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The value of collective reputation for environmentally friendly production methods: the case of Val di Gresta

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Working Paper in Economics 11/07

September 2007

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Abstract

In this paper we investigate consumers' preferences for various environmentally-friendly production systems for carrots. We use discrete-choice multi-attribute stated-preference data to explore the effect of collective reputation from growers of an Alpine valley with an established reputation for its environmentally-friendly production: Val di Gresta "the valley of organic orchards". Data analysis of the panel of discrete responses identifies unobserved taste heterogeneity for organic, biodynamic, place of origin and packaging along with extra variance associated with experimentally designed alternatives. Features of *WTP* distributions implied from the conventional utility specification in the preference space are contrasted with those obtained in the *WTP*-space. The latter approach produces more plausible results and only a very slightly inferior statistical fit.

Keywords

Mixed logit
Random utility parameters
Collective reputation
Sustainable agriculture
Choice modeling
Organic methods

JEL Classification

C15; C25; Q26

Acknowledgements

The authors would like to express their thanks to Pietro Bertanza for able research assistance.

1 Introduction

In order to be successful, new types of environmentally-friendly production methods (EFPMs) for vegetables require consumer recognition in the market place. While properly functioning markets have existed for a while for organic products, this is not so for vegetables produced by integrated pest management (IPM) and bio-dynamic (BD) (Steiner 1993) methods. In this study we use stated preference methods to assess how much consumers are willing to pay for these lesser known EFPMs when the product is grown by farmers with an established reputation.[1] Because of a lack of existing data from market transactions the data used in the empirical study consist of responses to hypothetical questions about purchasing decisions. The product of reference is carrots and the location of production is an Alpine valley with the rare characteristic of being totally dedicated to EFPMs: Val di Gresta (VdG).[2] All the produce of this valley is strictly grown using EFPMs, and certified as such. Over the last 30 years producers in this valley have invested and gained a solid reputation amongst local consumers for high quality environmentally-friendly products, especially organic. Part of the reasons why such a reputation is so well-established is thought to be the fact that all producers in the valley use EFPMs, so conventional chemicals are less likely to enter the valley soil system from near-by farms.

With the present study we contribute to the literature in at least two ways. We seem to be the first to use stated preference methods to specifically try and measure *WTP* for collective reputation. This requires a specific experimental design to identify interaction effects between place of origin and production methods, such designs have rarely been employed in the literature (see Lusk & Norwood 2005, Ferrini & Scarpa 2007, for recent surveys on this topic). On the methodological side we are also amongst the first to derive and compare sample distributions of individual-specific estimates for implicit *WTP* for product traits. These estimates are derived conditional on the pattern of observed choice of each individual respondent and are a consequence of preference-heterogeneity in a random utility framework employing (continuous) mixed logit panel estimators.[3]

More generally the paper contributes to the mounting body of evidence that shows how consumers have preferences over origins of production of experience goods. Examples can be found in the meat markets which were examined by Roosen et al. (2003), Alfnes (2004), Loureiro & McCluskey (2000), as well as in the market for Mediterranean products such as oranges, grapes and olive oil as described by Scarpa, Philippidis & Spalatro (2005), and again for olive oil as reported by Van der Lans et al. (2001) and Scarpa & Del Giudice (2004).[4]

[1]For studies of IPM on the production and consumption side see Cuyno et al. (2001), Govindasamy & Italia (1998) respectively.

[2]The interested reader is referred to www.val-di-gresta.it/ to learn more about this group of producers.

[3]Previous research on food choice (frozen meals) has focussed on individual specific parameter estimates from random parameter logit (for example see Mojduszka et al. 2001), but not on joint distributions of individual-specific *WTP* estimates.

[4]We refer the reader to these studies for references about the theoretical basis of production of origin labeling, such as protected designation of origin (PDO), protected geographical indications (PGI), and certificate of specific character (CSC), as defined by EU legislation (EC Regulations 208192 and 208292), which provides protection of

Theoretical results support eating quality standards as a means to prevent the dilution of quality amongst groups of farmers enjoying a collective reputation (e.g. the work by Winfree & McCluskey 2005, on Washington apples). In the latter stages of the phase during which collective reputation is being established it is important to identify and measure the magnitude of the premium that consumers are willing to pay for such a reputation. Winfree & McCluskey (2005) argue that having a large number of farmers sharing a given reputation increases the incentive to depart from the cooperative behavior which results in the collective high quality standards. In the production area of our empirical study in Val di Gresta the number of farmers is relatively low. So, now that a reputation for quality has been attained, the expectation is that it might be sustained over a long time.

Our focus on products from mountain areas is also of particular policy relevance, as it represents one of the rare success stories in the increasingly economically marginalized uplands of developed countries. Evaluating the measure of this success produces valuable information, given the intention of the EU Commission to phase out the old system of agricultural subsidies combined with the necessity to maintain a viable economy in marginal areas.

The remainder of the paper is organized as follows. This section continues by illustrating the background and motivation to this study and reviewing the importance of EFPMs in Italy, with particular attention given to Val di Gresta. The following section describes the objectives and methods. The third section presents the survey design and the data. Estimation and results are illustrated in section 5, while section 6 concludes.

1.1 Background

In the past ten years environmentally-friendly production methods for lower-impact agriculture have experienced rapid development in the EU. Politicians who are engaged in designing policies to jointly deliver farm income security and enhanced environmental standards are interested in the potential for double-dividends, i.e. the scope to jointly improve environmental conditions and produce foods that can command a premium in the market place, so as to make the production of such products self-sustaining.

Amongst the various EFPMs organic farming is the method that has been most successful in Italy, while BD agriculture and IPM are still quite uncommon. The recent growth in organic farming in Italy is due to several factors. From the supply side the dominant factor is widely agreed to be the substantial flow of subsidies used to create incentives for organic food production. From the domestic demand side there is increasing consumer recognition manifested via high *WTP* for organic products, especially in the aftermath of the various food scares which have afflicted Europe (Santucci & Pignataro 2002).

