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The Role of Sensory Profile in the Extra-Virgin Olive Oil Consumers Choice[§]

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Abstract

sensory profiles promoted by the Extra-virgin olive oil (EVO) is an important element of the Mediterranean diet and a valuable agricultural crop for Southern Europe countries in terms of both farm income and cultivated area. Moreover, given the increased popularity of the Mediterranean diet among consumers in US, Canada, Australia and large parts Asia, EVO consumption has grown almost worldwide.
In Italy olive-oil production has switched from low yields and low-input cultivation to a capital intensive farming system involving innovations of both agricultural practices and processing techniques: sensory characteristics of the product were significantly improved, changing the traditional taste from "neutral odour and flavour" and well known organoleptic features, to new complex sensory profiles. This evolution is due to the developments that have taken place in the sensory analysis of olive oil and the use of trained panel responses as a means of monitoring and guidance in the production of quality oils.
Currently, agricultural research and sensory panels managed not only to identify what aspects of taste and smell are indicators of quality of the oil but also the correlation of these with the production techniques. The situation today is that consumers can find on the market EVOs characterized by well-differentiated sensory profiles. On the consumption side, however, buyers seem still to prefer neutral flavour oils with little or no personality. This aspect deserves a central position in present research on EVOs because consumer preferences risk undermining all efforts to improve the quality of the product made from the production side. In the following work, the role of sensory components in the consumers preferences of EVOs will be explicitly evaluated through an Hedonic Price model. During October 2012, a sample of 68 EVOs available on the shelf of a Supermarket belonging to one of the largest big retailers operating in Italy were bought. The 68 different EVOOs were also evaluated by a panel of expert tasters to get a precise sensory profile for each of them. The results estimation of a simultaneous two equations model well highlighted the idiosyncrasy of the consumers' preferences towards the trained experts.

Keywords:

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1 Introduction

Extra-virgin olive oil (EVO) is an important element of the Mediterranean diet and a valuable agricultural crop for Southern Europe countries in terms of both farm income and cultivated area (de Graaff and Eppink, 1999; Owen *et al*., 2000). Moreover, given the increased popularity of the Mediterranean diet among consumers in US, Canada, Australia and large parts Asia, EVO consumption has grown almost worldwide (Santosa and Guinard, 2011; International Olive Oil Council, 2012). Contextually, olive-oil production has switched from low yields and low-input cultivation to a capital intensive farming system involving innovations of both agricultural practices and processing techniques. This led to a considerable improvement of EVO nutritional characteristics accompanied by a deep change in sensory profile, turning a traditional food, with well known organoleptic features, to a brand-new kind of dressing.

All described processes made traders, researchers and policy makers to need to deepen their knowledge about consumer preferences towards intrinsic and extrinsic characteristics of EVO, which were turning more and more complex and structured. In recent years, this has led to a wide range of scientific production with the objective of identification the main extra-virgin olive oil attributes for the postmodern consumer. This research field largely used choice models, which allowed to identify product characteristics most relevant for consumers, evaluating the willingness to pay for a product with those characteristics too (Caracciolo *et al*., 2012).

This work follows the same research branch, but it has some noteworthy differences. First, the method used in our study is the Hedonic Price, which has received little attention in this specific field of research; in addition, explanatory variables include as well as a large set of search attributes that consumers can acquire through the label and the bottle observation, sensory profile variables too, acquired by a panel of expert tasters. While Hedonic price estimation in the wine sector has been applied worldwide (Caracciolo *et al*., 2013), as regards olive oil, in our knowledge there are only two works which used hedonic price to estimate attributes implicit price. Ribeiro and Santos (2004) relate price to characteristics as acidity, olives territorial origin and production method (organic), while, Karipidis, Tsakiridou and Tabakis (2005) relate the product price to label information, packaging and to different supply chains.

In our case study, the extra-virgin olive oil price has been linked to attributes which can be detected by the consumer observing the bottle (information on the label and packaging). These features, however, are not the only ones taken into account by the consumers in their decision processes. Several studies using other methods of research, such as RUM (Ward *et al*., 2003; Mtimet *et al*. 2008) or experimental analysis (Delgado and Guinard, 2010, Caporale *et al*., 2006; Baourakis and Baltas, 2003) have clearly emphasized that organoleptic features, as sensory profile, play a very important role in the choice. So, in our hedonic price model, sensory features of oils were also included, as characterized by a panel of expert tasters.

This will allow us to face two issues, which are now very relevant within the olive oil market in EU: a) The influence of organoleptic features on the consumers' choices comparing to other attributes, as area of origin or production method and b) whether consumers' preferences are aligned with those expressed by trained experts. The answer to these two questions will depict some policy considerations about EU olive oil regulations regarding labelling and sensory profile.

The paper will be structured as follows, in the next section we present the data used for the hedonic price model, followed by a presentation of the empirical model applied in this case study and the

estimates obtained. Finally, some policy analysis considerations will be presented arising from the results of the model. The paper will conclude with some final remarks.

2 Data

The whole shelf of extra-virgin olive oil, in Auchan hypermarket in Nola (Naples), was purchased on October, 13th, 2012. Overall, sixty-eight different bottles of EVOs were purchased. This sampling design was motivated by several considerations: 75% of the whole olive oil sold in Italy was bought in supermarkets and hypermarkets (*source* IRI – Infoscan, 2009). Moreover, the Auchan EVO shelf is one of the largest available within the Italian market. Product prices, albeit with slight variations due temporary and localized promotions, are essentially fixed throughout the country. All the products involved during the analysis have been collected in Auchan under the same conditions; it means that price is not affected by supply chain specific characteristics. Moreover, it is presumable that oil bottles received the same logistical treatment, so storage conditions (temperature and light conditions) influenced the products in the same way. The latter aspect is particularly relevant for sensory analysis.

