

# Using sensory experiments to determine consumers' willingness to pay for traditional apple varieties

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## Abstract

The last two decades have witnessed an increasing enthusiasm of consumers for products with specific characteristics, whether related to origin or production technology. Several studies show that consumers are willing to pay price premium for organic products and we may expect that the same happens with other attributes, such as origin and tradition. The aim of this study, based on surveys conducted in the context of a taste panel, is to establish the price premium that consumers are willing to pay for the feature «traditional variety», using Portuguese traditional varieties of apples as a case study. Using contingent valuation to determine the willingness to pay and panel data techniques for estimation, a hedonic price model is developed to explain how the price that consumers declare to be willing to pay is related, besides variety, to different attributes of apples, such as appearance and taste, production method and threat of extinction. The results suggest that consumers, regardless of their socio-economic characteristics, are willing to pay a higher price not only for apples with better taste, appearance and smell, but also for Portuguese traditional varieties.

**Additional key words:** agro-biodiversity; contingent valuation; hedonic prices; landraces; *Malus × domestica*; panel data.

## Resumen

### Uso de experimentos sensoriales para determinar la disposición del consumidor a pagar por variedades tradicionales de manzano

En las últimas dos décadas se ha observado un creciente interés de los consumidores por productos con características específicas, ya sea relacionadas con el origen o el modo de producción. Varios estudios muestran que los consumidores están dispuestos a pagar un precio superior por los productos ecológicos, pudiendo esperarse que suceda lo mismo con otros atributos, como el origen y la tradición. El objetivo de este estudio, basado en encuestas realizadas en paralelo con un panel de degustación, es establecer el sobreprecio que los consumidores están dispuestos a pagar por la característica «variedad tradicional», utilizando, como caso de estudio, variedades tradicionales portuguesas de manzana. Utilizando la valoración contingente para determinar la disposición a pagar y técnicas adecuadas para el análisis de paneles de datos, se desarrolló un modelo de precios hedónicos para explicar cómo el precio que los consumidores declaran estar dispuestos a pagar considera la relación con diferentes atributos de las manzanas, como la variedad, el aspecto, las características organolépticas, el modo de producción y el peligro de extinción. Los resultados sugieren que los consumidores, independientemente de sus características socioeconómicas, están dispuestos a pagar un precio más alto no sólo por las manzanas con mejor sabor, apariencia y aroma, sino también por tratarse de manzanas de variedades tradicionales.

**Palabras clave adicionales:** agrobiodiversidad; datos de panel; *Malus × domestica*; precios hedónicos; valoración contingente.

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## Introduction

For decades, the main aim of the Common Agricultural Policy was to increase food yields. This influenced

the balance between agriculture and biodiversity. Governments have provided infrastructure, new inputs and subsidies, encouraging specialization (Grigg, 1992; Negri, 2005; Negri *et al.*, 2009). This has impor-

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Abbreviations used: FE (fixed-effects), OLS (ordinary least squares), RE (random-effects), WTA (willingness to accept), WTP (willingness to pay).

tant impacts, among which the loss of genetic diversity of crop plants and of agro-biodiversity. The case of apple (*Malus×domestica*) production is paradigmatic. The intensification in apple production led to the progressive abandon of regional apple varieties in favour of new ones, more productive and stable. Many of the European varieties were lost over the last century or are threatened with extinction. In Portugal, for example, Lima (1926) identified more than 100 different names for Portuguese varieties of apple. Although each one of the names does not necessarily correspond to a distinct variety, since in different regions the same name might be applied to different varieties and different names could correspond to the same variety, this figure clearly shows the genetic diversity that existed then in apple production. The same happened all around Europe, particularly in Mediterranean regions. As an example, Hammer *et al.* (1996), using the results of collecting missions in Albania, in 1941 and 1993, and in South Italy, in 1950 and in the eighties, found a degree of landraces genetic erosion of 72.4% and 72.8%, respectively.

