire and Data

Data was retrieved by ICM Research, an independent survey firm in the UK, who distributed the survey online among a population of randomly selected contracted clients. After selection, this sample was stratified according to the proportions of age, sex and region in each country, to ensure a representative sample. A sample of 2520 surveys was collected from five countries; Ireland (n = 500), Israel (n = 500), Italy (n = 508), Norway (n = 501) and the United Kingdom (n = 511). The countries were selected based on their geographical location and the characteristics of their aquaculture industries, aiming to include countries with both Atlantic and Mediterranean production sites. In the Atlantic area, the countries selected were Ireland, the UK and Norway. Ireland and the UK were selected as aquaculture production countries, with Ireland being characterized by its focus on the niche market of organic salmon aquaculture. Norway is included as European but non-EU member state that is characterized by its intensive large-scale salmon production. Outside of the Atlantic area, Italy and Israel were chosen as key sea bream farming countries operating in the Mediterranean area.

Respondents to the survey were all in the market as potential fish consumers. The choice experiment was part of a broader survey. Respondents were first told what the survey was about and given background information on what IMTA was and how it operated. It is recognized that providing respondents information about IMTA before the choice experiment can alter the expressed preferences. However, considering the lack of familiarity of respondents with IMTA, the CE could not be conducted without a basic understanding of the production method to allow a well-informed decision for every choice card presented. The survey consisted of four parts. The first part asked respondents about their perception of the aquaculture industry and marine environmental problems, followed by a section on seafood consuming behavior, focusing on respondents' use of ecolabels to make informed purchasing decisions. In the third part, respondents were presented with the choice experiment. In the final part respondents were asked about their socio-demographic indicators.

2.2. The Choice Experiment Methodology

The choice experiment (CE) method is a stated preference approach widely used to estimate the public's preferences and willingness to pay (WTP) for changes in environmental quality or new products. Choice experiments consist of a set of choice cards, each containing a set of alternatives from which respondents select their most preferred alternative. Each alternative consists of a combination of attributes that vary on attribute levels. In making their choices, respondents have to weigh the utility they derive from the different combination of attribute levels presented in each alternative. The assumption underlying this method is that respondents make fully rational decisions and therefore maximise their utility in every choice [38].

Choice cards often include two elements that assist the modelling process. A baseline alternative that reflects the status quo is often included in the choice cards. The inclusion of this alternative is necessary to mimic actual purchasing decisions when a new product enters the market; a consumer can choose to opt-out of a purchase altogether. This allows the statistical models to generate more welfare-consistent estimates [39]. The choice alternatives also include a monetary attribute. This allows the elicitation of an implicit price for each parameter, which reflects the respondents' WTP for a relative change in the attribute, given the changes in the other attributes [40]. The status quo alternative is always associated with a zero prize as no product is purchased in that decision. The aim of the choice experiment is to derive marginal values for attribute levels from the respondents' choices.

The choice experiment in this paper was designed to assess the public's marginal WTP for the attributes associated with IMTA products. In the choice experiment, respondents were presented with eight choice cards each, with each choice card consisting of three alternatives; two purchasing options and one opt-out option (no purchase). An example of a choice card for Ireland is given in Appendix A. The purchasing options were presented as a fillet of salmon for the Northern Atlantic countries and Sea Bream for the Mediterranean countries, as those are the main farmed species in each region. Respondents were first asked to "imagine that you walk into a supermarket and fresh (unfrozen) salmon [sea bream] is on your shopping list. The supermarket has several types of salmon [sea bream]. The packs are identical in size and quality, but some salmon [sea bream] is produced locally, some is produced abroad, and some is produced in a way that is better for the environment. They also vary in price. You are asked to indicate which of the salmon [sea bream] presented you would buy".

Respondents were then told what attributes they would have information on in the choice situation and to consider what they could afford to pay given their groceries budget. The attributes and attribute levels are described in Table 1. A pilot study conducted to determine the main attributes to present for seafood products found that a production location indicator was important in several sample countries. Literature suggests that consumers prefer locally produced food over imported produce [41,42] and that consumers' WTP for sustainability is partially influenced by attitudes towards other labels present in the market [43]. The experiment therefore includes production location as an attribute.

The sustainability attribute reflects the change in environmental pressure due to a change to an IMTA production system. Research has indicated that consumers have a WTP for sustainability in seafood, suggesting that production method should be included in the CE design [28]. Previous studies estimating WTP for specific production methods included an ecolabel reflecting the production system [19]. However, we decided against this approach for two reasons. First, the change in environmental pressure due to a shift to an IMTA production system can vary greatly, depending on species selection and the amount of the extractive species added to the production process, but also on environmental conditions, such as strength and direction of water currents [20,22]. A singular ecolabel would not confer such variations to individuals and therefore not inform individuals on environmental effects. Second, a common critique towards ecolabels is their dichotomous nature, which does not contribute to informing the public on the environmental impact of the product, but rather is limited on a defined set of indicators. Neither does it stimulate producers to continue to develop innovations to decrease environmental pressure once the ecolabel has been obtained. Indeed, by providing consumers with imperfect information, ecolabels can stimulate greenwashing [29]. Therefore, the inclusion of an IMTA label was not considered a fitting method to confer information to the public. Rather, a rating ecolabel was used.

Table 1. Overview of CE attributes and attribute levels.

Attribute	Attribute Level					Description
Production Location	National waters					The product is farmed in national waters
	Outside of national waters					The product is farmed outside national waters
Sustainability	Sustainability Level A					A 30% increase in environmental sustainability due to a move towards an IMTA production system
	Sustainability Level B					A 20% increase in environmental sustainability due to a move towards an IMTA production system
	Sustainability Level C					A 10% increase in environmental sustainability due to a move towards an IMTA production system
	Sustainability Level D					Monoculture production
Price per kg	Ireland	Israel	Italy	Norway	UK	
	€11	€9.08	€8.68	€7.80	€11.16	Low price in national market
	€17.50	€11.59	€11.42	€9.76	€18.14	Average price in national market
	€24.50	€12.82	€14.32	€11.70	€25.11	High price in national market
	€0	€0	€0	€0	€0	Status quo alternative price

A rated ecolabel approach was also used by Martinez-Espiñeira et al. [23] who estimated WTP for sustainability in food production processes and suggested by Aarset et al. [32] as a more viable approach to create bottom-up market incentives to shift to more sustainable production methods. In line with Martinez-Espiñeira et al. [23], the label design rates the environmental impact of the more sustainable production systems relative to conventional monoculture farms. The label design was based on the EU energy rating label [44]. This label is common on the European market for electronic appliances to indicate the amount of energy necessary to run an appliance in comparison to the product group. Several EU countries are using such environmental rating labels to inform consumer choices. The label used in the CE presents four levels of sustainability, ranging from A–D. The D label reflects the status-quo, or the environmental pressure resulting from monoculture production techniques. Respondents were informed that "integrated aquaculture attempts to mimic the natural ecosystem and produces less pollution. Depending on how the farms are set up, the amount of pollution will be different. The sustainability labels show you how good or bad the farming method is for the environment. The labels range from A–D, with A being best and D being worst for the environment. The labels show how much the environmental pressure of producing the salmon in the package has decreased from what we currently consider normal aquaculture (monoculture). Every level has a step of a 10% improvement in environmental sustainability." The labels A therefore being equivalent to a 30% decrease in environmental pressure. This information was shown on the labels to the respondents prior to the choice experiment.

