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A bottom-up model to describe consumers' preferences towards late season peaches

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Abstract

Peaches are consumed in Mediterranean countries since ancient times. Nowadays there are few areas in Europe that produce peaches with Protected Designation of Origin (PDO), and the Calanda area is one of them. The aim of this work is to describe consumers' preferences towards late season PDO Calanda peaches in the city of Zaragoza, Spain, by a bottom-up model. The bottom-up model proves greater amount of information than top-down models. In this approach it is estimated one utility function per consumer. Thus, it is not necessary to make assumptions about preference distributions and correlations across respondents. It was observed that preference distributions were neither normal nor independently distributed. If those preferences were estimated by top-down models, conclusions would be biased. This paper also explores a new way to describe preferences through individual utility functions. Results show that the largest behavioural group gathered origin sensitive consumers. Their utility increased if the peaches were produced in the Calanda area and, especially, when peaches had the PDO Calanda brand. In sequence, the second most valuable attribute for consumers was the price. Peach size and packaging were not so important on purchase choice decision. Nevertheless, it is advisable to avoid trading smallest size peaches (weighting around 160 g/fruit). Traders also have to be careful by using active packaging. It was found that a group of consumers disliked this kind of product, probably, because they perceived it as less natural.

Additional key words: PDO Calanda peaches; best-worst choice experiment; stated preference; individual preference.

Abbreviations used: CI (Confidence Interval); IUF (Individual Utility Function); LPM (Linear Probability Model); MMNL (Mixed Multinomial Logit Model); MNL (Multinomial Logit Model); PDO (Protected Designation of Origin); WLS (Weighted Least Square).

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Introduction

Fresh fruit consumption varies across regions in Spain. According to MAGRAMA (2014a) data, peaches consumption varies among regions. In 2013, it was estimated that in Aragon and Catalonia (the two most important production areas) consumption reached 6.03 and 6.35 kg/person, respectively.

Consumption from local fruit production areas often benefits from lower prices and higher quality. In 2011, the average price for peaches in Aragon and Catalonia was 1.44 and 1.53 €/kg, respectively. Peaches internal quality suffers when storage time is long and consumers have an advantage if they are close to production areas. Although closer markets are better, the actual trade tendency is the opposite as a result of the globalization process.

Growers have decided to harvest peaches still unripe in order to put the product in distant markets. Unripe peaches present harder pulp and can be handled better, with fewer injuries. Nevertheless unripe peaches lack flavour, aroma, texture and juiciness (Llacer *et al*., 2009). Taste is pointed by Cembalo *et al.* (2009) as the most important aspect that determines peaches consumption. According to Crisosto (2007) lack and taste unreliability are the main reasons why people do not eat more peaches.

In addition, the industry has developed attractive varieties of peaches by their appearance (colour, size, form, etc.) but tasteless. A good appearance increases

consumers' expectations about the fruit quality but poor eating experiences disrupt quality expectations. Unreliable quality decreases consumers' satisfaction and consequently consumers buying intention. This strategy may increase fruit demand in the short term but demand can decrease in the long term.

Providing information to consumers about peaches taste at purchasing point is an alternative way to increase peaches consumption in the long term. This information should balance expected with experienced quality. Thus, with more reliable quality, consumers' satisfaction should increase as well as peaches repurchasing. Taste information could be guaranteed by a brand with a minimum internal quality.

Fernandez-Barcala & Gonzalez-Diaz (2006) analysed consumers' quality perception of fourteen EU fruit and vegetable brands. They find higher willingness to pay for brands, when search costs for quality are substantial for consumers. These authors also argue that fruit quality should be controlled by an external and independent system, because consumers perceive it as a proof that firms are not trying to cheat them and then their brands equity will be higher.

There are many external and independent control systems. Food controls made by Regulatory Councils from Protected Designation of Origins (PDO) brands are common in Europe. PDO brands are granted by the European Union to recognise an origin with quality assurance. There are 332 PDOs and Protected Geographical Indications in Spain, 17 of them dealing with fruits. The PDO Calanda is the only PDO related to peaches (*Prunus persica*) (MAGRAMA, 2014b).

The production area of PDO Calanda peaches is located in the Southeast part of the Aragon region and they are marketed from mid-September until the first weeks of November. According to the Regulatory Council norms (BOA, 2009), those peaches have to be harvested at optimum ripeness. Ripeness is evaluated by colour, flesh firmness and soluble solid amount (a Brix greater than 12º). Those characteristics, associated with local tree varieties and climate conditions, have to guarantee a fruit with excellent taste (sweetness).

The production system has to follow specific production techniques, such as the "embolsado" (bagging the fruits on the tree) and the "aclareo" (fruit thinning). The "embolsado" consists of covering fruits with bags to protect them against the Mediterranean fly (*Ceratitis capitata*). This technique avoids the use of pesticides. The "aclareo" consists of eliminating some fruits from the tree in their first developing stage. This technique increases peach size (PDO Calanda peaches have to be larger than 73 mm of diameter), but it has a negative impact on productivity. Both production techniques demand about 50% of the total employment and 25% of the production cost (Barbacil, 2004).

In addition to costs associated with the production techniques, PDO Calanda peaches have higher costs because growers have to pay taxes to the Regulatory Council and there are also other costs related to the traceability process. When a consumer buys a PDO Calanda peach in the market, he/she can know who the producer is and where that peach has been produced. This system may influence positively consumers trust; however, it is economically sustainable only if the market recognises this quality as a plus.

The main aim of this work was to study consumers' preferences towards late season peaches, giving special attention to PDO Calanda peaches, in the city of Zaragoza (Spain). The second contribution of this work is to apply a new method, called bottom-up model, to describe those preferences.