Recently a tendency to re-introducing traditional local varieties has been observed, induced by changes in consumers' tastes and preferences, among other factors. As referred by Magnusson *et al.* (2003), empirical research provided evidence that, in addition to taste, consumers increasingly value other aspects of food, such as safety, nutritional value or the production system. Research all over the world pinpoints the increasing consumers' preference for organic food (Hammit, 1990; Schifferstein and Ophus, 1997; Miles and Frewer, 2001; Hursti and Magnusson, 2003; Grankvist and Biel, 2007). This preference is usually linked to the perception that this kind of food is healthier, tastes better and contributes to environmental protection. Estes and Smith (1996), Boland and Schroeder (2002), Loureiro and Hine (2002), Maguire *et al.* (2004) and Brugarolas *et al.* (2005) show that consumers are willing to pay a price premium for organic products. Market tendencies indicate that a wide sector of consumers prefer high quality products with better sensory characteristics regardless of a higher price (Grunert, 2002).

In what concerns regional varieties, with few exceptions (Brugarolas *et al.*, 2009), little has been made in order to understand consumer behaviour. Nevertheless, since some of the decision factors to purchase organic products are their organoleptic characteristics, nutritional value and environmental concerns, we can hypothe-

size that those concerns also affect other consumption choices, such as fruit and vegetable varieties. This hypothesis is sustained by three assumptions: First, consumers may enjoy the accessibility to authentic regional products with distinct organoleptic features. Second, the use of local varieties reduces the need for pesticides and other agro-chemicals, since they are theoretically better adapted to the local environmental conditions and therefore more resistant to pests and diseases (Zeven, 1998). Third, these production systems help to preserve genetic resources and biodiversity. Therefore, the production of regional varieties may increase the consumers' utility while contributing to both ecological and public health friendly productive systems.

In response to new consumption trends and to the need to find profitable alternatives for farmers, agricultural policies are introducing the protection of regional varieties as a strategy for the development of the agro-food chain, especially in the fruit and vegetable sectors. A recent example is given by the Operational Program for Fruit and Vegetables Organizations, recently approved by the European Commission. In the Portuguese program (MADRP, 2009), for instance, consumer demand for quality differentiated products is pointed out as an opportunity for the sector and the existence of products with differentiated quality is presented as a strong point. It is said that the production of differentiated fruit and vegetable, including regional varieties or products with specific attributes, particularly organoleptic ones, has significant potential in Portugal and that accordingly the country should seek the best solutions for their recovery. Although less incisive, the Spanish program (MARM, 2008) also refers the importance of Protected Designation of Origin, intrinsically associated with regional varieties, in the development strategy for the national fruit and vegetable sector. Technical and scientific judgments go in the same direction (Fonseca, 2008). Nevertheless, to successfully accomplish those goals, consumers must be willing to pay a price premium to offset the lower productivity and higher risk associated with the traditional varieties production systems. In fact, as pointed out by Dinis (2007) for the Portuguese apple variety 'Bravo', the productivity of traditional varieties may be significantly lower than the average found in the standard varieties. The findings of Brugarolas *et al.* (2009), concerning Spanish varieties of tomato (*Solanum lycopersicum* L.), corroborate this trend. Nonetheless, when market prices are not high enough to compensate farmers for the public goods and services they provide,

other solutions, such as public financial support, should be considered.

The main purpose of this paper is to determine the price premium that fruit and vegetable consumers are willing to pay for fruit and vegetable attributes, such as the feature «Portuguese traditional variety». In particular, experiments were carried out in order to capture the willingness of consumers to pay for traditional Portuguese varieties of apples, some of which virtually disappeared from the production universe and are completely absent from commercial circuits. Apples were chosen for two main reasons. First, apples represent over 25% of fruit production in Portugal and, secondly, there are still some traditional varieties of apple across the country that can be used in the study (MADRP, 2007).

Besides the effect of the variety factor on their willingness to pay (WTP), the impact of several factors, such as level of extinction, intrinsic characteristics of apples, production system (organic or conventional) and socio-economic and demographic characteristics of consumers will also be assessed.