Lastly, a monetary attribute was included in the CE to reflect a market situation and to enable the statistical derivation of the public's WTP for the other attribute levels. The CE price levels are based on the price range found in a survey of supermarket prices in each country. Based on these price ranges, a low, medium and high price were selected for each sample country. Within the model, the medium price level was taken as a base case. After the selection of the attributes and attribute levels, sixteen profiles were blocked into 4 versions of eight choice cards. Each choice card contained two alternatives and one opt-out option. The number of choice cards per respondent was limited to eight to avoid respondent fatigue. Variation in the attribute levels was achieved by using an efficient Bayesian experimental design based on the minimisation of the Db error criterion [45]. D-efficiency is a common approach for measuring experimental design efficiency [46]. A pilot study (n = 201) indicated that the attribute levels were appropriate as respondents selected the full price range when taking the choice experiment and indicated that they found the price range realistic when interviewed.

2.3. Modelling Approach

Discrete choice modelling is rooted in the concept of utility maximization. Lancaster [47] states that individuals derive utility, not from the consumption of a good, but from the set of attributes embodied by the good. The value of a good is therefore comprised of the bundle of attributes that the good holds. In a choice experiment, the value of specific attributes is elicited through statistical analysis. The Random Utility Model (RUM), developed by Mc Fadden [48] forms the basis for the statistical derivation of respondents' utility from the choice experiment data. The RUM states that the utility an individual derives from the consumption of a good consists of an observable and unobservable component. This can be expressed as

$$U_{in} = U(Z_{in,}S_n) + \varepsilon(Z_{in}, S_n), \quad (1)$$

where U_{in} reflects the utility of alternative i as perceived by individual n in choice set C. Alternative i will be chosen over alternative j if $U_i > U_j$. This utility is comprised of two parts. First, the observable component (U) consist of the CE attributes (Z_{in}) and socioeconomic characteristics of the respondents (S_n), which can be captured by the model. Second, the unobservable component (ε_n) reflects unmeasured variations that fall outside the influence of the experiment. Utility cannot be estimated precisely due to the existence of the latent unobservable component, but utility measures can be maximised by minimising the error terms. The design of the CE aims to capture as much of the public's utility derived from the product as possible in the CE attributes, thus minimising the unobservable component. In the modelling process, the error term can be minimized by including information about the respondent and choice context indicators in the model, thereby including the influence of these terms on the choices made into the model.

Multiple econometric techniques to elicit utility from CE data have been developed. The basic discrete choice model is the conditional logit (CL). However, the CL is limited in that it carries the independence from irrelevant alternatives (IIA) assumption and it does not control for unobserved preference heterogeneity, i.e., variations of preferences across the sample. Therefore, other models have been developed, of which the most prominent ones are the random parameter logit (RPL) and the latent class (LC) model. Both models account for preference heterogeneity, albeit in different ways and relax the IIA assumption. The RPL generalizes the CL by allowing the coefficients of observed variables to vary randomly over people rather than being fixed [49]. In contrast, the LC model assesses the source of preference heterogeneity by identifying underlying latent groups from the data set. Both the RPL and LC models have been created for this study, but this paper presents the results of the LC analysis, as this model gave a better fit with regards to statistical information criteria, as will be elaborated on in the next section.

The LC model specifies that the mixing of preference intensities takes place over a finite group of c preference classes [40]. Members of each class have similar preferences that are not directly observable from the CE data, i.e., they are latent. The parameters of u, expressed as β, can be estimated by the LC model while assessing preference heterogeneity sources across classes of respondents. The LC model assumes that preferences vary across the classes based on a non-parametric distribution. Following Greene & Henscher [50], suppose β takes C possible values labelled β1, . . . ; βc with probability prob_c reflecting the LC model estimates. The choice probability can be expressed as:

$$\text{Prob}_{ni} = \sum_{c=1}^{C} \text{prob}_c \frac{\exp(\beta_C' x_{ni})}{\sum_j \exp(\beta_C' x_{nj})}, \quad (2)$$

where the expected probability of alternative i being chosen by any respondent is dependent upon the expected value of the class probability. Class probability, expressed as $prob_c$ is estimated in each LC model, along with the parameters of u (expressed as β).

The number of classes in the model is assessed using information criteria (IC) statistics for each of the models. There is no common accepted IC to determine the correct number of classes [51] so several IC are used in combination. In this case we examined the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Hannan Quinn Information Criterion (HQ) statistics. These IC penalise for additional parameters to be included to determine the classes. The LC model has been used repeatedly in environmental economics [52,53] and, more specifically, for consumer preferences in seafood [54,55] and sustainability of seafood production [19,29].

The LC model was run for the pooled data set, containing the CE data of all the countries, and for each individual country. The model output is reported for the pooled and individual country level models. The model was additionally run on a subset of the CE data, excluding instances where sea bream was the product specified (Italy and Israel), as one could argue that the consumers' perceptions of production and preferences can vary across seafood species. As the results were similar in trends, coefficient strengths and marginal WTP estimates for CE attributes, the results of the full pooled data set including all country data are reported in this paper. (Results of the model, excluding the seabream CE data, are available from the authors upon request).

It should also be noted that there exists a high degree of heterogeneity in international responses towards seafood ecolabels. Several studies reviewed by Brécard et al. [29] point out numerous factors that determine the public's WTP. A number of these factors are the influence of culture, socioeconomic status, social norms, customs, political and moral values, institutions, political interests and political awareness [56–58]. Country specific dummies have been included in the model specification of the pooled data set to account for the effect of variations of these elements across the states. The comparison of several countries through a CE allows the researcher to assess if sustainability in the aquaculture production process is more valued in certain countries than others.

3. Results

Summary statistics for the entire sample of respondents (2520) are shown in Table 2. Overall, the sample was comparable to the national proportions in terms of gender, marital status, age and income. Even though 14% of the sample indicated they had heard of IMTA previously, a follow-up question asking for a description of IMTA resulted in no adequate description of IMTA being provided, suggesting that the true proportion of consumers familiar with IMTA is lower. This shows that consumers are not familiar with IMTA, regardless of whether or not IMTA experiments are taking place in the sample country. The majority of respondents indicated use of ecolabels either sometimes, most of the time, or always (1.86 average out of Likert 1–5).

Table 2. Summary statistics of choice experiment respondents.

n = 2520	Mean	Standard Deviation	Min.	Max
Demographic Variables				
Male (proportion)	0.46	0.50	0	1
Married/partner (proportion)	0.61	0.49	0	1
Third-level education (proportion)	0.44	0.50	0	1
Age (years)	41.1	12.72	18	65
Self-stated 'income below average' (proportion)	0.50	0.50	0	1
Attitudinal variables				
Have you ever heard of the term IMTA? (proportion)	0.14	0.35	0	1
Respondent uses ecolabels (Likert scale 1–4) [1]	1.86	0.92	1	4

[1] When you are buying seafood, do you look at ecolabels to decide which product you want to buy? Likert score (1–4): 1. Always, 2. Most of the time, 3. Sometimes, 4. Never.

