Aquacult Int (2012) 20:673–691
DOI 10.1007/s10499-011-9495-z

Exploring consumer's preferences for farmed sea bream

Gianluca Stefani · Riccardo Scarpa · Alessio Cavicchi

Received: 23 March 2011 / Accepted: 19 December 2011 / Published online: 5 January 2012

Abstract Sea bream (*Sparus aurata*) production plays a significant part in Italian aquaculture, contributing to almost 18% of national pisciculture sales revenue. In recent years, Italian firms faced higher competition from countries with lower production costs. This prompted responses toward both cost reduction and product differentiation. The objective of this study was to investigate the preferences of Italian consumers for sea bream from fish farms, with a focus on aspects of product differentiation as gleaned from the analysis of the market situation: price, product origin, type and place of fish farming, and, in particular, type of feed. Data were collected with a consumers' survey using personal interviews conducted on a questionnaire that included a choice experiment. Consumer preferences were analyzed with choice models based on stated preference data. The models made it possible to evaluate the potential of products with different combinations of attributes for which there is currently no market information available. In particular, the country of origin emerged as an important element of consumer choice, and to a lesser degree, organic certification and fish farming in marine cages also play a relevant role and may command a price premium.

Keywords Consumer preferences · Discrete choice models · Sea bream

G. Stefani (✉)
Department of Plant, Soil and Environmental Sciences, University of Firenze,
P.le Cascine 18, 50144 Firenze, Italy
e-mail: gianluca.stefani@unifi.it

R. Scarpa
Waikato Management School, University of Waikato, Private Bag 3105, Hamilton,
New Zealand
e-mail: rscarpa@mngt.waikato.ac.nz

A. Cavicchi
Department of Studies on Economic Development, University of Macerata,
P.zza Oberdan, 3, 62100 Macerata, Italy
e-mail: a.cavicchi@unimc.it

Introduction

Sea bream (*Sparus aurata*) production plays a significant role in Italian aquaculture. In 2009, total production was 9,600 tons with a value approaching 62 million euros and accounting for almost 18% of national sales revenue from pisciculture. Among the factors contributing to its significant growth in market share is the combination of traditional forms of fish farming, based on land and lagoon fish rearing, and the increasing use of hatcheries and marine cages.

Italian sales of sea bream have recently suffered from competition from countries with a lower cost of production, such as Greece and Turkey (Ismea 2010, p. 12). A recent study by the Department of Marketing and Institute of Aquaculture of the University of Stirling (2004, pp. 33–35) reported that production costs for Italian sea bream were 10–15% higher than those of Greek or Turkish competitors. Italian producers have responded to this competition by differentiating the national product from imports, offering larger fish (up to 800 grams, while those produced by foreign competitors average 300–400 grams) and undertaking initiatives to emphasize the quality of the product by means of process and quality certifications, brands, and labeling (ISMEA 2007, pp. 148–150).

One specific quality certification scheme is that for organic aquaculture, which responds to the requirements of consumers sensitive to animal well-being and environmental protection and who express demand for healthy and uncontaminated fish products. Organic fisheries have been operating in France and have also been emerging in Greece and Turkey. As of 2006, there were only two such fisheries in Italy (ISMEA 2007, p. 370). EU regulation 710/09 provides detailed rules on organic aquaculture animal and seaweed production; the EU completed the legislation for the certification of organic aquaculture within the framework already put in place for other agricultural products. This prompted the need for further investigations into consumer's preferences to explore the potential for product differentiation strategies.[1]

Differentiation of aquaculture products can also be based on particular aspects of the production process over which consumers have clear preferences. These include the type of fishery (marine cages or ponds) and the characteristics of the feed used. The reasons for the increased use of marine cages instead of ponds on land include social (reduced conflict with other coastal activities, such as tourism), ecological (decreased environmental impact), and other factors associated with production technology (Oca et al. 2002), all issues that, if properly communicated, could be relevant for consumer choices.

The objective of this study is to investigate the preferences of a sample of Italian consumers for farmed sea bream, keeping in mind the elements of differentiation mentioned above. In particular, five salient product attributes are examined: price, product origin, type of farming (organic vs. conventional), place of farming (sea cages vs. ponds on land), and feed type.

This paper is organized into six sections. Section 2 reviews the literature on consumer attitudes and choices regarding fish quality and eco-friendly production methods (including eco-labeling). Section 3 describes the materials and methods applied in the analysis with specific reference to the methodology of discrete choice models for stated choice and the related experimental design. Section 4 presents the results, while in Sect. 5, producers and retailers are offered some conclusions and recommendations on possible marketing strategies.

[1] At the time of writing, sea bream production according to organic principles in Italy were still certified by private entities.

Literature review: fish quality and eco-labeling in consumer choice

A growing number of studies have focused on consumer's perceptions of and attitudes toward quality of farmed fish. One line of inquiry is directed toward the use of different types of information and trust on its sources, exploiting both qualitative and quantitative data analysis techniques. Pieniak et al. (2007) and Pieniak and Verbeke (2008) reported the results of a European study exploring consumer's use of and trust in common sources of information. The study highlighted the presence of distinct segments of consumers, the composition of which varied across European countries. Those who ate fish more frequently appeared to be more interested in all types of information available about fish. The most sought-after information concerned quality certifications, safety guarantees, and directions for cooking. However, information about eco-compatible production methods was of intermediate interest to these consumers. The least sought-after type of information included feed composition, the well-being of fish from aquaculture, and the country of origin. Results of this study in part disagreed with those reported in other studies (Lombardi and Anderson 1998; Jaffry et al. 2004), which indicated that the country of origin was significant in interpreting consumer choice behavior.