## Material and methods

### Methodology

On a competitive market with highly differentiated goods, such as the food market, equilibrium prices can be used to infer the contribution of each attribute present on a product to its total value (Combris *et al.*, 2009). However, as pointed out by the author, this methodology presents some problems when there is an interest in new products. Most of the traditional Portuguese varieties of fruit and vegetable fall in this criterion, since their production almost ended and are now completely absent from commercial circuits and unknown to consumers.

To estimate consumer responses to this type of products research must turn to relatively new methods such as contingent valuation and experimental markets. However, the costs associated with the latter, especially when applied to large samples, are rather high and the question about what incentives to use is not an easy one to answer. In fact, the common feature of all incentive mechanisms, necessarily present in experimental markets, is that participants are given the chance to actually buy some products according to their elicitation. When comparing traditional varieties absent

from the market with common varieties, one may expect that participants will offer the former a price above their true value only because they can not find them in real markets and do not want to miss an opportunity to buy them. Therefore, it would modify the results of experimental markets. Those are the main reasons that sustain the option to use contingent valuation in the present study.

The use of contingent valuation assumes that consumers know the goods being valued, which is not true in the present case. To achieve this goal, sensory panels were combined with the survey. To assess the WTP for Portuguese regional varieties of apples, especially for those which disappeared from the market and that, in commercial terms, may be regarded as endangered, a taste panel for apples was prepared. The taste panel was carried out at the International Fair of Lisbon, between 7 and 10 November 2007, during a symposium on innovation. The reasons why that event was chosen have to do with the logistics associated to the taste panel implementation and mainly with the intention of collecting data from residents in Lisbon, the largest Portuguese consumption centre for specific quality food.

Nine different varieties, some foreign, others traditional Portuguese varieties (meant as landraces), produced in organic or conventional farming, some well known and others unknown to most consumers (Table 1), were tasted and evaluated. As the main goal was to evaluate the impact of the feature «traditional variety» on the WTP for apples, controlled by other important variables in consumers choice, it was not really relevant which particular varieties to choose, but to assure variability on the parameters to include in the model. Thus, it was firstly necessary to have two groups of

**Table 1.** Apples in the test panel

Variety name	Description		
	PTV <sup>1</sup>	OF <sup>2</sup>	Extinction
A) Malápíio da Serra	+	+	-
B) Maça Pedra	+	-	+
C) Golden Delicious	-	-	-
D) Tromba de Boi	+	+	+
E) Starking	-	-	-
F) Bravo	+	-	-
G) Querina	-	+	-
H) Pêro Pipo	+	-	+
I) Malápíio pequeno	+	-	-

<sup>1</sup> PTV: Portuguese traditional variety. <sup>2</sup> OF: organic farming.

varieties: foreign and traditional. Secondly, within each group, different intrinsic characteristics and different production technologies were required. Furthermore, on the last group different degrees of extinction were also needed. The choice over the foreign varieties was based on the fact that ‘Golden Delicious’ and ‘Starking’ are the two most familiar varieties for Portuguese consumers (Simões *et al.*, 2006). As to the traditional varieties it is important to refer that, with the exception of ‘Bravo’, most of them are absent from the market. Therefore, the apples currently available in an I&D Project experimental collection were used.

Participants were selected among the fair visitors. People passing by the taste panel area were randomly invited to participate in the experiment. Then a short explanation about the experiment (objectives, protocol, time needed and use of the results) was made and participants were free to refuse their further participation. Each participant was given a handout with two sectors: i) an evaluation grid, where according to a numeric scale they should evaluate separately several attributes for each variety, and ii) a row to state their WTP for each one.