The choice experiment data was analysed using NLOGIT6 statistical software. The search for the most appropriate specification (in terms of number of classes in model) consisted of modelling data assuming different numbers of latent classes for the individual country data sets and the pooled data set. The aim of this search was to develop a model that minimises the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Hannan Quinn Information Criterion (HQ) statistics. These statistics are measures of how well the model expresses variation in observed data. In the interpretation of the model results, differences in preferences as expressed by differences in the attribute level parameter across the classes. Statistics of model performance are listed in Table 3. The pooled model and the models for Ireland and Israel failed to converge when specified with 4 classes. Interestingly, all statistics indicated the same class selection for each country, leading to the selection of a latent class (LC) model with three classes for the pooled data, three classes for Ireland and Israel and four classes for Italy, Norway and the UK. It has been shown that the different criteria can indicate different optimum class numbers and the researcher needs to then make a judgement call based on other factors such as variable significance across classes [40].

Table 3. Criteria for number of classes.

	Classes	Log.Lik.	AIC	BIC	HQ
Pooled	2	−15,821	31,703	31,948	31,783
	3	**−14,937**	**29,968**	**30,340**	**30,089**
	4	-	-	-	-
Ireland	2	−3058	6162	6307	6213
	3	**−2882**	**5834**	**6054**	**5912**
	4	-	-	-	-
Israel	2	−2876	5799	5943	5850
	3	**−2727**	**5524**	**5744**	**5602**
	4	-	-	-	-
Italy	2	−3265	6575	6720	6626
	3	−3151	6371	6592	6450
	4	**−2911**	**5916**	**6212**	**6021**
Norway	2	−2933	5911	6056	5963
	3	−2840	5750	5970	5828
	4	**−2598**	**5290**	**5586**	**5395**
UK	2	−3077	6200	6345	6251
	3	−2894	5858	6079	5936
	4	**−2782**	**5658**	**5955**	**5764**

Notes: Numbers in bold are maximised criterion for model selection.

3.1. Cross Country Models

Tables 4–8 present the individual country latent class models while the pooled cross country model is presented in Table 9. A set of consumer profiles based on the results of the latent class models are also presented in Table 10. Weighted marginal WTP estimates for the CE model attributes of production location and sustainability levels are presented separately in Table 11 and as a product containing a set of attributes in Table 12. Finally, an overview of the marginal WTP estimates per class in each of the country specific models and the combined pooled model is given in Appendix B.

Table 4. Model Ireland.

Ireland (n = 500)	Latent Class 3 Classes		
Choice	**Class 1**	**Class 2**	**Class 3**
Location	1.597 *** (0.195)	−0.461 (0.347)	1.414 *** (0.101)
Sustainability C	0.774 *** (0.225)	0.935 *** (0.353)	0.191 (0.119)
Sustainability B	0.95 *** (0.24)	−0.361 (0.532)	0.894 *** (0.135)
Sustainability A	1.87 *** (0.254)	1.242 *** (0.42)	1.772 *** (0.135)
Price	−0.467 *** (0.042)	−0.365 *** (0.053)	−0.095 *** (0.01)
Opt-out Alternative Specific Constant (ASC)	−11.956 *** (2.11)	−3.887 *** (1.084)	−2.512 *** (0.363)
Interaction terms with ASC			
Male	−0.092 (0.767)	1.489 *** (0.425)	−0.009 (0.15)
Third level Education	−0.168 (0.838)	0.869 *** (0.336)	0.253 * (0.149)
Age	0.002 (0.048)	0.01 (0.017)	0.038 *** (0.006)
Married	0.391 (0.971)	−0.455 (0.333)	−0.27 * (0.156)
Income	0.037 (1.021)	0.056 (0.309)	−0.093 (0.148)
Class Probability	0.393 *** (0.035)	0.123 *** (0.032)	0.484 *** (0.03)

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

The latent class model output for the Irish data contained three latent classes, where the highest probability assigned was for class 3 (48%), followed by class 1 (39%) and class 2 (12%). The model showed significant positive consumer preference for seafood produced in Irish waters for the first (1.6, $P < 0.01$) and third (1.4, $P < 0.01$) classes. The second class showed a negative preference for the Irish produced attribute, but this coefficient was insignificant. With regard to sustainability in seafood production, Irish respondents showed a positive preference towards products with sustainability label C in class 1 (0.7, $P < 0.01$) and class 2 (0.9, $P < 0.01$), towards label B in class 1 (0.9, $P < 0.01$) and class 2 (0.9, $P < 0.01$) and towards label A in class 1 (1.9, $P < 0.01$), class 2 (1.2, $P < 0.01$) and class 3 (1.8, $P < 0.01$).

Overall, all latent classes were characterised by a positive preference for more sustainably produced seafood, although this preference was more clearly defined in class 1. Irish respondents had a significant negative preference in all classes for the price attribute (class 1: −0.05, $P < 0.01$; class 2: −0.4, $P < 0.01$; class 3: −0.1, $P < 0.01$) and the opt-out option (class 1: −11.9, $P < 0.01$; class 2: −3.9, $P < 0.01$; class 3: −2.5, $P < 0.01$). The models also include socio-demographic interaction terms where being male, married, having third-level education and income were interacted with the opt-out alternative specific constant (ASC). The interaction terms yielded insignificant parameters in the majority of classes in the Irish model. In class 2, demographic groups that opted out significantly more were male (1.5, $P < 0.01$) and highly educated (0.8, $P < 0.01$) respondents. In class 3 the elderly opted out significantly more than the other groups (0.04, $P < 0.01$).

Table 5. Model Israel.

Israel (n = 500)	Latent Class 3 Classes		
Choice	**Class 1**	**Class 2**	**Class 3**
Location	1.87 *** (0.238)	1.114 *** (0.089)	0.625 *** (0.233)
Sustainability C	0.947 *** (0.257)	0.494 *** (0.112)	0.993 ** (0.39)
Sustainability B	1.742 *** (0.333)	1.332 *** (0.134)	1.252 *** (0.415)
Sustainability A	2.77 *** (0.362)	2.076 *** (0.132)	2.824 *** (0.39)
Price	−5.879 (0.279)	−0.366 *** (0.035)	−0.407 *** (0.073)
Opt-out Alternative Specific Constant (ASC)	−5.879 (737)	−5.645 *** (0.621)	−1.622 * (0.927)
Interaction terms with ASC			
Male	5.931 (128.6)	0.308 (0.271)	−0.668 ** (0.282)
Third level Education	18.478 (622.73)	−0.201 (0.259)	−0.256 (0.291)
Age	−3.983 (351.6)	0.023 ** (0.01)	0.03 *** (0.011)
Married	24.793 (120.8)	−0.097 (0.305)	−0.683 ** (0.331)
Income	21.07 (531.63)	0.186 (0.282)	0.27 (0.362)
Class Probability	0.323 *** (0.023)	0.527 *** (0.048)	0.15 *** (0.019)

