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Is the extra virgin olive oil market facing a process of differentiation? A hedonic approach to disentangle the effect of quality attributes

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SUMMARY: The differentiation process by quality attributes continues to be an ongoing issue in the Spanish olive oil market. In addition, there is a significant percentage of uninformed consumers with erroneous and confusing ideas concerning this product of daily use. By estimating a hedonic price function using multiple regression analysis, this paper examines the price structure of extra virgin olive oil (EVOO) as well as the contribution of its attributes to the consumers' utility function in comparison with other olive oils. The price and attributes have been collected from the labelling of the products at the main supermarkets in two olive oil-producing cities of southern Spain. The results show that the EVOO price is higher in products whose labels clearly indicate either the acidity or the olive variety, and bear the "Certified Quality" of the Andalusian logo. Nonetheless, several key attributes for a differentiation of quality were no significant such as flavor and PDO. The evaluation of these attributes implies the emergence of an incipient differentiation process. Furthermore, brands have an impact on the price of EVOO but it depends on whether they are private or manufacturer's brands. This study provides insight into the Andalusian EVOO market as well as guidance for marketing strategies.

KEYWORDS: *Andalusia; Attributes; Box-Cox; Differentiation; Hedonic price function; Implicit price*

RESUMEN: ***¿Se está llevando a cabo un proceso de diferenciación en el mercado del aceite de oliva virgen extra? Un enfoque hedónico***. La diferenciación entre calidades de aceite de oliva es una tarea aún pendiente del sector oleícola, que se enfrenta a una gran cantidad de consumidores desinformados, que tienen ideas confusas y erróneas sobre un alimento de uso cotidiano. A través de la estimación de la función de precios hedónicos, este trabajo analiza la estructura del precio del aceite de oliva virgen extra (AOVE) así como los atributos que le añaden o le restan valor, con el objetivo de identificar en qué medida el mercado está poniendo en valor determinados atributos que diferencian al AOVE de otros aceites de oliva. La información necesaria sobre precios y atributos ha sido obtenida a partir del etiquetado de los productos presentes en las principales cadenas de supermercados de dos ciudades productoras de aceite de oliva de Andalucía. Los principales resultados muestran que el precio de un AOVE será mayor si en su etiqueta aparece la acidez o la variedad de aceituna, y si tiene el sello de "Calidad Certificada" de Andalucía, atributos que en efecto suponen la emergencia de un proceso, aún incipiente, de diferenciación del AOVE. Las marcas comerciales también tienen un importante impacto sobre el AOVE, pero éste depende de si se trata de una marca de distribuidor o de una empresa líder del sector. Esta información es interesante para conocer el mercado andaluz actual y puede servir a los productores para orientar posibles actuaciones dentro del marketing mix.

PALABRAS CLAVE: *Andalucía; Atributos; Box-Cox; Diferenciación; Función de precios hedónicos; Precio implícito*

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1. INTRODUCTION

Olive oil is one of the essential elements of the world-renowned Mediterranean diet and as a result, in recent years, according to the International Olive Council (IOC, 2015), since 2007 the consumption of olive oil has increased significantly in non-producing areas such as the United States (22.5%), Russia (58.8%) and China (77.8%). However, most of the world's consumption is still concentrated in the main producing countries (Spain and Italy represent around 40% of world consumption), where olive oil is traditionally used on a daily basis.

Most studies point out that consumers appear to have little knowledge about olive oil categories and properties in both non-producing countries (García-Martínez *et al.*, 2002; Matthäus and Spener, 2008) and the traditional producing ones (Fotopoulos and Krystallis, 2001; Calatrava-Requena and González-Roa, 2003; García-González and Aparicio, 2010; Sottomayor *et al.*, 2010; Torres- Ruiz *et al.*, 2012). In fact, according to Calatrava-Requena and González-Roa (2003), the common designation of "olive oil" used for the four different market categories[1] available for consumption leads to confusion among consumers. These categories differ from each other in terms of quality, composition and organoleptic properties, especially when comparing olive oil (OO) and extra virgin olive oil (EVOO).

In addition, the current legislation (EC, 2012a) does not help in this differentiation since it induces consumer to fall into a "semantic trap" caused by the use of the generic term of the product "olive oil" as a category itself. The market category olive oil ("Olive Oil - composed of refined olive oils and virgin olive oils"), obtained through a refining process, loses the name "virgin" because it is treated with chemical solvents. Refined olive oil (known by consumers simply as olive oil –OO from now on–) is a colorless product and has neither flavor nor aroma, so it is blended with a non-regulated small percentage (2–20%) of virgin olive oil which gives the product its organoleptic properties, resulting in homogenous products within this category. In this context, it is easy to understand that this product is hardly differentiable by means of its intrinsic characteristics.