Verbeke et al. (2007b) studied the divergence between consumer's perception and scientific evidence regarding differences between farmed and wild fish. The results of some focus groups held in Belgium demonstrated that consumers tend to associate the image of aquaculture with that of intensive livestock farms and its related problems of environmental pollution and hormone use. Thus, the production features of fish farming seem to play an important role in the creation of the image of the industry. In another research article, Verbeke et al. (2007a) classified consumers into groups on the basis of two dimensions: the importance attributed to fish quality and the perception of their own competence in evaluating it. On the one hand, the study highlighted the strong use of quality signals in the group of consumers who were uncertain, ate little fish, felt they had limited competence to judge, and were interested in the aspects of quality. On the other hand, it emphasized the use of such signals for those consumers who were "connoisseurs," ate a lot of fish, and had a strong perception of the relationship between consumption of fish and health. DeFrancesco (2003) estimated the willingness to pay for organic sea bream and sea bass through a stated preference study finding that a sizeable segment of Italian consumers is willing to pay a price premium that covers the higher costs of production of the organic product.

A complementary area of study evaluates models of consumer choice that make it possible to study the trade-off between the various qualitative characteristics of fish and its price. In recent years, a series of conjoint analysis studies have been published. These generally explore the impact of production process characteristics on consumer choice. Halbrendt et al. (1991) analyzed the relationship between price and attributes (product types, dimension, fish hybrids) in striped bass farming. Lombardi and Anderson (1998) studied the preferences of German retailers for catfish and explored the trade-off between price, preparation, size, and country of origin. The authors found that domestic origin had a positive effect on product evaluation. Halbrendt et al. (1995) inquired into retailer preferences for Atlantic fish with reference to the species, price, size, and freshness. Freshness and price seemed to be the determining factors in the choices of those interviewed.

Wessels and Holland (1998), Holland and Wessels (1998), and Wessels et al. (1999) analyzed the results of a survey of American consumers designed to study the preferences for fish labeled as "produced from sustainable fisheries" (eco-labeling). Among the attributes studied by these authors were price, production type (wild or farmed),

certification, and type of certifier. The authors identified different market sectors, some of which seemed to consider price as a signal of quality. High frequency of consumption and the habit of acquiring frozen fish were found to be inversely correlated with the willingness to pay a premium price for the certified product, while a positive correlation was observed for environmentalist attitudes. Donath et al. (2000) compared the attitude of American and Norwegian consumers toward certified wild fish using sustainable methods. They found significant differences between the two countries and took this as an indication of the specific character of the different country markets.

Fewer papers on consumer choices use the method of choice experiments to study the trade-off between different attributes in consumer choices. Jaffry et al. (2004) examined the English market for fish, analyzing consumer choices with a conditional logit model. The authors took into consideration the following attributes for six types of fish: presence of quality labeling, presence of eco-sustainable brand, product form (whole, filleted, canned, frozen, etc.), certifying agency, origin, production type (farmed or wild), price level, and type of brand (commercial, by the producer). The factors found to have the greatest positive influence on observed choices by English consumers were quality signals (quality or eco-friendly labels), domestic origin, and the fish being wild rather than farmed.

Quagraine and Engle (2006) explored the preferences of Arkansas restaurateurs for catfish and employed a logit model using price and sensorial attributes (color, consistency, and flavor). The authors reported heterogeneity of preferences, noting that not all restaurateurs are sensitive to price. Alfnes et al. (2006), instead, used a mixed logit model to study the choice of salmon color, using five price levels and five color categories. Unlike the previous studies, Alfnes et al. were based on revealed preference data as those interviewed had to actually buy the product they chose.

The extant literature reports a widespread use of discrete choice models in exploring the determinant of fish choice by consumers. The next section describes the nature of our research design on consumer's preference, with particular reference to the discrete choice model used in our data analysis.

Materials and methods

Factor analysis of consumers attitudinal constructs

Attitudinal constructs are important determinant of taste, but their analysis is complicated by the large number of involved variables, most of which are collinear. Factor analysis and specifically principal component analysis (PCA) are procedures used for data reduction and summarization. PCA identifies a limited number of latent variables or factors explaining a certain amount of the total variance in the original data. The procedure performs an orthogonal transformation of the data leading to the identification of a number of principal components or factors equal to the number of original variables and ordered according to the share of total variance explained. A reduced number of factors are then selected by retaining those that explain more variance than a single original variable.[2] Interpretation of the meaning of the factors is based on the sign and magnitude of the correlations (loadings) between the original variables and the factor. Orthogonal rotation methods, such as the

[2] Eigenvalues indicates the amount of variance associated with the factor. If standardized each original variable has variance 1 thus a rule of thumb is to retain only those factors with eigenvalues larger than one.

varimax, minimize the number of variables with high loadings on each factor, thus facilitating the interpretation (Hair et al. 1998).

Choice models

Choice experiments are a popular methodology for the analysis of consumer choice. Consumers are presented with a specific arrangement of fish alternatives (the choice set), which are experimentally designed to identify the effects of fish attributes on the probability of choice. Then, they are asked to select their preferred alternative out of such a set. Alternatives in the choice set should be mutually exclusive, exhaustive, and in finite number (Train 2003, 15). Consumers may be engaging in a series of such choices, depending on the specific experimental design.