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

The preferred model for the Israel data contained three classes, where the highest-class probability was for class 2 (53%) and smaller probabilities for class 1 (32%) and class 3 (15%). Respondents from Israel showed a positive preference for nationally produced aquaculture produce in all classes (class 1: 1.89 $P < 0.01$; class 2: 1.1, $P < 0.01$; class 3: 0.6, $P < 0.01$). Across all classes, positive preferences for more sustainable aquaculture production were expressed that increased as sustainability levels increased, from label C (class 1: 0.9, $P < 0.01$; class 2: 0.5, $P < 0.01$; class 3: 1, $P < 0.01$) to B (class 1: 1.7, $P < 0.01$; class 2: 1.3, $P < 0.01$; class 3: 1.3, $P < 0.01$) to A (class 1: 2.8, $P < 0.01$; class 2: 2.1, $P < 0.01$; class 3: 2.8, $P < 0.01$). Israeli respondents expressed negative preferences for the price attribute (class 2: −0.04, $P < 0.01$; class 3: −0.04, $P < 0.01$), although this was insignificant for class 1 (−5.9, $P > 0.1$). With regard to the opt-out option, respondents showed a negative preference towards the opt-out option in class 2 (−5.6, $P < 0.01$) and class 3 (−1.6, $P < 0.05$), but this remained insignificant in class 1 (−5.9, $P < 0.1$). The interaction terms were insignificant in class 1. In class 2, the elderly opted out more (0.02, $P < 0.5$) and in class 3, respondents that opted out were more likely to be female (−0.7, $P < 0.05$) and unmarried (−0.7, $P < 0.05$).

Table 6. Model Italy.

Italy (***n*** **= 508**)	**Latent Class 4 Classes**			
Choice	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Location	2.59 *** (0.324)	3.774 *** (0.212)	0.77 *** (0.101)	1.129 *** (0.208)
Sustainability C	0.749 ** (0.321)	0.769 ** (0.342)	1.186 *** (0.166)	0.481 (0.432)
Sustainability B	1.479 *** (0.386)	0.46 (0.292)	2.537 *** (0.166)	0.847 ** (0.352)
Sustainability A	2.37 *** (0.357)	0.867 *** (0.193)	3.83 *** (0.139)	2.298 *** (0.298)
Price	−1.063 *** (0.105)	−0.093 ** (0.045)	−0.252 *** (0.022)	−0.371 *** (0.053)
Opt-out Alternative Specific Constant (ASC)	−2.958 (0.00001)	−0.097 (0.663)	−4.326 *** (0.418)	−2.518 *** (0.647)
Interaction terms with ASC				
Male	−0.144 (0.00001)	−0.698 *** (0.26)	0.354 ** (0.167)	0.615 *** (0.154)
Third-level Education	0.058 (0.00001)	−1.316 *** (0.309)	0.27 * (0.159)	−0.124 (0.157)
Age	−1.939 (0.00002)	0.013 (0.012)	0.057 *** (0.008)	0.029 *** (0.009)
Married	0.126 (0.00001)	0.477 ** (0.236)	−0.02 (0.179)	0.384 ** (0.188)
Income	−0.55 (0.0001)	−0.328 (0.315)	−1.39 *** (0.214)	−0.538 *** (0.196)
Class Probability	0.18 *** (0.02)	0.224 *** (0.016)	0.448 *** (0.035)	0.144 *** (0.017)

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

The Italian sample was divided into four latent classes, with the probability of class 3 being the largest (45%), followed by class 2 (22%), class 1 (18%) and class 4 (14%). Overall, preferences for the attributes followed similar patterns, although differences exist between the classes in terms of attribute coefficient significance. Italian respondents have a positive preference for aquaculture produced in national waters across all classes (class 1: 2.6, $P < 0.01$; class 2: 3.8, $P < 0.01$; class 3: 0.8, $P < 0.01$; class 4: 1.1, $P < 0.01$). Respondents predominantly show a preference for aquaculture products with higher sustainability labels, although some differences exist. In class 1 and 3, preference is significant and positively related to sustainability across label C (class 1: 0.7, $P < 0.05$; class 3: 1.2, $P < 0.01$), label B (class 1: 1.5, $P < 0.01$; class 3: 2.5, $P < 0.01$) and label A (class 1: 2.4, $P < 0.01$; class 3: 3.8, $P < 0.01$). Although the model produced statistically insignificant results on label C (class 4) and label B (class 2), respondents expressed a positive and significant preference for aquaculture products with the highest sustainability label (A) across all classes. Respondents had a negative preference for products with a higher price across all classes. Preferences were negative for the opt-out option in the choice cards, although these were insignificant in class 1 (−3, $P > 0.1$) and class 2 (−0.1, $P > 0.1$). The interaction terms between demographic groups and the opt-out option were insignificant in most cases. None of the interaction terms were significant in class 1, while in other classes respondents were more likely to opt out when they were male (class 2: −0.7, $P < 0.01$; class 3: 0.4, $P < 0.05$; class 4: 0.6, $P < 0.01$), educated below third-level education (class 2: −1.3, $P < 0.01$), married (class 2: 0.5, $P < 0.05$; class 4:

0.4, $P < 0.05$), over 45 years of age (class 3: 0.06, $P < 0.01$; class 4: 0.03, $P < 0.01$) or had an income below the national average (class 3: −1.4, $P < 0.01$; class: 4 0.5, $P < 0.01$).

Table 7. Model Norway.

Norway (**n = 501**)	**Latent Class 4 Classes**			
Choice	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Location	1.214 *** (0.105)	0.044 (0.349)	1.19 *** (0.25)	3.461 *** (0.259)
Sustainability C	0.398 *** (0.135)	0.77 * (0.434)	1.103 ** (0.446)	0.242 (0.244)
Sustainability B	1.191 *** (0.157)	0.002 (0.547)	3.035 *** (0.465)	0.062 (0.204)
Sustainability A	2.001 *** 0.16437	−0.138 (0.51)	4.442 *** (0.478)	0.463 ** (0.213)
Price	−0.886 *** 0.056	−1.22 *** (0.21)	−0.235 *** (0.083)	−0.187 *** (0.063)
Opt-out Alternative Specific Constant (ASC)	−10.832 *** 1.059	−0.796 (1.612)	−5.397 *** (1.146)	−1.367 * (0.712)
Interaction terms with ASC				
Male	1.329 ** (0.566)	−0.872 * (0.479)	0.223 (0.391)	−0.323 (0.253)
Third level Education	0.141 (0.464)	−2.494 *** (0.49)	0.005 (0.459)	−0.399 (0.292)
Age	−0.021 (0.018)	−0.14 *** (0.023)	0.222 *** (0.02)	0.002 (0.009)
Married	0.326 (0.480)	1.46 *** (0.454)	−2.154 *** (0.474)	0.05 (0.261)
Income	−0.916 (0.585)	−1.411 ** (0.703)	−0.763 * (0.411)	0.305 (0.276)
Class Probability	0.475 *** (0.014)	0.091 *** (0.024)	0.167 *** (0.026)	0.267 *** (0.025)

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

The preferred model for the Norwegian data divided the respondents up into four latent classes, where class membership was the highest for class 1 (48%), followed by class 4 (27%), class 3 (17%) and class 2 (9%). Considerable preference differences were modelled across the Norwegian classes. National production location was preferred by class 1 (1.2, $P < 0.01$), class 3 (1.2, $P < 0.01$) and class 4 (3.5, $P < 0.01$), but remained insignificant for class 2. Sustainable aquaculture produce was preferred across all sustainability labels in class 1 (label C: 0.4, $P < 0.01$; label B: 1.2, $P < 0.01$; label A: 2, $P < 0.01$) and class 3 (label C: 1.1, $P < 0.05$; label B: 3, $P < 0.01$; label A: 4.4, $P < 0.01$). Preferences for the sustainability of aquaculture production were however insignificant for class 2 and class 4. All latent classes in the Norwegian data had a statistically significant preference for products with lower prices and a negative preference for the opt-out option, with the smallest class (2) being statistically insignificant for the alternative specific constant. With regard to the interactions between demographic variables and the alternative specific constant, Norwegian respondents were more likely to opt-out when male in class 1 (1.3, $P < 0.05$), when not having completed third-level education in class 2 (−2.5, $P < 0.01$), when under the age of 45 in class 2 (−0.1, $P < 0.01$) and over 45 in class 3 (0.2, $P < 0.01$), when married in class 2 (1.5, $P < 0.01$) and unmarried in class 3 (−2.2, $P < 0.01$) and when the respondent's income is below the national average in class 2 (−1.4, $P < 0.05$).