Material and methods

Bottom-up and top-down models

Top-down models, such as Latent Class and Random or Mixed Multinomial Logit (MMNL) Model, which are widely used to study preferences heterogeneity, may relax some preferences assumptions (McFadden & Train, 2000). While Latent Class models do not assume normal preferences distribution across the whole survey, this assumption has to be accomplished only within behavioural groups. Mixed MNL models relax the preferences correlation assumption, however they have to make assumptions about the type of distribution for the preferences (normal, lognormal, triangular and uniform) (Huber & Train, 2001).

The main difference between top-down and bottom-up models is that the first group of models estimates the average preference of a (sub)group of respondents, while a single individual is the basic unit of analysis for the second model. Bottom-up models are estimated directly by Individual Utility Functions (IUF), *i.e.*, one utility function per single respondent. IUF do not need any theoretical assumptions about preferences distribution and correlation among individuals because each individual preference is estimated independently of each other. Thus, it avoids the problem of mischaracterising mean/variance heterogeneity: the empirical distribution of the true heterogeneity is available (Flynn, 2010).

Despite the theoretical advantages, bottom-up models need a greater amount of preference information per respondent. This information is obtained through multiple responses choice task. An extreme case of IUF

estimation is presented by Pihlens & Louviere (2004). They carry out a choice experiment to evaluate choice errors of a single subject to different colours stimulus. Subjects answer 100 replications (choice sets) of paired comparisons. Their experiment is cognitive exhaustive (answer quality decrease) and it deals with preferences from only one person. Choice experiments with many replications would be economically non-viable for those studies that take into account preferences of many people, because surveys would need a long time to be answered. Louviere *et al.* (2008) suggest asking more questions about each choice set, instead of asking more choice sets to each person. It is less exhaustive but provides enough information to estimate IUF. Their method assembles the best-worst choice task, the optimal experimental design and the estimation process (see below).

Except choice experiments for laboratory in psychology, it is rare to find choice modelling studies with bottom-up models (Ebling *et al.*, 2010). In addition to the estimation simplicity, Frischknecht (2011) and Louviere (2011) present some reasons to use bottom-up models. According to them, bottom-up models allow making estimations with few observations (small samples population), and are a proper way to aggregate individuals decisions, valuing which attributes actually matter in the decision process, testing how much uncertainty exists in each individual response, checking the top-down models assumptions, and studying unobserved variability between and within individuals.

This paper describes how consumers make their purchase decision with respect to late season peaches attributes-levels and values preferences variability among consumers.

Best-worst choice task

Best-worst choice task was proposed by Louviere & Woodworth (1990) as a multiple choice extension of Thurstone's method of paired comparisons. Finn & Louviere (1992) applied it the first time to overcome rating scale bias. This characteristic was very important in studies as Cohen & Neira (2004) and de-Magistris *et al.* (2014). Even though this choice task was proposed more than 20 years ago, it was formalised recently. Marley & Louviere (2005) formalised the best-worst choice experiment for choices among things (Case 1) (in most studies, those things are attributes of products or services), while Marley *et al.* (2008) formalised it for choices within profiles (Case 2) and Marley & Pihlens (2012) for choices among profiles (Case 3). This work deals with choices among profiles.

In general, best-worst choice task consumers are asked to make statements about the best and the worst alternatives, among three or more available alternatives, only once or more times in each choice set. This choice task makes a good use of respondents' ability to identify extreme options. Hence, individual answers present less variability with best-worst tasks than ranking the alternatives of a choice set from the best to the worst alternatives. Lower variability in the answers has direct effects on diminishing the Confidence Interval (CI). Hence parameters become more accurate and it is possible to make more precise inferences about consumers' preference. Sufficient information to model a single respondent preference, with Bottom-up models, is given from full ranking of alternatives with the best – worst task (Louviere, 2011).

Optimal experimental design

It is necessary to make the experimental design after knowing which variables will be incorporated in the choice experiment (in our case, with a best-worst choice experiment, the variables are attributes-levels) and how preferences will be measured through the empirical model. The number of alternatives in each set and the number of choices are chosen based on the number of levels of each attribute and the empirical model. The number of choice sets is calculated based on the combination among attribute-levels (levels of attributes), but frequently it is too large to be answered in a survey. Thus, it is usual to adopt fractional factorial design, which is less exhaustive to be answered although it may lose statistical properties.

Efficient experimental designs are characterised by four properties: level balance, orthogonality, minimum overlap and utility balance (Huber & Zwerina, 1996). Level balance deals with the number of times that each attribute-level appears within choice sets and across them. Balanced design is obtained when all attributes-levels have to be presented the same number of times. Orthogonal design is when attributes-levels vary independently across alternatives and choice sets. Trade-offs in each choice situation is optimised as well as the amount of preference information by minimising asymptotic errors.

An efficient design minimises the variance-covariance estimator, *i.e.*, it maximises the amount of information the design conveys to identify marginal utilities. The information matrix to design under the conditional logit assumption is given by the matrix of second derivatives of the log-likelihood functions. A suitable algorithm would search, through different arrangements of attributes and levels, an optimal solution according to some criteria.

There are many criteria to measure the design efficiency. Actually, the right criterion has to be chosen in accordance with the study objective. Scarpa & Rose (2008) suggest using the D-error criterion if the desire is to perform a model that minimises the standard errors and covariance of estimated parameters. Bliemer & Rose (2011) find that experimental designs based on the D-error criteria instead of the orthogonal design produce estimated parameters with lower standard errors and sample size requirements decrease. In part, this difference is explained by the generation of dominant alternatives, which is greater in orthogonal design than in D-error. Louviere *et al.* (2008) recommend using D-optimal (D-error of 100%) in their bottom-up model.

No biased estimators are obtained if expected parameters converge to real values and efficient parameters as those that have the minimum variance. Attributes levels are combined to get non biased and efficient parameters, following suggestions of Street *et al*. (2005) and Street & Burgess (2007). Their strategies to construct a statistically efficient experiment design are based on modular mathematic, which starts with an Orthogonal Main Effect Plan (http://www2.research.att.com/~njas/oadir/) and then there is a generation of choice sets' options based on the first selected profiles.