A sample of fruits of each variety was placed on a table. The samples were composed of a basket with 8 examples of the fruit and a small plate with fresh cut slices for the tasting procedure. Next to each sample participants could find a card with information about the variety designation, its origin (Portuguese landrace or foreign variety), threat of extinction (yes or no) and production technology (organic or conventional). The order in which the apples were presented to participants changed during the tests and was randomly set. Participants were asked to carefully read the information on the boards before proceeding to sensorial score. They were allowed to closely observe, touch, smell and taste each apple and were not authorized to share opinions or comments with each other. After that, they should classify the apples, on a scale from 1 to 5, where 1 meant the worse evaluation and 5 the better evaluation, regarding the following attributes: appearance, texture, taste and smell.

Being aware that attribute scoring could be influenced by the information provided on the cards — since a blind valuation was not performed and participants

had information about the name of the variety, its production technology, threat of extinction and origin before the attribute scoring— the protocol plan was set on providing all that information to avoid emphasizing particular features, with the purpose of simulating, as closely as possible, real purchasing conditions. In fact, as suggested by several authors cited by Grankvist and Biel (2007), the purchase of everyday food, such as apples, is a behaviour often executed with little or no cognitive evaluation, often guided by habits. The presentation of particular features in an explicit and isolated way could draw the attention of participants and possibly would lead them to over value these features when regarded as «positive». In particular, there was some apprehension on the fact that participants could overestimate the «traditional Portuguese variety» feature.

The method used for determining WTP was Contingent Valuation with all respondents being asked, using an open-ended question format, how much they would pay for different types of apples. As pointed out by Mitchell and Carson (1989: p. 97) using open-ended questions in order to obtain the respondent’s WTP may be problematical because «respondents often find it difficult to pick a value out of the air, as it were, without some form of assistance». Even though in the case of fruit in general this might not be a major problem, because fruit purchase is a daily activity and consumers are very much aware of market prices, in order to guarantee that all participants had a good perception about apples price it was used €1.00 kg<sup>-1</sup> as a reference value<sup>1</sup>. Participants should write on the handout the relative price they would be willing to pay for 1 kg of each variety. During the experiments participants were allowed to revise and change both sensory evaluation and WTP.

At the end, in order to obtain their socio-economic and demographic characterization participants were asked to complete a short questionnaire.

Participants were visitors of the showroom, over 16 years of age, who had agreed to collaborate. Two hundred and thirty one persons were involved, 52% female and 48% male, about half living in the Lisbon area. A clear majority of participants (71.5%) attended higher education and 50% of them declared net monthly income between €1,000 and 2,000. About 60% said

<sup>1</sup> In the absence of Portuguese statistics on consumption prices, it was decided to use as a proxy of the retail price the maximum price of the most important variety in Portuguese market — ‘Golden Delicious’ — at Lisbon Wholesale Market, on the week before the survey (€ kg<sup>-1</sup>) was carried out. To verify a potential bias of WTP around the guide price, the null hypothesis H<sub>0</sub>: WTP = 1 was tested, for the entire sample and for each variety, using a t test. For the entire sample, with  $\alpha = 5\%$ , H<sub>0</sub> was soundly rejected ( $t = 7.341$ ) and, with the exception of ‘Maçã Pedra’ and ‘Querina’, the same happened with each variety.

they lived or had lived in rural areas. When compared with national averages, this sample shows some bias towards higher income and education levels. Therefore, the generalization of results to national population must be cautious. However, it is possible to get some important clues about the behaviour of higher segments consumers, often related with greater propensity for differentiated products.

This sample would allow obtaining 2,079 values of WTP (231 individual  $\times$  9 varieties). However, since not all individuals stated that value for all varieties, there were only 2,050 observations left for the dependent variable.

## Model

The theoretical framework of the present study is the consumer theory proposed by Lancaster (1966), which relies on the assumption that the price consumers are willing to pay for a certain good depends on the utility they derive from it and that this utility is a function of a set of attributes that exist in different combinations in the goods available for consumption. The demand theory proposed by Lancaster (1966) is the conceptual framework of hedonic price methodology, which has been applied in several studies, particularly in agricultural and food economics (Estes and Smith, 1996; Kozłowska *et al.*, 2003; Steiner, 2004; Huang and Lin, 2007; Panzone and Simões, 2007; Troncoso and Aguirre, 2007; Drescher *et al.*, 2008; Wang *et al.*, 2008) and environmental and natural resources economics (Palmquist, 1984; Anstine, 2000; Srinivasan and Blomquist, 2009).