Table 8. Model United Kingdom.

UK (n = 510)	Latent Class 4 Classes			
Choice	**Class 1**	**Class 2**	**Class 3**	**Class 4**
Location	1.40 *** (0.195)	1.479 *** (0.387)	0.02 (0.233)	0.609 *** (0.092)
Sustainability C	0.935 *** (0.248)	1.219 * (0.67)	1.103 *** (0.274)	0.224 (0.137)
Sustainability B	1.638 *** (0.326)	2.17 *** (0.798)	1.438 *** (0.375)	0.905 *** (0.162)
Sustainability A	2.664 *** (0.378)	3.126 *** (0.805)	2.227 *** (0.349)	1.485 *** (0.162)
Price	−1.129 *** (0.112)	−0.37 *** (0.132)	−0.972 *** (0.105)	−0.107 *** (0.027)
Opt-out Alternative Specific Constant (ASC)	−12.034 *** (2.96)	−3.074 *** (0.974)	−0.968 (0.98)	−6.837 *** (1.233)
Interaction terms with ASC				
Male	−0.645 (0.794)	1.129 ** (0.532)	0.607 ** (0.304)	0.851 ** (0.346)
Third level Education	−0.756 (0.604)	−1.183 *** (0.427)	−0.208 (0.393)	0.695 ** (0.305)
Age	0.023 (0.028)	0.057 *** (0.019)	−0.067 *** (0.024)	0.058 *** (0.018)
Married	−0.783 (0.783)	2.746 *** (0.552)	−2.202 *** (0.354)	1.304 *** (0.383)
Income	−0.328 (0.981)	1.534 *** (0.398)	−0.507 (0.318)	1.143 *** (0.386)
Class Probability	0.389 *** (0.03)	0.098 *** (0.028)	0.172 *** (0.04)	0.342 *** (0.033)

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

Data from the British respondents were modelled assuming four classes, consisting of two classes with a class probability of 39% (class 1) and 34% (class 4) and two classes with lower class probabilities of 17% and 10%. British respondents showed a positive preference for aquaculture products produced in national waters (class 1: 1.4, $P < 0.01$; class 2: 1.5, $P < 0.01$; class 4: 0.6, $P < 0.01$), although this preference was statistically insignificant for class 3 (0.02, $P > 0.1$). Respondents also expressed a positive preference for products from more sustainable aquaculture production processes, across all labels; although label C was insignificant in class 2 ($P > 0.5$) and class 4 ($P >.01$). This suggests that these classes prefer only larger increases in sustainability. All classes showed a statistically significant negative preference for the price attribute ($P < 0.01$) and all but class 3 ($P > 0.1$) had a negative preference for selecting the opt-out option in the choice cards ($P < 0.01$). In terms of interaction terms, in no demographic group opted out significantly more on average in class 1. In class 2 however, respondents selected the "I would not purchase either" option significantly more when they were male (1.1, $P < 0.05$), when their highest completed education level was below third level (−1.2, $P < 0.01$) or if they were married (2.7, $P < 0.01$). In class 3, the opt-out was selected more by respondents that were male (0.6, $P < 0.05$), under 45 years of age (−0.1, $P < 0.01$) or unmarried (−2.2, $P < 0.01$). In class 4, respondents opted out more when male (0.9, $P < 0.05$), completed third level education or higher (0.7, $P < 0.05$), are over 45 years of age (0.1, $P < 0.01$) and have an income higher than the national average (1.1, $P < 0.01$).

Table 9. Model pooled data.

Pooled (*n* = 2520)	**Latent Class 3 Classes**		
Choice	**Class 1**	**Class 2**	**Class 3**
Location	1.126 *** (0.046)	0.225 *** (0.067)	3.142 *** (0.155)
Sustainability C	0.482 *** (0.054)	0.482 *** (0.054)	0.127 (0.119)
Sustainability B	1.039 *** (0.066)	2.016 *** (0.126)	0.230 * (0.122)
Sustainability A	1.734 *** (0.066)	3.211 *** (0.139)	0.495 *** 0.125
Price	−0.585 *** (0.022)	−0.197 *** (0.011)	−0.120 *** (0.014)
Opt-out Alternative Specific Constant (ASC)	−10.571 *** (0.514)	−1.657 *** (0.26)	3.210 *** (0.379)
Interaction terms with ASC			
Male	−0.304 * (0.184)	0.094 (0.088)	0.495 *** 0.125
Third level Education	0.178 (0.183)	−0.230 *** (0.087)	0.186 (0.174)
Age	0.0343 *** (0.007)	0.029 *** (0.004)	−0.006 (0.006)
Married	0.031 (0.187)	−0.156 * (0.090)	−0.265 * (0.148)
Income below average	0.276 (0.187)	−0.239 *** (0.091)	0.156 (0.144)
Ireland	−6.053 *** (0.513)	−0.289 * (0.170)	0.495 *** 0.125
Italy	−0.019 (0.401)	0.709 *** (0.160)	−3.311 *** (0.247)
Norway	1.940 *** (0.285)	3.705 *** (0.230)	−3.330 *** (0.252)
UK	2.635 *** (0.294)	0.761 *** (0.171)	0.493 ** (0.244)
Class probability	0.543 *** (0.018)	0.278 *** (0.009)	0.178 *** (0.010)

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

In the 3-class model for the pooled data set, 54% (*n* = 1,161) of the respondents we assigned to the first class, 28% (*n* = 705) to the second class and 18% (*n* = 454) to the third class. The coefficients of all parameters are significant on the 1% level, with the exception of the third class, where the lower sustainability level (c) was insignificant. The interaction terms with the opt-out ASC varied strongly between the classes.

3.2. Consumer Profiling across Classes

In Table 10, consumer profiles based on the latent class parameters are described. Here it should be noted that the classes are not mutually exclusive but latent, meaning that respondents are assigned a probability of membership in each case. Respondents are thus not assigned 100% to any single class.

Consumer profiling is based on the coefficient values in each class. A total of five consumer profiles were created. The profiles identified in the latent classes are (1) the "Green Buyer", (2) the "Local Buyer", (3) the "Determined Buyer", (4) the "Flexible Buyer" and (5) the "Economic Buyer".