On the other hand, Extra Virgin Olive Oil (EVOO from now on) is a "superior category olive oil obtained directly from olives and solely by mechanical means" (this description appears in fine print and not necessary close to the official designation – "Extra Virgin Olive Oil"), thus, it is entirely made of olive juice, maintaining its healthy and organoleptic properties. The category EVOO is heterogeneous in nature, varying according to olive varieties, harvest year, post-harvest handling and manufacturing process, among other things. These are factors that generate differentiating properties such as flavor, aromas and textures which are transferred to food. Hence, the EVOO possesses a high potential for differentiation, with the wine market of some Spanish regions as a good example to follow to endow the EVOO with added value (Langreo, 2002). Specifically, it is crucial to avoid EVOO being seen as a standard commodity by consumers.

Although OO and EVOO are clearly two different products, it is worth noting that the level of consumption of EVOO is lower than that of OO (Table 1). However, as Table 2 shows, EVOO is around €0.30 kg^{-1} more expensive than OO, therefore, it is not the price the main cause of the lower consumption of EVOO in Andalusia.

Additionally, the accusations of "dumping" strategies involving EVOO carried out by large distribution companies, have become quite frequent in recent years, using EVOO as a bait or "produit d'appel" to attract potential clients (Briz-Escribano *et al.*, 2010). This is a worrying situation because the lack of differentiation between the two market categories causes EVOO to be under-valued (Calatrava-Requena and González-Roa, 2003; Torres- Ruiz, *et al.*, 2012) and it has led to the creation of a government agency, the Agency of Information and Food Control (BOE, 2014), which is responsible for preventing these illegal business practices that damage the olive oil image and obscure its differentiation.

Nonetheless, the olive oil sector seems to have begun a new stage based on differentiation strategies in order to increase the added value of EVOO. The apparent emergency of this phenomenon may be due to a combination of factors such as: i) the recent activities carried out by the Spanish Olive Oil Inter-professional Association, focused on promoting mono-varietal EVOOs (BOE, 2003); ii) the determination of the Protected Designations of Origin (PDOs) to protect their genuine EVOO (Pérez y Pérez *et al.*, 2013) and the commitment of many cooperatives to gain a greater EVOO fraction by packaging and selling by their own (MAPA, 2003); and finally, iii) a growing niche in the market segment of consumers informed and interested in healthy, quality products (Navarro *et al.*, 2010).

Taking into account the above-mentioned complex situation, the aim of this paper is to examine

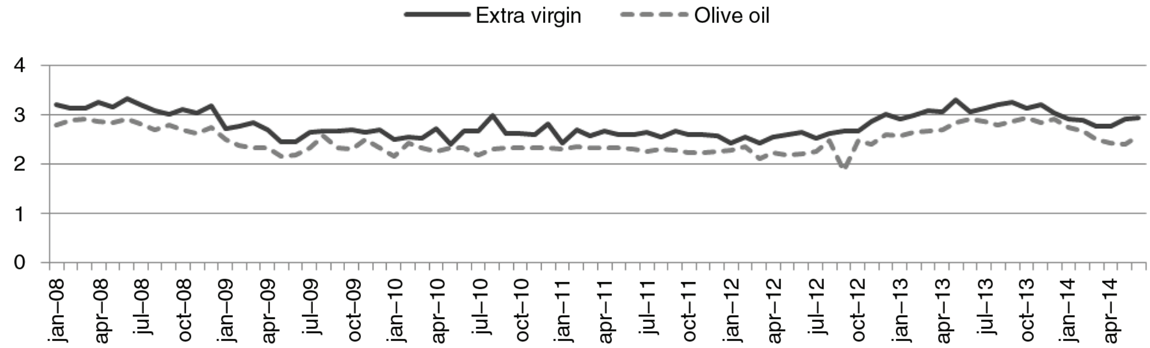
Table 1. Consumption per capita in Andalusia (kg)

	2008	2009	2010	2011	2012	2013
Extra virgin olive oil	4.27	4.48	4.09	3.55	3.22	3.07
Olive oil	4.99	4.98	4.67	4.41	4.21	3.44
Total olive oil	9.9	10.03	9.29	9.21	9.18	8.41

Source. MAGRAMA (2015).

[1]The olive oil categories are extra virgin olive oil, virgin olive oil, olive oil and olive-pomace oil (EC, 2012a)

Table 2. Monthly evolution of target prices in Andalusia (€ kg^{-1})



	2008	2009	2010	2011	2012	2013
Extra virgin	3.14	2.65	2.6	2.58	2.62	3.11
Olive oil	2.8	2.36	2.28	2.28	2.28	2.8

Source. MAGRAMA (2015).

whether the market is really facing a differentiation process or it is a business strategy. Thus, we collected 299 observations of EVOO products available from main supermarket chains to estimate a hedonic price model, as Karipidis *et al*. (2005) in Greece, Santos and Ribeiro (2005), in Portugal, and Romo *et al*. (2013), in Chile have done. We examined the underlying characteristics of EVOO that are involved in determining its price. The estimation of a hedonic price function has the advantage of working with real products that are available to consumers in the marketplace and to estimate the value placed on each EVOO attribute and which of them contribute to the differentiation process. Although there are alternative methodological approaches, such as conjoint analysis and choice experiments, they focus on stated preferences using hypothetical products (see some examples at Fotopoulos and Krystallis, 2001; Scarpa and del Giudice, 2004; Krystallis and Ness, 2005; Bernabéu *et al*., 2009; Erraach *et al*., 2014; Aprile *et al*., 2012). To the author's knowledge, there are no previous studies on the olive oil Spanish market that analyze the value placed on each EVOO attribute using a hedonic function.