The standard framework for the analysis of data from such choice experiments is the random utility model (RUM) proposed by McFadden (1974). According to this approach, a consumer (denoted by $n = 1,\ldots, N$) is assumed to choose the alternative that yields her the highest expected utility among the available alternatives (denoted by i) in each choice situation (denoted by t). For each alternative i in each choice set, the utility U_{itn} perceived by the respondent n is completely known to her, but not by the analyst. The latter can represent it as the combination of a deterministic component linked to the design attributes of the alternative $\mathbf{x}_{itn}$ and the vector $\boldsymbol{\beta}_n$ of utility weights that the respondent attaches to each attribute of choice. Such linear index, denoted by V_{itn}, is called the indirect utility function for the alternative. The remaining part of utility is treated as a random unobservable stochastic component, ε_{itn}. This leads to the following utility formulation in the analysis of the choice data:

$$U_{itn} = V_{itn} + \varepsilon_{itn} = \beta_n' \mathbf{x}_{itn} + \varepsilon_{itn}, \tag{1}$$

where $\boldsymbol{\beta}$ is a vector of coefficients to be estimated, and $\mathbf{x}$ is a vector of explanatory variables for the observed choice. They refer, in our case, to the attributes of sea bream (price, product origin, type of farming, place of farming, and feed type) salient for qualitative choice.Assuming a distribution density for ε_{itn}, the probability that the alternative i is chosen is given by (ignoring the other subscripts to avoid cluttering):

$$\begin{aligned} P_i &= \mathrm{Prob}\left(\varepsilon_j - \varepsilon_i < V_i - V_j \forall j \neq i\right) \\ &= \int_{\varepsilon} I\left(\varepsilon_j - \varepsilon_i < V_i - V_j \forall j \neq i\right) f(\varepsilon) d\varepsilon, \end{aligned} \tag{2}$$

where $I(\cdot)$ is an indicator function taking the value of 1 when the expression within brackets is true and 0 otherwise. When ε_i is independently and identically distributed (iid) as type I extreme value, the integral has a closed form, and a multinomial logit model is obtained (McFadden 1974) with probability of choosing the ith alternative from the underlying set given by:

$$P_i = \frac{e^{Vi}}{\sum_j e^{V_j}} \tag{3}$$

or

$$P_i = \frac{e^{(\beta' x_i)}}{\sum_j e^{(\beta' x_j)}} \tag{4}$$

Because the previous formulation treats all respondents as having the same preferences, we break away from such restrictive assumption and used the mixed logit model, which allows the utility weights (taste parameters) to vary randomly across individuals rather than being fixed (Train 2003, 138–154; Hensher and Greene 2003). The probabilities of choosing an alternative are thus a weighted average of different logit probabilities (4) where the weights are given by the density functions of the distributions of parameters (the mixing distributions). Notably, the marginal probability of choosing the *i*th alternative by the *n*th individual is given by:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta, \tag{5}$$

where L_{ni} is the logit probability given by Eq. 4 evaluated at $\boldsymbol{\beta}$ and $f(\boldsymbol{\beta})$ are the weighting density functions that account for individual distribution of taste parameters.

The mixed model can also be used to identify groups of consumers that ignore certain attributes of farmed fish. This would imply that for some consumers, the weight of the ignored attribute is set to zero (it is irrelevant). Recent methodological work (Scarpa et al. 2009) has shown that this form of "attribute non-attendance" (ANA) is behaviorally important for three reasons. First, because it affects overall parameter estimates as well as the model prediction. Secondly, because the heterogeneity of choice behavior determined by the hypothetical nature of the choice exercise often leads some respondents to ignore important attributes of choice, such as price. Finally, because there is cumulating evidence that heterogeneity of attribute attendance can often be confounded with that of taste intensity. The marginal probability of choice in an ANA model takes the form of a latent class probability:

$$P_{ni} = \sum_k \pi_k L_{ni}(\beta_k), \tag{6}$$

where π_k denote the probability of each attribute non-attendance class. Different classes have different β coefficients set to zero, indicating that those coefficients have not been attended to by respondents of that class.

Irrespective of the overall model specification, linear indirect utility implies that marginal willingness to pay for attributes can be derived using the marginal rates of substitution between fish attributes and money:

$$\mathrm{WTP}_w = \int \frac{-\partial V_{ik}/\partial x_{wk}}{\partial V_{ik}/\partial \mathrm{price}_k} f(\beta) d\beta = \int \frac{-\beta_{wk}}{\beta_{\mathrm{price},k}} f(\beta) d\beta, \tag{7}$$

and

$$\mathrm{WTP}_w = \sum_k \pi_k \frac{-\partial V_{ik}/\partial x_{wk}}{\partial V_{ik}/\partial \mathrm{price}_k} = \sum_k \pi_k \frac{-\beta_{wk}}{\beta_{\mathrm{price},k}}, \tag{8}$$

respectively, for the mixed logit model or the latent class ANA model.

While the mixed logit model with continuous parameters is more suitable to evaluate variation of taste, in our case the attribute non-attendance model is more suitable to derive accurate WTP estimates. We will use this model to derive the WTP estimates for the innovative vegetable feed.

Data collection

The survey data were collected from sea bream consumers during June and July 2009, by means of in-person interviews recorded on a "pen and paper" questionnaire. The survey

was carried out by a market research firm, which oversaw to sample stratification, piloting, organized and monitored the acquisition of data, and delivered the data in digital format. The objectives of the questionnaire were to produce information on consumer attitudes and preferences about the purchase of farmed sea bream, with particular focus on the type of feed used (either with vegetable or with fish meal protein).

The questionnaire was divided into the following sections: (a) introduction: purchasing habits for fish and for farmed and wild sea bream, (b) choice experiment on farmed sea bream, (c) attitudes about fish consumption and the environment, and (d) social and demographic data.

An initial version of the questionnaire was given to a limited number of respondents in a pilot in which they were asked to report their thoughts on the choice task at hand while they filled in the questionnaire.