Selecting late season peaches attributes-levels

There are many definitions of food quality. Basically, it can be defined by two points of view: objective quality or perceived quality. Perceived quality is based on the consumers' perspective. It is defined as a subjective individual evaluation encompassing the total characteristics of a product that satisfy the consumers' needs. Nelson (1970) proposed to distinguish among many types of product quality attributes based on the ease with which they can be communicated to consumers. Search attributes can be verified at the time of the purchase (*e.g.,* fruit size or colour); experience attribute can be assessed only after the purchase has taken place (for example, taste or convenience); and credence attributes cannot be objectively verified and are based on trust (for example, healthiness or method of production).

In our case, four late season peaches attributes (peaches origin, type of packaging, peach size and price) have been selected and three levels have also been considered for each attribute as a result of a literature review, a focus group, personal interviews to fruit and vegetable managers in supermarkets, and local supermarket monitoring (Table 1).

Table 1. Attributes and attributes-levels employed in the experiment.

Attribute	Attributes-levels
Origin	From Calanda area with PDO
	From Calanda area without PDO†
	From other area without PDO
Packaging	Active packaging
	No active (normal) packaging†
	Bulk
Peach size (g)	Smallest (160)
	Medium (250)†
	Largest (380)
Price (€/kg)	Lowest price = 1.5
	Medium price = 2.5†
	Highest price = 3.5

† Reference levels to estimate effect codes.

The empirical model[1] (Eq. [1]), takes only main effects into account and it is an additive function of the alternative *j*. Peaches "from Calanda area without PDO" is coded as the reference-level for peaches origin. The marginal utility between the reference-level of peaches origin and peaches "from Calanda area with PDO", estimated by $\beta_{1,q}$, shows how much consumer *q* values the PDO Calanda brand. If consumer *q* prefers a certified peach over a non-certified peach (both produced in the Calanda area), this parameter will take a positive value. However, if the consumer is indifferent between these two attribute-levels (his/her utility does not increase or decrease), the estimated parameter will be statistically equal to zero. The value of $\beta_{2,q}$ assess to what extent consumer *q* appreciates the Calanda production area, but without any guaranty of quality associated to the PDO brand.

$$\begin{aligned} U_{jq} = {} & \beta_{1,q}\, \textit{from Calanda area with PDO} + \\ & + \beta_{2,q}\, \textit{from other area without PDO} + \\ & + \beta_{3,q}\, \textit{active packaging} + \beta_{4,q}\, \textit{bulk} + \\ & + \beta_{5,q}\, \textit{smallest size} + \beta_{6,q}\, \textit{largest size} + \\ & + \beta_{7,q}\, \textit{lowest price} + \beta_{8,q}\, \textit{highest price} + \varepsilon_{j,q} \end{aligned} \quad [1]$$

Innovations are essential to adequate products to new consumers' life style requirements and provide strong elements to companies to be more competitive. Packaging may influence consumers purchase decisions positively or negatively. They protect the product against injuries and customers purchase time at selling

[1] It is an individual utility function because it calculates one utility function for each consumer.

points is shorter (it is not necessary to weigh the product). However, products look might change (someone may feel it as less natural), taste may change, it is not possible to select the piece of fruit that consumers want and it may also have negative environmental impacts.

The experiment includes peaches sold in bulk and two different types of tray packaging, one is the active packaging and the other is the normal (non active) one. Respondents were informed that active packaging did not imply negative effects on health and organoleptics characteristics and it allowed keeping stocks 12 days more than with no active packaging. The alternative of active packaging has been tested and is available for PDO Calanda peaches (Montero-Prado *et al.*, 2011).

Stocking fruits for longer time increases product convenience because consumer *q* needs to go shopping less often. In the empirical model, convenience is measured by the marginal utility between normal and active packaging, given by $\beta_{3,q}$. The evaluation about the convenience seems to be appropriate, especially if it is taken into account that consumers nowadays go to supermarkets less often in Spain. The influence of tray packaging is achieved by estimating the marginal utility between peaches conditioned in normal packaging and in bulk, measured by $\beta_{4,q}$, on consumers *q* purchase decision.

Peach sizes are important on consumers purchase decision. Consumers perceive that the larger the peach the less proportion of stone to flesh they will buy. Large peaches may be also related with good ripeness and higher sweetness (Bruhn, 1995). Nevertheless, based on focus group comments, not all consumers are able to eat the largest PDO Calanda peach at once. Thus, different peaches sizes were shown to respondents in the experiment. The weight of the smallest peach was about 160 g, a medium size was about 250 g and the largest was about 380 g. The second peach size is the minimum size accepted by the PDO Calanda peaches Regulatory Council norms. Therefore, $\beta_{5,q}$ from the empirical model, measures the marginal utility of shifting from a medium size peach to a smallest one, whereas $\beta_{6,q}$ estimates the marginal utility of changing from a medium size peach to a the largest one.

Price was included in the experiment because consumers may consider it as a cost and as a quality cue, at purchasing site. It is a quality cue when there is not available information about product quality, the consumer does not trust or he/she is not able to value the available information. Price-levels were selected based on market monitoring. The price of 2.5 €/kg was coded as the reference-level for price. In the empirical model, the parameter $\beta_{7,q}$ estimates the variation of utility when consumer *q* can buy a peach with the same quality for 1.5 €/kg instead to 2.5 €/kg. The parameter $\beta_{8,q}$ measures the variation of utility when there is a price increase from 2.5 €/kg to 3.5 €/kg.

