Consumer Preference Heterogeneity and Preference Segmentation: The Case of Ecolabeled Salmon in Danish Retail Sales

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ABSTRACT

Popularity of sustainably produced food products has grown rapidly in recent years. Ecolabels are used to indicate the environmental sustainability of products and have been implemented in the seafood market, with the leading ecolabel being that of the Marine Stewardship Council (MSC) for wild fish. However, the effect of ecolabels in consumer decision making remains unclear in regard to actual purchasing behavior. This study analyzes scanner data from a household panel in Denmark, accounting for consumer heterogeneity using random parameter and latent class logit models to identify the effect of ecolabels. The results indicate substantial consumer preference heterogeneity with respect to important salmon attributes. Salmon attributes that confer convenience to household fish consumption appear to be very important in consumer choices. Ecolabeling has a significant effect on household decision making, but the majority of consumers are more likely to choose non-labeled products, which may be due to the low availability of ecolabeled products. Five consumer segments are identified, revealing one consumer segment with a preference for organic labeled salmon, comprising 15% of households. However, a consumer segment for MSC-labeled salmon is not identified. The implication is that management can rely on a segment of consumers to implement organic principles in salmon farming, but the preference for sustainable salmon fishing is inconclusive due to uncertain confounding effects.

Key words: Ecolabeling, salmon, demand preferences, random coefficient approach.
JEL Codes: C23, D12, Q11, Q22.

INTRODUCTION

Marine fisheries are a classic example of common-pool resources (Ostrom 2009). Therefore, insights into how people respond to different management strategies are important. In recent decades,

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sustainably managed fish stocks, in particular, have become increasingly important with respect to consumers' purchase decisions (Wessells, Johnston, and Donath 1999; Johnston et al. 2001; Jaffry et al. 2004; Johnston and Roheim 2006; Brécard et al. 2009; Salladarré et al. 2010; Uchida et al. 2014; Fonner and Sylvia 2015; Bronnmann and Asche 2017). The main idea of sustainability is that humans should use natural resources without compromising the ability of future generations to meet their needs (WCED 1987). Furthermore, the economics of sustainability involves efficiency; in other words, it is important not to waste scarce resources in achieving sustainability goals (Baumgärtner and Quaas 2010). The Marine Stewardship Council's (MSC) Label, founded by the World Wide Fund for Nature (WWF) and Unilever in 1997, is the leading certification for sustainable seafood. In 2017, the label appeared on 296 fishery products, covering 12% of the global marine wild catch (MSC 2017). However, ecolabels remain controversial, as there is an ongoing discussion about the extent to which they provide reliable information with respect to overexploitation of fish stocks (Froese and Proelss 2012; Roheim et al. 2018). The mechanism of ecolabels is highly influenced by the increasing globalization of fish markets, as they have become an important part of international seafood trade and marketing (Washington 2008). Thus, there is a strong need for research with respect to how and in which ways different groups of consumers contribute to more sustainable use of marine fisheries.

Since the prevailing studies stated above are often characterized by hypothetical bias (Loomis 2011), access to data that allow actual consumer behavior to be measured is necessary for revealing whether there are significant, heterogeneous market effects of ecolabels. However, studies using such data are scarce, largely due to limited availability, particularly in an emerging sustainable seafood market. A number of studies provide indirect evidence that ecolabels on seafood are effective by using survey data to estimate the willingness to pay (WTP) for ecolabels or by using retail data to estimate the price premium based on hedonic price functions. However, very few studies investigate the actual market impacts of ecolabels on seafood and how they account for heterogeneity in consumer choice preferences.

Teisl, Roe, and Hicks (2002) indicate that the dolphin-safe label on canned tuna increased demand for labeled products. Hallstein and Villas-Boas (2013) examined the impact of traffic-light labeling in a California retail chain. They show that consumers reduce their purchase of seafood with a yellow label, while the green and red labels have limited impact. In this article, we will shed further light on the actual and heterogeneous consumption pattern of households regarding sustainably certified salmon products.

Since ecolabels for seafood were first introduced at the turn of the century, a large number of studies using survey data have indicated a strong preference for them and a substantial positive WTP for products carrying them (Wessells, Johnston, and Donath 1999; Johnston et al. 2001; Jaffry et al. 2004; Johnston and Roheim 2006; Brécard et al. 2009; Salladarré et al. 2010; Uchida et al. 2014; Fonner and Sylvia 2015; Bronnmann and Asche 2017; Bronnmann and Hoffman 2018). Gudmundsson and Wessells (2000) show that a necessary condition for an ecolabel to change the behavior of producers towards more sustainable practices is that it must be profitable for producers to use them. Accordingly, since the certification process and the use of an ecolabel are costly, there must be a price premium associated with supplying labeled products. Thus, consumer recognition and acceptability are a prerequisite.

In recent years, consumer recognition and acceptability have motivated a number of studies using market data to show that there is a positive premium associated with many ecolabeled products. These are mostly hedonic price studies (Roheim, Asche, and Insignaris-Santos 2011;

Sogn-Grundvag, Larsen, and Young 2014; Asche et al. 2015; Blomquist, Bardolino, and Waldo 2015; Ankamah-Yeboah, Nielsen, and Nielsen 2016; Bronnmann and Asche 2016; Asche and Bronnmann 2017; Alfnes, Chen, and Rickertsen 2018; Zhang et al. 2018), but there are also other studies that have examined the impact of certification on market price dynamics (Wakamatsu 2014; Stemle, Uchida, and Roheim 2016; Ankamah-Yeboah, Nielsen, and Nielsen 2019). These hedonic studies provide evidence in a large number of cases that there is a positive premium associated with an ecolabel, but it varies significantly; in some cases, it is zero. However, the actual market impact of ecolabels in consumer decision making is contested, as is the existence of the price premium associated with the label (OECD 2006; Washington 2008). Thus, due to the limited availability of actual data and studies focusing on seafood choices, it is unknown whether there is actually any market effect of ecolabels.