The paper is structured as follows: the following section provides the theoretical background of the hedonic price methodology, including the data which has been used in this paper; the estimation of the hedonic price function and the main conclusions of the study are then presented.

2. MATERIALS AND METHODS

2.1. The hedonic price function

The hedonic price approach developed by Rosen (1974) argues that the price of a heterogeneous good is formed by adding the price of its characteristics or "attributes", called implicit prices $P(z_i)=P(z_{i1}, z_{i2}, \ldots, z_{ik})$, with the price of a good being a function of the vector of attributes, z_i. According to Lancaster (1971), consumers obtain utility directly from these attributes, rather than the product itself. Considering that consumers choose only one product and that they are price takers, their utility is given by the expression:

$$U(z_i, x; s)$$

where x is the vector of others goods in the consumer basket, and s is the characteristics of each consumer. Consumers make their decisions maximizing their utility and subject to a budget constraint $M=x+P(z_i)$, thus the expression:

$$\frac{U_{z_{ik}}}{U_x}=P_{z_{ik}}$$

indicates that the marginal ratio of substitution between the attribute z_{ik} and x must be equal to the implicit price of the attribute, $P_{z_{ik}}$. Finally, this approach makes the assumption that the market is in a state of perfect competition, so in the long-run equilibrium the implicit price of each attribute can be read into the value consumers place on each attribute (Combris *et al*., 1997).

The economic theory does not solve the problem as to which is the most suitable functional form of the hedonic price function, so it is a decision that researchers have to make empirically. The linear form implies that the implicit prices are constant, i.e. the additional price of one attribute is not influenced by the amount acquired (Gracia *et al*., 2004), and it is only possible if consumers are able to compose the set of attributes at their own discretion (Gracia and Pérez y Pérez, 2004).

Thus, The Box-Cox transformation has usually been applied to solve this problem (Box and Cox, 1964). This approach nests alternative functional forms by adding non-linear parameters, θ and λ, on the dependent and independent variables, respectively. The most frequent forms of the hedonic price function are the linear-logarithmic (lin-log), the semi-logarithmic (log-lin) and the double logarithmic (log-log), which can be tested through these Box-Cox transformations:

$$P=\begin{cases} \dfrac{P^{\vartheta}-1}{\vartheta} if\, \vartheta \neq 0 \\ Ln\vartheta\, if\, \vartheta = 0 \end{cases} \qquad Z_i=\begin{cases} \dfrac{Z^{\lambda}-1}{\lambda} if\, \lambda \neq 0 \\ Ln\lambda\, if\, \lambda = 0 \end{cases}$$

According to Sanjuán-López *et al.* (2009), the Vuong test (Vuong, 1989) may be helpful in choosing the convenient form. The Vuong test is based on a comparison of the predicted probabilities of two models and it is given by the expression:

$$Vuong = \frac{\sqrt{n}\left[\frac{1}{n}\sum_{i=1}^{n} LR_i\right]}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(LR_i - \overline{LR_i}\right)^2}}$$

where n is the number of observations, LR_i is the likelihood ratio between the models j and k ($LR_i = ll_j - ll_k$), and $\overline{LR_i}$ is the mean. It is distributed as a Normal, thus, values larger than the critical $N_{\alpha/2}$ ratify model j and values smaller than $-N_{\alpha/2}$ favor model k; other values indicate that there are no significant differences between the two models (null hypothesis).

Nevertheless, explanatory variables are commonly dummy variables, thus the use of the semi-logarithmic form is present in many agri-food studies, such as in Golan and Shalit (1993), Oczkowski (1994), Combris *et al.* (1997; 2000), Gracia and Pérez y Pérez (2004), Steiner (2004), Brentari *et al.* (2011), Dinis *et al.* (2011) and Sogn-Grundvag *et al.* (2013).

2.2. The case study of Andalusian consumers

The information needed to apply this method can be obtained from a variety of sources, among them: specialized consumption guides (Oczkowski, 1994; Angulo *et al.*, 2000; Morilla and Martínez, 2002; Troncoso and Aguirre, 2006; Rodríguez and Castillo, 2009), household surveys (Loureiro and McCluskey, 2000; Gracia and Pérez y Pérez, 2004), experimental auctions (Martínez-Carrasco *et al.*, 2014) or, like in this case, from the labels and packaging in supermarkets (Stanley and Tschirhart, 1991; Steiner, 2001; Karipidis *et al.*, 2005; Santos and Ribeiro, 2005; Sanjuán-López *et al.*, 2009; Romo *et al.*, 2013). The database has been built using products from the main supermarket chains[2] in two EVOO-producing cities in Andalusia in September 2014, with a total of 299 observations, measuring the price per liter.