During October 2012 were indeed analyzed 68 different EVOs by uniVino[1] experts: uniVino organized the experiment in order to provide a complete sensory profile for EVOs. Only one jury evaluated each and every EVO in a blind way. This ensured the judgments homogeneity.

The card used to identify the sensory profile is as set out in Regulation (EEC) No. 2568/91 and subsequent amendments. Each member of the *uniVino* jury expressed his opinion about oil sensory characteristics, filling in the card specified by Regulation (EEC) No. 2568/91 in order to identify levels of sensory features (*fruity*, *bitter*, *pungent* and *sweet*) and possible defects (rancid, musty, winey, fusty).

In particular, *fruity* means the range of flavours related to the olive variety and to healthy olives use, harvested while green or veraison. It is perceived via the nose or retronasally. This feature identifies a fresh and pleasant odour, which reminds of rubbed olive leaf, fruit, tomato leaf, artichoke, cut grass, green apple, almond. These sensations are the more perceptible, the more natural phenolic compounds are there, which are antioxidants protecting the oil during the storage and preventing our cells from aging. That aroma is particularly intense when the oil is “young”, and when fresh and vegetable odours prevail (green *fruity*); moreover, the term “ripely *fruity*” can be referred to an oil obtained from ripe fruit, which has a light and sweetish taste.

Bitterness is a typical taste sensation of an oil from green olives or veraison olives. Often this positive aspect of oil is confused by consumers with a free acidity feature, which it is not a perceptible flavour as free acids of the oil are odourless and tasteless. Pungent is a tingling tactile sensation, typical of oils produced in the early season or from green olives.

Sweet refers to an oil with a slight odour, which usually does not have taste and aromatic peaks and it can have a pleasant almonds aftertaste, usually it is obtained from ripe olives.

Oil defects can be of several kinds. The most common ones are: rancid, a flavour reminiscent of walnut, fat or plastic paint, due to air oxidation, or to old and bad stored oil; there are also fermentation-caused defects, such as “winey-vinegary”, a vinegar-like odour due to acetic acid and ethyl acetate excess during the fermentation; “Musty”, with a typical odour, due to fungi and yeasts grown on piled olives, “fusty”, typical flavour from olives stored in piles which have undergone an

[1] www.univino.it

advanced stage of fermentations, “muddy”, the odour reminiscent of brine and cheese, it is due to a long contact between oil and sediment that settles in underground tanks and vats. Other possible defects are “heated”, “rough” and “grubby”.

Each member of the jury expressed his judgment on each and every oil sensory feature using a scale from 0 to 5: 0 = not noticeable, 1 = barely noticeable, 2 = mild, 3 = average, 4 = high, 5 = extreme. The same scale was also used to evaluate defects.

At the end of each analysis, the members of the jury expressed a global opinion on the studied oil using a scale from 1 to 9, as required by EU regulation aforementioned.

1 to 3 = severe defects, clearly perceptible, odours and flavours totally unacceptable for consumption;

4 = considerable defects, at the edge of acceptability, unpleasant odours and flavours, that are clearly perceptible;

5 = perceptible defects, fruity slightly flawed, abnormal odours and flavours;

6 = barely perceptible and little defects, with a light fruity of any kind;

7 to 9 = no defects, fruity of olive and other fresh fruits.

The feedback obtained from the *uniVino* jury, along with search attributes which were detectable by observing the product on the shelf, were used as independent variables in the estimated Hedonic Price model.

Table 1 shows product characteristics sorted into three groups:

1. search attributes acquired through the label ;
2. search attributes acquired through the bottle observation;
3. experience attributes acquirable through the tasting experience.

The latter set of features, already used in some wine analysis (Orrego *et al*., 2012), is even more relevant in the olive oil case, as it is a frequent and repeated purchase product, so the taste experience occurs in relatively rapidly, in particular in Italy, which has the highest EVO consumption in the world. Search attributes detectable through the package observation are: bottle material (30% of the bottles was made from plastic), bottle type (10% had the typical traditional Italian design), bottle size (1 l or 0.75 l) and product appearance (10% oils were not filtered so they had a deeper color).

Twelve search attributes were instead detectable through the label. Three of them were country of origin-linked: the 56% of the sample was made of olive oils produced exclusively in Italy, the 22% had the PDO mark and the 69% reported Central Italy as the bottling place. This feature, according to other surveys (Cicia et al., 2005), is important in purchasing decision as the consumer often confuses it with the olives production place.

Table 1. Descriptive statistics of the EVO sample

Variables	Descriptive statistics			
	Modalities	Range	Average	Standard deviation
Price	Continuous		7.66	3.66
Sensory attributes				
Defects	Ordinal	0 - 5	0.38	0.75
Fruity	Ordinal	0 - 5	1.97	1.29
Bitter	Ordinal	0 - 5	1.81	1.27
Pungent	Ordinal	0 - 5	2.03	1.16
Sweet	Ordinal	0 - 5	1.75	0.7
Global evaluation	Ordinal	1 - 9	5.47	1.13
Search attributes on label				
PDO	Dichotomous	Yes:1 No:0	0.22	0.42
100% Italian	Dichotomous	Yes:1 No:0	0.56	0.5
Central Italy bottling	Dichotomous	Yes:1 No:0	0.69	0.46
Organic	Dichotomous	Yes:1 No:0	0.1	0.31
Other certifications	Dichotomous	Yes:1 No:0	0.21	0.41
Private label	Dichotomous	Yes:1 No:0	0.18	0.38
Sensory information	Dichotomous	Yes:1 No:0	0.56	0.5
Brand	Dichotomous	Yes:1 No:0	0.32	0.47
Website / Toll-free number	Dichotomous	Yes:1 No:0	0.76	0.43
Awards	Dichotomous	Yes:1 No:0	0.09	0.29
Nutritional info	Dichotomous	Yes:1 No:0	0.65	0.48
Search attributes bottle related				
750 ml	Dichotomous	Yes:1 No:0	0.26	0.44
Not filtered	Dichotomous	Yes:1 No:0	0.1	0.31
Plastic	Dichotomous	Yes:1 No:0	0.3	0.17
Traditional design	Dichotomous	Yes:1 No:0	0.09	0.29

Two features were related to certified production techniques: 10% of the oils analyzed was obtained through the organic method, while 21% had other types of ISO qualifications.