Table 10. Classification of preferred models of pooled and country data.

		Green Buyer		**Local Buyer**		**Determined Buyer**		**Flexible Buyer**		**Economic Buyer**		**Indifferent Buyer**	
	n	Class	%	Class	%	Class	%	Class	%	Class	%	Class	%
Pooled	**2520**	Class 2	28	Class 3	18	Class 1	54	-	0	-	0	-	0
Total			**28**		**18**		**54**		**0**		**0**		**0**
Ireland	**500**	Class 3	48	-	0	Class 1	39	-	0	-	0	Class 2	12
Israel	**500**	Class 3	15	Class 2	53	-	0	Class 1	32	-	0	-	0
Italy	**508**	Class 3	45	Class 2	22	-	0	Class 1	18	Class 4	14	-	0
Norway	**501**	Class 3	17	Class 4	27	Class 1	48	-	0	Class 2	9	-	0
UK	**511**	Class 3	17	Class 4	34	Class 1	39	-	0	-	0	Class 2	10
Total			***28***		***27***		***25***		***10***		***5***		***4***

3.2.1. The Green Buyer

The first two profiles relate to the main CE attributes; production location and sustainability level. Respondents in the "Green Buyer" class are characterised by a strong preference for sustainable seafood production. The class represents a positive coefficient for the sustainability attributes, which translates into a WTP for the sustainability attributes that is significantly higher than in the other classes and compared to other attributes.

The second class from the pooled data model is labelled as the green buyer due to its positive preference for the sustainability attributes C, B and A (attribute coefficients (and standard error) of 0.48 (0.05), 2.02 (0.13) and 3.21 (0.14) respectively) and the comparatively low preference for production location. Elder people were more likely to select the opt–out (0.03 (0.004)), while highly educated respondents (−0.23 (0.09)), low income respondents (−0.24 (0.09)) and married respondents (−0.16 (0.09)) were less likely to select the opt-out. With regard to the country interactions, respondents from this class are more likely to select the opt-out when they are Italian (0.71 (0.16)), Norwegian (3.71 (0.23)) or British (0.76 (0.17)), compared to the base case.

Latent classes characterised by their high utility associated with sustainability are modelled for every country and represented a large proportion of the population of Ireland (class 3, probability 48%) and Italy (class 3, probability 45%) and smaller proportions for Norway (class 3, probability 17%), the UK (class 3, probability 17%) and Israel (class 3, probability 15%). The profile of the Green Consumer is represented by the largest proportion of respondents (class 2, probability 28%) and the only latent class to be modelled in every data set. The allocation towards green or local buyer profiles is based on the comparative coefficients of the sustainability attribute and on the height of the WTP for the individual attributes in the specific class. Although characterised by their preference for sustainability, the Irish, Israeli and Norwegian respondents in this profile also have a positive utility for national production location paired with their preference for higher sustainability.

3.2.2. The Local Buyer

The "Local Buyer" has a strong positive preference for seafood that is produced in national water, as opposed to imported seafood. This preference is elicited from a positive coefficient for the location attribute and a WTP for the location attribute that is high, both in comparison to the other attributes as well as for the location attribute WTP in other classes.

Members of the third class from the pooled model had strong positive preferences for fish produced in national waters (3.14 (0.16)). The sustainability attribute coefficients did not show a clear preference pattern, although the highest sustainability attribute is significant (0.5 (0.13)). With regard to representativeness of the sample, male respondents in this class were more likely to select one of the purchasing decisions than women (0.5 (0.13)). Compared to the base case, male respondents from Ireland (−0.5, (0.13)), Italy (−3.31 (0.25)) and Norway (−3.33 (0.25)) are less likely to select the opt-out, while respondents from the UK select the opt-out significantly more (0.49 (0.24)). However, the preference for the opt-out is still negative for all countries, i.e., respondents from all countries prefer to select a purchasing option over the "I would not buy any of these products, even if this product was on my shopping list" option.

In the single country analysis, the profile of the local buyer can be attributed to 27% of the respondents, spread over Israel (class 2, probability 53%), the United Kingdom (class 4, probability 34%), Norway (class 4, probability 27%) and Italy (class 2, probability 22%). Although Irish respondents have among the highest WTP for nationally produced seafood in the sample, no latent class was allocated to the local buyer profile in the Irish model.

3.2.3. The Determined Buyer

The determined and flexible buyer profiles relate to the shopping habits of respondents and their resoluteness in making purchasing decisions. Respondents in the "Determined Buyer" profile are characterised by their determination to buy what is on their shopping list, regardless of the attributes of the product. This is reflected by a negative coefficient for the alternative specific constant in the model.

The first class from the pooled data model is labelled as 'determined buyer' due to its strong negative preference for the opt-out option (−10.57 (0.51)). The class is further characterised by positive coefficients for the national production location (1.13 (0.05)) and the sustainability attributes C, B and A (0.48 (0.05), 1.04 (0.07) and 1.73 (0.07) respectively). The country interactions terms in the pooled model indicate that Irish respondents have a stronger tendency to select one of the purchasing options (−6.05 (0.51)) compared to the base case of Israelis, whereas Norwegian and the British respondents selected the opt-out option more (in 2 out of the 3 classes in the Norwegian case and for all classes in the UK case) in comparison to the base case (1.94 (0.29) and 2.64 (0.29), respectively). This means that the results of the model cannot be generalised over the Norwegian and British public as much as over the other sample countries, as they have selected the opt-out more. However, considering the strong negative coefficient for the constant, Norwegian and British respondents have a negative preference for the opt-out; i.e., they prefer to select a purchasing option over the opt-out option, but this preference is significantly weaker than in the other sample countries. This tendency is consistent for these countries across the different classes.

Across the individual country models, the profile of the determined buyer was allocated to latent classes in Ireland (class 1, probability 39%), Norway (class 1, probability 48%) and the United Kingdom (class 1, probability 39%), together accounting for 25% of the sample population. The modelled classes produced significant coefficients for all attributes, but were identified as determined buyer classes due to the strength of the negative coefficient for the opt-out ASC; it was over 6 times the nearest coefficient in the class in Ireland, over 5 times in the Norwegian class and 4.5 in the UK class. The modelling of these classes is based on the purchasing habits rather than preference for one of the attributes, but the respondents represented by these classes did display significant preferences for the CE attributes.

3.2.4. The Flexible Buyer

In contrast to the determined buyer, the "Flexible Buyer" shifts easily from one product to the other when the product attributes do not fit the respondents' preferences. This is expressed by the absence of a significant negative coefficient for the alternative specific constant. The determined and flexible buyers can however still have strong preferences for the CE attributes, which should be recognised in the interpretation of the latent class models.

In the individual country models, a latent class flexible buyer are assumed for Israel (class 1, probability 32%) and Italy (class 1, probability 18%), together representing 10% of the total sample population. Classes were allocated to the flexible buyer profile based on their respondents' tendency to switch to other (substitute) products and their lack of a preference for lower prices. They were allocated to the flexible profile due to insignificant coefficients for the constant, which reflects a lack of a detectable preference for buying the type of product the respondent intended to buy when entering the shop. In the Israel class, no significant preference for lower priced products was visible. As the classification of these latent classes is based on shopping habits, it should be recognised that the classes in Israel and Italy both have significant positive coefficients for the CE attributes production location and sustainability, thus contributing to the WTP of those attributes.