In 2001, Italy had 1,240,000 hectares under organic agriculture spread over more than 60,000 farms making it the third country in the world and the first in Europe in terms of value of organic produce. More recently this trend seems to be reversed, as in 2002 both number of

food names on a geographical or traditional basis.

farms and area cultivated decreased by 7.6% and 5.6%, respectively. This reversal is partly due to loss of subsidies and funds brought about by the new agri-environmental measures of the EU Common Agricultural Policy.

Most of the land used for organic production is devoted to permanent pastures or fodder crops (54%) and is concentrated in a few districts (regions), located in the major islands (Sardinia and Sicily) and the South of Italy, accounting for almost 58% of the total organic agricultural area and hosting the majority of organic farms (61%). Since 2002 these regions witnessed the strongest decrease. In the Centre-North, instead, land use for organic production has increased, but only slightly. Perhaps this is due to the higher value-added of organic products since, especially in the North, many organic farms show an sophisticated degree of vertical integration (i.e. many transform and market their produce collectively and/or directly). Also, produce from farms in the North travels a shorter distance to market since most of the demand is also located in this area of the country (Marino 2004).

1.2 Consumer perception of quality and purchase behavior

It is estimated that only 5% of Italian consumers regularly purchase organic food, but at least one consumer out of three does so occasionally (Torjusen et al. 2004). In 2003 the expenditure for organic food in Italy was estimated to be 1.3 billion US$, or about 1.5% of household expenditure on food (ISMEA 2004).

But what is the perception of quality of organic food in Italy? In the last decade organic products have received greater attention from Italian consumers. There is a growing demand for food produced with environmentally-friendly techniques. This can be linked to increased consumer awareness about human health and environmental issues, the development of rural communities as a consequence of a return to the countryside by a section of previously urban population (especially retired people) and the concern for food safety.

Since the end of the ’90s, several studies have investigated household preferences for EF-PMs, focusing on qualitative and quantitative attributes thought to be driving the growth of sales of organic products in Italy (Canavari et al. 2002). Despite much empirical work the structure of household preferences is still poorly understood. In the beginning Italian consumers of organic products were mostly motivated by ecological awareness. They were simply looking for food derived from lower-impact agriculture. More recently, in addition to these environmental concerns, consumers have also focussed on food safety and security. According to a nation-wide survey (ISMEA 2002), the main reason for purchase seems to be linked to the absence of chemicals harmful to health; secondly organic products are perceived to be better monitored by regulating authorities; thirdly there is the ‘in-any-case-they-won’t-do-any-harm’ attitude. Environment-related motivations were quoted only fourth, this ranking being shared with other European consumers (Zanoli et al. 2001). At present it would appear that health motivations are the leading determinants of choice for both regular and occasional organic consumers. The latter seem more concerned with personal satisfaction derived from organic food consumption, while regular consumers seem to show more altruistic values, associated to children’s welfare and the environment (Zanoli & Naspetti 2002).

Official statistics on consumer expenditure on environmentally-friendly products show that this is distributed over almost all categories of products. Amongst them, dairy products account for 25%, fruit and vegetables and bread and biscuits both 14%, beverages 10% and eggs 6%. Not surprisingly, organic meat is still almost absent, because this sub-sector still needs to be properly organized. Although all sectors showed very strong growth in past years (+80% in 2001-2000) they experienced a trend reversal in 2003 (ISMEA 2004).

According to a recent study (ISMEA 2002), organic consumers in Italy can be divided into five groups. For identification purposes these have been labeled as: 'historical', 'supermarket', 'occasional', 'taster' and 'I wish, but I can't' consumers. The first group accounts for 30% of the Italian organic consumers, but generates 60% of total expenditure. The 'supermarket' consumers are as numerous as the previous group but account for a lower share of expenditures (30%) and mostly live in Northern Italy. They represent a very interesting segment in terms of marketing strategy since their supermarket purchases are usually impulse-driven. 'I wish I could' is an emerging segment, with a very limited economic weight (6%) but much promise. They are mostly young people living in the Center and South of Italy. Finally, the 'taster' segment is a very small one (1%) with medium-high income, very low information about organic, who buy organic food only very occasionally.

On the demand side price remains a crucial factor as the retail price difference between conventional and organic is still quite high (Zanoli & Naspetti 2002). Reliability of supply varies across areas, and this is still an obstacle to consumption growth through the large distribution channels. Finally, the need for ancillary information—about place of origin, methods of production and modes of monitoring—are other important issues for developing demand (Zanoli & Marino 2002).

2 Collective reputation of Val di Gresta's growers

The area of study, the 'Val di Gresta' (abbreviated in VdG), is a valley located in the mountains of the Trentino region, in the North East of Italy. It is located between 400 to 1,300 meters above sea level. The hill slopes are terraced and tend to have a South-Westerly aspect, thereby receiving a long daily exposure to solar radiation. Because of this and its proximity to Garda Lake—Italy's largest lake—the valley enjoys a warmer micro-climate than the neighboring regions, which is particularly suitable for growing vegetables that can be placed in the market early on in the season, thereby capturing a premium over the produce marketed in full season.

Vegetables—mainly cabbages and potatoes—have been grown in the valley since the beginning of the last century. Cultivation of carrots was introduced during the '40s, while at the beginning of the '70s several other kinds of vegetables were introduced. More than 20 types of vegetable are currently grown in the valley. The particular vocation of the area to vegetable cultivation is due to the good differentiation of soils along the valley. Agricultural products from VdG have a reputation that goes beyond the local markets in the Trentino Region, as 80% of the products are marketed outside of this Region. The area of the valley destined to vegetables exceeds 100 hectares, which is quite surprising when considering that it is organized in terraced plots with each terrace of 1,000 square meters, or less.