In a study not focused on seafood, Grunert, Hielke, and Wills (2014) provide evidence that general concern about sustainability does not influence actual purchasing behavior to any extent. Using actual purchase data, Andersen (2011) shows that animal welfare plays a minor role in real-world demand for agricultural products, despite increasing interest in animal welfare both within populations and among legislators. In a stated preference survey, Ankamah-Yeboah et al. (2019) further find that purchase decisions for trout in Germany are affected by animal welfare, but the authors are unable to identify a significant effect from an environmental sustainability standpoint. However, consumer welfare improvements are enhanced when both animal welfare and environmental sustainability are combined. Hence, the literature on revealed and stated preference studies provides mixed evidence regarding the impact of ecolabels.

A potential challenge of the price premium literature is that it does not account for potential consumer responses to higher prices. The theory of consumer behavior assumes that ceteris paribus, a higher price will lead to a lower quantity purchased. However, this can be offset if consumers have a sufficiently strong preference for sustainably produced seafood such that they are willing to pay a higher price when the attribute of sustainability is added to the product. Whether this is the case, of course, is an empirical question, and results from the consumer preference literature indicate that this may well be the case.

Consumer preference studies also recognize that different groups of consumers may have different preferences with respect to ecolabels and try to capture this by estimating taste preferences to follow certain distributions or clusters that are linked to demographic variables.

The aim of this study is to investigate the market impact of MSC-labeled wild salmon and organic-labeled farmed salmon on consumer behavior in Denmark by clustering consumers on the heterogeneity of ecolabel preferences. Household scanner data captures actual consumer behavior and provides substantial information on consumer demographic characteristics. The study further provides information on which consumers (and the size of consumer groups) achieve increased utility from knowing that the salmon they buy is farmed organically or caught sustainably. This knowledge is necessary to assess the effectiveness of ecolabels, since they are a voluntary instrument founded on consumer acceptance. If no consumers care about sustainable and organic principles, then ecolabels have no effect. If many consumers care, then ecolabels may be an effective way to make production more sustainable and organic. Hence, policy makers can rely more on the market to determine sustainable and organic principles when backed by consumers, while more strict management is needed when many consumers do not care.

Denmark is an interesting country in which to conduct such a study, as it has a long tradition of buying organic food products. Organic products have a market share of 8%, ranking Denmark as having the highest market share for organic products in the world (Willer and Lernoud 2016). Salmon is also of particular interest, as it is one of the most controversial aquaculture species. On the one hand, it is highly successful in terms of quantity produced, on the other, it is controversial with respect to its environmental impact (Regnier and Schubert 2017; Landazuri-Tveteras et al. 2018) and quality attributes (Jardine et al. 2014).

The remainder of the article is organized as follow: The data description is introduced in the next section, followed by the model specification. The results are then presented and discussed, and the last section presents the conclusions.

SCANNER DATA DESCRIPTION AND DESIGN

The past three decades have witnessed a surge in the use of consumer choice models calibrated on supermarket scanner data to understand the impact of marketing mixed variables on consumer choice. However, the use of scanner data for choice analysis is challenged by pre-analysis data preparation strategies. There is no standard practice but only recommendations that can reduce bias, particularly due to unobservable alternatives considered by consumers (Andrews and Currim 2005).

The consumer scanner data used in this study are provided by the 'Gesellschaft für Konsumforschung' (GFK) and include 2,788 households, which are stratified as being representative of the Danish population. The data set contains 1,477 salmon-consuming households with 6,432 purchase transactions for 2014, which is long enough to observe several product categories and short enough to assume stable consumer preferences. Participating households submit their food purchase information each time they visit any type of retail outlet. Using 'European Article Number' (EAN) codes, each purchased salmon product can be clearly identified. In its raw form, the data contain purchases of many stock keeping unit (SKU)/EAN codes, representing brands, sizes, prices, and product forms by households. The strategies for data preparation involved several considerations.

First, the choice set of discrete choice models must exhibit alternatives that are mutually exclusive from the decision maker's perspective (Train 2009). Hence, following a study by Allender and Richards (2012) for a single purchase event, we choose households that purchase only one salmon product at a time (multiproduct purchases per single visit to the shop were negligible). This is because if households buy more than one product at one purchase event, then one cannot distinguish between households that are variety seekers and households that consist of several members with diverging preferences (Hoffmann and Bronnmann 2019). We also select households with at least five salmon purchase occasions within the observed period to reflect a real salmon consumer.

Another interesting element is what Guadagni and Little (1983) call entity aggregation. Most choice models using scanner panel data have employed different levels of entity aggregation: brand level (Seetharaman, Ainslie, and Chintagunta 1999; Bucklin, Gupta, and Siddarth 1998; Erdem and Keane 1996), brand-size level (Andrews and Currim 2002; Roy, Chintagunta, and Haldar 1996), brand-form level (Kamakura, Kim, and Lee 1996), or the level of the SKU (Ho and Chong 2003; Zanutto and Bradlow 2006). Later developments in the choice modeling literature conduct analyses at the EAN code level with the goal of extracting the maximum amount of information possible from the choice data (Fader and Hardie 1996; Ho and Chong 2003). We follow suit and use the product's EAN code as the unit of analysis, in which case, brand, size, and product characteristics become decision-making variables.