Estimation approach

Louviere *et al.* (2008) approach generates artificial observations to increase the information amount. Thus, if there are three alternatives in each choice set and all alternatives are ordered by the Best-Worst task, estimations without artificial observations consider that consumer *q* makes one choice between six available alternatives (MaxDiff approach) or two choices, one among three and another between two available alternatives (Sequential Best-Worst approach). With artificial observations, the estimation process considers that consumer *q* makes three choices in each choice set (all alternatives are chosen) and each choice is made among three available alternatives.

In the survey, every individual made multiple choices and ranked all alternatives of the choice sets (via the best-worst choice task). Then, according to the alternative rank position, individual preferences are calculated with Linear Probability Models (LPMs), such as Multinomial Logit Model (MNL), or Weighted Least Square (WLS) regression models (Louviere *et al.*, 2008). MNL models also deal with a great amount of information because they take into account not only the alternatives that are chosen in the choice set, but the strength of competition within each set (Orme, 2009). The MNL function is weighted according to the probability of the chosen alternative, as shown in Louviere & Woodworth (1983).

Theoretically, let *S* be a complete set of choice situations, each choice situation has *J* alternatives, and each alternative is described by a ($k \times 1$) vector of explanatory variables x_{sj}. For a single consumer *q* the conventional likelihood function in multinomial logistic regressions is given by Eq. [2]. In this equation the dependent variable y_{qsj} is a dummy variable equal to 1 (one) when alternative *j* is chosen in the choice set *s* by consumer *q* and equal to 0 (zero) otherwise. The function is maximised with respect to the betas (β'_{qk}).

$$L_q = \prod_{s=1}^{S}\prod_{j=1}^{J}\left(\frac{\exp\left(\beta'_{q,k}x_{s,j}\right)}{\sum_{j=1}^{J} exp\left(\beta'_{q,k}x_{s,j}\right)}\right)^{y_{q,s,j}} \quad [2]$$

The modified likelihood function considers that all *J* alternatives are chosen once, consequently the number of observations increases, but each alternative *j* in choice situation *s* has to be weighted according to its probability to be chosen. The modified likelihood func-

tion is written as Eq. [3], where w_{ijs} is the weight variable. The weight variable value varies according to the alternative j rank position in the choice situation s (Louviere & Woodworth, 1983). These weights can be understood in two ways: a) as marginal choice frequencies associated with each choice option defined by each alternative combination; and b) as information needed to decompose the choices into a generic indirect utility function represented by main effects.

$$L_q = \prod_{s=1}^{S}\prod_{j=1}^{J} w_{i,j,s}\left(\frac{\exp\left(\beta'_{q,k}x_{s,j}\right)}{\sum_{j=1}^{J} exp\left(\beta'_{q,k}x_{s,j}\right)}\right)^{y_{q,s,j}} \quad [3]$$

The weights of w_{ijs} change according to the choice set size. The smallest choice sets size of the Best-Worst Choice Experiment has three alternatives and its best alternative (ranked 1st) receives weight 4 (w_{ijs} = 4), the second worst alternative (ranked 2nd) is weighted 2 (w_{ijs} = 2), and the worst alternative (ranked 3rd) receives the weight equal to 1 (w_{ijs} = 1). For larger choice set sizes, such as with 4, 5 and 6 alternatives, the best alternative is weighted 8, 16 and 32, respectively, and the worst alternative maintains the same value (w_{ijs} = 1).

The advantage of this technique is that is can be implemented in any maximum likelihood estimation software that allows weighted observations. Stata, Nlogit, Biogeme and Latend Gold are able to carry out such estimations. In our case, we have used Biogene 1.7 (Bierlaire, 2008).

Data collection

Data were collected from a survey conducted in a medium-sized Spanish town, Zaragoza, during the late peaches season in October 2008. All respondents were PDO Calanda peaches consumers. They were identified when it was asked them if they had bought PDO Calanda peaches in the last two years. Sample size was set at 316 PDO Calanda consumers of peaches who were visiting two hypermarkets. As there were about 650,000 citizens in Zaragoza in 2008, its population can be considered infinite and assuming a confidence level of 95.5%, k=2 and p=0.5, this sample size results in a sampling error of ±5.6% in Zaragoza (Trespalacios *et al.*, 2005). The sampled consumers' profile is similar to the actual population. Consumers' socio-demographics characteristics are shown in Table 2.

Consumers' ages were calculated from their birthdates and are grouped in five age classes. These age classes have the same range than the statistical information from Aragon. In 2008, the average age of the Aragonese population was 42.9 years old and the average age for PDO Calanda peaches consumers was 46.5 years old.

Table 2. Consumers' socio-demographic characteristics.

Characteristic	Survey		Population of Aragon† (%)
	Number of consumers	%	
Age (years old)			
From 15 to 25	17	5.4	11.9
From 26 to 35	62	19.6	18.4
From 36 to 50	110	34.8	26.9
From 51 to 65	80	25.3	20.1
Older than 65	47	14.9	22.7
Average age	46.5		42.9
Gender			
Female	187	59.2	50.1
Male	129	40.8	49.9
Education			
Elementary	87	27.5	34.1
High school	130	41.1	41.4
College	99	31.3	24.4
Total	316	100.0	100.0

† The information of Aragon is from IAEST (2010).

The percentage of women (59.2%) on the survey was higher than for the Aragon population (50.1%). This difference can be desired because it reflects the real percentage of women buying peaches in the market. According to Cerdeño (2006) women are to a great extent responsible of fruits and vegetables purchase in Spain.

On average, sampled consumers have higher education level than the average population of Aragon. The percentage of consumers attending college is 31.3% and elementary school is 27.5% while in Aragon those percentages are 24.4% and 34.1%, respectively.

Results

Individual preferences description without statistical inference

In order to represent the preference of 316 consumers, 316 IUFs, each one with 8 parameters, were estimated. In total, 2,528 parameters were calculated. Each estimated parameter represents how much utility improves or diminishes when a consumer exchange an attribute-level (the attribute-level of reference) to another. The average values of these estimated parameters are shown in the Table 3.