Three features were related to oil intrinsic properties, they were expressed through information about the product sensory profile, about nutritional properties, or about awards received in national or international competitions.

On some labels was possible to detect a toll-free number or a website that allowed the consumer to deepen the information on the product, if he wanted to.

The possible brand impact was evaluated through two different variables. The first takes into account the presence of a private label; while a second variable identifies the brand impact defining as

products of national importance those belonging to brands with an higher ranking in value in distribution points with a surface higher than 100 m² (source IRI - Infoscan, 2009).

About sensory analysis made by the jury for each oil, we have both the total score and the single scores associated with different attributes such as fruity, bitter, pungent and sweet and to the possible defects. By averaging the scores obtained from 68 oil, we had an average profile with sensory characteristics. Finally, it has been collected the dependent variable of the hedonic price model, expressed in price per litre, which has an average of 7.66 Euro.

3 Model Specification

Hedonic price method finds its roots in a pioneering article by Waugh (1928) in which the author observed that prices of some types of fresh vegetables varied considerably in the Boston wholesale market, and once regressed price with respect to certain vegetables physical characteristics revealed a clear relationship between price and product quality features. However, thanks to the works by Griliches the method showed its great potential (Griliches, 1961; Griliches, 1971; Fraumeni, 2000), while Rosen in 1974 will demonstrate how in market equilibrium, the implicit price can be seen as the value that consumers associate to an additional unit of a product feature.

Over the years, the method has found wide applications in many fields such as automotive industry (Atkinson and Halvorsen, 1984; Arguea and Hsiao, 1993; Couton et al 1996; Matas and Raymond, 2009), real estate market (Witte et al, 1979; Palmquist, 1984; Netusil et al. 2010), computer industry (Chow, 1967; Triplett, 1989). It was largely used for the identification of implicit price given by consumers to the environmental characteristics, too (Tagliafierro, 2005; Limehouse 2010).

The method has been widely applied in the market of agricultural products. In fact, in this research field, the method appears very promising as it allows to estimate the marginal value of product characteristics, whether research, experience or credence. Hedonic price studies in agri-food sector range from wine (Golan and Shalit, 1993; Oczkowski, 1994; Nerlove, 1995; Combris, Lecocq, and Visser, 1997; Steiner, 2004), fruit juices (Verneau, 2002, Eastwood, Brooker and Terry, 1986; Huffman, 1988; Portugal & von Oppen *et al*. 1999), wheat (Ahmadi-Esfahani and Stanmore, 1997), milk (Kolodinsky, 2008, Wang et al. 2008) to coffee (Teuber R. and R. Herrmann, 2012; Schollenberg L. 2008).

The hedonic pricing method assumes that goods consist of a bundle of characteristics and are valued by their utility-generating attributes. In other words, the market price reflects the good composition of the attributes, which, on the contrary, have no explicit price. To this extent, it is possible to value the attributes that compose the final good by analyzing the systematic variation in the price (Rosen, 1974). While the hedonic price estimation has been applied worldwide to the wine, few studies analyzed explicitly oil olive market (Karipidis *et al*., 2005). However, to date no previous research has explored how the sensory attributes of oil olive could influence the consumers' willingness to buy. In this paper, the hypothesis being tested is that the market price of the selected extra virgin oil olive, is a function of both oil olive search attributes and packaging, but also of sensory profiles: A hedonic price function not only may include the objective characteristics appearing, for example, on the label of the bottle but also the sensory attributes. Within this specification, the jury grade is a regressor of the hedonic equation. However in our model specification, the jury grade will constitute, at the same time, a dependent variable of a separate equation, the grade equation. The grade and the hedonic

equations constitute a system of equations, wherein the jury grade is endogenous, and they were estimated simultaneously via three stage least squares (Zellner and Theil, 1962).

(1) *hedonic equation* $\ln P_o = \mathbf{X}_o \boldsymbol{\beta} + g_o \delta + e_o$,

grade equation $g_o = \mathbf{Z}_o \boldsymbol{\gamma} + u_o$ with o =1,...,O

The dependent variable of the hedonic equation (ln Po) consists on the logarithm of the observed price in the market; $\mathbf{X}_o$ is a 1 × m vector of all observable attributes that characterize the olive oil o and $\boldsymbol{\beta}$ is a m × 1 parameter vector, measuring the effects of these attributes on the market price. The hypothesis being tested in this equation is that the market price of oil olive is function of both observable attributes and of the jury grade go, expressed in a 9 items scale, could affect through the estimation of parameter δ the oil olive market price.

The jury grade constitutes, in turn, the dependent variable of the grade equation. This equation measures through the estimation of s × 1 parameter vector $\boldsymbol{\gamma}$, the relationships between the jury grade and the 1 × s vector of the sensory attributes $\mathbf{Z}_o$. The hypothesis being tested in the grade equation is that the jury grade, is a function of the oil's sensory profile.

Within this specification, a chain of causal relationship between the sensory profiles and the market price through the jury grade role is involved: implicitly, we are assuming that the sensory profile of the oil olive affects the oil olive price indirectly through the overall grade given by the experts.

4 Empirical Analysis

Table 2 shows the estimation of the Hedonic Price model obtained through simultaneous equations, where one of the two is a semi-logarithmic equation with, as an independent variable, the *uniVino* judgment expressed as a linear function of oil sensory features.