Choice set formation is a controversial part of scanner data preparation. The analyst observes only choices that were made, but the consideration and choice sets are unobservable. The theory of consideration set postulates that consumers follow a two-stage decision process for brand choice. Consumers first narrow down the global set of alternatives to a smaller set (the consideration set), from which a choice is made in the second stage (Van Nierop et al. 2010). Ignoring the consideration set can lead to an underestimation of marketing control variables (Bronnenberg and Vanhonacker 1996). According to Van Nierop et al. (2010), consideration sets can be incorporated by directly assessing sets stated by consumers through surveys, which in our case would require unavailable resources. The second approach, the revealed consideration set approach, identifies the consideration set indirectly from the observed choice data (Mehta, Rajiv, and Srinivasan 2003) by integrating over all possible consideration sets of which there are 2^C-1, where C is the number of choice options. With large consideration sets, the revealed approach leads to larger brands that lead to computationally infeasible estimations.

In this study, the number of choice sets results in 44 EAN code product lines after identifying smaller product lines that have less than 5% choice shares as a composite product. These product lines identify six homogenous categories of distribution channels, namely, Coop, Dansk Supermarked, Reitan, SuperGros, Internet/Mail Order, and Other Food, where the first four categories are the main retail chains. Due to the lack of resources to implement a consumer survey to identify the choice sets considered, we use the revealed consideration set approach. To reduce the dimensionality problem of choice sets, we design them such that consumers face only a fraction of the global choice set; i.e., products available during the week of visit to the distribution channel or retail outlet. Though this approach still leads to a situation of uncertainty of actual choice sets with consequential bias, it reflects changing product lines in retail shops. After all the necessary data pruning, the data set resulted in 474 households with an average of 9 choice sets. The range of choice set size per visit was 2 to 19, and the maximum purchase occasion observed was 47. With varying choice sets and choice occasions for households, a total of 4,047 purchase situations were observed, which resulted in 41,904 observations.

For the chosen products, prices were observed by households. However, for the non-chosen alternatives in the choice set, prices were constructed as the average unit price that was observed in the distribution channel visited during the specified period. This follows Hoffman and Bronnmann's (2019) study of the carbonated soft drink market in Germany, where non-chosen alternative prices were constructed as the average price based on observed purchases of other households during the same month and in the same region for each product. In the current study, the choice sets defined at the "week-distribution channel level" allow observed prices to vary by location, since distribution channels are made up of many retail outlets scattered over the country. This implies that multiple alternatives can be encountered by households, and since discrete choice models are based on mutual exclusivity, taking averages of these product lines seems reasonable.

More than 80% of the volume of salmon imported into Denmark is farmed fresh or chilled Atlantic salmon (Ankamah-Yeboah, Nielsen, and Nielsen 2016). The only ecolabel available for these products is organic labeling.[1] There is also some wild salmon in the data set that carries the label of the MSC and originates from the Pacific Ocean fisheries. The MSC label is the most

1. The Aquaculture Stewardship Council (ASC) was first established in 2012, and there are no products with that label in our data set, but they are available in small quantities in Danish retail outlets. This is similar to the setting observed by Asche et al. (2015).

common ecolabel for seafood, but it only labels wild seafood. Since the data have no identifier for farmed and wild fish products, we are only able to determine the effect of organic and MSC-labeled products over non-labeled salmon products being wild or farmed.

The data are summarized in table 1. Organic certified salmon products comprise slightly more than 4% of the observations, as do MSC-labeled wild salmon. The attribute levels of non-ecolabel,

Table 1. Data Summary

Variable	Description	Mean 1	Mean 2
ATTRIBUTE			
Price	Price per kg of salmon purchased in DKK	177.693 (65.57)	169.457 (68.30)
Certification			
Organic	= 1 if organic certified, 0 otherwise (no ecolabel)	0.041	0.044
MSC	= 1 if MSC certified, 0 otherwise (no ecolabel)	0.044	0.045
Product Type			
Filletf	= 1 if filleted fish, 0 otherwise (whole fish)	0.762	0.799
Processed Form			
Smokedp	= 1 if smoked fish, 0 otherwise	0.511	0.538
Marinp	= 1 if marinated fish, 0 otherwise	0.149	0.154
Storage Form			
Chilled	= 1 if stored fresh/chilled, 0 otherwise (frozen)	0.887	0.883
Package Size			
Pack_299	= 1 if pack <300 g, 0 otherwise	0.797	0.810
Pack_599	= 1 if pack = 300–599 g, 0 otherwise	0.142	0.136
Pack_899	= 1 if pack = 600–899 g, 0 otherwise	0.045	0.042
Pack_900	= 1 if pack >899, 0 otherwise	0.016	0.012
Brand			
PrivLabel	= 1 if private/store label, 0 if brand label	0.293	0.307
SOCIAL CLASS			
Inc1 (1^{st} Quartile)	= 1 if in lowest 25%, 0 otherwise	0.308	
Inc2 (2^{nd} Quartile)	= 1 if in low medium 25%, 0 otherwise	0.214	
Inc3 (3^{rd} Quartile)	= 1 if in high medium 25%, 0 otherwise	0.291	
Inc4 (4^{th} Quartile)	= 1 if in highest 25%, 0 otherwise	0.187	
Educ1	= 1 if have vocational high education, 0 otherwise	0.473	
Educ2	= 1 if have short further education, 0 otherwise	0.134	
Educ3	= 1 if have medium further education, 0 otherwise	0.291	
Educ4	= 1 if have long further education, 0 otherwise	0.101	
Educ5	= 1 if have no or up to senior high education, 0 otherwise		
Age1	= 1 if less than 30 years, 0 otherwise	0.008	
Age2	= 1 if 30–44 years, 0 otherwise	0.093	
Age3	= 1 if 45–59 years, 0 otherwise	0.257	
Age4	= 1 if more than 59 years, 0 otherwise	0.641	
Urban1	= 1 if lives in the urban capital region, 0 otherwise	0.300	
Urban2	= 1 if lives in urban area mainland, 0 otherwise	0.436	
Urban3	= 1 if lives in rural area, 0 otherwise	0.264	
Hhsize1	= 1 if single member household, 0 otherwise	0.316	
Hhsize2	= 1 if two-member household, 0 otherwise	0.505	
Hhsize3p	= 1 if three or more member household, 0 otherwise	0.179	
FamnoChild	= 1 if family has no child (0–14 years) present, 0 otherwise	0.823	
Femshoper	= 1 if shopper is a female, 0 otherwise	0.798	