Table 3. Marginal utility average value and normal distribution test.

Variables	Average	Kurtosis	Skewness
From Calanda area with PDO	0.36	–0.913	–0.323
From other area without PDO	–0.34	–0.704	0.166
Active packaging	–0.04	2.640	–1.001
Bulk peaches	–0.01	3.419	0.477
Smallest size (160 g/fruit)	–0.10	1.312	–0.891
Largest size (380 g(fruit)	0.04	2.120	0.392
Lowest price (1.5 €/kg)	0.06	1.784	0.143
Highest price (3.5 €/kg)	–0.15	0.712	–0.208

Source: Authors calculations based on the survey sample.

Consumers have strong preference for peaches from Calanda area and peaches with PDO Calanda. On average, utility increases when consumer exchange peaches from other area without PDO Calanda recognition to peaches from Calanda area, but without PDO Calanda. Exchanging peaches from Calanda area without PDO to other peaches from the same area with PDO increases also utility. Marginal utility from origins' levels have the highest values when compared with other marginal utility. These strong preferences may be explained by the proximity between the city of Zaragoza and Calanda area and by the great PDO Calanda reputation. Espejel *et al.* (2007) studied the case of preferences for air-cured ham, Alfonso *et al.* (2001) evaluated the preferences for lamb meat and Espejel & Fandos (2008) studied the preferences for olive oil, and they also found strong preferences for other local PDOs in the city of Zaragoza.

Peaches sold in normal packaging provide higher utility than peaches traded in active packaging or in bulk. Although receiving natural treatment with *Syzygium aromaticum* oil, consumers dislike peaches in active packaging because it is associated with a longer shelf-life, which loses freshness and is less natural. However, consumers are more willingness-to-pay for convenient products. For example, Baselice *et al.* (2014) found that consumers renounce to fresh-cut products in comparison to longer shelf-life products. Convenience explains why consumers prefer peaches in natural packaging instead in bulk. One example of the inconvenience is that consumers spend more time purchasing peaches in bulk than in normal packaging. Bulk peaches must be weighed and consumers have to take queues in the market.

Usually, greater peach size is better. Results show that the largest size (380 g/fruit) is preferable to medium size (250 g) and medium size is preferable to the smallest size (160 g). Why larger fruit is preferable? According to Bruhn (1995) a lot of consumers believe that large peaches are sweeter than small ones because small fruits are perceived as harvested too early. In our case, at the interview, many consumers declared that largest size peaches represent abundance while the smallest size denotes poorness. This result highlights the importance of the PDO Calanda Regulatory Council policy, which determines a minimum size for the product. Normally, larger peaches have higher price in the market.

During the survey period, peach price was sold around 2.5 €/kg. Consumer behaviour did not run away from the classical economic theory prediction regarding prices. The increase in price causes disutility among consumers. The highest disutility was observed when price was increased from 2.5 to 3.5 €/kg.

Estimating consumers preferences of the entire sample using MNL models provides consistent estimations only if preferences (represented by estimated parameters of each attribute-level) across consumers are normally distributed (Louviere *et al.*, 2000). Thus, Kurtosis, Skewness, Kolmogorov-Sminov, Shapiro-Wilk statistics and statistical significance, which are used to value more objectively how well preferences distributions performed as normal distributions, are calculated for every parameter distribution (Table 3).

Neither estimated parameter is normally distributed. In this case, if a top-down model was estimated, results have been seriously biased, with misleading inferences and conclusions (Fiebig *et al.*, 2010).

The estimated parameters (marginal utilities) distributions of peaches "from Calanda area with PDO" and "from other areas without PDO" are less dispersed around the mean than any other estimated variable and more spread than in a normal distribution because their Kurtosis statistics are -0.913 and -0.704, respectively. Estimated parameters (marginal utilities) of both origins levels are not distributed asymmetrically. The estimated parameters of attribute-level "from Calanda area with PDO" tend to be right tail distributed while the estimated parameters of attribute-level "from other area without PDO" have the opposite tendency.

Bulk peach utilities are more centred on the average value (-0.01) than any other variable, which means that most consumers show similar preference about this packaging type. Regarding the preference asymmetry, "active packaging" has -1.001 Skewness (left-skewed), meaning that there are more consumers with smaller marginal utility values than the average. This asymmetry is also checked for preference distribution of estimated parameters such as "from Calanda area with PDO", "high price" and "smallest size" peaches. On the other hand, there are more betas with higher values than the average utility (Skewness > 0) for "bulk", "largest size", "from other areas without PDO" and "low price" peaches.

Preferences (estimated parameters) have to be uncorrelated to obtain consistent estimations with MNL models (top-down models) (Louviere *et al.*, 2000). Table 4 shows the correlation among all consumers' preferences towards late season peaches attributes-levels. The highest correlations are observed among marginal utilities of attribute-levels from the same attribute and present negative values. Thus, top-down models would have provided wrong conclusions. For origins levels, it means that there are two tendencies for preferences ordering. One includes those people who like peaches with the PDO Calanda brand and also like peaches produced in the Calanda area and the second preference tendency shows that those people who like peaches not produced in Calanda area also dislike the PDO Calanda brand.

The negative correlation among packaging levels marginal utilities means that those who prefer normal packaging over bulk also like active packaging or those who prefer bulk peaches instead of normal packaging also refuse active packaging.

In our case, both basic conditions required in MNL models (normal distribution and uncorrelated preferences) were not accomplished. Thus, bottom-up models provide consistent estimated parameters as well as consistent conclusions. Next section deals with the consumers preferences description based on bottom-up model estimations. Some statistical inferences have to be imposed.