For our study, a maximum price of €6 per liter was considered as maximum for a daily shopping basket, i.e. an EVOO that it is used for cooking, frying and raw for breakfast, salads, etc. Products with higher prices tend to be less than a liter, packaged in glass bottles with a more elaborate design, characteristics that are typical of premium products, such as those listed in the some exclusive EVOO guides, such as Flos Olei, Iber Oleum and Olivatessen. To the author's knowledge, these products are not intended to be used either in large quantities or in the same way as the oils collected in this analysis.

From the information included on the label and the package of these 299 products a list of EVOO attributes was selected following two guidelines for the hedonic prices approach: first, the higher the number of attributes, the more precise the price determination, however, it is important to discard high correlations between attributes to avoid problems of multicollinearity; second, it is necessary to consider existing marketing legislation in order to understand how the EVOO attributes can be presented on the label.

A previous data analysis discarded some attributes mainly for two reasons: not enough degree of freedom (less than 5% of the observations) and lack of significance in the bivariate analysis[3] (see Table 3). As a result of these tests, this paper finally focuses on the attributes that appear in Table 4, all of which are presented either on the label or on the package.

3. RESULTS

First, we determined the functional form of the model using Box-Cox transformations (see Table 5). The results show that the semi-logarithmic (log-lin), corresponding with the values ϑ=−1 and λ=0, was the only form non-rejected.

In addition, Vuong's test was applied (see Table 6) and it indicated that the semi-logarithmic (log-lin) and double logarithmic (log-log) forms are equally suitable, since there are no significant differences between them.

In line with Rodríguez and Castillo (2009), additional statistical parameters were calculated for these two models (Table 7). Both models had similar goodness of fit values (R^2), broke the assumption

[2]The supermarket chains used in this study were Carrefour, Hipercor, Eroski, Mercadona, Deza, Piedra, Supersol, MAS and Lidl, including hypermarkets located within shopping centers, as well as local supermarkets and discount stores.

[3]All the attributes discarded can be seen along with the corresponding statistical tests in the Annex.

TABLE 3. Attributes previously rejected

	Attribute	Description	Reason for rejection
Production and extraction system	Organic Production	Dummy (1= Organic EVOO; 0= otherwise)	Not enough degree of freedom
	Integrated Production[4]	Dummy (1= Integrated production logo; 0= otherwise)	No significance in bivariate analysis (Mann-Whitney test)
	Harvest year	Dummy (1= harvest year is indicated; 0= otherwise)	Not enough degree of freedom
Intrinsic and organoleptic aspects	Flavor	Dummy (1= fruity, spicy or bitter flavour is indicated; 0= otherwise)	No significance in bivariate analysis (Mann-Whitney test)
	Olive varieties	Categorical (1= Picual; 2= Arbequina; 3= Hojiblanca)	No significance in bivariate analysis (Kruskal-Wallis test)
	Healthy claims*	Dummy (1= EVOO with some healthy claims; 0= otherwise)	Not enough degree of freedom
Certified quality and origin	Protected Designation of Origin	Dummy (1 = EVOO with some PDO; 0= otherwise)	No significance in bivariate analysis (Mann-Whitney test)
Distribution and brands	Supermarket	Categorical (including 9 different supermarkets)	No significance in bivariate analysis (Kruskal-Wallis test)
	Cooperative brand	Dummy (1= cooperative brand 0= otherwise)	No significance in bivariate analysis (Mann-Whitney test)

*The three health claims authorized by the European Food Safety Authority (EFSA) for olive oil (EC, 2012b) are source of vitamin E, high unsaturated fat and the content of polyphenols.
Source. Own elaboration.

TABLE 4. Description of the attributes

Attribute	Acronym	Levels of the attribute	Expected sign
Cold extraction	COLD	Dummy (1= EVOO obtained by cold extraction; 0= otherwise)	+
Acidity	ACID	Dummy (1= acidity or maximum acidity is indicated; 0= otherwise)	+
Variety	VAR	Dummy (1= olive variety is indicated; 0= otherwise)	+
Certified Quality of Andalusia	CERTQ	Dummy (1= EVOO has the “Certified Quality” label; 0= otherwise)	+
Private label brand	PRIVL	Dummy (1= Private label brand; 0= otherwise)	–
Leading brand	LEADB	Dummy (1= Brands of the main companies of the olive oil sector*; 0= otherwise)	+
Size	SIZE	Continuous (liters)	–
Lightweight packaging	LIGHT	Dummy (1= plastic or Tetra Pak package; 0= otherwise)	–
Protective packaging	PROT	Dummy (1= the package is opaque and protects from light; 0= otherwise)	+

*These brands are Carbonell, La Española, Hojiblanca, Coosur, La masía, Koipe, Ybarra, Borges.
Source. Own elaboration.

of normality[5] of residuals (Kolmogorov-Smirnov test) and presented no heteroskedasticity problems (Breusch-Pagan test). On the other hand, Ramsey’s RESET test showed that the linear specification of the semi-logarithmic model was rejected, and the values of both Akaike and Schwarz criteria were lower than those of the double logarithmic ones.

