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INVESTIGATING PREFERENCES FOR  
ENVIRONMENT FRIENDLY PRODUCTION PRACTICES:  
Taste Segments for Organic and Integrated Crop Management  
in Italian Households

by  
Riccardo Scarpa, Fiorenza Spalatro, and Maurizio Canavari

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# **INVESTIGATING PREFERENCES FOR ENVIRONMENT FRIENDLY PRODUCTION PRACTICES**

## **Taste segments for organic and integrated crop management in Italian households**

Riccardo Scarpa, Fiorenza Spalatro, and Maurizio Canavari \*

### **ABSTRACT**

This paper reports some preliminary results on a mixed logit random utility analysis of conjoint data from costumers' preferences over agricultural products. The data are collected via a telematic sample representative of Italian households. The survey instrument was implemented via a computer supported system. A multivariate normal full correlation structure is imposed in the mixed logit estimation and the implications of such a taste structure are examined.

### **1. INTRODUCTION**

Environment-friendly production methods represent a way to meet society's need for a lower-impact agriculture and a way to cater for a category of consumers with particular preferences. Amongst environment friendly products two categories appear of special interest, that of organic food, and that of food produced using integrated crop management (ICM). The latter may be seen by the consumer as a "softer" alternative to the former, as it allows the controlled use of pesticides and relies on much less stringent

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production restrictions and protocols. Finally, quality certification programmes are now available to certify specific production practices which can be applied to food produced with both the above methods.

While the determinants of price mark-ups for organic products are quite well understood (La Via and Nucifora, 2002), despite much empirical work (Antonelli, 1996; Canavari *et al.*, 2002; Chinnici *et al.*, 2002; Cicia and Perla, 2000; Mora Zanetti, 1998; Santucci *et al.*, 1999; Gregori and Prestamburgo, 1996), in Italy the structure of household preferences for environment-friendly production methods is still poorly understood. A number of issues make such an understanding complicated. Some are related to the quality of data available from conventional sources of market transactions, some to the perception that households have of certification methods for agricultural products. At least in Italy, revealed preference data are particularly difficult to collect without the co-operation of large organized retailers, who tend to shun away from collaboration with university researchers on the grounds of their right to protect their marketing strategies from indiscrete eyes. So, revealed preference data, of the kind used, for example, by Bonnet and Simioni (2001) or Dipak *et al.* (1994), are either very difficult or extremely expensive to obtain.

An alternative to revealed preference data is represented by stated-preference data, which are often considered more informative because of the higher flexibility that experimental design can provide (Louviere *et al.*, 2000). Such an approach is commonly employed for studying preferences for fruit and vegetable products (vander Pol and Ryan, 1996).

Following seminal studies in the US (Misra *et al.*, 1991), recent research based on stated preference have investigated in some detail the structure of preferences for some relatively high-value products from Italian agriculture, such as strawberries and table grapes (Scarpa and Spalatro, 2001) and extra-virgin olive oil (Cicia *et al.*, 2002; Del Giudice and Scarpa, 2002). One common finding of these studies is that conventionally available socio-economic covariates go only a small way towards explaining taste-heterogeneity. A larger fraction of the variation in taste-intensity remains “unobserved”, yet it can be accounted for “unconditionally” on measurable socio-economics covariates by means of random parameter models. How much of these findings extend from high value-added products such as fruit, cheese and olive oil, to low value products, such as potatoes and other starchy products, remains an empirical question. As the market for products obtained with environment friendly methods grows, the answer to such a question is of increasing interest to the policy makers, who seek to find alternative ways to boost farmers income and decrease the negative impacts of conventional production methods which rely on higher levels of chemical input use.

Some basic questions pertain to a) the way taste heterogeneity defines market shares; b) what is the price differential different products are likely to command in the market place, and c) what kind of modelling approach performs best in modelling taste variation.

The present paper reports on an investigation of preferences for potatoes based on stated preference data collected from a representative sample of 2,000 Italian households using the telematic network administered by Nielsen S.p.A market research unity. The choices were derived by asking to rate preferences for pairs of alternatives. Each alternative was described on the basis of standard commercial attributes as well as environment-friendly production methods, such as organic, and integrated crop management. Quality certification programmes and area of production (domestic/foreign)

were also included to investigate the intensity of home-bias which appeared to be significant in other studies (Scarpa *et al.*, 2001).