Individual preferences with statistical inference

Statistical inferences about estimated parameters are undertaken to deal with consumers' indifference towards late season peaches attributes-levels. In the case of IUF calculated with the bottom-up model, it is possible to identify which levels – from the same attribute – have the same utilities for each consumer by making statistical inferences on each estimated parameter.

In this case, the null hypothesis checks if the marginal utility is statistically equal to zero (H_0: $\beta = 0$) and the alternative hypothesis checks if the marginal utility is different from zero (H_1: $\beta \neq 0$). Statistical significance levels of 1%, 5% and 10% are considered (often measured by *p*-values) on empirical studies. Thus, if the null hypothesis is refused at 1% of statistical significance, it means that the estimated parameter is different from zero with a probability of 99%. In consequence, when one IUF estimated parameter of individual *q* is refused to be zero at 1% of *p*-value, it means that consumer *q* prefers one attribute–level instead of the attribute–level of reference with 99% of accuracy. The null hypothesis is accepted when consumer *q* is indifferent between those attribute–levels with the same accurateness.

Each IUF has 8 betas or parameters to be estimated (Eq. [1]). Figure 1 shows the consumers' preference through changes at different statistical significance of estimated parameters. At 40% of *p*-value, 39, 164, 68, 27, 10 and 3 IUFs have 1, 2, 3, 4, 5 and 6, respectively, parameters statistically different from zero. At this *p*-value, consumers' preferences complexity can be taken into account, nevertheless accuracy is low. There is a 40% probability of making error type I (refusing the true hypothesis). The accuracy at this significance level is too small.

Most empirical studies assume a statistical accuracy of 10% of *p*-value. At this *p*-value, the analysis has an acceptable accuracy and 210 consumers (66.5% of total consumers) are not indifferent among all attributes-levels. The differentiation between attributes-levels allows describing the different consumers' preference structure. At 10% of *p*-value, there are 140 IUFs with one parameter statistically different from zero and 70 IUFs have 2 estimated parameters statistically different from zero. When an IUF had 2 estimated parameters

Table 4. Correlation among estimated marginal utilities

Variables	($\beta_{1,q}$)	($\beta_{2,q}$)	($\beta_{3,q}$)	($\beta_{4,q}$)	($\beta_{5,q}$)	($\beta_{6,q}$)	($\beta_{7,q}$)
From Calanda area with PDO – ($\beta_{1,q}$)	1.00						
From other areas without PDO – ($\beta_{2,q}$)	–0.67	1.00					
Active packaging – ($\beta_{3,q}$)	0.24	–0.14	1.00				
Bulk – ($\beta_{4,q}$)	–0.10	0.16	–0.70	1.00			
Smallest size – ($\beta_{5,q}$)	0.20	–0.15	–0.04	0.00	1.00		
Largest size – ($\beta_{6,q}$)	–0.07	0.07	–0.09	0.10	–0.73	1.00	
1.5 €/kg – ($\beta_{7,q}$)	–0.22	0.08	0.04	–0.05	–0.03	–0.03	1.00
3.5 €/kg – ($\beta_{8,q}$)	0.27	–0.14	0.02	0.16	0.10	–0.03	–0.76

Source: Authors calculations based on the survey sample.

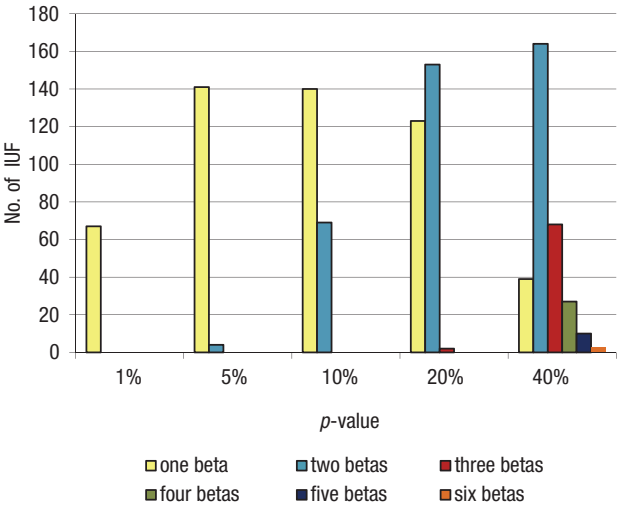

Figure 1. Number of parameters (marginal utility) different from zero at different *p*-values. *Source:* Authors' calculations based on the survey sample.

statistically different from zero, they were from different levels from a same attribute. The remaining 106 IUF had all estimated parameters statistically equal to zero, *i.e.*, they were indifferent among all attribute-levels over the reference-levels. Preferences description may be done with estimated parameters' details, as shown in Table 5.

According to the results, there are 88 IUFs with $\beta_1 > 0$ and all other betas are statically equal to zero. It is represented in the Table 5 by: $U_{\text{with DOP Calanda}} > U_{\text{from Calanda area without DOP}} = U_{\text{from other area without PDO}}$. It means that peaches from Calanda area with PDO Calanda provide higher utility than (*i.e.*, they are preferable to) peaches from Calanda area without PDO Calanda (reference-level) to 88 consumers. At same time peaches from other area without PDO provide same utility than peaches from Calanda area without PDO, *i.e.*, consumers are indifferent between peaches produced in Calanda area or not. These 88 consumers are also indifferent among all other attribute-levels. In summary, they only have a strong preference toward PDO Calanda peach brand.

Similarly, there are 15 consumers with a strong preference for the production area. They prefer peaches from Calanda area without PDO over peaches from other area without PDO and they are indifferent among all other attributes-levels. Other 48 consumers have a strong preference for the production area as well as for the PDO Calanda brand. They want peaches produced in Calanda area with the PDO Calanda. In total, 151 (88+15+48) consumers, who were not indifferent with any attribute-level of origin, were grouped in the Origin Sensitive Group. In addition to this group consumers were grouped in the Packaging Sensitive Group, Size Sensitive Group and Price Sensitive Group.