This choice was suggested by several considerations. The use within the hedonic price function of the variable "scores obtained from product assessment by independent juries" is not new in hedonic price models, as it is already been used in the case of wine. In these cases, however, the aim is to highlight the impact on product price by the same judgment. While, in our case this variable is an index of sensory and organoleptic quality of the product. However, since this quality is defined, in accordance with Regulation (EEC) No. 2568/91, based on sensory features such as *fruity*, *bitter*, *pungent*, *sweet* and possible defects; the quality, in fact, is also sometimes a function, which in our model has been modeled along with the hedonic price equation through simultaneous estimation of the equations system.

Using this approach it is possible to evaluate the hypothesis that experts have a negative impact on price, since, as other studies have pointed out, consumers often show preferences towards EVO that may not agree with those of panelists.

Analysis of the results in Table 2 lead to interesting reflections. The hedonic price model shows quite clearly that search attributes that are statistically significant and with an higher implicit value are those origin-linked (Country Of Origin Labeling - COOL): Italian origin of olives, PDO and bottling place have a positive impact on price, respectively, of: + 41.8%, + 23.0% and + 27.9%. This conclusion is consistent with works that used random utility models (Caracciolo *et al*., 2012). Particularly interesting, however, it's the impact of the bottling place that has a greater importance than the PDO certification.

The same coherence in literature can be found about high implicit prices of “organic” characteristic (+ 40%). In contrast with other works using RUM methods, here, the implicit price is not significantly different from zero, or even negative, for well-known brands and private labels (- 17.8%). The other features available on labels have an implicit price not significantly different from zero, except for nutritional information that seem to have a negative impact on price (- 21.6%).

Regarding packaging features, they have a significant and negative coefficient, as traditional packaging has - 21.3% and 750 ml bottle has - 11.6%.

A deeper discussion is needed about the “organoleptic quality” variable, as supposed, it has a significant and negative value. Each additional point awarded by the jury leads to a reduction in price of 8.6%. The second equation shows that a positive judgment is positively correlated to no defects, and to strong notes of fruity and pungent, while sweet and bitter sensory features have a positive sign but values are not statistically significant.

This result seems to be in line with what reported in a recent meta-analysis of RUM studies using hypothetical choices in order to investigate consumer preferences about EVO characteristics (Caracciolo *et al*., 2012). In that case it was clear that consumers preferred oils with a neutral taste, i.e. without strong fruity, bitter and pungent flavors.

It should be noted, finally, the presence of the “defects” variable, which has a negative sign and is statistically significant, not only in the equation that describes the score assigned by the jury, but also in the hedonic price model (- 8.7%). This could be explained as some by the fact that some oils, known as flawed to producers, have lower prices.

Table 2. Estimates of the structural simultaneous system of equations (hedonic and jury grade)

	Hedonic equation				Jury grade equation		
	β Coef.		Std. Err.	Marginal effect (% change)	γ Coef.		Std. Err.
Sensory attributes							
Global evaluation	-0.09	**	0.047	-8.61			
Defects	-0.091	*	0.054	-8.70	-0.661	***	0.104
Fruity					0.453	***	0.062
Bitter					0.001		0.058
Pungent					0.144	**	0.064
Sweet					0.071		0.111
Search attributes on label							
PDO	0.207	**	0.108	23.00			
100% Italian	0.349	***	0.073	41.76			
Central Italy bottling	0.246	***	0.085	27.89			
Organic	0.322	***	0.115	37.99			
Other Certifications	0.035		0.078				
Private label	-0.196	**	0.086	-17.80			
Brand	-0.048		0.081				
Sensory information	0.089		0.073				
Website / Toll-free number	-0.152		0.1				
Nutritional info	-0.243	***	0.075	-21.57			
Awards	0.03		0.106				
Not filtered	0.204		0.134				
Packaging							
750 ml	-0.123	***	0.168	-11.57			
Plastic	0.331		0.096				
Traditional design	-0.239	*	0.145	-21.26			
Constant	2.2	***	0.29		4.411	***	0.302
# observations	68				68		
R^2	0.75				0.77		

5 Policy Discussion

This study pushes to a deep reflection about EU's policy towards EVO quality. In fact, our study clearly sets out how market does not recognize quality standards that the EU itself codified by Regulation (EEC) No. 2568/91 and subsequent amendments.

This regulation has been strongly influenced by oil research developments occurred in the 70s of last century. Montedoro (1972) and Solinas et al. (1978) showed that bitter and pungent flavours are due to antioxidants within oil, while reaserchers from Seville Instituto de la Grasa showed how, depriving oil from bitter and pungent flavors (polar and more soluble in water), it loses its antioxidant properties (Vazquez Roncero et al., 1976; Gutierrez et al., 1977). Such researches greatly influenced

oil production techniques, starting from the harvest anticipation to veraison, in order to maximize the presence of these substances within the final product.

In 1991 the EU, with the aforementioned Regulation (EEC) No. 2568/91, adopts these findings and states that sensory analysis for extra-virgin olive oil, based on Panel Test system is a discriminating tool. The regulation, in fact, giving guidance about classification of various oil types, considers some organoleptic aspects as necessary to define an oil as “extra-virgin”. In fact, it is specified that extra-virgin olive oil can be defined as this, only if derived solely from olives using mechanical or other physical means, has an acidity lower than 1, and a global Panel Test assessment higher or equal than 6.5.

Community regulations strictly define Panel Test role, too: "*The panel organizer shall be a suitably trained, knowledgeably person who is an expert on the kinds of oils which he will come across in the course of his work. (...) The work of the panel supervisor calls for sensory skill, meticulousness in the preparation of the tests and their rigorous arrangement, as well as for skill and patience in the planning and execution of the tests. (...) He shall ensure that his opinion is not known and shall prevent possible leaders from asserting their criteria over the other tasters. He shall also be responsible for training, selecting and monitoring the tasters in order to ascertain whether they are keeping up to an adequate level of aptitude." Also "Eight to 12 tasters are required for the test*"

In 1992 (Regulation EEC No. 1683/1992) puts forward details that deepen what was decided in the previous year and defines a specific vocabulary for sensory analysis, in most (3288/1992) are given further directions about how to constitute taste committees, as described in Regulation 2568/91, in order to define activities and inspection by the Member Countries.