Preliminary results indicate that the observed data support the presence of unobserved more than conditional heterogeneity. Secondly, there is evidence that the distributions of taste intensity for organic, integrated crop management (ICM) and quality certification (QC) share a common correlation structure, rather than being independent of each other. Thirdly, the largest price differential (€/kg 2.47) is commanded by organic potato production in the relatively small (10%) share of the market of those who favour organic and ICM potatoes, but dislike QC. Finally, the mean WTP for ICM potatoes is always inferior to that for organic ones, and is highest in the largest market share (41%) of favour all three the production systems.

The remainder of the paper is organized as follows, in section 2 we briefly mention the theory underlying the empirical analysis. In section 3 we illustrate the process by which the stated preference data were collected. In section 4 we describe the econometric analysis and discuss the results. Section 5 concludes.

## 2. THEORY

Mixed logit (MixL) estimation (or random parameter logit) stands as probably the most significant advance in random utility discrete choice analysis (McFadden and Train, 2000). MixL estimates have been made possible since the methods for simulated maximum-likelihood have become a practical alternative to practitioners. An appealing way to interpret MixL estimates is in the context of random utility theory, which is a well understood paradigm to interpret discrete choices, and need not be illustrated here (see Train 2003 for an up-to-date treatment of logit modelling and random utility theory). This advance in modelling discrete choices significantly enriched the amount of information that can be obtained from conjoint analysis surveys, especially in the contexts of choice ridden with preference heterogeneity, such as in food-related choices. The focus of this paper is on the additional information that can be gleaned from a full correlation structure across distributions of taste intensities vis-à-vis the more conventional way to represent taste heterogeneity in these models, i.e. through the inclusion of interaction variables with socio-economic covariates.

With few exceptions (Train, 1998; Scarpa and Spalatro, 2001; Del Giudice and Scarpa, 2002; Scarpa *et al.* 2003), mixed logit models are estimated under the assumption that taste intensities are distributed independently of each other (Layton, 2000; Garrod *et al.*, 2002; Hensher and Greene, 2001). This is often a necessity because correlated structures are often more difficult to estimate from a given dataset, and may require the researcher to impose restrictions in the covariance matrix so as to reach convergence. However, correlated taste structures are substantially informative in that they allow researchers to derive joint distribution functions and hence joint taste-segments probabilities. For markets for which taste segmentation is not well developed or understood, such as for the market of potatoes produced with environment-friendly methods, such a structure can help uncover the size of the segments and the expected WTP for the production related product attributes, hence helping the identification of those segments for which it is potentially profitable to specialize the production.

The notion that taste intensity for agricultural products varies across consumers (households) is quite intuitive and need not be argued further (Moro and Sckokai, 2000). For some specialized (typical) products taste variation for origin and ways of production is shown to vary significantly across cities, possibly in relation to the degree of ethnic heterogeneity (Scarpa and Spalatro, 2001; Del Giudice and Scarpa, 2002). From the researcher's perspective however, an issue of interest is the development of an operational approach to obtain policy relevant information from such a variation. For example, in a context of policy design it is often useful to be able to obtain descriptions of taste variation conditional on socio-economic co-variates. Market shares are then estimated on the basis of the population distribution of such covariates. However, taste variation for food products may well be orthogonal to commonly measured socio-economic co-variates. In the absence of such a relationship, the estimation of a correlation structure, and hence of a joint distribution, still identifies the market shares for various taste segments, and conditional on these WTP for food attributes can be obtained.

The identification of segments for which it is potentially profitable to specialize the production can be achieved by combining information on the segment sizes, willingness to pay (WTP) distributions and costs of production (at the retail level) and of certification programmes. Let  $c^*$  be the cost of production per unit of weight of a particular potato type identified by taste conditions  $\theta$ , where  $\theta$  is a  $1 \times k$  vector, then the potential market share is going to be proportional to  $\Pr(\text{WTP} > c^* | \theta > 0)$ . In other words is given by the share of people in a taste segments who are willing to pay above the cost of production, given that their taste intensity parameter are positive (i.e. they like the attributes defining the taste segments of the product). Under independence of taste intensities, by definition this is the product of marginals:

$$\Pr(\text{WTP} > c^* | \theta > 0) = \prod_{i=1}^k \Pr(\text{WTP} > c^* | \theta_i > 0), \quad (1)$$

while with correlation across  $\theta_i$  this is:

$$\Pr(\text{WTP} > c^* | \theta) = \int_1 \dots \int_k f(\text{WTP} > c^* | \theta_1, \dots, \theta_k) d\theta_1, \dots, d\theta_k \quad (2)$$

Such a probability can be estimated from the parameter regulating the behavior of the joint distribution of taste intensities. Suppose we assume that  $\theta \sim \Phi(T, \Omega)$ , where  $\Phi$  is the multivariate normal with mean  $T$  and variance covariance matrix  $\Omega$ . Then, one relatively simple way to simulate those probabilities is using the Cholesky decomposition of  $\Omega = C^T C$  and simulating a sufficiently large vector of variates  $\mu + C'z$ , where  $\mu$  is a  $1 \times k$  vector,  $C$  is the  $k \times k$  lower triangular Cholesky matrix and  $z$  is an  $k \times r$  vector of standard normal variates. The distribution properties of such simulated variates can then be analyzed to derive the statistics of interest.