The VdG Fruit and Vegetable Producers' Association is a farmers' cooperative founded in 1969, on the basis of a pre-existent association founded in the '40s. This farmers' cooperative is the largest in the area and it supplies an average of 2-2.2 thousand metric tons of fruit and vegetables per year. It has a special logo, which is a ladybird. Other produce includes cucumber, onion, bean, salad, apple, and kiwi. Produce grown using organic methods accounts for 70% of all environmentally-friendly produce, the remaining fraction being grown using IPM and bio-dynamic methods.

Carrots represent one of the most important products of the VdG and are mostly produced by organic farming, and in a much smaller quantity by IPM. This vegetable is available from July till March and production in 2003 was 25 metric tons for organic carrots, and 5.5 for IPM. With such small scale production it is difficult to measure consumer recognition of the collective reputation for the VdG origin starting from market transactions. Furthermore, although the bio-dynamic methods are just as applicable to carrot growing as to growing other produce in the valley, they are little used for this crop.

2.1 Lesser known EFP methods

Bio-dynamics (BD) and Integrated pest management (IPM) are lesser known EFPMs of potential great interest to VdG's farmers. Bio-dynamics was defined in 1924 by Dr. Rudolf Steiner a Yugoslavian brought up in the Austro-Hungarian empire who pioneered a philosophical approach to science called 'anthroposophy.' According to the BD Farming and Gardening Association: BD is 'a science of life-forces, a recognition of the basic principles at work in nature, and an approach to agriculture which takes these principles into account to bring about balance and healing,..., an on-going path of knowledge rather than an assemblage of methods and techniques. Dr. Steiner emphasized many of the forces within living nature, identifying many of these factors and describing specific practices and preparations that enable the farmer or gardener to work in concert with these principles. Central to the bio-dynamic method are certain herbal preparations that guide the decomposition processes in manures and compost.

The Council Directive 91/414/EEC of 15 July 1991 (and followings) concerning the placing of plant protection products on the market (article 2), defines integrated control (IPM) as: the rational application of a combination of biological, biotechnological, chemical, cultural or plant-breeding measures whereby the use of plant protection products is limited to the strict minimum necessary to maintain the pest population at levels below those causing economically unacceptable damage or loss. IPM emphasizes the growth of a healthy crop with the least possible disruption to agroecosystems and encourages natural pest control mechanisms. It focuses on a careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep plant protection products and other interventions to levels that are economically justified in order to reduce or minimize risks to human health and the environment.

3 Objectives

Apart from the main question of how consumers' reward producers' for their collective reputation, our objective is to explore whether uncommon forms of EFPMs—namely BD and IPM—are distinctly recognized by consumers and may hence command a price differential of the type organic products do, when labelled as grown in an area wit established reputation. Furthermore, given that one of the most frequently lamented traits of environmentally-friendly carrots is the presence of skin imperfections, we also investigate the *WTP* for this attribute. Because environmentally-friendly carrots are also produced outside VdG, to identify the combined effect of being from Val Di Gresta *and* produced with each of these methods we used interaction effects between each EFPM *and* VdG origin. Such effects, if present, will constitute our measure of the acquired reputation for these methods by the farmers of the valley. In particular, while there is a well-established certification process for organic and IPM produce for VdG products, the certification process for BD produce is only very recent (2003) and does not have a clearly established reputation. The short history and small volume of sales of product with this attribute makes it difficult to use revealed preference data to determine such an effect, hence our reliance on data from a stated preference survey.

3.1 Survey and data

The survey instrument was calibrated via focus groups and a pilot study in early summer 2004, while the final survey data were collected through face-to-face interviews during summer and autumn 2004. Respondents were randomly selected at supermarkets and grocery shops in the region of Trentino Alto Adige (North-East of Italy) and they were buyers of carrots that could be either from VdG or not and either organically grown or not. A total of 240 completed surveys were collected producing a total of 1,949 product choices.

There were five product attributes of interest. These included: certification of production methods (conventional, bio-dynamic, integrated pest management and organic), certification of origin (VdG, elsewhere), skin imperfections (absent, less than 10% of the skin, more than 10% of the skin), packaging (pre-packaged or loose) and finally, retail price in €/kg (1.3, 1.5 and 2.2). Utility weights for all of these were to be identified in estimation, with the addition of three 2-way interaction effects between the three EFPMs and VdG origin, which were necessary to establish the existing (with organic and IPM) and potential (with bio-dynamic) reputation effects of VdG producers.

To make good use of the sample surveys the attributes and attribute levels were arranged according to an experimental design that guaranteed the identification of the effects of interest in an efficient way. The complete experimental design was a fraction of the full factorial selected so as to identify main effects and the two-way interactions of interest. As discussed at length in the experimental design literature for discrete choice experiments based on logit models, using experimental designs predicated on linear multivariate models is sub-optimal (e.g. Ferrini & Scarpa 2007). Designs obtained by minimizing the D-error of the matrix of levels are more efficient (i.e. increasing the information content of the Fisher information matrix). These are obtained starting from a generic orthogonal design and using swapping and cycling algorithms (Zwerina et al. 1996). A D-optimal design was obtained by cycling and swapping the orthogonal design obtained using Design Expert v. 6. The final design consisted of 41 profiles which were divided in five separate blocks with D-optimal properties. None of the main attributes and—importantly for the achievement of our objective of identifying reputation effects—none of the 2-way interaction effects between the four EFPMs and place of origin were aliased.

The 41 orthogonal profiles were blocked so that respondents performed either 8 (blocks 1-4) or 9 (block 5) choice tasks. Each choice task included a no-purchase option and two experimentally-designed alternatives involving a purchase (product profiles). An example of a choice task is reported in table 1 and the design statistics for the attributes used in the survey are reported in Table 2.