The Packaging Sensitive Group has 13 consumers (4.1% of total). A Packing Sensitive Consumer has more (or less) utility when exchanging a peach in bulk and/or a peach conditioned in active packaging for another peach conditioned in normal packaging and he/she is indifferent among all other attributes-levels. Within this group, 6 consumers dislike peaches prepared in active packaging ($U_{\text{bulk}} = U_{\text{normal packaging}} > U_{\text{active packaging}}$) while 2 consumers like it ($U_{\text{bulk}} = U_{\text{normal packaging}} < U_{\text{active packaging}}$). Active packaging preserves peaches 12 days more than the normal one, but some consumers dislike it because the product may lose freshness and normal looking. On the other hand, there are other consumers that value the convenience of the storage.

Peach size is very important for 13 consumers (4.1% of total). They belong to the Size Sensitive Group. In total, 6 consumers effectively reject the smallest peaches ($U_{\text{smallest}} < U_{\text{medium}} = U_{\text{largest}}$), 4 consumers simply want the largest peaches ($U_{\text{smallest}} = U_{\text{medium}} < U_{\text{largest}}$) and 3 consumers like the largest peaches and they avoid buying the smallest ($U_{\text{smallest}} < U_{\text{medium}} < U_{\text{largest}}$). It states that there is a small market segment in which is viable for growers to produce medium (250 g/peach) and large (380 g/peach) size peaches. In relation to plum and nectarine, Sterling Rice Group (SRG, 2005) observed that larger peaches are more acceptable by consumers. They also found that peach size impact more positively on purchasing when they are between tennis ball and softball size. Normally, larger peaches have higher market price.

Price Sensitive Group is the second largest group, with 33 consumers (10.4% of all consumers). A great part of those consumers (14 people) behave such as the Classical Economic Theory predicts, lower price always increase utility. In table 5, it is shown by the following expression: $U_{1.5€/kg} > U_{2.5€/kg} > U_{3.5€/kg}$. Within Price Sensitive Group exist 9 consumers that refuse the highest price for peaches, but they are indifferent between peaches sold at 2.5 and 1.5€/kg ($U_{1.5€/kg} = U_{2.5€/kg} > U_{3.5€/kg}$). For them, the fair price is around 2.5€/kg and when price is higher they feel explored. For other 3 consumers, late season peaches only matter if they are sold for 1.5€/kg ($U_{1.5€/kg} > U_{2.5€/kg} = U_{3.5€/kg}$). They are indifferent between 2.5 and 3.5€/kg probably because 2.5€/kg is the reservation price. Price was also used as a quality cue for 7 (1 + 4 + 2) consumers (2.2% of consumers). Price, as an extrinsic quality attribute, gains more importance than intrinsic attributes in purchasing situations when it is difficult to evaluate quality by experience and credence attributes (Zeithaml, 1988). In our case, an experience attribute is the PDO Calanda peaches taste and a credence attribute is the PDO Calanda peaches production system.

Table 5. Consumers preferences for late season peaches attribute-levels, at 10% of *p*-value

Utility of late season peaches attributes-levels	No. of consumers	% of consumers
$U_{\text{with DOP Calanda}} > U_{\text{from Calanda area without DOP}} = U_{\text{from other area without PDO}}$	88	27.8
$U_{\text{with DOP Calanda}} = U_{\text{from Calanda area without PDO}} > U_{\text{from other area without PDO}}$	15	4.7
$U_{\text{with PDO Calanda}} > U_{\text{from Calanda area without PDO}} > U_{\text{from other area without PDO}}$	48	15.2
Origin Sensitive Group	**151**	47.8
$U_{\text{bulk}} > U_{\text{normal packaging}} = U_{\text{active packaging}}$	1	0.3
$U_{\text{bulk}} < U_{\text{normal packaging}} = U_{\text{active packaging}}$	1	0.3
$U_{\text{bulk}} = U_{\text{normal packaging}} > U_{\text{active packaging}}$	6	1.9
$U_{\text{bulk}} = U_{\text{normal packaging}} < U_{\text{active packaging}}$	2	0.6
$U_{\text{bulk}} > U_{\text{normal packaging}} > U_{\text{active packaging}}$	3	0.9
Packaging Sensitive Group	**13**	4.1
$U_{\text{smallest}} < U_{\text{medium}} = U_{\text{largest}}$	6	1.9
$U_{\text{smallest}} = U_{\text{medium}} < U_{\text{largest}}$	4	1.3
$U_{\text{smallest}} < U_{\text{medium}} < U_{\text{largest}}$	3	0.9
Size Sensitive Group	**13**	4.1
$U_{1.5€/kg} > U_{2.5€/kg} = U_{3.5\ €/kg}$	3	0.9
$U_{1.5€/kg} < U_{2.5€/kg} = U_{3.5\ €/kg}$	1	0.3
$U_{1.5€/kg} = U_{2.5€/kg} < U_{3.5\ €/kg}$	4	1.3
$U_{1.5€/kg} = U_{2.5€/kg} > U_{3.5\ €/kg}$	9	2.8
$U_{1.5€/kg} > U_{2.5€/kg} > U_{3.5\ €/kg}$	14	4.4
$U_{1.5€/kg} < U_{2.5€/kg} < U_{3.5\ €/kg}$	2	0.6
Price Sensitive Group	33	10.4
No indifferent (or sensitive) consumers	210	66.5
Indifferent consumers	106	33.5
Total consumers	316	100

Source: Authors calculations based on the survey sample.

Discussion

Changes of life styles and nutritional habits have increased chronic health problems. A great effort has been performed to advise people to practice more physical activities and consume healthy foods, such as fruits and vegetables. In many cases fruit consumption is not satisfactory because its features do not fit consumers' needs and wishes. According to Crisosto (2007), in the last decades the peach industry has focused more on fruit appearance than on its internal quality.