### 3. DATA

The stated preference data were collected from a sample of 2,000 households representative of the Italian population of consumers. The sample and the administration of the survey were conducted by AC Nielsen Market Research Italy on behalf of a

research project lead by the EU. The survey administration was conducted via pc terminal installed in the homes of respondents. The household member in charge of grocery shopping was asked to take part and each respondent was asked to provide a rating from a scale of 21 points for only one pair of product alternatives. The 11 mark in the scale identified indifference between the two alternatives. The marks 10 to 1 identified increasing preference for the first alternative that appeared to the left of the pc screen, while the marks 12 to 21 indicated increased intensity of preference for the alternative on the right of the screen. Choice sets were designed by randomly pairing alternatives from a main effect partial factorial orthogonal design. The number of factors was 12, each expressed at 2 levels, except for price that was expressed at 3 levels. For such a set-up we obtained a total number of 16 profiles using the “orthoplan” routine in SPSS.

#### 4. ECONOMETRIC ANALYSIS AND RESULTS

In a recent paper Hensher and Greene (2001) provide an extended review on the increased complexity that analysts must cope with when estimating mixed logit models, with particular reference to the need to avoid distributional specifications with meaningless or counter-intuitive behavioral implications. In our case we first postulated and then tested that the attributes of relevance for our investigation display heterogeneous taste-intensities across the population of Italian households. We focused on taste-heterogeneity for three attributes: *organic*, *integrated crop management* and *quality certification*, while all the other attributes were assumed to have fixed taste-parameters. Taste for price (or loss of income) was considered fixed<sup>1</sup>. Table 1 reports the 6 models estimated by (simulated) maximum likelihood with 120 Halton draws (Train, 1999). The last three columns report models with 20 interaction variables between potato attributes (Price, ORG, ICM and QC) and socio-economic covariates (sex, age and education level of the respondent and income and size of the household). For the sake of brevity, we only report the attribute estimates (detailed estimates can be obtained from the corresponding author). In these models age of respondent was negative and significant in its interaction with QC, suggesting that older respondent appreciate quality certification less than younger ones. It was also positively significant in its interaction with ICM, and nearly so in its interaction with ORG, suggesting an effect in the other direction for integrated *crop management* and organic production of potatoes. The last effect to be found significant was the interaction between size of the household and ORG, suggesting that respondents with larger households appreciate organic production relatively more than others. This is perhaps justified if parents with many children try to safeguard their children’s health by buying organic rather than conventional.

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<sup>1</sup> The distributional assumptions concerning the price parameter are problematic because they determine the distribution of WTP for each parameter, that, in commonly employed linear utility models, is given by the negative of the ratio of the parameter of interest and the parameter for price. For some choices of distribution the distribution of the ratio has infinite first central moments. For example, when both are normally distributed. We actually tested for the log-normal (suggested by Train) and the constrained triangular (suggested by Hensher and Greene) distributions for the price parameter, but departing from other findings in other empirical settings (Scarpa *et al.*, 2003; Train, 1998) in both cases we found the estimates for the spread parameters to be insignificant, hence rejecting the null hypothesis of heterogeneity for price.