In the second section of the questionnaire, we collected socio-economic data and asked some information about the respondent's attitude towards organic product consumption. Looking at the sample characteristics in Table 3, the average age of the respondents is 50 years old. 66% of those interviewed are females and 34% are males. 19.5% of the sample has a university degree, which is definitely a large fraction for Italian standards. In this respect the sample cannot therefore be taken as fully representative of the population of consumers, and this is a limitation of this study. The average family size is 2.8 members and 29% of the respondents have children aged under 15. 88% of respondents were usually in charge of grocery shopping.

Attribute	*Alternative* A	*Alternative* B	*Buy neither*
Production method	Organic	Conventional	
Origin Val di Gresta	Yes	No	
Skin imperfection	more than 10% of the skin	absent	
Packaged	Yes	loose product	
Price in Euro	1.30	2.22	

Table 1: Example of a choice task in the choice experiment.

4 Method

Previous work on the analysis of preferences on the place of origin of food that employed choice modelling emphasized the importance of *unobserved* heterogeneity. For example, Scarpa, Philippidis & Spalatro (2005) show that—in the case of table grapes and olive oil—

Table 2: Attributes in the survey

Attributes and levels	*(%)*
Production method	
Conventional	27.2
Integr. pest mgmt.	22.8
Bio-dynamic	27.2
Organic	22.8
Skin imperfection	
Many	31.8
Some	36.3
Few	31.8
Packaging	
yes	51.1
no	48.9
Cost (Euro)	
1.3	35.5
1.5	28.9
2.2	35.5
Collective reputation	
Val di Gresta	50.0
Out of Val di Gresta	50.0

even when all the the socio-economic co-variates are employed to account for *observed* heterogeneity a statistically significant component of *un*observed heterogeneity remains. These are variations in preference intensities for food attributes that are not systematically associated with socio-economic co-variates. In other words, their data provide strong evidence of taste differences amongst people that 'appear' to be the same when described using socio-economic co-variates.

However, heterogeneity effects linked to the purchase option relative to the no-purchase option were not investigated in that study because the choice-set did not include a no-buy option, but just the choice between a pair of product profiles. The exclusion of a no-buy option effectively forces respondents to choose from experimentally designed alternatives of purchase. The negative implications of 'forced-choice' are investigated in Dhar & Simonson (2003). Their main results suggest that 'survey instruments that include the no-choice response are likely to produce more accurate predictions' and that 'including the no-choice option is likely to have greater impact for new or infrequently purchased products'. In the present study we included the no-purchase option in each choice-set, because in each choice situation the respondent may prefer not to buy either of the alternatives from the experimental design.

Table 3: Descriptive statistics

Variable	*(average value or %)*
Age	50.3
Household members	2.9
Gender of respondents	
Man	34.2%
Woman	65.8%
Children under 15	28.8%
Education level	
Primary school	7.9%
Secondary school	27.7%
High-school	44.9%
University	19.5%
Buyers	88.0%
Average annual income (Euro)	25,600

Of particular interest is heterogeneity of the parameter for marginal income. Many studies assume this to be fixed, thereby avoiding the complication of having a random parameter as the denominator of a ratio when computing marginal *WTP* measures. A fixed marginal utility of money, however, goes against economic intuition as the same money unit can have different values in households with different income constraints. Similarly, allowing marginal utility of income to be completely random, which happens when the negative of the money coefficient is assumed to be log-normally distributed, does not capture the systematic effect of income constraints. These are important, especially in stated-preference studies, because they can offer the opportunity to researcher to implement theoretical validity tests. For example, the implicit *WTP* for a group subject to tighter budgetary constraints (e.g. households with a high number of children or with low income) should be lower than the *WTP* of other segments. For this reason in our choice of indirect utility specification we follow the approach suggested by Morey et al. (2003) and use a piece-wise linear formulation for this parameter in the random utility specification.

4.1 The basic RUM model with random taste and error components

Denote the individual by n and the choice-occasion by t. Then, in our estimation the basic specification for the choice probability is conditional logit. That is, conditional on the vector of taste parameters β_{nt}—K elements of of which can be random and are denoted by $\tilde{\beta}_n^k$—and conditional on the individual-specific error-components ε_{in}, the probability of selection by respondent n of a specific alternative i in choice t of the sequence $\langle t = 1, \ldots, T \rangle$ from the choice-set containing the generic alternative j is logit:

$$\Pr(int|\beta_n, \varepsilon_n) = \frac{e^{x_{int}\beta_n + \varepsilon_{in}}}{\sum_{j=1}^{j=3} e^{x_{jnt}\beta_n + \varepsilon_{in}}}, \tag{1}$$

Where x_{int} and β_{nt} are respectively, a conformable vector of variables explaining choice and of parameters to estimate, while ε_{nt} is an error component associated with each of the experimentally designed alternatives involving purchase in each choice set. This is an additional error component to the conventional Gumbel distributed error of the multinomial logit model. It is meant to capture additional variance associated with the cognitive effort of evaluating a hypothetical purchase.

Assuming independence across the T choices by the same individual n, the joint probability of a sequence of choices $\langle i_{t=1}, i_{t=2}, \ldots, i_{t=T}\rangle$ is:

$$\Pr(\langle i_{t=1}, i_{t=2}, \ldots, i_{t=T}\rangle_n|\beta_n, \varepsilon_n) = \Pr(n|\beta_n, \varepsilon_n) = \prod_{t=1}^{t=T} \frac{e^{x_{int}\beta_n + \varepsilon_{in}}}{\sum_{j=1}^{j=3} e^{x_{jnt}\beta_n + \varepsilon_{in}}}. \tag{2}$$

Notice that although independent the choice-probabilities all share the same draw for the random taste parameter, thereby accounting for stability of preferences across a sequence of choices by the same individual n, and inducing correlation amongst probabilities of choice by the same individual.