TABLE 5. Box-Cox transformations

Functional form	ϑ value	λ value	Statistic (p-value)	Result
log-log	0	0	5.77 (0.02)	Rejected
log-lin	0	1	1.99 (0.16)	Non-rejected
lin-log	1	0	22.24 (0.00)	Rejected
lin-lin	1	1	44.69 (0.00)	Rejected

Source. Own elaboration.

[4]Integrated Production refers to a system of farming or production which produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming.

[5]Based on the central limit theorem, the sample size (over 100 cases) makes this assumption less restrictive (Wooldridge, 2009, p.172).

Table 6. Vuong's test

	LR_i	Vuong statistic	Accepted form
log-log *vs* log-lin	3.2	0.01	–
log-log *vs* lin-log	424.0	3.03*	log-log
log-log *vs* lin-lin	427.8	2.98*	log-log
log-lin *vs* lin-log	420.8	3.08*	log-lin
log-lin *vs* lin-lin	424.6	3.02*	log-lin
lin-log *vs* lin-lin	3.8	0.01	–

*Indicates that values are higher or lower than the critical values of 1.96 and −1.96, respectively, rejecting the null hypothesis of no difference between models.
Source. Own elaboration.

Based on the previous tests, we chose the double logarithmic model for our hedonic price function, mathematically expressed as:

$$Ln\left(P_i\right) = \beta_0 + \sum \beta_j Ln\left(Q_i\right) + \sum \beta_k Q_k$$

where P_i is the EVOO price measured in € l^{-1}, Q_j and Q_k are the continuous and dummy variables, respectively, and β are the regression coefficients for each variable. These regression coefficients are interpreted as elasticity, in the case of continuous variables, and as the marginal change in the logarithmic, for dummy variables. We employed the equation proposed by Kennedy (1981) to calculate the percentage impact (PI_k) that each dummy variable has over the price:

$$PI_k = 100 * \left(e^{\left(\hat{\beta}_k - 0{,}5 * Var\left(\hat{\beta}_k\right)\right)} - 1 \right)$$

where $Var\left(\widehat{\beta_k}\right)$ is the estimated variance of each variable.

The hedonic price function was estimated by means of Ordinary Least Squares (OLS) and it is shown in Table 8. Values appearing in the fifth column are the result of applying the percentage impact on a reference price, in this case the average price of the sample (€3.99 l^{-1}), so implicit prices were calculated. The model performance is very good and shows a goodness of fit of 0.661 (Table 7).

With respect to the EVOO attributes "acidity", "variety" and "Certified Quality" have a positive impact of 5.1%, 1.9% and 4.8%, respectively. Consumers are paying a higher price for products whose label includes information about the degree of acidity (€0.20 per liter), the olive variety (€0.08 per liter), and whether it has the logo indicating that the EVOO meets certain quality requirements according to the quality standard of the public certifying body (€0.19 per liter).

Regarding the different types of brands, the model confirms the negative impact that private label brands have on the price (−14.4%) and the opposite effect that a leading brand has on it (6.1%). Thereby, consumers are paying an extra price of €0.24 per liter for these EVOOs belonging to leading brands which portrays the highest positive impact on price obtained among the attributes considered.

The last attributes are related to the external appearance of EVOO: packaging size and materials. As expected, the bigger the package the cheaper the average unit price (per liter) of the product. As indicated by the elasticity value, when the size increases by 1%, the price per liter decreases 0.056%; so, for example, if we have three products of 2, 3 and 5 liters (increases of 100%, 200% and 400%), the consumer will pay €3.77, €3.54 and €3.10 for each liter of product, respectively.

Finally, the attribute with the biggest impact on the price of EVOO is the packaging material, causing the price to fall by 22.7% if it is made of plastic or Tetra Pak. Non-significant results were found for the important role that packaging plays. Namely that opaque materials protect EVOO against the effects of the light. The attributes "protective packaging" and "cold extraction" were not statistically significant.

Table 7. Comparison between double logarithmic and semilogarithmic models

	Double logarithmic (log-log)		Semilogarithmic (log-lin)	
	Statistic	p-value	Statistic	p-value
R^2	0.669	–	0.662	–
Adjusted R^2	0.661	–	0.654	–
F statistic	83.91	0.00	81.3	0.00
Kolmogorov-Smirnov test	0.072	0.001	0.075	0.00
Breusch-Pagan test	1.06	0.302	1.44	0.23
RESET test	2.44	0.065	2.91	0.035
Akaike information criterion	−448.6	–	−442.2	–
Schwarz information criterion	−411.6	–	−405.6	–

Source. Own elaboration.

Table 8. Hedonic price function

Attribute	B	Standard error	PI (%) or elasticity	Implicit price (€/L)[a]
(Constant)	1.515***	0.016	–	–
ACID	0.062**	0.025	5.07	0.20
VAR	0.027*	0.016	1.92	0.08
CERTQ	0.056***	0.018	4.81	0.19
PRIVL	−0.144***	0.022	−14.36	−0.57
LEADB	0.068***	0.017	6.13	0.24
SIZE	−0.056***	0.011	−0.056	–
LIGHT	−0.250***	0.016	−22.74	−0.91

*, ** and *** indicate that the parameter is statistically significant at the 10%, 5% and 1% level, respectively.
[a]Reference price: €3.99 /L
Source. Own elaboration.