The next Regulation (EEC) No. 796/2002 redefines methods for analytical expression of extra virgin olive oil introducing as a sensory discriminating factor the median for “fruity” (values above zero) and the median of the defects (it must be zero). For this purpose, it was also introduced a new sensory evaluation card to make the expression of the Panel judgment more strictly codified.

By Regulation (EEC) No. 1989/2003, the maximum acidity level of extra-virgin was lowered to a value of 0.8%.

Regulation (EEC) no. 640/2008 updated definitions of oil sensory evaluation terms and gave further information about sensory features and related optional references on the label. It was then possible to define oils according to sensory attributes on the label, but only if they are certified by an official panel. There are also further recommendations about Panel test: "The testers must be selected and trained on account of their skill in distinguishing between similar samples. The International Olive Council’s (IOC) manual on the selection, training and monitoring of qualified virgin olive oil tasters must be followed."

Panel capabilities are so constantly monitored through Ring Tests managed by IOC or, in Italy, from Ministry of Agriculture and Forestry. Ring Tests consist of an evaluation of five oil samples sent from IOC or Ministry in order to check the Panel’s skill in recognizing oil sensory features. Any failure in a Ring Test can make the Panel decay. This makes judgments from different Panels to be strongly homogeneous.

This body of laws makes the oil a unique product in agri-food system for what concerns EU regulations. Not even in the case of wine, where sensory profile is particularly relevant too, it is observed such strictness.

This address seems to be almost "exasperated" in what is specified in procedural guidelines of the 67 PDO and PGI oils registered in Italy until 31 December 2012. Table 3 shows required values in addition to the minimum Panel global score of different features as fruity, bitter, pungent and sweet, in order to obtain a certification. Since the minimum required score to define an oil as “extra-virgin” is 6.5 (Reg EEC 2568/91), it’s clear that the different procedural guidelines aim to increase this value, which, as shown by Table 2 model, involves a consequent increase of fruity, pungent and bitter values. It’s interesting to note that, only 7 of 67 procedural guidelines provide an high value of "sweet", which seems to be the most preferred feature by consumers (Caracciolo *et al*., 2012).

Table 3. Required standards in Italian EVOs PDO/PGI regulation

EVO	EVOs characteristics				
	Fruity	Bitter	Spicy	Sweet	Global score
Toscano PGI	3				7 - 9
Riviera Ligure PDO /Riviera dei fiori	2 - 3	2	1	4	7 - 9
Riviera Ligure PDO /Riviera del Ponente Savonese	2 - 3	2	1	4	7 - 9
Riviera Ligure PDO /Riviera di Levante	2 - 3	3	3	3	7 - 9
Seggiano PDO	3				7 - 9
Alto Crotonese PDO	2				6
Aprutino Pescarese PDO	4 - 5				7 - 9
Brisighella PDO	3 - 4	2	3		7 - 9
Bruzio PDO/Fascia Prepollinica	3				7 - 9
Bruzio PDO/Valle Crati	3				7 - 9
Bruzio PDO/Colline Joniche Presilane	2				6
Bruzio PDO/Sibaritide	2	2			6
Canino PDO	5	1	1		7 - 9
Cartoceto PDO	2 - 3				7 - 9
Cilento PDO	2 - 3	2 - 3	2 - 3		7 - 9
Collina di Brindisi PDO	3	2	2		7 - 9
Colline di Romagna PDO	3 - 4	2	2		7 - 9
Colline Pontine PDO	3 - 4	2 - 3	2 - 3		7 - 9
Colline Salernitane PDO	3 - 4	2 - 3	2		7 - 9
Colline Teatine PDO	2 - 4				7 - 9
Colline Teatine PDO/Frentano	3	2	2		7 - 9
Colline Teatine PDO/Vastese	3	2			7 - 9
Dauno PDO/ Alto Tavoliere	3			3	7 - 9
Dauno PDO/ Basso Tavoliere	3	2	2		7 - 9
Dauno PDO/ Gargano	3				7 - 9
Dauno PDO/ Sub-Appennino	3				7 - 9
Garda PDO/ Bresciano	2 - 3	2	2		7 - 9
Garda PDO/ Orientale	2			3	7 - 9
Garda PDO/ Trentino	2				6
Laghi Lombardi PDO	2 - 3	2	2		7 - 9
Lametia PDO	3				6
Lucca PDO	2 - 3	2 - 3	2 - 3	3	7 - 9
Molise PDO	2 - 3	1	1		7 - 9
Monte Etna PDO	2	2	2		7 - 9
Monti Iblei PDO/ Monte Lauro	3		3		7 - 9
Monti Iblei PDO/ Val d'Anapo	2		2		7 - 9
Monti Iblei PDO/ Val Tellaro	3		3		7 - 9
Monti Iblei PDO/ Frigintini	4		3		7 - 9
Monti Iblei PDO/ Gulfi	4		3		7 - 9
Monti Iblei PDO/ Valle dell'Irminio	2		2		7 - 9
Monti Iblei PDO/ Calatino	2		2		7 - 9
Monti Iblei PDO/ Trigona - Pancali	2		2		7 - 9
Penisola Sorrentina PDO	3	2 - 3	2 - 3		7 - 9
Pretuziano delle Colline Teramane PDO	3	3	3		7 - 9
Sabina PDO	3	3	3	3	7 - 9
Sardegna PDO	3	3	3		7 - 9
Tergeste PDO	3	2 - 3	2 - 3		7 - 9
Terra d'Otranto PDO	3	2	2		7 - 9
Terre di Bari PDO/ Castel del Monte	4	3	3		7 - 9
Terre di Bari PDO/ Bitonto	3	2	2		7 - 9
Terre di Bari PDO/ Murgia dei Trulli e delle Grotte	2	2	2		7 - 9
Terre di Siena PDO	3	1	1		7 - 9
Terre Tarantine PDO	3	3	2		7 - 9
Tuscia PDO	3	1	1		7 - 9
Umbria PDO/ Colli Assisi-Spoleto	4 - 5	4	4		7 - 9
Umbria PDO/ Colli Martani	3 - 4	3 - 4	3 - 4		7 - 9
Umbria PDO/ Colli Amerini	3	2 - 3	2 - 3		7 - 9
Umbria PDO/ Colli del Trasimeno	2 - 3	2 - 3	2 - 3		7 - 9
Umbria PDO/ Colli Orvietani	3	3	3		7 - 9
Val di Mazara PDO	3			1	7 - 9
Valdemone PDO	3 - 4	3			7 - 9
Valle del Belice PDO	3 - 4	2 - 4	2 - 4		7 - 9
Valli Trapanesi PDO	4	2	2		7 - 9
Veneto PDO/ Veneto Valpolicella	2	2			6
Veneto PDO/ Veneto Euganei e Berici	3	2			7 - 9
Veneto PDO/ Veneto del Grappa	3	2			7 - 9
Vulture PDO	3	2 - 3	2 - 3		7 - 9