Randomness of taste-intensities is represented by the choice of one appropriate distribution $g(\cdot)$ for each element of $\tilde{\beta}_n^k$. Each $g_k(\cdot)$ is completely defined by the combination of location (μ_k) and scale (σ_k^2) parameters (the variance).[5]

The marginal probability of choice is derived by integrating expression 1 over the appropriate distribution functions for the K random parameters:

$$\Pr(n, \beta_n|\varepsilon_n) = \int_{-\infty_{k=1}}^{\infty} \ldots \int_{-\infty_{k=K}}^{\infty} \Pr(n|\beta_n, \varepsilon_n) g_1(\mu_1, \sigma_1^2) \ldots g_K(\mu_K, \sigma_K^2) d\tilde{\beta}_n^1 \ldots d\tilde{\beta}_n^K \tag{3}$$

The additional alternative-specific error-component ε_n is assumed to be (normally distributed) white noise and therefore is centered on zero, but with a variance σ^2.[6] So, one can write $\varepsilon_n \sim \mathcal{N}(0, \sigma_\varepsilon^2)$ or just $\varepsilon_n \sim \phi(\sigma_\varepsilon^2)$. The marginal probability of choice is therefore obtained by integrating equation 3 over the error-component space:

$$\Pr(n, \beta_n, \varepsilon_n) = \int_{-\infty}^{\infty} \Pr(n, \beta_n|\varepsilon_n)\phi(\sigma_\varepsilon^2) d\varepsilon_n \tag{4}$$

[5]We intentionally borrow the notation of the normal distribution, although $g_k(\cdot)$ need not be normal.

[6]Choice-complexity is normally tackled by parameterizing the distributional features of the Gumbel-distributed error-term, such as the scale parameter (e.g. Swait & Adamowicz (2001) and DeShazo & Fermo (2002)) or its variance directly (e.g. Scarpa et al. (2003)).

while the sample log-likelihood is given by the sum across respondents of the log of the probability of sequences:

$$\ln \mathcal{L} = \sum_{n=1}^{N} \ln \Pr(n) = \sum_{n=1}^{N} \ln [\Pr(n, \beta_n, \varepsilon_n)]. \tag{5}$$

Because equations (3) and (4) have no closed-form during estimation they are simulated (Train 2003) by averaging the probabilities computed at a sufficiently high number of pseudo-random draws with good equidispersion properties.[7] Notice that both β_n and ε_n are indexed by n these can change only across individuals (panel estimation). If they were indexed by nt they would change across *both* choices and individuals (cross-section estimation). In this study we adopt the panel approach so as to model permanence of preferences and error (additional variance from the no-buy option) across choices by the same respondent.

To characterize more meaningfully the economic implications of taste variation for an attribute we focus on marginal *WTP* for attributes. With linear indirect utility marginal *WTP* can be shown to be equal to $WTP = -\beta/\gamma$, where γ is the (possibly composite) marginal utility of income, i.e. the cost coefficient or a sum of adequate coefficients when this is a composite. An estimator of this is simply derived by using the invariance property (Slutsky theorem) of continuous functions of the maximum likelihood estimator by plugging in the estimates in the ratio, which is a continuous function of the estimates, as follows:

$$\widehat{E}[WTP_n] = \frac{-\hat{\beta}}{\hat{\gamma}}. \tag{6}$$

For random parameters the individual-specific mean *WTP*—denoted as $\widehat{\widehat{E}}[WTP_n]$—can be estimated from knowledge of the T choices made by each respondent in the panel (Train 2003, Scarpa, Willis & Acutt 2005). To compute such conditional value distributions one can adopt the approach shown in Greene et al. (2005) using a simulated estimate as follows:

$$\widehat{\widehat{E}}[WTP_n] = \frac{1/R \sum_{r=1}^{R} WTP_n L(\hat{\beta}_{nr}|data_n)}{1/R \sum_{r=1}^{R} L(\hat{\beta}_{nr}|data_n)}, \tag{7}$$

where r denotes the simulation draws $1, 2, \ldots, R$, and $L(\cdot)$ denotes the likelihood evaluated at the r draw.

According to their proponents, such estimates seem to overcome the problem of behaviorally unrealistic ranges which are often encountered when using the more commonly employed estimator based on population moments:

$$\widehat{\widehat{E}}[WTP_n] = \frac{1}{R} \sum_{r=1}^{R} \frac{-\hat{\beta}_{nr}}{\hat{\gamma}_{nr}} = \frac{1}{R} \sum_{r=1}^{R} \widehat{WTP}_{nr}. \tag{8}$$

[7] Train (1999) reports that 100 Halton draws are approximately equivalent to the precision obtained with 1,000 pseudo-random draws, and this is the number of draws used in our estimation.

This latter estimator is sometimes found to produce behaviorally implausible estimates, especially when the assumed distributions of the taste parameter implies 'fat-tails', such as when using the log-normal, which can be used to 'bound' the negative of price to the positive orthant. Or when values approximate to zero are drawn and used in the denominator of the ratio. In this event the ratio 'explodes', implying extremely high consumer surplus estimates.[8] In our case, however, the denominator is the marginal utility of income which consists of non-random terms (γ and other shifters representing budget constraints for selected categories of respondents), and hence it simply scales the whole ratio in equation (7).

In the remainder of this section we explain how we tackle each of the important modeling decisions involved in the specification testing of complex mixed logit models with continuous mixtures. The decisions we focus on are the selection of variables with heterogeneity, the choice of mixing distributions, and the error component variables.

4.2 Taste heterogeneity

The decision of what product attributes to allow to be random is based on the model performance on the available data. We tested a series of models allowing each taste parameter to be variable according to a chosen distribution, except for marginal utility of income, which we specify either as a constant, or as a piece-wise linear spline, as proposed by Morey et al. (2003). Our study differs from the latter in that, apart from high income, other latent variables representing constraints on income (such as the number of kids in the household) are additional determinants of heterogeneity in marginal utility of income γ. For example, a general utility specification incorporating this form of heterogeneity, as well as random parameters for other attributes $\tilde{\beta}_{hn}$ and one error component ε_n is:

$$U_{nti} = \sum_{g=1}^{G} x_g \beta_g + \gamma + 1(\text{high inc})\gamma^h + 1(\text{2kids})\gamma^{2k} + 1(\text{3kids})\gamma^{3k} \quad (9)$$

$$+ \sum_{h=1}^{H} x_h \tilde{\beta}_{hn} + 1(\text{buy})\varepsilon_n + 1(\text{nobuy})\alpha + u_{nti}, \quad (10)$$

where $1(\cdot)$ is a binary indicator function.