Mean 1 and Mean 2 indicate the statistics from the choices with (N = 41,904) and without the non-chosen (N = 4,047) alternatives, respectively. For all the dummy variables, the means represent the respective shares. The standard deviation is in parentheses.

filleted, smoked, fresh, and smaller package sizes of less than 300 grams hold the highest shares in their respective categories. Private labels hold the smallest share compared to brand labels.[2] The demographic variables include income, education, age, the degree of urbanization of the community, household size, children, and gender of the shopper. The age of the shopper is skewed, with those over 60 representing more than 60% of the sample.[3] Mean 1 and 2 statistics suggest that there is no significant difference in data structure for household choices and choice set when the non-chosen alternatives are added. The average price and standard deviation suggest that the coefficient of variation is approximately 40%, which signals enough variation in prices to identify a price effect.

MODEL SPECIFICATION

Discrete choice modeling is based on random utility theory (McFadden 1974) and Lancaster's (1966) approach to the individual utility maximization problem. Lancaster's theory postulates that consumers derive utility from the product's described attributes. Consider a consumer who faces *J*. product alternatives in each of *T* choice situations; the latent utility (U) that consumer n obtains from attribute j in choice situation t can be decomposed into two components: systematic utility (V) and a random component (ε), represented as:

$$U_{njt} = V_{njt} + \varepsilon_{njt} = \beta'_n x_{njt} + \varepsilon_{njt}. \tag{1}$$

If the consumer chooses the alternative that brings the greatest utility, then the probability (P) of the choice of the alternative j over i can be expressed as:

$$P_{nj} = prob\left(V_{nj} + \varepsilon_{nj} > V_{ni} + \varepsilon_{ni}\right) = prob\left(\varepsilon_{ni} - \varepsilon_{nj} < V_{nj} - V_{ni}\right). \tag{2}$$

By assuming that (1) each of the ε_{nj} are independently and identically distributed according to the extreme value distribution, otherwise known as the Gumble distribution (Greene 2012), and (2) allowing the systematic utility to comprise individual consumers' taste preference β_n (taste heterogeneity), a random parameter logit (RPL) model can be estimated. In this study, we estimate the RPL model given that it has the advantage of overcoming the independence of irrelevant alternatives (IIA) property linked to the standard multinomial logit (MNL) model (Train 2009).

The probability of consumer n choosing alternative j in period t can be expressed as (Revelt and Train 1998):

$$P_{njt}(\beta_n) = \frac{\exp\left(\beta'_n x_{njt}\right)}{\sum_{j=1}^{J} exp\left(\beta'_n x_{nit}\right)}. \tag{3}$$

An alternative model for identifying preferences among consumers is the latent class model (LCM). Unlike the RPL model, which assumes random parameters to follow a certain continuous distribution, the LCM is somewhat less flexible in that it approximates the underlying distribution with a discrete one (Hensher, Rose, and Greene 2015). In LCM analysis, it is assumed that a discrete finite number of classes, S, are sufficient to account for preference heterogeneity across segments. The choice probability that an individual n of segment s chooses alternative i from set J at time t is expressed as:

2. Private labels are subsequently designated as economy-packed products since they are associated with lower-priced products.
3. This is not surprising, as the consumption of seafood is generally higher among older people (Jahns et al. 2014).

$$P_{in|s} = \frac{\exp(\beta_s' x_{nit})}{\sum_{j=1}^{J} exp\left(\beta_s' x_{njt}\right)} \quad s = 1, \ldots ; S, \tag{4}$$

where equation (4) is a standard MNL in segment s. In this study, we estimate a random parameter latent class logit model (RPLCM), which is a combination of RPL and LCM (Bujosa, Riera, and Hicks 2010; Hess, Stathopoulos, and Daly 2012; Franceschinis et al. 2017). However, only the cost coefficient is allowed to follow a continuous distribution while all other attributes are assumed to be fixed across classes. The cost coefficient is assumed to follow a lognormal distribution with the interest of allowing it to follow the theoretically expected negative sign. This is because as the number of classes to be estimated becomes larger, positive cost coefficients are observed, which makes the interpretation of results implausible.