4. DISCUSSION

By estimating the hedonic price function, the intrinsic value of the EVOO attribute was obtained, information that is relevant to understand the current situation of the EVOO market and to differentiate this high-quality product from OO.

First, the results show that the acidity on the label is an attribute that adds value to EVOO, yet this is a controversial aspect. The acidity is one of the intrinsic attributes characterizing the four olive oil categories (for EVOO, the maximum threshold is 0.8%), together with the wax content, the peroxide value and the ultraviolet absorption (EC, 2012a). Santos and Ribeiro (2005) and Romo *et al.* (2013) consider acidity as a continuous variable measured in degrees but the sign of the impact that they obtain does not agree with each other (negative and positive sign, respectively). This numerical information is not always available, so in this paper we considered it as dichotomous variable. According to current regulations (EC, 2012a), producers can optionally indicate the acidity value together with the above-mentioned chemical parameters or their maximum values allowed for the EVOO category on the label. The first option would be of more interest to consumers but it would be essential for them to know the true meaning of these chemical parameters so they can use them as differentiating elements among substitute products. In this sense, the results obtained by Sottomayor *et al.* (2010) indicate that acidity is the principal attribute for consumers in Portugal.

Regarding the OO category (the main substitute of EVOO in Andalusia), in the absence of any specific regulations on these matters, the large companies' marketing strategies have traditionally linked acidity with flavor, creating two different products. Thus, consumers can find OOs with 0.4 degrees of acidity, associated with a mild flavor, and products with 1 degree of acidity, associated with an intense flavor. The truth is that there is no direct relationship between acidity and flavor but it is common for consumers to have this idea in mind even when comparing EVOOs.

The true information that these four above-mentioned chemical parameters give to consumers is about free fatty acids and primary and secondary oxidation. For the EVOO category low values of these parameters indicate that the olives have been harvested at an optimum ripeness and there have not been temperature problems during milling and storage, i.e. the EVOO is fresher and more stable against oxidation. This information is completely different and has nothing to do with the erroneous relationship between flavor and acidity. A study carried out by the government of Andalusia in 2009 shows that the 41% of consumers thought that acidity is one of the most influential factors in flavor, 48% affirmed that acidity influences flavor and only the 5% of consumers chose the correct option: acidity is a chemical indicator to categorize olive oils (CAP, 2009). Thus, it is important to remove these types of erroneous associations that consumers might have in their minds so that acidity can be a differential attribute.

With respect to the other attributes, flavor is the hallmark of EVOO, the main organoleptic and easiest attribute for consumers to appreciate. Calatrava-Requena and González-Roa (2003) maintain that flavor is the most commonly stated aspect influencing consumer purchasing decisions. Although the relationship between flavor and price has not been significant in the previous bivariate analyses, this attribute is strongly determined by olive variety, so when the olive variety appears on the label, the consumer can expect an EVOO which is more fruity (Arbequina variety) or more bitter (Picual and Hojiblanca varieties). Thus, the consumer can obtain some prior information about the organoleptic profile of the EVOO. The positive impact that the olive variety has on the price demonstrates that the sector is betting on a varietal differentiation which is helping to highlight the heterogeneity of EVOO. Nevertheless the results show that the variety has the lowest implicit price, probably because consumers are not aware of the link between variety and flavor. Furthermore, olive variety could be an interesting strategy to differentiate between categories since the variety is not allowed to be included on OO category labels. In addition, this attribute contributes to showing how heterogeneous EVOO is in comparison with the standardized OO.

The positive impact of the Andalusia "Certified Quality" logo can be interpreted from two perspectives. Obviously, not only does this label indicate that the product meets the quality requirements imposed by the certifying body but also that it is produced in Andalusia. The latter is easier to be recognized by consumers since the logo is the same for other regional products. The origin of EVOO is one of the most important aspects for many consumers, as is shown by Sottomayor *et al.* (2010) in

Portugal, Jiménez-Guerrero *et al.* (2012) in Spain and Fotopoulos and Krystallis (2001) in Greece. However, consumers should bear in mind that this certification prevents against frequent alarms about fraud in olive oil which are often denounced by Spanish consumer associations (Facua, 2013).

In addition, current legislation (EC, 2012a) only allows producers to indicate the provenance by mentioning the European Union, the Member State or a PDO, including this logo on the label. Moreover, this is an attribute that can only be included on EVOO labels and, as in the case of the variety of olive, can also be used to differentiate it from the OO category.

Despite the fact that these three attributes are optional information, they have a differentiation power that it is interesting for both producers and distributors. By including them on EVOO labelling, the product can increase its added value compared to other EVOO products and, more importantly, to OO products. These three attributes are related to the quality of the product and have a positive implicit price, suggesting that there is an on-going incipient process of differentiation by quality. However, there are many other attributes which are exclusive of EVOO that are not very common nowadays, such as harvest year or health claims, that could be useful for differentiating EVOO.