The choice experiment

The central part of the questionnaire was the choice experiment, in which each respondent was asked to identify her favorite alternative from a selection of four experimentally designed alternatives in a sequence of six choice tasks (scenarios). Since the research project concerned only farmed sea bream, only this type of fish was used as product in the choice contexts. The price difference between wild and farmed sea bream is such that the two markets can be considered only partially linked. In order to simplify the experimental design and the choice task for respondents, the choice was limited to whole (unprocessed), fresh sea bream. Fish size was also fixed at the most common size in trade of 600–700 grams. We used an experimental design with generic unlabelled alternatives, which means that alternatives differ only in terms of attribute levels. The attributes used to illustrate alternatives in the choice task were identified on the basis of the literature as well as the objectives of the exploration (see Sect. 2).[3]

The five attributes and their associated levels were:

- Price (levels: 5,10,15, and 20 euro/kg)
- Origin (levels: Italian, foreign)
- Type of fish farming (levels: from organic aquaculture, from conventional aquaculture)
- Place of fish farming (levels: marine cages, ponds)
- Type of feed (levels: fish and vegetable meal, only fish meal)

Each respondent was asked to evaluate six choice tasks, each including three generic alternatives and one "no answer" option, with a total of four alternatives from which respondents were asked to identify their favorite one. Considering that each alternative was described by five attributes, the cognitive load required of the respondent seemed to be adequate, as previously suggested by the outcome of the pilot study. An example of one of the six choice tasks faced by respondents is provided in Fig. 1.

After each of the six choices, the interviewee was asked two follow-up questions. The first asked whether the consumer would change his or her frequency of purchase (increase, decrease, stay the same), should the product chosen be the only one available on the market. If the answer was affirmative, then the second follow-up question asked the interviewee to indicate approximately how many purchases he or she would make annually

[3] In a preliminary stage of the research salient attributes were also investigated in a focus group with consumers aimed at eliciting the main dimensions attached to the consumption of farmed fish.

Scenarios 1.1

	Seabream A	Seabream B	Seabream C	None of the preceding ones
price	15 €/Kg	10 €/Kg	10 €/Kg	
Origin	Italian	Foreign	Foreign	
place of fish farming	ponds	marine cages	marine cages	
type of feed	only fish meal	only fish meal	fish and vegetable meal	
type of fish farming	from organic aquaculture	from organic aquaculture	from conventional aquaculture	
I would like to purchase this seabream :				

Fig. 1 Example of choice scenarios

in that situation. The goal of this question was to explore possible variations in the quantity purchased associated with the choice of given alternatives.

Experimental design

Orthogonal designs do not ensure efficiency of the logit choice probability estimators of utility parameters in standard discrete choice models. This is so because such models are highly nonlinear in the parameters (Scarpa and Rose 2008). Ferrini and Scarpa (2007) demonstrated that orthogonal experimental designs are not efficient for estimating logit models except for those rare cases in which the data analyst has no a priori information on the parameters to estimate. So, such designs have been superseded in best practice by fractional factorial designs that satisfy other criteria, such as efficiency (minimum variance) of the estimator. This, however, can only be computed with some a priori knowledge of β, the utility parameters. For cases with high uncertainty about the a priori distribution of these parameters, Sándor and Wedel (2001) suggested using Bayesian designs to formally address the uncertainty at this stage of research. Scarpa et al. (2007) further suggested that uncertainty can be progressively reduced in the design as it becomes resolved with progressive sampling, using a sequential design. In such sequential design, the a priori distribution becomes gradually more informed as the sample increases. Following the first sample wave, one updates the subsequent design on the basis of the distribution of parameters estimated for the preceding waves.

Thus, a D-efficient Bayesian sequentially adaptive design was used, based on the following parameters:

- Number of choice sets = 24
- Number of blocks = 4 (6 choice sets per respondent)
- Alternatives: 3 generic alternatives for each choice set
- Criterion of optimization: D_b efficiency (minimization of the Bayesian D-error)

The order in which the non-monetary attributes were presented to respondents was systematically rotated for the various choice sets. This was done in order to avoid any systematic influence of the order of presentation in the data collection and hence in the estimates of utility parameters.

The choice model hypothesized for the construction of the experimental design was based on the following representation of representative utility (observable) for the different alternatives:

$$\begin{aligned} V_a &= b_1\text{PRICE} + b_2\text{ORG} + b_3\text{IT} + b_4\text{VEG} + b_5\text{CAG} \\ V_b &= \beta_1\text{PRICE} + \beta_2\text{ORG} + \beta_3\text{IT} + \beta_4\text{VEG} + \beta_5\text{CAG} \\ V_c &= \beta_1\text{PRICE} + \beta_2\text{ORG} + \beta_3\text{IT} + \beta_4\text{VEG} + \beta_5\text{CAG} \\ V_{nc} &= \beta_0 \end{aligned} \tag{9}$$

the coefficients of the attributes were generic and thus common to the three alternatives, while the non-choice was represented by an alternative-specific constant. The name of the variables reflected the dummy coding for the levels. For example, ORG (organic) took on the value of 1 if the production type attribute was "organic," and a value of 0 if it was "conventional." The search for the optimal experimental design was conducted with Ngene© (2008) software. On the basis of the experimental design identified, an initial experimental trial was conducted with 101 subjects, estimating an initial version of the model (11) with MNL maximum likelihood estimator. The estimates of the parameters were then used to obtain the experimental design optimized for the second wave. This adaptive design follows the prescriptions of previous favorable findings (Scarpa et al. 2007).