The classification model can be constructed using household-specific attributes to explain the heterogeneity across segments. In this case, the estimation of the LCM can be a simultaneous determination of class-specific utility parameters for S segments and class membership probabilities, H_{ns}, for individual n in segment s. The class probabilities are specified by the multinomial logit form (Green and Hensher 2003):

$$Prob[class = s] = H_{ns} = \frac{\exp(\theta_s' z_i)}{\sum_{s=1}^{S} exp\left(\theta_s' z_i\right)}, \quad \theta_S = 0, \tag{5}$$

where z_i is a set of household or consumer-specific covariates, such as social classes and perceptions. One class is normalized to zero to allow for model identification. The determination of the optimal finite number of classes is commonly performed by relying on the statistical information criteria (Ruto, Jarrod, and Scarpa 2008). Following the information criteria alone could lead to an unreasonably large number of classes and poor estimates (Scarpa and Thiene 2011). Swait (1994) suggests the use of the researcher's judgment, overall parsimony of the model, and theoretical insights. In this study, the information criterion is used with Swait's (1994) suggestions.

ESTIMATION RESULTS AND DISCUSSION

The RPL model was estimated using the parameter estimates from the MNL as priors. The estimation results are presented in table 2. For model identification purposes, the price parameter was assumed to be fixed, while the remaining parameters were assumed to follow a random normal distribution. Comparison of the MNL and RPL loglikelihood estimates, McFadden R^2, and Akaike Information Criterion indicates that the RPL best fits the data. Hence, we discuss the results of the RPL model.

As expected, the price parameter is significantly negative at the 1% level. The random parameter attributes related to salmon products have different levels of significance, and the corresponding standard deviations are all significant at the 1% level, except for package size greater than 900 grams. The significance of the standard deviation parameters indicates that preferences are heterogeneous among salmon households. As a result, we compute the share of households falling on the positive side of the normal distribution (see the *share* column in table 2) using the formula $100 * \Phi(b_k/\sigma_{b,k})$, where Φ is the cumulative standard normal distribution and b_k and $\sigma_{b,k}$ are the mean and standard deviation of the kth RP coefficient, respectively.

The coefficient estimates of the attributes indicate the marginal utility of the respective attribute level. Thus, it shows the gain (if positive) or loss (if negative) in utility following a change from the

Table 2. Multinomial Logit and Random Parameter Estimation Results

Variable	MNL Model Coefficient	Std. Error	RPL Model Coefficient	Std. Error	RP Std. Dev.	Std. Error of RP Std. Dev.	Share (%)
Price[h]	–0.156***	(0.028)	–0.229***	0.033	–	–	–
Organic	0.064	(0.106)	–2.991***	0.624	4.578***	0.532	26
MSC	–0.120	(0.105)	–0.662***	0.250	1.468***	0.381	33
Smoked	0.255***	(0.055)	0.474***	0.106	1.640***	0.095	61
Marinp	0.214***	(0.067)	–0.073	0.120	1.549***	0.120	48
Chilled	–0.320***	(0.075)	–0.200	0.127	1.565***	0.176	45
Filletf	0.229***	(0.058)	0.508***	0.114	1.827***	0.115	61
Pack_599	–0.006	(0.058)	–0.188**	0.091	0.924***	0.129	42
Pack_899	0.193**	(0.098)	–0.901***	0.272	3.305***	0.350	39
Pack_900	–0.204	(0.165)	–0.634**	0.262	0.624*	0.350	16
Privla	0.090**	(0.044)	–0.067	0.075	1.075***	0.086	48
Log-likelihood	–8,547.74		–7,291.407				
AIC	17,117.5		14,624.8				
# Choice Obs.	4,047		4,047				
McFadden R^2	0.442		0.524				

Note: ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively. #e–# indicates #x10$^{-\#}$. Share indicates the calculated share of households lying on the positive domain of the normal distribution for each attribute parameter. [h] Price is rescaled by dividing by 100.

reference attribute level to the respective attribute level. For the sake of exposition, the *filletf* parameter of 0.508 indicates that the choice of filleted salmon, on average, increases consumers' utility by 0.508 relative to whole salmon. The other parameters can be interpreted in similar ways.

The credence attributes, organic and MSC labels, have statistically significant negative parameters. This indicates that the majority of consumer households have a decreased utility for these product attributes, given the statistically significant standard deviation and the relative size of the standard deviation compared to the mean. The computed shares indicate that approximately 26 and 33% of the households, respectively, have increased utility for choosing organic and/or MSC-labeled salmon. These findings reflect the notion of Grunert, Hielke, and Wills (2014) that at the general level, while consumers express concern with environmental issues, this concern diminishes at the product-related level. Andersen (2011) uses the same consumer scanner data for eggs and finds that the share of households with positive WTP were 35% for organic and barn eggs and 31% for free-range eggs, with market shares between 10 and 26%.

Regarding processed products, smoked salmon is preferred by most households (61%) relative to other processed salmon products, while the nonsignificant mean parameter estimate related to marinated products indicates that preferences for this attribute are approximately equally distributed between the positive and negative domains of the normal distribution. Moreover, approximately half of the population has a preference for chilled non-frozen salmon products given that the mean parameter estimate is approximately zero and the standard deviation estimate is significantly different from zero. The marginal utility estimate of filleted products shows substantial heterogeneity, with the majority of households having a preference for fillets over whole fish. Non-frozen salmon products showed equal distribution between household members who prefer this attribute and those who are sensitive to this attribute.