**Table 1.** Simulated Maximum-likelihood estimates of logit models.

Variables	MNL	MixL	MXLC	MNL_SE	MixL_SE	MXLC_SE
Log- <i>L</i>	-987.15	-981.79	-978.33	-975.67	-970.35	-967.54
Adj. Pseudo-R squared	0.114	0.117	0.118	0.113	0.116	0.117
Organic $\mu$	0.58 (0.01)	0.97 (0.25)	1.13 (0.27)	-1.11 (0.68)	-1.29 (1.03)	-1.69 (1.32)
Organic $\sigma$	----	2.32 (0.75)	3.21 (0.93)	----	2.10 (0.62)	3.15 (0.90)
Integ. Crop Manag. $\mu$	0.21 (0.09)	0.34 (0.13)	0.36 (0.17)	-1.90 (0.69)	-2.16 (0.83)	-2.72 (1.15)
Integ. Crop Manag. $\sigma$	----	0.67 (0.76)	1.02 (0.75)	----	0.13 (1.18)	0.89 (0.76)
Quality Certification $\mu$	0.56 (0.08)	0.77 (0.19)	0.87 (0.19)	1.17 (0.56)	1.67 (0.76)	2.06 (0.95)
Quality Certification $\sigma$	----	0.84 (0.77)	0.10 (4.75)	----	0.47 (1.13)	0.07 (5.11)
White Pulp	-0.33 (0.08)	-0.41 (0.12)	-0.48 (0.13)	-0.34 (0.08)	-0.40 (0.19)	-0.49 (0.13)
Large Size	0.19 (0.10)	0.23 (0.12)	0.28 (0.14)	0.23 (0.09)	0.26 (0.18)	0.32 (0.14)
Medium Size	0.26 (0.09)	0.34 (0.13)	0.40 (0.14)	0.27 (0.09)	0.33 (0.12)	0.39 (0.14)
Poor Appearance	-0.60 (0.08)	-0.78 (0.14)	-0.88 (0.14)	-0.62 (0.08)	-0.75 (0.13)	-0.88 (0.14)
5 kg bag	0.15 (0.08)	0.24 (0.11)	0.30 (0.13)	0.17 (0.08)	0.24 (0.11)	0.31 (0.13)
Domestic origin	0.84 (0.08)	1.14 (0.20)	1.29 (0.18)	0.84 (0.09)	1.07 (0.19)	1.26 (0.18)
Price	-0.70 (0.23)	-0.97 (0.33)	-1.05 (0.35)	-0.45 (1.68)	-0.35 (2.07)	-0.29 (2.52)

Source: authors' calculations on survey data

Taste heterogeneity was first assumed to be independent across attributes, and the significance of standard deviation estimates was assessed by computing the likelihood ratio test where the restricted model is the MNL and the unrestricted is the mixed logit without correlation (MixL). Then a full correlation pattern was allowed for to test for jointness in taste distributions (MXLC), and the significance of the off diagonal elements of the Cholesky matrix was assessed by computing the likelihood ratio test where the restricted model is the mixed logit without correlation (MixL). Table 2 reports the various likelihood ratio test statistics.

A number of points can be made by looking at the values in the table. Firstly, it is clear that the data cannot reject the null hypothesis of unobserved heterogeneity, and in particular its joint form, since the models MXLC and MXLC\_SE achieve significantly higher log-likelihood values (statistics in bold) than their immediate counterparts MixL and MixL\_SE. Secondly, the addition of socio-economic covariates via the 20 interaction variables never represents a significant improvement on their immediate counter-parts (statistics in underlined italics) despite involving substantial over-parameterization. Accounting for heterogeneity in an unobserved fashion provides a much better fit and a much smaller small addition of parameter estimates, than accounting for it in a form

**Table 2.** Chi-square statistics for the various restrictions.

	<i>Restricted Models</i>					
	MNL	MixL	MXLC	MNL_SE	MixL_SE	MXLC_SE
Log-lik.	-987.15	-981.79	-978.32	-975.67	-970.35	-967.54
MixL	0.013	----				
MXLC	0.007	<b>0.074</b>	----			
MNL_SE	<u>0.291</u>	----	----	----		
MixL_SE	0.071	<u>0.295</u>	----	<b>0.014</b>	----	
MXLC_SE	0.046	<u>0.197</u>	<u>0.365</u>	0.012	<u>0.132</u>	----

Source: authors' calculations on survey data

conditional on socio-economic covariates, as can be seen comparing the log-likelihood statistical improvements obtained from the basic MNL to the MixL (or MXLC) to that obtained from MNL to MNL\_SE. This result is common to other studies (e.g. Scarpa and Spalatro, 2001).

Having established that the null hypothesis of joint taste parameter distribution is supported in the data we concentrated on the model without socio-economic variables MXLC\_SE and used the parameter estimates of the joint distribution of tastes to simulate taste segment shares, and marginal and conditional distributions of WTP for each of the three production related attributes. These are reported in table 3.

The largest taste-based market share is of about 40% and regards those who enjoy ORG, ICM and QC in potatoes in segment A. In this large segment mean WTP for ORG is €/kg 1.42, the soft alternative to ORG, ICM has a mean WTP of €/kg 0.80, while QC a potentially additional attribute to either ORG or ICM shows a value of €/kg 0.64.