Discrete choice model estimation

Data from the choice experiment were used to estimate a first mixed logit model, which can account for heterogeneous preferences considering the panel nature of the data (since each respondent made six choices). The model allows researchers to induce a correlation between the error terms of the alternatives A, B, and C in such a way as to differentiate the variance of the error term for non-choice. The estimation was conducted by maximizing the simulated sample log-likelihood. To this end, it was necessary to choose which parameters to estimate as random and according to what probability distribution. The parameters of all the alternative-specific constants (B, C, and "no choice") were kept as fixed,[4] while the parameters of the five attributes (PRICE, IT, CAG, ORG, VEG) were estimated as random, with the distributions indicated in Table 1.

The variable "A, B, or C" was a dummy with value 1 for alternatives A, B, and C constructed with the experimental design and 0 for the alternative of "non-choice" (or status quo). Setting equal to 0 the average of the random parameter associated with this variable (but leaving the variance free), a correlation was induced between the error terms for these three alternatives, and at the same time, the variance of the error term was differentiated for the "non-choice" alternative (Scarpa et al. 2005).

The sample likelihood in estimation was simulated using 150 quasi-random draws based on a Halton sequence (Train 2003, 234).

[4] We inserted alternative-specific constant because they were significantly different from zero and improved model fit. A bias against the third alternative was indeed observed.

Table 1 Distributions for random parameters

	Distribution	Constraints on parameters			
		Min	Max	Mean	SD
PRICE	Triangular	0	2β	β	β
ORG	Normal			Free	Free
IT	Normal			Free	Free
VEG	Normal			Free	Free
CAGE	Normal			Free	Free
A, B o C	Normal			0	Free

The sample

A nationally representative survey based on probabilistic area sampling was conducted via face-to-face, in-home interviews. The sampling method was Random Location Sampling, which provides a country-representative subdivision into locations; the locations are selected randomly across potential locations to give national representativeness (i.e., probability of extraction proportional to population). Particularly, the interviews were stratified by territorial district and population of the municipality of residence. In order to determine the sample size in the stratification cells, a preliminary inquiry was conducted on a panel of consumers maintained by the market research agency, which made it possible to identify the relative number of subjects responsible for purchasing the product and the number of households who ate fish at least once a month and ate sea bream. The sample size was then re-proportioned on the basis of the data of the pre-survey. This led to over sampling compared to the data of the resident population in the southern regions and the islands (44% instead of 35%) and to under sampling in the northeastern (13% instead of 19%) and central (15% instead of 20%) regions.

Within each stratification cell, respondents were chosen through quota sampling in such a way as to reflect the principal demographic parameters of the reference population. The final sample consisted in 255 respondents, 251 of whom completed the choice task.

The sampling unit was the household, and the respondent was the person responsible for the actual purchase of sea bream. The sample reflected the spatial distribution of those responsible for purchasing fish and who ate it fresh at least once a month, as indicated by the pre-survey results. Conditional on this, men responsible for purchasing were 20% of the sample, compared to their proportion of 49% in the Italian population. The difference is obviously due to the gender distinction about family roles.

Those interviewed were prevalently concentrated in the intermediate age group between 35 and 64.

The education level of the sample was on average high; over half of the subjects had high school degrees or higher. The questionnaire took on average approximately 30 min to complete.

Results

Attitudes about eating fish and about the environment

The questionnaire queried respondents on their attitudes toward eating farmed sea bream and the environment. An initial series of questions asked respondents to indicate their

Table 2 Factor analysis of sea bream constructs: rotated factor loadings

	Fishbones	Cooking	Health
It could be cooked in many ways	−0.05	**0.69**	0.05
It is a safe food	−0.28	**0.61**	0.46
It is widely available in markets and retail chains	−0.23	**0.51**	−0.19
It is an expensive food	0.27	−0.13	**0.73**
Eating it is good for your health	−0.16	0.45	**0.69**
I like to cook it when I have guests for dinner	0.12	**0.64**	0.11
It is hard to cook	**0.59**	−0.19	0.09
It has a unpleasant smell	**0.83**	0.15	−0.17
There are too many fishbones	**0.74**	−0.10	0.15
% Of variance explained	20.2%	20.2%	14.8%

Loadings higher than 0.5 are in bold

degree of agreement on general statements about farmed sea bream in terms of their influence on purchasing decisions. The scoring scale ranged from 1 (complete disagreement) to 5 (complete agreement).

Most of those interviewed said they agreed for the most part or completely on the safety of farmed sea bream, its beneficial characteristics for health, and the ease of access to the product on the market. They also indicated a fairly good degree of agreement with the dietary aspects of farmed sea bream, while they disagreed on the negative aspects about the presence of bones and bad odor. Responses on the influence of price were more variable.

Exploratory factor analysis of the constructs was conducted via PCA. Three latent factors were selected that explained overall 55% of the variance.[5] After rotation of factors with the varimax method, we obtained the correlations of the variables with the factors (loadings) illustrated in Table 2.

One component covered all the negative aspects of sea bream consumption and was named "fishbones." The second component was correlated with all the positive aspects linked to "cooking" sea bream, including safety aspects. Finally, the third component was linked to both the health aspects and to the cost of the food and could be summarized in the expression, "it's expensive, but good for you." Extraction of an additional factor was also considered. However, this led to a fourth rotated component where the only relevant loading was related to the variable that measures market accessibility of sea bream, which no longer loaded on the second component. All other relevant loadings remained almost unchanged.