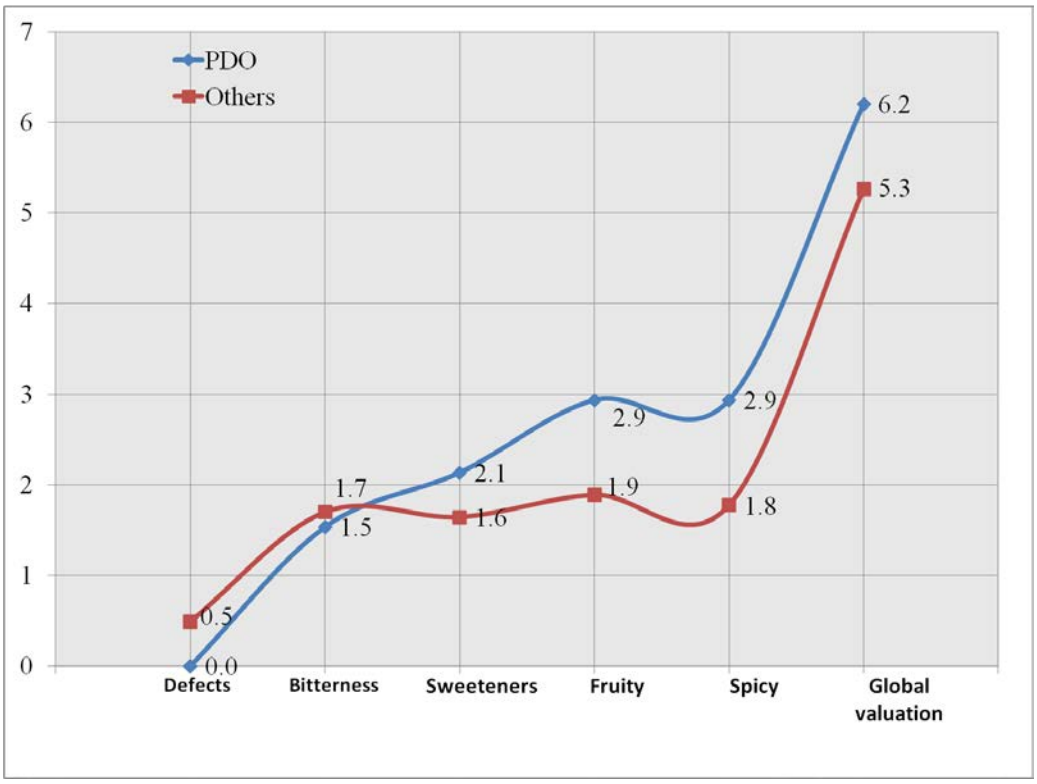

Figure 1. PDO Sensory Profile vs "Others" Sensory Profile

Much restrictive values required by PDO/PGI procedural guidelines emerged clearly in this study, too. Fig. 1 shows the mean scores of PDO/PGI oils vs. others. Although sensory analysis was blind, it is clear that PDO/PGI oils have a superior sensory profile as well as an higher average of global score.

In fact, consistently with reflection hitherto produced, in Hedonic Price model, shown in Table 2, it is clear that among the three COOL indicators used in this study, PDO certification generates the lower premium price, equal to almost an half of "100% Italian" certification, and even lower than "bottling place" premium price, which gives no guarantee about olives origin.

At this point, a clear paradox arises, as more than twenty years passed from the birth of the EU policy that aimed at raising EVO quality features through a strict defined and vertically controlled oil sensory profile; so products that receive an high score from Panels and juries are penalized on the market.

This conclusion seems to be paradoxical, a kind of an attempt from policy makers to force consumers' sensory preferences. They have been accustomed to EVO neutral taste due to traditional production techniques, and accentuated from the '60s by a strong growth in vegetable oil consumption, which was historically alien to Italian food culture until First World War (ISTAT, 1968), so consumers find it hard to recognize EVOs with more complex sensory profiles as higher quality products.

With a consumers' preferences structure set this way, EU policy inspired by healthy considerations should have been accompanied by a strong communication policy that would emphasize health related aspects, so ultimate European legislation should have recognized high sensory profile EVOs as higher quality products. This lack of communication is not a new element, considering that even in organic farming the same criticism has been drawn toward EU policy.

6 Concluding remarks

The Hedonic Price analysis about EVOs in Italy conducted in this study clearly emphasized certain elements. Among several attributes that the consumer might consider while buying an oil bottle, the ones that seem to be rewarded by the market, are primarily those origin-linked (COOL attributes), such as: olives territorial origin, bottling place and PDO certification, followed by organic production method.