The preference for fillets is supported by Ankamah-Yeboah, Jacobsen, and Olsen (2018) and Ankamah-Yeboah et al. (2019), who found increased marginal utilities for highly filleted rainbow trout among German consumers. The affinity towards filleted products can be linked to consumers' preference for convenience and time savings on household food preparation compared to the use of whole fish (Ahmad and Anders 2012). In a review by Carlucci et al. (2015), the authors indicate that studies focused on comparing the convenience of fresh and processed fish confirmed convenience for processed products and the lack of convenience for fresh fish products. Whole fish were inconvenient due to the large amount of time and greater effort required to prepare (Neale et al. 2012). In a study by Birch, Lawley, and Hamblin (2012), convenience emerged as an important demand driver for chilled and frozen fish.

The mean and standard deviation parameters for the attribute private label show that approximately half of Danish households prefer this attribute, while the remaining half prefer brand labels. There is also considerable heterogeneity in package size between households. As shown in table 2, we identify that households have a preference for small packages (less than 300 grams), the reference attribute. Regarding larger package sizes, 42% of households have a preference for 300–599 g package sizes, and 39% of households prefer 600–899 g salmon package sizes. The marginal utility of the 900 g and above package size is negative and lacks preference heterogeneity among households.

We further explore salmon demand preferences through discrete distributions to reveal latent segmentation of preferences among households in Denmark. In searching for the optimal number of latent classes, we follow Swait (1994) by combining information criteria, theoretical insights, and model parsimony. By allowing parameters to be freely estimated, we identified a significant, positive price estimate for two-class models and beyond (results not presented). Such models are not theoretically consistent with the expected negative price associated with demand models. As a result, we impose a bound on the price parameter by assuming that it follows a negative lognormal distribution and identify the most parsimonious model based on the Bayesian information criterion. As shown in figure 1, a five-class model was selected based on parsimony and interpretability of class preferences. Not all sociodemographic variables presented in table 1

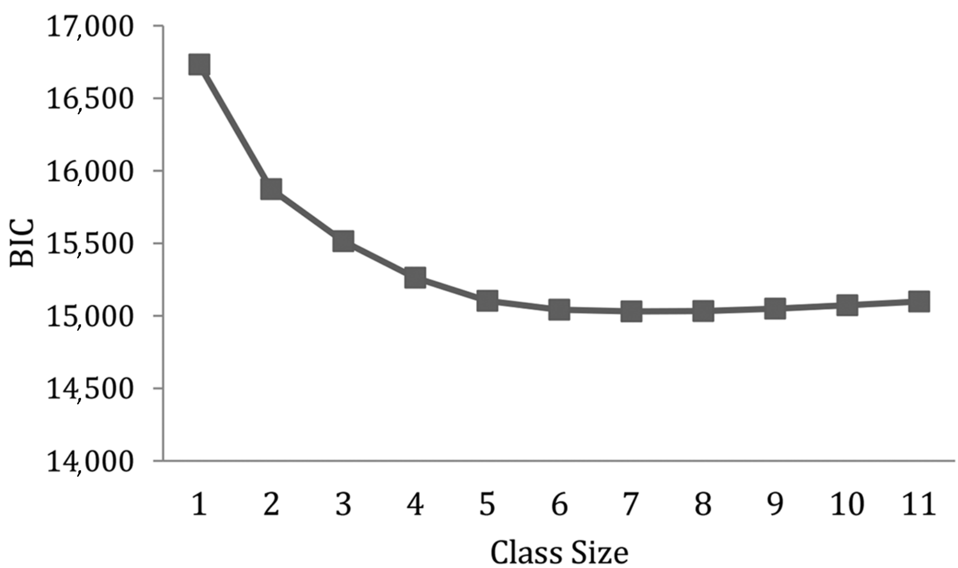

Figure 1. Determining the Optimal Number of Classes using BIC

are included in the estimation because of collinearity problems. All sociodemographic variables in classes 2–5 are interpreted by comparing them to those of class 1.

It should be noted that we use the lognormal distribution on the price parameter as a constraint;[4] hence, we limit the results to a preference space estimation without looking at WTP estimates. This is because the lognormal distribution is known to carry undesirable effects, such as a biased mean value caused by its long tail. This tends to give extremely large WTP values, with high probabilities yielding large portions of cumulative mass close to zero, which distort the analysis. Hence, the use of lognormal distributions for valuation purposes is not recommended (Sillano and de Dios Ortuzar 2005).

The class share at the bottom of table 3 indicates the fraction of consumers in each segment. The column indicated p(wald) shows whether attributes jointly and significantly (if marked with asterisks) contribute to the choices made. P(wald =) tests the null hypothesis of the equality of attribute parameters across classes, where asterisks indicate a rejection of the null. Class 1 was used as the reference for the class probability model.

In class 1, it can be observed that consumer households are less likely to opt for organic and fresh salmon products and are sensitive to price. Additionally, they are also not influenced by MSC-labeled, marinated, and larger salmon packages of more than 900 grams. Rather, they have positive preferences for frozen fillets, private labels and salmon packages in the range of 300–900 grams. As shown by Ankamah-Yeboah, Nielsen, and Nielsen (2016), private labels for salmon products in Danish retail sale command an average discount of approximately 2% and, hence, can be viewed as an economy-packed product. Given that organic and fresh products have higher prices than their counterparts, this segment of consumers could be described as those who seek inexpensive products. Compared to all other classes, they are more likely to be living in urban area 3; i.e., the rural areas in Denmark, and make up of approximately 27% of the consumer households.