Another set of questions asked interviewees to express their degree of agreement on a series of statements on environmental issues. The questions were part of a scale to measure attitudes toward the environment, proposed by Grunert and Juhl (1995). This scoring scale also ranged from 1 (complete disagreement) to 5 (complete agreement), and scores were also analyzed using principal components analysis. The first three components in Table 3 explain 61% of the overall variance. Table 3 presents the loadings (correlations) between the three rotated components (varimax method) and the items of the scale. The first latent factor could be called "critical" environmentalism and was correlated with criticism of the food industry and willingness to boycott products. The second component described a

[5] The number of factors was chosen with the criterion of the eigenvalue greater than or equal to 1. Single loadings larger than 0.5 were retained to interpret the factors.

Table 3 Factor analysis of environmental constructs: rotated factor loadings

	Critical	Skeptical	Uncritical volunteer
I would donate a day's pay to a foundation to help improve the environment	0.23	−0.24	**0.67**
I think the Italian government is doing enough to control pollution.	−0.05	0.12	**0.88**
I would be willing to stop buying products from companies guilty of polluting the environment, even though it might be inconvenient for me	**0.64**	−0.14	0.38
I often discuss environmental issues with my friends.	**0.70**	−0.26	0.13
I become incensed when I think about the harm being done to plant and animal life by pollution.	**0.85**	0.01	−0.04
In my household we do not buy products just because they stem from sustainable production.	−0.16	**0.69**	−0.14
When I think of the ways industries are polluting the environment, I get frustrated and angry	**0.84**	0.06	0.05
I am not willing to pay a pollution tax even if it would considerably decrease the air pollution	0.16	**0.76**	0.00
I seldom read articles or watch TV-programs on environmental issues.	−0.44	**0.55**	0.05
% Of variance explained	29.1%	16.7%	15.7%

The 3 components explain 61% of the total variance. Loadings higher than 0.5 are in bold

"skeptical" attitude to environmental issues and was correlated with statements of disinterest about environmental themes. Finally, the last component reflected an attitude of "uncritical volunteer," correlated with trust in government intervention and willingness to financially support associations.[6]

The overall scoring of the scale was obtained by averaging the points of the nine items (once scores of negative statements were inverted). On average, the sample showed a score of about 3.5, indicating moderate pro-environmentalism.

Price and frequency of sea bream purchasing

The data set obtained by the study also made it possible to explore in more depth the behavior related to price within the discrete choice model. Since this product is purchased repeatedly, a simple one-time discrete choice does not completely capture the relationship between the mix of attributes and consumer behavior (Corsi 2007).

The responses to the follow-up questions described in section five were used to explore the robustness of the observed choices to variations in the quantity of fish purchased. A breakdown of these data is provided in Table 4. Most consumers (67%) stated they would not modify their frequency of purchase (and thus the quantity) if the sea bream they chose in the six scenarios were the only ones available. This percentage dropped below 60% when the price of the sea bream chosen was set at the far end of the variation interval (5 and 20 euros per kg). In agreement with economic theory, the frequency of purchase tended to increase when the sea bream chosen was low priced and tended to decrease in the

[6] We also considered the extraction of a fourth factor. However, the additional factor was strongly correlated only with the unwillingness to pay a pollution tax which no longer loaded on the second factor. We maintained the previous factor extraction because the three factors are to some extent sensibly interpretable.

Table 4 Relationship between price in CE and hypothetical frequency of purchase

Price	As usual (%)	More frequently (%)	Less frequently (%)	Not stated (%)	Total (%)
5 Euro	59	39	1	1	100
10 Euro	84	10	6	0	100
15 Euro	66	14	20	0	100
20 Euro	57	6	34	2	100
Total	67	18	14	1	100

Figures are percentage of choices for each level of price of the chosen product

opposite case. If one assumes that price is a signal for quality, we observed a classic substitution of quality for quantity.

Individual means of utility coefficients and attitudinal scores

The results of the mixed logit model are reported in Table 5. It is important to bear in mind that the values of the coefficient estimates reported in the table are those of the hyper-parameters of the population taste distributions. The mean for the vegetable feed is the only parameter to lack statistical significance, but it does display a large and significant variability as shown by the standard deviation estimate. The Italian origin shows the strongest effect, followed by rearing in marine cages, with organic production only in third position. The model can be used to compute for each attribute the means of the specific distribution for every respondent by conditioning on the observed choices (Train 2003, 262–270).

Table 5 Mixed logit with status quo effect

	Coefficients	Standard error	*Z* value	*P*
Random parameter				
PRICE	−0.10	0.01	−10.14	0.00
ORG	0.63	0.10	6.40	0.00
IT	2.63	0.18	14.64	0.00
VEG	−0.01	0.09	−0.10	0.92
CAG	1.02	0.11	9.41	0.00
"A, B or C"	0.00	(Fixed parameter)		
Fixed parameters				
Alternative B	0.17	0.09	1.76	0.08
Alternative C	−0.30	0.10	−3.07	0.00
No choice	0.08	0.24	0.34	0.73
Standard deviation of random parameters				
Triangular PRICE	0.10	0.01	10.14	0.00
Normal ORGANIC	0.74	0.16	4.61	0.00
Normal Italian	1.62	0.18	8.89	0.00
Normal VEG	0.43	0.20	2.19	0.03
Normal CAGE	0.87	0.14	6.13	0.00
Normal "A, B o C"	2.36	0.27	8.85	0.00

Table 6 Mixed logit: distribution of individual coefficients broken down by stated importance of the price factor

Price is an important factor when purchasing sea bream		PRICE	ORG	IT	VEG	CAG	N
Indifferent to completely disagree	Mean	−0.09	0.61	2.60	−0.00	1.03	83
Agree or completely agree	Mean	−0.10	0.63	2.66	0.00	0.99	168
	t test	3.52	−0.30	−0.43	−0.26	0.65	
	Sig. (2-tailed)	0.00	0.77	0.67	0.79	0.51	

Table 7 Mixed logit distribution of individual coefficients across environmental attitude scores

Environmental attitude		PRICE	ORG	IT	VEG	CAG	N
Scores $\leq$ 3.55	Mean	−0.1	0.57	2.63	0.00	0.93	118
Scores $>$ 3.55	Mean	−0.1	0.67	2.65	0.00	1.07	133
	t test	−0.39	−2.19	−0.20	−0.17	−2.12	
	Sig. (2-tailed)	0.69	0.03	0.84	0.86	0.03	

In other words, one can compute estimates of the means of the respondents' taste distributions for each of the five attributes of sea bream, which can be cross-tabulated with other variables of interest, such as the principal component factors or the attitudinal scores.