This study used, as independent variables, EVOs sensory profile too, because of their great importance both on the consumer side and about EU quality policy seen through the body of laws. This profile was obtained through the judgments of an independent jury.

The study highlights a clear discrepancy, as oils that received an higher rating by experts jury are not rewarded by the market. While experts tend to reward high sensory profile oils, which often are the ones with an higher healthy antioxidants content, consumers seem to prefer lower sensory profile products. This poses a profound reflection about European Union's policy in this sector, which over the last twenty years aimed at increasing sensory/quality profile of this product.

References

AAVV, Commission Regulation (EEC) No 2568/91 of 11 July 1991 on the characteristics of olive oil and olive-residue oil and on the relevant methods of analysis

AAVV, Commission Regulation (EEC) No 1683/92 of 29 June 1992 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-residue oil and on the relevant methods of analysis

AAVV, Commission Regulation (EEC) No 3288/92 of 12 November 1992 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-residue oil and of the relevant methods of analysis

AAVV, Commission Regulation (EC) No 796/2002 of 6 May 2002 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-pomace oil and on the relevant methods of analysis and the additional notes in the Annex to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff

AAVV, Commission Regulation (EC) No 1989/2003 of 6 November 2003 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-pomace oil and on the relevant methods of analysis

AAVV, Commission Regulation (EC) No 640/2008 of 4 July 2008 amending Regulation (EEC) No 2568/91 on the characteristics of olive oil and olive-residue oil and on the relevant methods of analysis

Ahmadi-Esfahani F.Z. & Stanmore R.G. (1997) Export demand for attributes of Australian wheat in Asia and the Middle East, Food Policy 22 (2) pp. 145-154.

Arguea, N. & Hsiao, C. (1993), Econometric Issues of Estimating Price Functions: With An Application to the US Market for Automobiles. Journal of Econometrics, 56 (1-2) (March), pp. 243-67.

Atkinson, S.E. & Halvorsen (1984), A New Hedonic Technique for Estimating Attribute Demand: An Application to the Demand for Automobile Fuel Efficiency, The Review of Economics and Statistics, 166, 417-426.

Baourakis G. & Baltas G. (2003) Comparative Behavioural Analysis in Selected EU Countries: A Brand Modelling Approach, Operational Research. An International Journal 3(2) pp.165-182.

Brooker, J.R., Terry D. E., Eastwood D. B., (1986) Hedonic Pricing Of Food Items Based On Nutritive Attributes, Journal of Food Distribution Research, (17) 1.

Caporale G., Policastro S., Carlucci A., Monteleone E. (2006) Consumer expectations for sensory properties in virgin olive oils, Food Quality and Preference 17, (1-2) pp. 116-125.

Caracciolo F., Cavallo C., Cicia G. and Del Giudice T. (2012) Private and public policies for extra-virgin olive oil: a meta-analysis on consumer preferences, 126th EAAE Seminar, Capri, June 27th- 29th, 2012.

Caracciolo, F., Cembalo, L. and E. Pomarici (2013). The hedonic price for an Italian grape variety, *Italian Journal of food science*, 3(25).

Chow G. C.(1967) Technological change and the demand for computers. American Economic Review, 57(5): 1117–30.

Cicia G., Del Giudice T., and Scarpa R. (2005) Welfare Loss due to lack of traceability in extra-virgin olive oil: a case study, Cahiers Options Méditerranéennes , 64: 19-32

Combris, P., S. Lecocq, and M. Visser. (1997) Estimation of a Hedonic Price Equationfor Bordeaux Wine: Does Quality Matter?, Economic Journal 107: 390–402

Couton, C. et al (1996), Hedonic prices for environmental and safety characteristics and Akerlof effect in the French car market, Applied Economics Letters, 3(7), 1996.

de Graaff, J., and L. A. A. J. Eppink, 1999. Olive oil production and soil conservation in southern Spain, in relation to EU subsidy policies, Land Use Policy 16, 259-267.

Delgado C., Guinard J. (2010) How do consumer hedonic ratings for extra virgin olive oil relate to quality ratings by experts and descriptive analysis ratings?, Food Quality and Preference 22(2), pp. 213-225.

Eastwood, D. B., J. R. Brooker, and D. E. Terry, (1986), Household Nutrient Demand: Use of Characteristics Theory and a Common Attribute Model, Southern Journal of Agricultural Econonmics, 17(12), pp.235-46.

Fraumeni, B. (2000), Zvi Griliches and his contribution to economic measurement, Survey of Current, Business, 1, 15–17.

Golan, A. and Shalit, H. (1993), Wine Quality Differentials in Hedonic Grape Pricing, Journal of Agricultural Economics 44, 31 1-321.

Griliches, Z. (1961), Hedonic Price Indexes For Automobiles: An Econometric Analysis Of Quality Change, The Price Statistics of the Federal Govern, 1961.

Griliches, Z. (1971), Introduction: hedonic price indexes revisited, Price indexes and quality change, Cambridge MA: Harvard University Press.

Gutiérrez González-Quijano R., Janer del Valle C., Janer del Valle M.L., Gutiérrez Rosales F. y Vázquez Roncero A. (1977) Relación entre los polifenoles y la calidad y estabilidad del aceite de oliva virgen, Grasas y Aceites 28 101-106

Huffman, W.E. (1988), An Econometric Methodology for Multiple-Output Agricultural Technology: An Application of Endogenous Switching Models, in Agricultural Productivity: Measurement and Explanation, Capalbo, S. M. and J. M. Antle (eds.), Washington, D. C.: Resources for the Future, Inc., 1988, pp. 229-244.

International Olive Oil Council (2012). Table 4: Consumption (1000 tonnes). Retrieved from: <http://www.internationaloliveoil.org/documents/viewfile/4190-consommation1/3 >.

Karipidis P., Tsakiridou E. and Tabakis N. (2005) The Greek Olive Oil Market Structure, Agricultural Economics Review, 6 (1).