Brands also play an important role in EVOO price. On one hand, consumers associate the brands of large companies with tradition and familiarity; these brands are reliable in the view of consumers despite the fact that their price can be higher than others. This result corresponds to the concept of “brand equity”, i.e. “a set of brand assets and liabilities which are linked to a brand, its name or its symbol and add to or subtract from the value provided by a product or service to a firm and/or that firm’s customers” (Aaker, 1991, p.15). Nevertheless, when brand equity is the main driving force behind consumer purchasing decisions, consumers may ignore other important quality attributes or even the the existence of two differentiated categories (OO and EVOO), especially if consumers do not have enough information available to them or lack of knowledge. These brands have the highest positive implicit price of the quality attributes analysed. This fact should be taken into account by small and medium scale producers aiming at obtaining a competitive advantage.

Conversely, the negative impact that private label brands have on price suggests that these products are still cheaper than others, as Santos and Ribeiro (2005) and Romo *et al.* (2013) also point out. Traditionally, these brands have been related to generic products although in recent years it is possible to find new high-quality products under these brands.

In general, plastic is associated with a lower quality product, and the opposite is true for materials like glass. This attribute has the highest negative impact on the price, reducing it by almost 23%, compared to the 18% obtained by Romo *et al.* (2013). With respect to the package size, the results agree with Karipidis *et al.* (2005), who found an elasticity of 0.07. Regarding these attributes, bigger and plastic packages are associated with lower quality by many consumers. Parras-Rosa *et al.* (2013) indicate that the glass bottle has the characteristics of the ideal olive oil package according to consumers. Thus, the sector should think about the benefits of selling EVOO in smaller and non-plastic packages.

Lastly, the sample used in this paper is based on products available at the main supermarket chains where consumers habitually buy their whole food basket, but it does not take into account specialized establishments such as delicatessens and gourmet shops or cooperatives that sell their products directly to consumers. For this reason, in addition to the selected price range, other interesting attributes have not been considered, such as the Organic Production label.

It is important to highlight that the PDO label, a sign of quality par excellence, had no influence on price, although there were only 23 products with this quality label in the sample. Within the region of Andalusia, there are twelve PDO of EVOO representing 40% of the total surface area of olive groves. This limited availability, together with the small volume of these products that consumers can find at supermarkets make it difficult for them to recognize and fully appreciate the differential characteristics that these PDO-EVOOs possess. According to Erraach *et al.* (2014), an EVOO certified by a PDO generate more utility to consumers than an EVOO without this certification. The same results were found in Greece by Fotopoulos and Krystallis (2012) and in Italy by Aprile *et al.* (2012), Van der Lans *et al.* (2001) and Scarpa and del Giudice (2004). Thus, it can represent an opportunity for PDOs to diversify their supply and reach more consumer segments.

In any case, the assumption of a state of perfect competition is the main limitation of the hedonic price approach. Broadly speaking, the EVOO market is characterized by a high number of consumers and sellers, with no barriers to entry and no information failure. Yet, there are a large number of small cooperatives competing with large private firms and distribution companies that can be acting as oligopolies: around 80% of the total olive oil sold in the Spanish market is managed by only six companies (MAPA, 2003) which highlights the asymmetry of the market. In addition, olive oil production has the characteristic of a fluctuating supply from year to year, due to the effect of “veceria”[6] and the weather conditions, which have a remarkable effect on prices.

[6]Process by means of the olive tree yielding fruit one year and none the next, a phenomenon which is in turn aggravated by the region’s fluctuating rain and temperature patterns.

Finally, it seems clear that consumers should be aware of olive oil differences to be able to properly evaluate and appreciate higher quality products, therefore differentiating between EVOO and OO categories. This knowledge is fundamental to undertake effective marketing strategies for small and medium enterprises in order to gain added value to their products.

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ANNEX: BIVARIATE ANALYSES

PRODUCTION AND EXTRACTION SYSTEM

Integrated Production Rank

	Integrated	N	Mean Rank	Sum of Ranks
Price per liter	No	281	149,23	41935,00
	Yes	18	161,94	2915,00
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	2314,000
Wilcoxon W	41935,000
Z	-,605
Asymp. Sig. (2-tailed)	,545

a. Grouping Variable: Integrated

Cold Extraction Rank

	Cold Ext	N	Mean Rank	Sum of Ranks
Price per liter	No	275	146,38	40253,50
	Yes	24	191,52	4596,50
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	2303,500
Wilcoxon W	40253,500
Z	-2,454
Asymp. Sig. (2-tailed)	,014

a. Grouping Variable: Cold Ext

INTRINSIC AND ORGANOLEPTIC ASPECTS

Acidity

	Acidity	N	Mean Rank	Sum of Ranks
Price per liter	No	265	142,42	37741,50
	Yes	34	209,07	7108,50
	Total	299		

Test Statistics[a]

	Price per liter
Mann -Whitney U	2496,500
Wilcoxon W	37741,500
Z	-4,234
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: Acidity