In general, class 2 households are not affected by ecolabels when buying salmon. They have decreased marginal utility for smoked and marinated products, but similar to class 1 households, they have increased marginal utility for packages in the size range of 300–900 grams. They are also sensitive to prices, but in contrast to class 1 consumers, class 2 consumers opt for the more expensive fresh quality and brand-labeled salmon products. This segment of consumers is more likely to be located in urban areas 1 and 2, which represent the urban capital region and urban mainland areas, respectively.

Class 3 households, as opposed to class 1 households, have decreased marginal utility for MSC ecolabels but are not affected by organic labels. They are a mix of consumers who are less likely to consider filleted and fresh salmon products in their salmon purchases. Rather, they prefer processed salmon products that are marinated and smoked and are insensitive to price. Class 3 has increased marginal utility for brand labels and decreased marginal utility for fresh products. Though they are less likely to choose fillets, they prefer salmon packages sizes below 300 grams. This preference structure is surprising, given that smaller packages are more likely to contain fillets. In this sense, class 3 can be described as being composed of random choosers, which make up approximately 19% of the sample, and those who are most likely families without children below 14 years and live in the urban capital and mainland regions.

4. A lognormal price parameter is consistent with the case of an RPL demand model where price is restricted to be a fixed parameter instead of a free varying parameter, similar to normal distribution.

Table 3. Latent Class Estimation Results

Attribute	Class 1	Class 2	Class 3	Class 4	Class 5	P(wald)	P(wald=)
Fixed Parameters							
Organic	–3.846***	–8.081	–0.292	3.350***	–2.143***	***	***
MSC	0.186	–0.365	–0.903*	–0.709	–1.265***	***	**
Filletf	0.422***	0.701***	–2.288***	2.519***	0.741*	***	***
Smokedp	1.761***	–1.901***	1.784***	1.363***	–0.267	***	***
Marinp	0.093	–1.236***	2.245***	–0.068	2.220***	***	***
Chilled	–1.013***	0.496***	–0.477*	–0.938***	–1.687***	***	***
Privlab	0.819***	–0.231*	–0.831***	–1.000***	0.716***	***	***
Pack_599	0.683***	0.282**	–0.999***	–0.746***	–0.436*	***	***
Pack_899	1.085***	1.132***	–9.517	0.727	–0.408	***	*
Pack_900	0.097	–0.221	–0.944**	1.237*	–1.530	*	**
Random Parameters							
Price^m	–5.675***	–9.947***	–3.190	–1.386*	–6.635***	***	***
Std. dev. price	(1.390***)	(1.143***)	(1.767***)	(1.243***)	(1.474***)		
Class Membership							
Intercept	0.000	–1.387**	–2.383**	–1.541**	–1.726**	***	
Femshop	0.000	0.168	–0.404	0.035	0.649	–	
Famnochild	0.000	0.400	1.467**	–0.501	0.262	**	
Urban1	0.000	1.670***	2.086***	2.276***	0.970*	***	
Urban2	0.000	0.975**	0.948**	1.569***	0.044	***	
Loglikelihood	–7,304.79						
BIC	15,102.47						
R^2 (0.282)	0.163	0.266	0.229	0.349	0.278		
Class share	0.274	0.254	0.188	0.153	0.131		

Note: ***, **, and * indicate 1, 5 and 10% significance levels, respectively; m indicates the mean parameter converted from the lognormal distribution parameters using the formula $-\exp(b + \sigma_b^2/2)$.

Consumer households in class 4 are consumers that have increased marginal utility for organic labeled salmon but do not appear to be influenced by MSC ecolabeled products. They have increased marginal utility for fillets, smoked and brand-labeled products and decreased marginal utility for fresh products. Class 4 is only marginally sensitive to price, and this is expected as they prefer more expensive products, such as organic and brand labels. In terms of salmon packaging, they seem to only avoid sizes between 300–600 grams. These organic salmon-consuming households are more likely to be living in urban capital and mainland regions.

Compared with all the other segments, class 5 consumers have decreased marginal utility for both organic and MSC ecolabels and are less likely to choose these products. They prefer fillets, marinated products, and private labels. Package sizes do not matter much in their choices, and they are very sensitive to price. This segment has a preference towards products that can be characterized as economy-packed and are a good value for money. This segment also avoids choosing any product labeled to be environmentally friendly. They make up approximately 13% of the consumers and live in the capital region.

An overview of the results indicates that the demand for ecolabeled salmon is characterized by heterogeneous consumer preferences. Based on the latent class model, there is a market for organic salmon, but no market is identified for MSC-labeled salmon. Preference segmentation by LCM complements and enhances the identification of preference structures through consumer latent clustering. The divergence between the organic label and the MSC label might be driven by the fact that the organic label (the red Ø-label) on the fish is the same label used on agricultural products and is well known among Danish consumers. The popularity of the MSC label, on the other hand, might be limited in recognition and, hence, influences its valuation.