The distributions of the individual-specific means of the parameters from the mixed logit estimates were analyzed to explore the importance respondents attributed to the price factor, which is one of the item investigated in the questionnaire (part c). Those who stated a higher importance of price also had a consistently higher price coefficient in their utility function as derived from their pattern of choices and thus tended to choose less expensive products (Table 6).

Similarly, attitudinal scores toward the environment influenced the value of the parameters of the choice model in relation to the "environmental" attributes. That is, toward organic aquaculture and use of marine cages (Table 7). Both parameter estimates in the utility functions from observed choice are found significantly higher for those respondents who scored high in the environmental attitude scale. This result is to be expected since those with more pro-environment attitudes would also be those most interested in environment-friendly methods, such as organic production. However, it should be noted that the parameter for the variable about mariculture (farming in marine cages) also had a higher value: mariculture thus seemed to be associated with the environmental aspects of fish farming.

One last validation analysis between attitudes and individual means of utility coefficients was conducted on the correlation between these and the individual scores of the latent factors related to the attitudes toward sea bream and toward the environment.

Table 8 shows in bold the correlations that are significant (at the 10% level). The subjects who assigned high values to the "fishbones" component of the attitude toward sea bream, and thus emphasized the negative aspects of eating fish, tended to give greater importance to price and less to the Italian origin of fish farming: this category could be termed "disenchanted" about consumption of this fish.

Table 8 Mixed logit: correlation of individual means of random coefficients with latent factors about sea bream and environmental attitudes

Attitudes: latent factors		PRICE	ORG	IT	VEG	CAG
Sea bream: fishbones	Pearson correlation	**−0.11**	0.01	**−0.24**	0.07	**−0.12**
	Sig. (2-tailed)	***0.10***	*0.88*	***0.00***	*0.24*	***0.05***
Sea bream: cooking	Pearson correlation	**0.15**	0.01	0.01	0.05	−0.05
	Sig. (2-tailed)	***0.02***	*0.83*	*0.89*	*0.42*	*0.40*
Sea bream: health	Pearson correlation	**0.24**	0.05	**0.17**	0.10	0.06
	Sig. (2-tailed)	***0.00***	*0.46*	***0.01***	*0.11*	*0.37*
Environment: critical	Pearson correlation	−0.01	**0.14**	0.06	0.05	**0.17**
	Sig. (2-tailed)	*0.94*	***0.03***	*0.31*	*0.42*	***0.01***
Environment: skeptical	Pearson correlation	−0.04	0.00	0.04	−0.04	−0.06
	Sig. (2-tailed)	*0.53*	*1.00*	*0.53*	*0.55*	*0.35*
Environment: uncritical volunteer	Pearson correlation	0.06	−0.07	0.10	−0.06	0.08
	Sig. (2-tailed)	*0.35*	*0.27*	*0.12*	*0.35*	*0.19*
	N	249	249	249	249	249

Correlations that are significant (at the 10% level) are in bold. Significance levels of correlation coefficients are in italics

Instead, those who assigned a higher score to the "cooking" component tended to give less importance to price. Low importance to the price attribute was also observed for the respondents with higher scores for the "health" component. The latter also seem to be more attentive to the Italian origin of the fish, which could be considered an indicator of the product's healthfulness. In addition, this factor was the only one that showed positive correlation, albeit weak, with the value of the parameter on the type of mixed vegetal and animal feed. One could thus advance the hypothesis that while this attribute coefficient was insignificant, the attribute itself could be somewhat important for those who were more attentive to the health aspects of eating sea bream.

Finally, the subjects who showed what we define a "critical" attitude toward the environment were also those who attributed greater importance to the organic method of production and mariculture. It was this component of the pro-environmental attitudes that mainly drove the choices toward these attributes. The other two latent factors related to the attitude toward the environment did not show significant correlations with the parameters of the logit model, except for a weak positive correlation between the "volunteer" factor and the parameter about Italian origin. This latent factor was positively correlated with the willingness to contribute voluntarily for the environment but also with the conviction that the Italian government is doing something for the environment. One might hypothesize, albeit with due caution, that the importance attributed to Italian origin also shows an ethnocentric component.

Willingness to pay for attributes

In order to estimate WTP for each attribute, we took into account the possible occurrence of heterogeneity of choice behavior and attribute attendance that could lead some respondents to ignore important attributes such as price. A series of attribute