Flavor Rank

	Flavor	N	Mean Rank	Sum of Ranks
Price per liter	No	251	148,50	37273,00
	Yes	48	157,85	7577,00
	Total	299		

Test Statistics [a]

	Price per liter
Mann-Whitney U	5647,000
Wilcoxon W	37273,000
Z	-,687
Asymp. Sig. (2-tailed)	492,

a. Grouping Variable: Flavor

Olive Varieties

	Varieties	N	Mean Rank
Price per liter	Picual	24	32,71
	Arbequina	22	36,34
	Hojiblanca	17	25,38
	Total	63	

Test Statistics[a,b]

	Price per liter
Chi-square	3,518
	2
Asymp. Sig.	,172

a. Kruskal-Wallis test
b. Grouping Variable: Varieties

Ranks

	Varieties	N	Mean Rank	Sum of Ranks
Price per liter	No	217	136,79	29684,00
	Yes	82	184,95	15166,00
	Total	299		

Test Statistics[a]

	Price per liter
U de Mann-Whitney	6031,000
W de Wilcoxon	29684,000
Z	-4,299
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: Flavor

CERTIFIED QUALITY AND ORIGIN

Protected Designation of Origin

Rank

	PDO	N	Mean Rank	Sum of Ranks
Price per liter	No	276	149,73	41326,50
	Yes	23	153,20	3523,50
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	3100,500
Wilcoxon W	41326,500
Z	-,185
Asymp. Sig. (2-tailed)	,854

a. Grouping Variable: PDO

Certified Quality of Andalusia

Rank

	Certified Quality	N	Mean Rank	Sum of Ranks
Price per liter	No	228	140,84	32112,00
	Yes	71	179,41	12738,00
	Total	299		

Test Statistics[a]

	Price per liter
Mann - Whitney U	6006,000
Wilcoxon W	32112,000
Z	-3,283
Asymp. Sig. (2-tailed)	,001

a. Grouping Variable: Certified Quality

DISTRIBUTION AND BRANDS

Supermarket

Rank

	Supermarket	N	Mean Rank
Price per liter	Carrefour	93	139,92
	Hipercor	44	171,02
	Mercadona	10	144,45
	Eroski	84	161,74
	Deza	27	129,94
	Lidl	2	97,25
	Piedra	6	128,33
	MAS	19	145,39
	Supersol	14	146,14
	Total	299	

Test Statistics[a,b]

	Price per liter
Chi-square	8,116
df	8
Asymp. Sig.	,422

a. Kruskal Wallis test
b. Grouping Variable: supermarket

Leading brand

Rank

	Leading Brand	N	Mean Rank	Sum of Ranks
Price per liter	No	155	127,58	19774,50
	Yes	144	174,14	25075,50
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	7684,500
Wilcoxon W	19774,500
Z	-4,654
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: Leading brand

Private label brand

Rank

	Private label	N	Mean Rank	Sum of Ranks
Price per liter	No	253	162,37	41078,50
	Yes	46	81,99	3771,50
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	2690,500
Wilcoxon W	3771,500
Z	-5,802
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: Private label

Cooperative brand

Rank

	Cooperative Brand	N	Mean Rank	Sum of Ranks
Price per liter	No	242	153,06	37039,50
	Yes	57	137,03	7810,50
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	6157,500
Wilcoxon W	7810,500
Z	-1,260
Asymp. Sig. (2-tailed)	,208

a. Grouping Variable: Cooperative brand

PACKAGING

Material

Ranks

	Package	N	Mean Rank
Price per liter	Dark glass	59	238,29
	Transparent glass	13	219,92
	Transparent PET	176	114,11
	Tin	20	208,40
	Tetra-pack	7	151,57
	Dark PET	24	109,17
	Total	299	

Test Statistics[a,b]

	Price per liter
Chi-square	114,928
df	5
Asymp. Sig.	,000

a. Kruskal-Wallis test
b. Grouping Variable: Package

Protective packaging

Rank

	Protective packaging	N	Mean Rank	Sum of Ranks
Price per liter	No	189	121,39	22942,00
	Yes	110	199,16	21908,00
	Total	299		

Test Statistics[a]

	Price per liter
Mann-Whitney U	4987,000
Wilcoxon W	22942,000
Z	-7,504
Asymp. Sig. (2-tailed)	,000

a. Grouping Variable: Protective packaging

Lightweight packaging

Ranks

	Lightweight packaging	N	Mean Rank	Sum of Ranks
Price per liter	0	92	229,20	21086,00
	1	207	114,80	23764,00
	Total	299		

Test Statistics[a]

	Price per liter
Mann -Whitney U	2236,000
Wilcoxon W	23764,000
Z	-10,563
Asymp. Sig.(2-tailed)	,000

a. Grouping Variable: Lightweight packaging

Size

Correlations

			Size	Price per liter
Spearman's rho	Size	Correlation coefficient	1,000	-,575**
		Sig. (2-tailed)	.	,000
		N	299	299
	Price per liter	Correlation coefficient	-,575**	1,000
		Sig. (2-tailed)	,000	.
		N	299	299

**. Correlation is significant at the 0,01 level (bilateral).