In practice, the formal testing for a candidate parameter to be deemed 'random' is complicated by the fact that the restriction implies the distribution is degenerate due to the scale = 0 (i.e. for fixed parameters all mass is on one value). Because zero is at the boundary of the range of values admitted for the scale parameter, rather than within its interval, the asymptotic distribution of the test statistic under the null is unknown. So, whenever the null involves such a

[8] Amongst the various alternative approaches put forward to mitigate such an effect we mention the work by Train & Sonnier (2005) based on bounded transformations of normal variates, and by Train & Weeks (2005) and Scarpa et al. (2006), who discuss the implications of modeling heterogeneity directly in *WTP* space and provide examples of empirical applications.

restriction a likelihood ratio test will not be adequate because the asymptotic distribution of the test statistic is unknown, so other selection criterion need to be invoked. When this is the case we used the Bayesian information criterion and the Akaike information criterion. If the model with variability is superior to the restricted model according to these criteria, then that attribute may be deemed variable in nature.

The choice of parametric distribution for the attributes displaying taste variation is possibly the most delicate one. The pros and cons of various tractable distributions have been discussed at length in the literature in this field (see for example Train 2003, Greene et al. 2005, Train & Sonnier 2005, Train & Weeks 2005, for some in-depth discussions of this problem and some suggestions for remedies). Here the random taste parameters for attributes are all assumed to be normal, and hence are unconstrained in terms of axis.

4.3 Error component for purchase decisions

The presence of a no-buy option is known to modify the substitution patterns within the alternatives of even relatively simple choice situations, thereby undermining the logit assumption of independence of irrelevant alternatives. The simple inclusion of an alternative-specific constant (ASC) for the no-price option cannot account for such a violation. Previous attempts to address this issue used the nested logit model (Haaijer et al. 2001). Some more recent Monte Carlo results (Scarpa, Ferrini & Willis 2005, Ferrini & Scarpa 2007) suggest that error-component models—which may be formulated to account for similar correlation patterns across utilities as the nested logit—show higher robustness to mis-specification. We hence build on this result and we test for the presence of error components associated with the two alternatives involving purchase in each choice-set.

The resulting model in equation (9) includes a zero-mean normal error, which is additional to the Gumbel error, associated only with the utility of alternatives that portray a purchase decision (a non status-quo decision). This joint error induces correlation patterns (Brownstone & Train 1999) amongst the utilities of purchase.

4.4 Hypotheses

The hypotheses to be tested concern the following:

1. relevance of environmentally-friendly production methods (EFPMs) in consumer choice, and their interactions with place of origin (VdG);

2. the presence of unobserved heterogeneity or randomness in taste parameters (identification of $\tilde{\beta}_h$);

3. the presence of extra variance in alternatives involving purchase (significance of σ_ε);

4. the presence of a piece/wise linear effect of latent variables on marginal utility of income (various γ coefficients)

5. the presence of correlation across random coefficients.

Starting from a general model, each set of hypotheses has an associated restriction:

1. a given environmentally-friendly production method or its interaction with being produced in VdG is deemed as relevant in consumer choice if its $\hat{\beta}$ is statistically different from zero;

2. a given taste parameter is deemed as affected by unobserved heterogeneity or defined as random if its estimated scale parameter $\hat{\sigma}$ is statistically different from zero. This may or may not happen in conjunction with a corresponding location parameter estimate statistically different from zero;

3. additional variance in the utility of alternatives implying purchasing decisions is revealed by a significant scale parameter estimate $\hat{\sigma}_{\varepsilon}$ for the distribution of a zero mean error ;

4. piece-wise linearity of marginal utility of income is implied by significance in the estimated parameters for the interaction variables between cost and indicator functions for income effects;

5. finally, absence of correlation across random normal parameters can be tested by imposing a joint restriction on all elements of the associated Choleski matrix to be equal to zero.

4.5 Model evaluation and testing of hypotheses

Selected estimation results are reported in Table 4. We proceed using a bottom-up approach. We start from a basic fixed parameter conditional logit specification (Model 1 in Table 4). In Model 2 we allow for interactions between EFPMs and origin from VdG. Such an addition significantly improves the fit of the model, with a likelihood ratio test showing a p-value of $<$0.001.

Model 3 is the result of a specification search to identify possible random parameters. The taste parameters for organic and bio-dynamic are found to be random under the assumption of a normal distribution, while tests for randomness of IPM rejected the null. The values of BIC and AIC suggest this specification with random tastes is superior to Models 1 and 2 based on fixed parameters. Model 4 is the same as Model 3, except that it introduces a random error component associated with all utilities for alternatives involving purchase. The values of BIC and AIC greatly support the presence of such an error component and the attendant additional covariance that this introduces in utilities associated with hypothetical product profiles.