3.2.5. The Economic Buyer

The "Economic Buyer" profile captures respondents' price sensitivity. Respondents in this class have a preference for products with lower prices. Although not observed in the pooled data set, the economic buyer profile is allocated to classes in Italy (class 4, probability 14%) and Norway (class 2, probability 9%), together representing 5% of the total sample population. The economic buyer profile was allocated according to the negative preference for the price variable. The Italian class holds positive preferences for the sustainability and location attributes, but these preferences are only significant for the higher sustainability attribute levels. This suggests that these individuals pay extra only for larger increases in sustainability. In the Norwegian class 2, price was the only variable that was significant (at the 5% level). In terms of representativeness of the latent classes for the sample population, this profile is comparatively weakly represented.

Table 11. Weighted marginal WTP for CE attributes across countries by the preferred models.

	Model (Number of Classes)	Nationally Produced	Sustainability A	Sustainability B	Sustainability C
Pooled	LC (3)	€6.02 ***	€6.89 ***	€4.16 ***	€2.45 ***
UK	LC (4)	€6.23 ***	€15.18 ***	€9.44 ***	€3.43 ***
Italy	LC (4)	€11.33 ***	€10.21 ***	€6.21 ***	€4.28 ***
Ireland	LC (3)	€8.35 ***	€10.97 ***	€5.21 ***	€1.93 ***
Israel	LC (3)	€3.41 ***	€10.29 ***	€5.23 **	€3.27 ***
Norway	LC (4)	€6.45 ***	€4.88 ***	€2.88 ***	€1.40 *

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

Table 12. Price premium for seafood with varying attributes of pooled data.

Combination Attribute Levels		Weighted WTP for Attribute Combination			
Production Location	**Sustainability Label**	**Class 1**	**Class 2**	**Class 3**	**Weighted**
National	A	€4.89	€17.49	€30.21	€12.91
National	B	€3.70	€11.40	€26.10	€9.84
National	C	€2.75	€7.68	€26.10	€8.29
International	A	€2.97	€16.34	€4.11	€6.89
International	B	€1.78	€10.26	€1.91	€4.16
International	C	€0.82	€6.53	€1.06	€2.45

Table 11 lists the marginal willingness-to-pay for the change in attribute levels. Estimates reported are weighted for the latent class membership probabilities. The public's marginal WTP for seafood produced in national waters varies from €3.41 (in Israel) to €11.33 (in Italy) and is estimated at €6.02 for the pooled data set, ceteris paribus. The marginal WTP for the sustainability attributes vary from €1.40 (Norway) to €4.28 (Italy) for sustainability label C, from €2.88 (Norway) to €9.44 (UK) for sustainability label B and from €4.88 (Norway) to €15.18 (UK) for sustainability label A. The pooled data analysis produced estimates of €2.45, €4.16 and €6.89 per kilo of unfrozen product that has sustainability label C, B and A, respectively, ceteris paribus. The pattern in WTP estimate is comparable between countries. Marginal WTP for both sustainability and national production location is positive and increases as sustainability increases. This pattern holds over all countries. However, difference does exist in the magnitude of marginal WTP estimates. The average marginal WTP for CE attributes is the highest in the UK, followed by Italy, Ireland, Israel and lastly Norway.

4. Discussion

This paper presented the results of a latent class analysis of CE data with the aim of assessing the market potential of sustainable seafood production techniques, such as IMTA. Latent classes were modelled for data sampled in Ireland, Israel, Italy, Norway and the United Kingdom both separately and for the pooled data from all countries. Classes were allocated to consumer profiles according to the estimated attribute preference parameters signs and significance, leading to respondents in each class being labelled as green, local, determined, flexible, or economic buyers. More specifically, latent classes in the pooled data model were identified as green (28%), local (18%) and determined (54%) buyers. While these profiles remain dominant in the country data analysis, a number of smaller profiles were detected that remained unidentified under the three class model on the pooled data set.

The profiles of the green and local consumer reflect respondents' preferences for the CE attributes sustainability and production location, whereas the determined and flexible profiles reflect how easily an individual shifts to an alternative product based on the product attributes. Interestingly, the proportion of the public assigned to the profile of green consumer (28%) is comparable to the proportion of consumers labelled green consumers by the OECD [59] (27%). As the determined buyer class covers a relatively large proportion of the respondents in Ireland (39%), Norway (48%) and the UK (39%) the general public of the sampled countries seems to be characterised as determined buyers rather than as a flexible buyer.

The public's WTP is positive for all CE attributes and across the sample countries and the pooled data, indicating that the public is willing to pay a price premium for products produced in a more sustainable method such as IMTA. Marginal WTP for the locally produced attribute is estimated in the pooled data at €6.02, ceteris paribus, indicating a willingness to pay a price premium for seafood products that are produced in national waters. The results also indicate that the public is willing to pay a price premium for products that are produced more sustainably. This WTP increases as the degree of sustainability increases by decreasing the environmental impact by 10% (€2.45—sustainability label C), 20% (€4.16—sustainability label B) or 30% (€6.89—sustainability label A) per kilo of product.

Price premiums are mentioned as a method of stimulating seafood producers to shift to more sustainable production techniques such as IMTA [60]. However, this is conditional upon the additional profits going to producers, rather than to retailers. Considering the international character of the seafood market and the power of retailers in the market, some form of governance may be necessary if bottom-up pressure by the public is to steer the industry to become more sustainable. The EU may well be the best suited institution to govern seafood market steering policies in Europe, as it holds some transnational power and can create a standardised instrument that transcends national market boundaries and works at the European level [61] in contrast with the fragmented approach of national governments.

Given the strong competition in the globalised seafood market, the European aquaculture industry can match the global industry only when it creates a valuable market position for itself. For example, the Irish salmon industry recovered from a decline in production after a combination of disease and negative market conditions by carving out a high-value niche market for organic salmon [62]. The European aquaculture industry could come closer to matching global growth rates by creating a similar niche for its products. Production methods such as IMTA could expedite the development of such a sustainable niche market.

The significant WTP for more sustainable forms of aquaculture does not in itself guarantee higher profits for producers that switch to such production methods. This will also depend on the marginal costs of providing higher sustainable levels in production. Given the potential synergies across the products produced in an IMTA system with possible reduction in costs associated with feed loss and waste processing (plus increasing demand for sustainable produced food), the marginal cost could actually decrease in the long run but this remains an area for future research. Further research is also needed in terms of the pooled model specification. The model presented controls for non-observed heterogeneity in mean preferences. In this type of cross-country study however, consumers may interpret and process choice tasks and situations differently [63]. Control for this scale heterogeneity could improve the fit of the pooled model.

The creation of an ecolabel as demonstrated in this survey could simultaneously fulfil multiple functions; for the public, they provide previously hidden information on the environmental impact of a product, allowing them to maximize their utility; for a producer, they provide the opportunity to differentiate their product and increase their market value; while governments use ecolabels as a policy instrument to stimulate environmentally friendlier production to reach policy goals. An increasing proportion of the European public is aware of the environmental impact of seafood production and is willing to pay a price premium for more sustainable products. Public awareness and willingness-to-pay analysis can therefore be considered a tool to stimulate the European aquaculture industry while facilitating blue growth and reaching the goal of 'Good Environmental Status'. Simultaneously, an EU ecolabel guarantees the public that the product observes EU production standards, which, as Magennis et al. [64] points out could reassure those individuals reluctant to purchase seafood that is imported from countries where regulations are perceived as insufficient.