The second largest segment, segment B, is that including those who only like quality certification, but are not attracted to organic and integrated crop management. This segment has a mean WTP for QC approximately equal to that of the previous larger segment. The estimated size of this segment indicates that QC can potentially be supported as a marketing strategy decoupled from ORG and ICM. That is, quality

**Table 3.** Estimated taste-based market shares and mean WTP for attributes by segment.

Segment	$\beta > 0$	$\beta < 0$	Shares	E(WTP  $\beta$ ) in €/kg		
				Organic	ICM	QC
A	Organic,ICM,QC		0.4086	1.42	0.80	0.64
B	QC	Organic,ICM	0.2257	-----	-----	0.60
C	Organic,ICM	QC	0.0981	2.47	0.52	-----
D	Organic	ICM,QC	0.0941	0.87	-----	-----
E	ICM,QC	Organic	0.0806	-----	0.31	1.22
F		Organic,ICM,QC	0.0563	-----	-----	-----
G	Organic,QC	ICM	0.0366	0.30	-----	0.19
H	ICM	Organic, QC	0.0000	-----	-----	-----

Source: authors' calculations on survey data

certification programs which are not associated to environment friendly production methods may still win a premium price of similar magnitude for this attribute.

Three more shares of around 8-9% each are also identified. The first, segment C, includes those who are attracted by organic and ICM potatoes, but not by QC. The mean WTP that this segment shows for ORG is more than €/kg 1 higher than that of the largest segment, while mean WTP for ICM is about 30 ¢cent/kg lower, suggesting that respondents in this segment perceive ORG as much more desirable than its alternative ICM. The second, segment D, share is made up by respondents who only like ORG, but dislike the other two. The mean WTP for ORG is considerably lower than in the other two segments, only 0.87 €/kg. The third share of 8% of the market, segment E, includes those who have somewhat unusual preferences: they like ICM and QC potatoes, but not organic ones. These people do not seem to appreciate that the two methods are, at least in part, substitutes and are willing to pay a substantial amount for QC (€/kg 1.22), but relatively little for ICM (31 ¢cent/kg). A segment with similarly unusual preference is segment G, which accounts for only 3.66% and enjoys ORG and QC but not ICM, displaying only a low WTP. The segment in which none of these production attributes is appreciated (F) has an estimate share of 5.63%, while that including those disliking organic production and QC, but liking ICM shows an estimated null share.

Amongst the other attributes that respondent found desirable, but were treated as fixed in our analysis, it is interesting to signal the large weight assigned to *domestic origin* of the product, which indicates the presence of home-bias in this market, similarly to what has been found in other studies on different agricultural products (Scarpa *et al.*, 2001; Del Giudice and Scarpa 2002).

## 5. CONCLUSIONS

Certification of production protocols has been put forward as a means to differentiate agricultural market and cater for differentiated market segments while at the same time extracting more surplus from consumers and boosting farmers' income. In this context environment friendly production methods and quality certification programmes are amongst the most promising policy tools to achieve double dividends for society by diminishing externalities and increasing consumers' satisfaction and increasing demand for safe high quality food. However, the perception and hence preferences for these forms of production are still poorly investigated, especially in low value added products, such as potatoes. This study presents some preliminary results from a nation wide survey in which pair-wise rating of product profiles were obtained from the member of the household in charge of grocery shopping. The sample was of 2,000 households representative of the Italian population, while survey instrument was developed to be administered via pc.

In the analysis of the responses we employed the random utility paradigm implemented via mixed logit and ascertain that the sample displays *joint* taste intensity distribution for environment friendly production methods such as organic, integrated crop management and quality certification. The estimated correlation structure was then employed to estimate taste-based market share and mean WTP for each desirable attribute in each share.

Perhaps the most interesting results of this analysis are those concerning the shares of some segments, and within each segment the strength of the taste for some of the

attributes. The results seem to indicate that only 23% of the share of the households in Italy is not interested in environment friendly production practices, and only little more than 36% is not interested in organic potatoes. Integrated crop management, which can be seen as a “soft” alternative to organic is disregarded by 41% of the households, while quality certification by 25% and can command the same mean WTP in segments that appreciate and do not appreciate environment friendly production, hence indicating that this practices can be easily decoupled from each other.

The “core” of households that enjoy only environment friendly production methods in potatoes is made up by segment C, which represent about 9% of the households. In this segment the mean WTP for organic is nearly 5 times that for ICM, showing that perhaps there is some return from educating consumers more about the role of ICM as a substitute to organic production, perhaps through targeted advertising.

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