Model 5 allows for piece-wise linear marginal utility of income. This is a direct extension of Model 4 and as such it can be tested by using likelihood ratio tests for joint restrictions on the additional γ parameters for affecting marginal utility of income. Restrictions to zero on the effects of high income, having 1 or 2 children, and having 3 or more children show a p-value of

	Model 1	*Model* 2	*Model* 3	*Model* 4	*Model* 5	*Model* 6
Fixed parameters						
Cost	–0.80(10.7)	–0.80(10.7)	–1.17 (11.2)	–1.08 (10.7)	–1.41 (6.8)	–1.40 (8.0)
Cost$\times$high income					0.52 (2.4)	0.52 (2.9)
Cost$\times$1-2 kids					–0.32 (1.8)	–0.40 (2.8)
Cost$\times$3 or more kids					–1.39 (2.2)	–1.17 (1.4)
Bio-dynamic	–0.02 (0.1)	–0.15 (0.6)				
Organic	0.69 (9.3)	0.38 (1.7)				
Val Gresta	0.71(12.6)	0.37 (1.6)				
Integr.pest mgmt.	0.02 (0.1)	–0.29 (1.2)	–0.33 (1.4)	–0.78 (2.4)	–0.79 (2.4)	–0.82 (2.5)
Many skin imperf.	–0.47 (6.6)	–0.47 (6.6)	–0.74 (7.3)	–0.70 (7.2)	–0.70 (7.2)	–0.72 (7.2)
Few skin imperf.	0.05 (0.3)	0.02 (0.1)	–0.07 (0.4)	0.06 (0.3)	0.06 (0.3)	0.02 ($<$.1)
Org.$\times$ Val Gresta		0.59 (1.4)	1.00 (2.2)	1.31 (2.3)	1.37 (2.4)	1.48 (2.3)
Biodyn.$\times$ Val Gresta		0.19 (0.6)	0.54 (1.4)	0.59 (1.3)	0.67 (1.4)	0.60 (1.2)
Integr.$\times$ Val Gresta		0.54 (1.7)	0.81 (2.4)	1.15 (2.5)	1.13 (2.4)	1.34 (2.6)
No-purchase $\hat{\alpha}$	–2.15(12.8)	–2.36(10.8)	–3.04(12.1)	–4.61(11.0)	–4.70(11.2)	–4.73(10.3)
Random parameters						
Bio-dynamic $\hat{\mu}$			–0.37 (1.2)	–0.66 (1.8)	–0.69 (1.9)	–0.51 (1.5)
Bio-dynamic $\hat{\sigma}$			1.62 (7.8)	1.44 (7.5)	1.44 (7.6)	2.55 (8.8)
Organic $\hat{\mu}$			0.43 (1.7)	0.22 (0.7)	0.19 (0.6)	0.11 (0.3)
Organic $\hat{\sigma}$			1.20 (7.6)	0.99 (6.5)	1.02 (6.7)	1.38 (6.6)
Val Gresta $\hat{\mu}$			0.43 (1.6)	0.19 (0.6)	0.16 (0.5)	0.09 (0.3)
Val Gresta $\hat{\sigma}$			1.46(11.3)	1.06 (8.9)	1.02 (8.7)	1.12 (4.0)
Error component						
Purchase $\hat{\sigma}_{\varepsilon}$				2.69 (9.6)	2.62 (9.7)	2.55 (8.8)
Pseudo-R^2	0.11	0.11	0.17	0.22	0.23	0.23
$\ln \mathcal{L}^*$	–1,684	–1,682	–1,551	–1,457	–1,449	–1,443
Bayes IC	3,411	3,424	3,179	3,034	2,997	3,068
Akaike IC	3,383	3,386	3,130	2,957	2,935	2,936
	Observed choices = 1,949			Respondents = 240		

Table 4: Estimates for the models. In brackets absolute values of t-statistics.

	Bio-dynamic	Organic	Val di Gresta
Bio-dynamic	1.381 (0.21)	0.485 (0.16)	0.302 (0.17)
Organic	0.499	0.841 (0.18)	0.710 (0.22)
Val di Gresta	0.274	0.684	0.807 (0.20)

Table 5: Mod. 6: correlations (lower triangular), Choleski matrix (upper triang. and diagonal).

0.001. Hence the null is rejected for any confidence level higher than this very low value. We also note that the signs of these income interactions support the theoretical validity of the study as high income decreases marginal utility of income and having more kids increase it.

Finally, Model 6 allows for a full covariance structure across random components. The accompanying correlation table and elements of the Choleski matrix are reported in Table 5. Unsurprisingly, this model implies positive correlation of taste intensities between EFPMs and VdG origin as well as a positive correlation between the two random EFPMs.

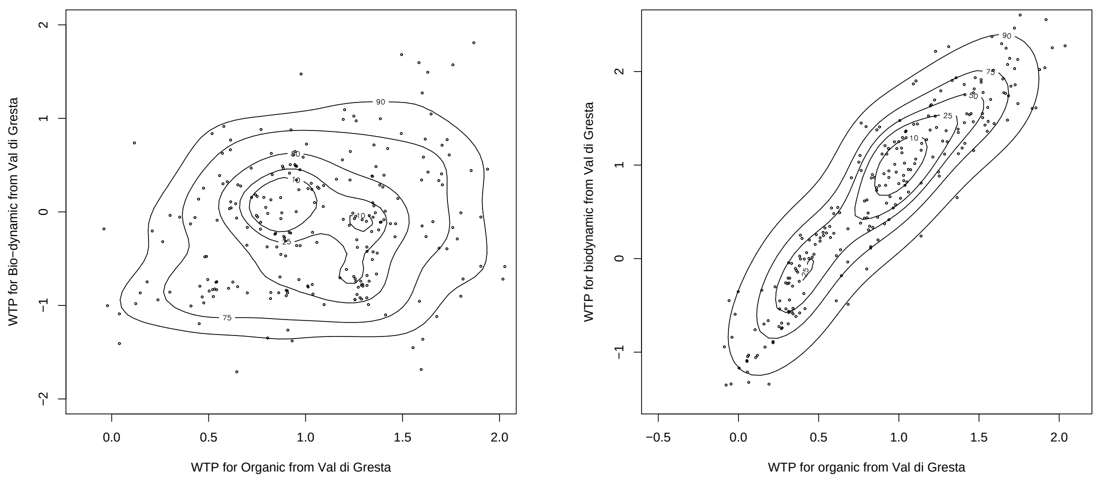
5 Results and discussion

Model 5 emerges as the specification most supported by our data according to the information criteria. All hypotheses fail to be rejected at very low probabilities of type I errors. We conclude that there is evidence of taste variation for bio-dynamic, organic and place of origin, the utilities of purchase alternatives are correlated and have larger variance than the one for the no-buy, and marginal utility of income varies across respondents responding to latent constraints, such as the number of kids and income level.