Furthermore, an ecolabel as proposed in this paper provides information to the public on the degree of environmental impact. A common criticism towards ecolabels is that they do not provide information on the degree of environmental improvement, and green grading schemes have been proposed by scholars [32]. A sustainability grading label provides this information to the public and continually stimulates producers to decrease the environmental impact of their production process, so as to reach a higher ecolabel tier. Lastly, a lack of knowledge and trust in regulatory organisations, paired with distrust towards the food industry, and ignorance and scepticism about the independence of certifiers, has been identified as elements that are decreasing the ecolabel impact [32]. A grading label as proposed has the advantage of consumer familiarity and trust, as this is a widely used and accepted label across EU countries.

Seafood preferences for sustainability and production location can be generalized over countries in terms of preference patterns, but WTP estimates were heterogeneous in degree. Differences among countries can have implications for the success of eco-labelling programs. Differences in socioeconomic status, knowledge on environmental issues, price sensitivity or the perceived importance of other seafood attributes that the ecolabel competes with may all impact on the success of a new ecolabel [24]. These differences highlight the need for flexible implementation of cross border eco-labelling programs, as well as the need for education of the European public on environmental issues and their role as responsible consumers. Finally, a key aspect of investment in IMTA will be the extent to which consumers are willing to pay higher prices for fish and shellfish which are produced using this technique. The results presented here highlight the fact that consumers are willing to pay a price premium for the additional sustainability IMTA systems could provide, although the location of such systems will also remain an important consideration in any purchasing decision.

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Appendix A

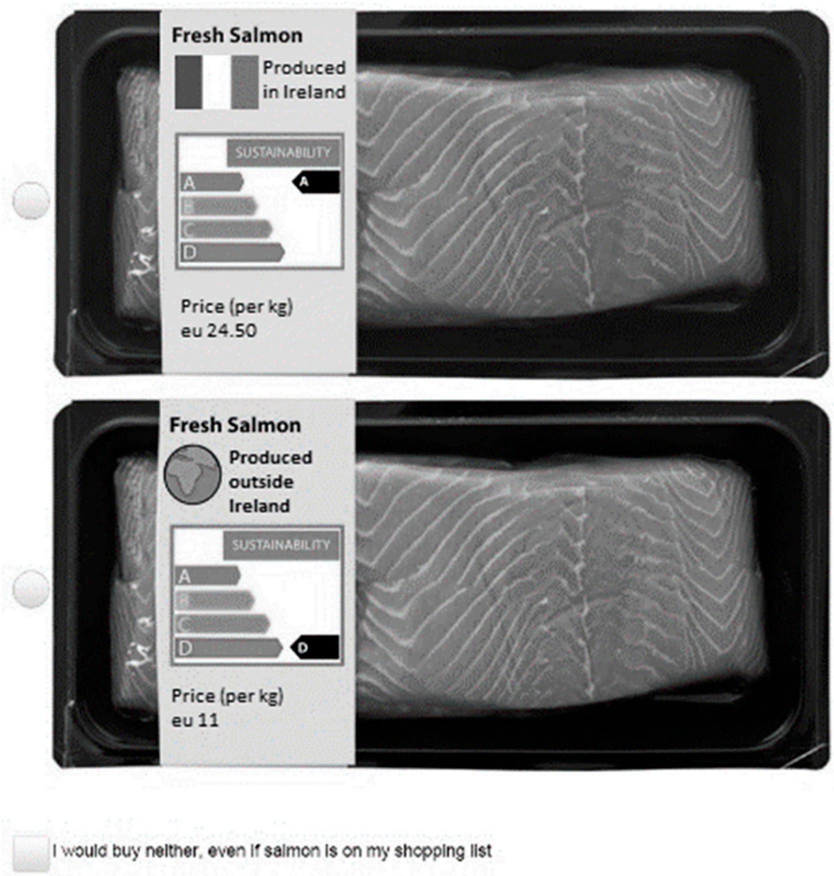

Figure A1. Example Choice Card as Presented in the Choice Experiment.

Appendix B

Table A1. Marginal WTP per Latent Class per Country and for the Pooled Model.

	Class 1	Class 2	Class 3	Class 4	Weighted
Ireland					
Class probability	39% ***	12% ***	48% ***		100%
Location	€1.35 ***	€−0.16	€7.16 ***		€8.35 ***
C	€0.65 ***	€0.32 **	€0.97		€1.93 ***
B	€0.80 ***	€−0.12	€4.53 ***		€5.21 ***
A	€1.58 ***	€0.42 **	€8.98 ***		€10.97 ***
Israel					
Class probability	32% ***	53% ***	15% ***		100%
Location	€0.28 ***	€1.60 ***	€1.52 *		€3.41 ***
C	€0.14 ***	€0.71 ***	€2.42 **		€3.27 ***
B	€0.26 ***	€1.92 ***	€3.05		€5.23 **
A	€0.41 ***	€2.99 ***	€6.89 *		€10.29 ***
Italy					
Class probability	18% ***	22% ***	45% ***	14% ***	100%
Location	€0.45 ***	€9.07 **	€1.37 ***	€0.44 ***	€11.33 ***
C	€0.13 **	€1.85 *	€2.11 ***	€0.19	€4.28 ***
B	€0.26 ***	€1.11	€4.52 ***	€0.33 **	€6.21 ***
A	€0.41 ***	€2.08 **	€6.83 ***	€0.89 ***	€10.21 ***

Table A1. *Cont.*

	Class 1	Class 2	Class 3	Class 4	Weighted
Norway					
Class probability	48% ***	9% ***	17% ***	27% ***	100%
Location	€0.65 ***	€0.003	€0.85 ***	€4.95 ***	€6.45 ***
C	€0.21 ***	€0.06	€0.78 *	€0.35	€1.40 **
B	€0.64 ***	€0.0002	€2.16 ***	€0.09	€2.88 ***
A	€1.07 ***	€−0.01	€3.15 ***	€0.66 **	€4.88 ***
United Kingdom					
Class probability	39% ***	10% ***	17% ***	34% ***	100%
Location	€0.48 ***	€0.39 **	€0.003	€1.95 ***	€2.83 ***
C	€0.32 ***	€0.32	€0.20 ***	€0.72	€1.56 ***
B	€0.56 ***	€0.57	€0.25 ***	€2.90 ***	€4.29 ***
A	€0.92 ***	€0.83 *	€0.39 ***	€4.76 ***	€6.90 ***
Pooled					
Class probability	54% ***	28% ***	18% ***		100%
Location	€1.93 ***	€1.15 ***	€26.10 ***		€6.02 ***
C	€0.82 ***	€6.53 ***	€1.06		€2.45 ***
B	€1.78 ***	€10.26 ***	€1.91 *		€4.16 ***
A	€2.97 ***	€16.34 ***	€4.11 ***		€6.89 ***

*: $P < 0.1$; **: $P < 0.05$; ***: $P < 0.01$.

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