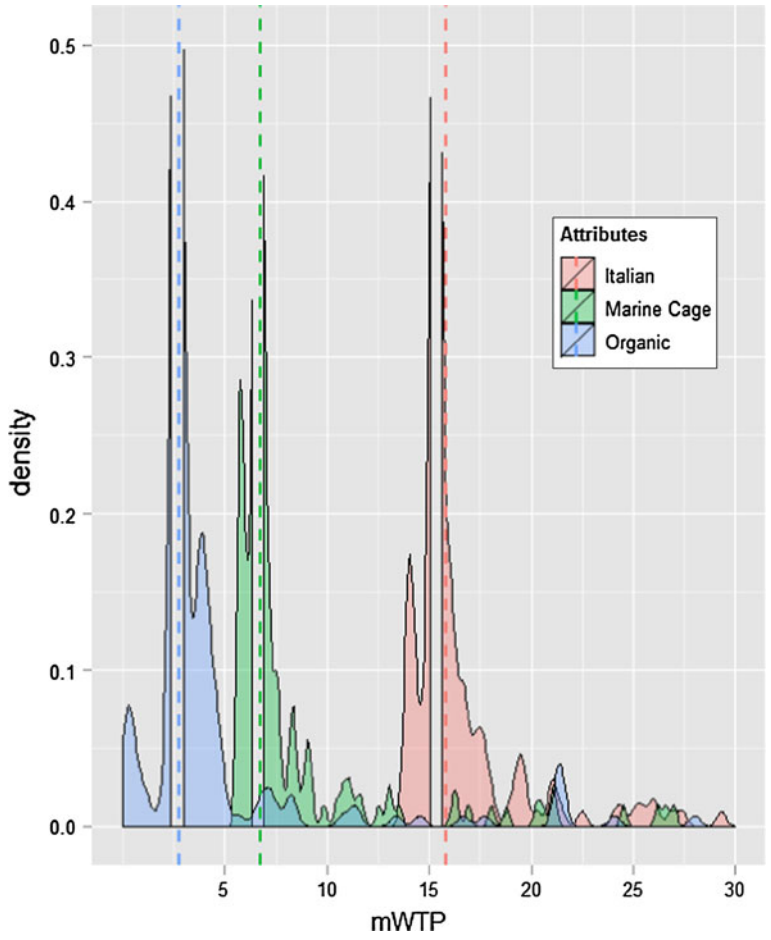

Fig. 2 Densities of marginal WTP for significant attributes (medians as *dashed lines*)

non-attendance models were estimated and reported similar results. In terms of non-attendance, the best model (available from the corresponding author) had 4 classes.[7] One class is collecting respondents whose pattern appears random and has a membership probability of 11.27%. The second class collected those who ignored price as well as the vegetable feed with membership probability of 15.57%. A third that collected those ignoring organic production, with membership probability of 7.83%. The largest class included those who ignored the opt-out alternative, with membership probability of 65.33%. The distributions of marginal WTP estimates for significant attributes are reported in Fig. 2 as density kernels of sample values.[8] Individual-specific WTP were calculated applying Eq. 8 above setting to zero β coefficients for non-attended attributes in each class.

[7] The attribute non attendance model shows a value of 2.08 for the Aikake Information Criterion slightly better than the one obtained for the mixed logit model (2.10).

[8] Derivation of welfare estimates for attributes such as vegetable feed with insignificant utility coefficients is uninformative.

As can be seen, the highest marginal WTP is commanded by Italian origin (median Euro18.1), followed by production in marine cages (median Euro 6.75) and organic comes last (median Euro 2.76).

Conclusions and recommendations

The objective of the study was to investigate the preferences of Italian consumers for sea bream from fish farms, with reference to the elements of differentiation gleaned from analysis of the market situation: price, product origin, type and place of fish farming, and, in particular, type of feed. Consumer preferences were analyzed with a choice model based on stated preferences and supplementary attitudinal questions. The estimated choice models made it possible to evaluate the potential of products with different combinations of attributes for which there is currently no market information available. In particular, the importance of domestic origin emerged as an element that guides consumer choices and, to a lesser degree, that of fish farming in marine cages and of organic certification. Instead, it seems that the feed type does not influence purchasing choices. It should be noted, however, that the choices expressed in the discrete choice model do not translate directly into variations of the quantities purchased. The study revealed that at least for the price factor, there was a certain substitution of quantity for quality: those who choose more expensive products stated that they would purchase them in smaller quantities.

The subjects interviewed demonstrated preference heterogeneity in their choices, indicating that there may be distinct segments, especially in relation to the various components (latent factors) of the attitude toward sea bream and toward the environment. Instead, frequency of purchase and financial situation did not seem to distinguish the consumers in terms of the parameters of the choice model.

Based on the findings of this study, several marketing suggestions can be made. As great importance was given to the domestic origin of the product, it would be very useful to communicate this feature clearly to Italian consumers. Another factor of possible differentiation of the product is related to mariculture, which was perceived positively compared to production in ponds. Consumers should also be provided with clearer information on this aspect of production which may command a price premium.

Finally, within the sample clear differences were observed across group of consumers, which suggests the existence of market segments that could be targeted with differentiated marketing strategies. Greater attention to the environment, in a critical sense, was correlated with greater interest in the organic type of fish farming and in use of marine cages. Interest in health-related issues corresponded to lower sensitivity to price (but it is necessary to consider possible reduction in quantity purchased for the higher price levels) and strong interest in the origin understood as indication of the healthfulness of the product. Attention to culinary aspects was also accompanied by limited sensitivity to price: probably there was not the willingness to exchange lower quality for a better price. Finally, emphasis on the negative aspects of eating sea bream (fishbones, difficulty of preparation), an attitude we have defined as "disenchanted," was accompanied by greater sensitivity to price and lesser interest in the aspects of the production process (origin, type, and place).

Further inquiry is necessary, especially to investigate the relationship between national origin and value of the product for the consumer and to verify the health characteristics attributed by consumers to sea bream farmed in different systems.

Acknowledgments The authors gratefully acknowledge financial support from the Italian Ministry of University through the FISR, Special Integrated Fund for Research, Food Quality and Well being, project n. 176 "Innovative model for integrated management of mariculture plants for food safety and quality and environmental quality" (ALLITTIMA).

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