Note that the fixed parameters are baseline tastes. That is, they refer to taste commons to all respondents, so that the interaction parameters express intensities over and above these baselines. For example, from model 5 the average *WTP* per Kg for the attribute IPM not from VdG is negative (€0.56=–0.79/1.41), but the mean *WTP* for IPM from VdG is positive (€0.36=(–0.79+0.16+1.13)/1.41). We interpret this as evidence of the reputation effect of growers from this valley. Similarly, the *WTP* for the attribute organic when it is not from VdG is positive but low: only €0.13=0.19/1.41. But it is €1.22=(0.19+0.16+1.37)/1.41 per Kg when it is combined with the origin from VdG and for low income respondents. For high income responses this is much higher: €1.93=(0.19+0.16+1.37)/(1.41–0.52) per Kg.

The estimated mean marginal *WTP*s for all EFPMs from VdG—broken down by income constraints—are summarized in Table 6 for both uncorrelated (Model 5) and correlated (Model 6) specifications. Such values—derived as from eq. (8) with a composite γ—illustrate the advantage of accounting for a systematic heterogeneity in marginal utility of income, rather than

Figure 1: Bivariate kernel plots of conditional *WTP* estimates in €/kg.



(a) Model 5, without correlation.

(b) Model 6, with correlation.

assuming this parameter to be randomly distributed according to some unconditional parametric distribution. Estimated values are plausible and show how *WTP* is lowest for respondents with many children and low income. The relative magnitudes of the *WTP* estimates evaluated in combination with their precision seem to suggest that IPM would probably better received by consumers of VdG products than bio-dynamic methods. Nevertheless, the degree of uncertainty of the estimates is such that no clear-cut indication seems to emerge, except that the premium for organic from VdG ranges between a mean value of €0.55/Kg for people with low income and more than 2 kids up to €1.94/Kg for people on a high income and no-kids.

In Figure 1 we illustrate the implications of such results on the distribution of respondent-specific conditional *WTP* estimates for the sample, as from eq. (7). To illustrate this we use the bivariate kernel plots with cross-validated band-width of the distributions of marginal $\widehat{WTP}_i$ for the organic and BD when these are associated with VdG origin. The plot in panel 1.a illustrates the estimates from Model 5, which assumes independence across random parameters, while the plot in the plot in 1.b reports those from Model 6, which allows for correlation. We note the marked effect of a positive correlation in panel 1.b and that both ranges of implied *WTP* are plausible. The density in plot 1.b suggests bi-modality with a first mode at around €1/Kg for both EFPMs, and a second one at around €0.4/Kg for organic from VdG and bio-dynamic from VdG does not command any additional *WTP*. Both joint distributions are concordant in indicating mostly positive values for organic carrots from VdG, while the distribution of values for bio-dynamic carrots from this location is in large part negative or clustered around zero.

This is consistent with a low or nil *WTP* for BD.

The point estimates from interaction effects that became estimable by using an experimental design with 2-way effects suggest that there is a premium for all 3 EFPMs when they are associated with VdG origin. This is a clear indication of the collective reputation of this group of producers, and a measure of their success in pursuing a high quality standard in production. The estimates for BD, though are very inaccurate.

Attribute	*Bio-Dyn.×Gresta*		*Organic×Gresta*		*IPM ×Gresta*	
	Uncorr	*Corr*	*Uncorr*	*Corr*	*Uncorr*	*Corr*
Low income and no kids	0.10	0.13	1.22	1.20	0.36	0.43
	(0.4)	(0.5)	(6.0)	(6.4)	(1.5)	(1.7)
High income and no kids	0.16	0.21	1.94	1.92	0.57	0.68
	(0.4)	(0.5)	(6.6)	(8.0)	(1.5)	(1.7)
High income and 1 or 2 kids	0.12	0.14	1.42	1.31	0.42	0.47
	(0.4)	(0.5)	(6.6)	(7.7)	(1.5)	(1.7)
High income and 3 or more kids	0.05	0.07	0.66	0.69	0.20	0.24
	(0.4)	(0.5)	(4.0)	(2.8)	(1.4)	(1.5)
Low income and 1 or 2 kids	0.08	0.10	1.00	0.93	0.29	0.33
	(0.4)	(0.5)	(5.7)	(6.6)	(1.5)	(1.7)
Low income and 3 or more kids	0.04	0.06	0.55	0.57	0.16	0.20
	(0.4)	(0.5)	(4.4)	(3.3)	(1.5)	(1.5)

Table 6: Conditional estimates of marginal $\widehat{WTP}$ in €/kg for carrots produced in Val di Gresta with EFPMs. In brackets approximate absolute values of t-statistics obtained with the delta method.

6 Conclusions

We developed a choice-experiment to investigate consumer preferences over environmentally-friendly production methods (EFPMs) in carrots grown in a distinctive Alpine valley (Val di Gresta) where producers have been investing in building a collective reputation for the last three decades. To address unobserved taste heterogeneity we investigate the consequences of different specifications of mixed logit and to account for differences in marginal utility of income we used a piece-wise linear specification.

The presence of a reputation effect is supported by both the distribution of individual-specific *WTP* estimates, and by the significance of interaction effects between EFPMs and Val di Gresta origin. Integrated pest management practices, as well as the better established organic method of production seem to be the most promising avenues for producers from this valley, while bio-dynamic approaches appear to be less valued by consumers. Investment based on collective reputation is confirmed as an effective avenue through which producers located in marginal areas can secure customer loyalty and increase their revenues, thereby decreasing their reliance on external subsidies.

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