The value of MSC-labeled fish products on the European market has been estimated to be absent in some markets and for some species while being present in the range of 10–14% premium, if any (Asche et al. 2015; Sogn-Grunvåg et al. 2014; Roheim et al. 2011; Blomquist et al. 2015). It is therefore not surprising that the market for MSC is unidentified. The value of organic fish, on the other hand, ranges from approximately 20–38% or more (Asche et al. 2015; Aarset et al. 2000; Ankamah-Yeboah, Nielsen, and Nielsen 2016). The lack of market identification could be driven by the market share. Approximately 80% of salmon imports into Denmark are farmed Atlantic salmon (Ankamah-Yeboah, Nielsen, and Nielsen 2016). Given that the share of MSC labels is low and that the data are limited in identifying wild-caught fish products and their origins, it is possible that all wild-caught products probably carry the MSC label, in which case the effects could be confounded and, hence, unidentified.

The low share of organic ecolabel consumers, consisting of approximately 15%, could be driven by the low organic fish market share and its lack of availability at all times. Alternative products assumed to be considered, and from which consumers' choice decisions were made, are constructed from all products that were purchased by other members of the GfK panel in the chain for a given week. The systematic lack of organic fish availability at all times implies that alternative products considered might not have organic options available; hence, organic consumers might be forced to choose conventional products. This could influence the estimated share and the estimated negative mean value from the RPL model as opposed to evidence from stated preference studies indicating a preference for organic products by the majority of consumers. This, however, signals that there might be room for expansion of the organic market and possibly for MSC if strategic communication and public awareness are created among consumers.

CONCLUSION AND POLICY IMPLICATIONS

During the last decade, several papers have provided evidence showing that consumers are willing to pay premium prices for ecolabels through market surveys. The effect of the ecolabel in fish demand studies is limited and is mostly observed in hedonic price studies, which do not account for price effects in consumer choices. In this study, we use household scanner data to investigate organic and MSC-ecolabel effects on consumer demand for salmon retail sales in Denmark while accounting for other important fish attributes. A random parameter logit model indicates substantial consumer heterogeneity with respect to preferences for MSC-labeled wild salmon and organic labeled farmed salmon, with most households having a reduced utility, on average, for ecolabels relative to conventional salmon. Attributes such as chilled fresh products, fillets, and processed salmon products, such as smoked and marinated products, appear to be important in salmon choice decision in Danish households. These attributes are important, as they are associated with increased convenience compared to reference attributes.

By adopting a latent class model, we find five consumer segments with heterogeneous preferences for salmon quality attributes. Specific to ecolabeled products, we identify consumers who (1) do not have a preference for organic products, (2) are indifferent to both ecolabeled products and conventional salmon, (3) do not have a preference for MSC products, (4) have a preference for organic products, and (5) have a negative preference for any ecolabeled product. Such preference segmentation collaborates the normal distribution assumption of parameters estimated in the RPL model. With latent segmentation, organic salmon-consuming households are identified, while MSC salmon consumer segments could not be identified in this study.

The disparity between organic label and MSC label demand might be fundamentally related to a number of reasons. First, it might be because the organic label, the red Ø, is well-known to Danish consumers, as opposed to the MSC label. Second, it could be attributed to an artifact of the data and model limitations in that the data do not identify farmed and wild-caught salmon products separately. It is known that a significant share of Danish imports are farmed salmon, of which a smaller share consists of organic products. It is possible that a significant share of wild-caught salmon entering the Danish market are MSC certified, although some salmon are also caught domestically in the Baltic Sea and not MSC labeled. If the large majority of the wild supply is MSC certified, then the MSC label could be confounded with the wild attribute, which can lead to nonidentification. Future related studies could explore how distinguishing wild and farmed products might change the present results. Moreover, considering that a consumer segment on MSC-certified salmon could not be identified, the ecolabel will not enhance sustainable management of salmon fishing in the current situation. Furthermore, considering the presence of a market segment for organic labeled salmon, policies to implement organic principles in salmon farming can, in the current situation and to a limited extent, rely on consumers, since this segment consists of only 15% of households. Considering the relatively small market share for ecolabeled seafood, it seems reasonable to believe that room for expansion remains by increasing the availability of organic products. For the MSC ecolabel, public awareness and communication to increase the consumer knowledge base might be a way to create consumer preference. It may also be that a higher availability of ecolabeled products and product forms will lead to a higher share of the consumers actually choosing these products and paying a premium price. Nevertheless, a high price premium limits the probability of choosing ecolabeled products, and this has been shown in Johnston et al. (2001) among Norwegian and US consumers, where increasing the ecolabel seafood price premium significantly decreased the probability of purchasing the product. Ankamah-Yeboah, Nielsen, and Nielsen (2019) have shown that an increased supply of organic salmon products will lead to decreased price premiums.

The evidence presented so far shows that communication and public awareness for ecolabeled salmon is complicated by the different sources of production. Consumers may need to become more aware of MSC ecolabels in Denmark. The results show that there are consumers who do not seem to care about any ecolabel. Grunert, Hielke, and Wills (2014) and Uchida et al. (2014) indicate that such a lack of preference for ecolabels might be because consumers are not informed or that they genuinely do not care. This behavior, however, cannot be determined by market data. In addition, different groups of consumers have preferences for different ecolabels, indicating that there are also nuances with respect to what type of sustainability one prefers. It is particularly notable that there are no consumer groups that prefer both ecolabels, indicating that they are just looking for specific sustainably produced fish. The results can be enhanced in the future if related work focuses on testing how differing choice designs and modeling approaches affect the underlying consumer preference structure.

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