PDO Calanda peaches have followed a different strategy. Although PDO Calanda peaches are more expensive to produce, its quality is very high but it has to be tested with the consumers' preferences. They have an excellent taste and this experience attribute is a guaranty for consumers. Our results show that origin's attributes-levels are the most important characteristics at purchase time in the city of Zaragoza (Spain). Peaches from the Calanda area and especially those with PDO Calanda are the most important features for consumers. This perception was stronger among those consumers who lived in the production area. During the interviews, many consumers, with stronger preference for products from Calanda, said that they worked in the Calanda region. It stresses the need to reinforce market linkages with local consumers through promotion. However, it is important to recognise other groups which do not appreciate so much the origin or the quality of PDO Calanda peaches. Then, it clarifies the existence of different market segments that have to be treated in a different way.

Altogether, engaging people to the production areas seems to be a good marketing strategy. Rural tourism, associated with high quality products, can be an interesting alternative to promote products, such as PDO Calanda peaches. In this sense, the Calanda area is well articulated because, besides having high quality products, it keeps linkages with people through traditional villages' festivals. Another element that can contribute to strength linkages are the celebrities from that area, such as Luis Buñuel, who was a famous film-maker, with an international recognition.

Other important aspect, perhaps the most important, to improve PDO Calanda peaches market is its standard of quality. It is not easy to produce peaches covered by bags to reach good ripeness, sugar content, appearance and size, but the market recognises this quality differentiation. Polo & Albisu (2010) found that 40% of wholesalers who marketed PDO Calanda peaches claimed that the premium price of this product was 20% higher than those peaches from Calanda area without PDO.

Search attributes, such as peach size and type of packaging, are not so important on consumers' purchase decisions. However, in general, consumers do not want the smallest size peaches (160 g/fruit). They have stronger preferences for the largest size. Bruhn (1995) found that 6% of consumers from the major markets in USA considered the size of peaches as an extremely important attribute, which is in agreement with our estimation. In other places, such as in Brazil, Trevisan *et al.* (2006) also observed this kind of preference.

In USA, pricing has favoured large-size fruit (Lopez *et al.*, 2007). Hence, the PDO Calanda norm, which stipulates a minimum peach size is advisable for a better market performance.

Price is the second most valuable attribute in this choice experiment. The price is considered more often as a result of the economic cost than as a quality cue. In marketing, when consumers take the price into account as a quality cue, it means that they are not able to understand other quality cues or information is not available (Chang & Wildt, 1996). Hence, those few consumers who took the price as a quality cue were not able to consider the information about origin, packaging and peach size on their choice decisions. They represent the group of consumers that need more information for purchasing PDO Calanda peaches.

In the choice experiment (applied in 2008), about 90% of consumers is indifferent between the market prices range (from 1.5 €/kg to 3.5 €/kg) in the survey. It is possible that consumers are more price sensitive nowadays, after the economic crisis, than described in the results. There are two reasons to believe that the change has occurred. First, preferences are assessed through statements in a hypothetical purchase situation. Stated choice experiments suffer with hypothetical bias. If there is hypothetical bias people tend to be less sensitive to price. The second reason is that the global economic situation has changed from 2008 to 2015, so it is possible that people is now more sensitive towards price.

Nevertheless is important to keep in mind that the PDO Calanda peaches production cost, estimated by Romero-Salt (2006), was 0.57 €/kg, on average. Introducing peaches in bags represented 24.56% of the total production cost while labour was 23.33%. Fruit thinning represents an important part of the labour costs because it demands more than 200 h/ha, and it improves the fruit ripening process and peach size. It should reach a market price according to those costs and the premium price should compensate for them plus a reasonable benefit.

The biggest change to increase fruit consumption will be achieved when people eats fruit outside their home more often. In order to take part of the snack market, fresh fruits and vegetables are sold in packages. Results show that consumers have higher preference for bulk peaches, however there exists people who prefer peaches wrapped in packages too. Active packaging improves PDO Calanda peaches shelf live without any quality change. Most consumers are indifferent concerning this kind of packaging and some of them refuse it. Active packaging provides less utility to those people because they perceive it as less natural and unhealthy. In the future, it might be a transition towards more packaging but it seems that consumers are no yet ready to pay for it, especially after the economic crisis. Nevertheless, producers should keep track of changes in the market place.

Statistical models should be derived from individual behaviour and not otherwise. Scientists should try to use statistical models that require fewer assumptions about preference to those that require more. Top-down models provide consistent results only if preferences are uncorrelated and normally distributed among individuals. This work shows that classical statistical assumptions of top-down models may not be accomplished, mainly in those variables in which consumers have strong preference – in this case, origins levels. Therefore, a bottom-up model could overcome these theoretical limitations of top-down models.

Individual utility functions could be used to illustrate consumers' preferences. In this case, the researcher can identify which attribute-level each consumer has (dis) utility or is indifferent through statistical inferences. The statistical inferences about consumers' preferences were undertaken at 10% *p*-value. Although this

statistical level represents an arbitrary decision, it is adopted in the major empirical studies. It is still necessary to proceed with new studies to determine the best *p*-value to deal with preference description through bottom-up models. This kind of models offer good ground to know the different market segments, which have been differentiated in this work for Calanda peaches.

A limitation of this work is that, the expressed preference towards the PDO Calanda brand has to be interpreted with caution. The study has evaluated the opinion of PDO Calanda peaches consumers and not of those who do not consume that kind of fruits (although there is a small part of the population) and the sample was undertaken only in the city of Zaragoza. Zaragoza inhabitants have a close relationship with the Calanda area, especially in the holly week. Probably, if the study was carried out in other markets, such as Madrid or Barcelona, the preference towards the PDO Calanda brand could be less intense.

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