Kolodinsky J. (2008) Affect or information? Labeling policy and consumer valuation of rBST free and organic characteristics of milk, Food Policy, 33 pp. 616-623.

Limehouse F. F. (2010) The Demand for Environmental Quality: An Application of Hedonic Pricing in Golf, Journal of Sports Economics 11 (3) pp. 261-286.

Matas, A. & Raymond J. (2009) Hedonic prices for cars: an application to the Spanish car market, 1981-2005. Applied Economics, 41 (22) 2887-2904.

Mtimet N., Kashiwagi A.K., Zaibet L., Masakazu N. (2008) Exploring Japanese olive oil consumer behavior, 12th EAAE Congress 'People, Food and Environments: Global Trends and European Strategies', Gent (Belgium), 26-29 August 2008.

Montedoro, G. (1972) Costituenti fenolici presenti negli oli vergini di oliva Nota I: Identificazione di alcuni acidi fenolici e loro potere antiossidante. Sci. Tecnol. Aliment, 3, 177-186.

Nerlove, M. (1995), Hedonic Price Functions and Measurement of Preferences - The Case of

Swedish Wine Consumers., European Economic Review, 39 (1), 1697-1716.

Netusil, N. R. et al. (2010) Estimating the Demand for Tree Canopy: A Second-Stage Hedonic Price Analysis in Portland, Oregon, Land Economics, 86 (2) pp. 281-293.

Oczkowski E. (1994), A Hedonic Price Function For Australian Premium Table Wine, Australian Journal of Agricultural and Resource Economics, 38 (1) pp. 93-110

Orrego M. J. E., Defrancesco E., Gennari A. (2012) The wine hedonic price models in the "Old and New World": State of the art, Revista de la Facultad de Ciencias Agrarias, 44(1): 205-220

Owen, R. W., A. Giacosa, W. E. Hull, R. Haubner, G. Würtele, B. Spiegelhalder, and H. Bartsch, 2000. Olive-oil consumption and health: the possible role of antioxidants, The lancet oncology 1, 107-112.

Palmquist, R.B. (1984) Estimating the Demand for the Characteristics of Housing. Reiew of. Economics and Statistics, 66 (August):394-404.

Portugal L.A. J. et al. (1999), Agricultural markets from theory to practice: field experience in developing countries, Agricultural markets from theory to practice: field experience in developing countries.

Portugal, L. A. J. & von Oppen M. (1999), The use of hedonic price analysis in agricultural research: market prices and the quality characteristics of beans in Colombia. In Harriss-White, B. (Ed.), Agricultural Markets from Theory to Practice. Field experience in developing countries. Macmillan Press Ltd, London, pp 180-190.

Ribeiro, J. C., Santos J. F. (2005), Portuguese olive oil and the price of regional products: does designation of origin really matter?, Tékhne – Polytechnical Studies Review, Vol. II No.3, pp.61-76.

Rosen, S. (1974). "Hedonic prices and implicit markets: product differentiation in pure competition." Journal of Political Economy 82(1): 34-55.

Santosa, M., and J.-X. Guinard, 2011. Means-end chains analysis of extra virgin olive oil purchase and consumption behavior, Food Quality and Preference 22, 304-316.

Schollenberg L. (2012) Estimating the hedonic price for Fair Trade coffee in Sweden, British Food Journal, 114 (3), pp. 428 – 446.

Solinas, M., Di Giovacchino, L., & Mascolo, A. (1978). I polifenoli delle olive e dell'olio d'oliva. Nota III: Influenza della temperatura e della durata della gramolatura sul contenuto in polifenoli degli oli. Riv. Ital. Sost. Grasse, 55, 19-23.

Soressi M., (2009), L'olio arranca sospinto da promozioni e offerte, Olivo e Olio, 10, pp. 16-17.

Steiner, B.E. (2004) Australian wines in the British wine market: A hedonic price analysis, Agribusiness, 20 (3) pp. 287-307

Tagliafierro C. (2005), La stima del valore del paesaggio nei modelli edonici spaziali: un'applicazione nel mercato immobiliare di Massa Lubrense, Rivista di Economia Agraria, 3: 577-602.

Teuber R. & Herrmann R. (2012) Towards a differentiated modeling of origin effects in hedonic analysis: An application to auction prices of specialty coffee, Food Policy 37, pp. 732-740.

Triplett, J.E. (1989), Price and Technological Change in a Capital Good: A Survey of Research

on Computers, in D.W. Jorgenson and R. Landau (eds.), Technology and Capital Formation, Massachusetts Institute of Technology Press, Cambridge, MA.

Vázquez Roncero A., Janer del Valle C. y Janer del Valle Mª.L. (1976) Componentes fenólicos de la aceituna. III. polifenoles del aceite, Grasas y Aceites 27 185-191.

Verneau, F. & Nizza S. (2002) Scelte di consumo e variabilità di prezzo: il settore dei succhi di frutta in Italia, Rivista di Economia Agraria, 57 (1), pp. 89 - 107.

Wang Z., Mao Y., Gale F. (2008) Chinese consumer demand for food safety attributes in milk products, Food Policy 33, pp. 27-36.

Ward, R.W., Briz, J. and de Felipe, I. (2003), Competing Supplies of Olive Oil in the German Market: An Application of Multinomial Logit Models, Agribusiness 19 (3), 393–406.

Waugh, F. V. (1928) Quality Factors Influencing Vegetable Prices. Journal of Farm Economics 10, 185-96.

Witte, A. D., Sumka, H. J. and H. Erekson (1979) An Estimate of a Structural Hedonic Price Model of the Housing Market: An Application of Rosen's Theory of Implicit Markets" Econometrica 47, 1151-1173.

Zellner, A. and H. Theil. 1962. Three-Stage Least Squares: Simultaneous Estimation of Simultaneous Equations. Econometrica 30(1), pp. 54-78.