The assumption underlying this type of models is that the products differ among themselves only by their attributes and that the demand for each of them can be obtained from the WTP for products with different features or different levels of these features. Essentially, it represents the decomposition of the price of goods into values assigned to the characteristics they present. In its simplest form, the hedonic model seeks to explain the price at which an asset is sold as a function of the amount of attributes it contains. Let  $P_i$  be the price of an item  $i$  with a set of attributes  $Z_j$ . Then, the hedonic price function can be written as:  $P_i = P(Z_1 \dots Z_j \dots Z_n)$ .

From this equation it is possible to estimate the marginal value assigned by consumers to each of the characteristics  $Z_j$  in the price they pay.

As referred by Haab and McConnell (2003), hedonic prices apply when goods with different characteristics are sold in real markets and, therefore, the sale price reflects the market equilibrium conditions. In this case, however, there is no market for most of the apple varieties studied, and it was not possible to use observed preferences in actual markets to estimate the premium consumers are willing to pay for traditional varieties, particularly for those who are in process of extinction. Thus, rather than a market price actually observed, the WTP stated by consumers will be used. In fact, when markets are absent, WTP along with minimum willingness to accept (WTA) are the two standard measures of economic value. WTP is the appropriate measure whenever, as in the present case, an agent that has no property rights over a certain good wants to acquire it (Carson, 2000). WTP has a formal relationship with the demand curve, since the aggregate demand is given by the number of units bought by the consumers whose WTP is at least the actual price. In the present study we are dealing with the purchase of everyday food and, although apples with the feature «traditional variety» are rarely present in the market, WTP decisions are based on a full understanding of the available alternatives as a prolonged experience of the market. In that sense, we may use WTP as a proxy of the price that consumers will be willing to pay in the actual Portuguese fruit market equilibrium conditions, taking in consideration present consumers' preferences and income.

The theoretical model says nothing about the functional form of the hedonic price equation, making choice a strictly empirical question. The more usual options are linear function (Boland and Schroeder, 2002; Maguire *et al.*, 2004; Srinivasan and Blomquist, 2009), the semi-logarithmic function (Estes and Smith, 1996; Steiner, 2004; Huang and Lin, 2007) and Box-Cox functional form (Jordan *et al.*, 1985; Anstine, 2000; Loureiro and McCluskey, 2002). In the present study both linear and semi-log estimations were performed with very similar results: the statistical significant dependant variables remained unchanged and the same happened with the signs and magnitude of the coefficients. Therefore, in the absence of theoretical guidelines, the semi-log functional form was chosen on the basis of convenience, since the coefficients are easier to interpret and fit better the objective of the study - to evaluate the impact of the feature «traditional variety» on the relative increase on WTP for apples. In this case, for small changes in the value of the variables, each

coefficient measures the relative change (coefficient  $\times 100\%$ ), in WTP caused by a unit change in the value of the respective regressor, holding all other explanatory variables constant.

Thereby, the WTP of individual  $j$  for each kilo of apples of variety  $i$  ( $WTP_{ij}$ ) is specified in its logarithmic form as follows:

$$\ln WTP_{ij} = \alpha_0 + \sum_{n=1}^4 \beta_n ORG_{nij} + \sum_{r=1}^3 \gamma_r VAR_{ri} + \sum_{s=1}^{12} \lambda_s SOC_{sj} + e_{ij}$$

The variables included in  $ORG_{nij}$  refer to the evaluation given by each of the inquired to a set of four organoleptic characteristics of apples (appearance, taste, texture and smell) of the nine varieties studied.

$VAR_{ri}$  represents apples attributes that are not dependent on respondents' evaluation, namely geographical origin of the variety (Portuguese traditional variety or foreign variety), danger of extinction and production method. Finally,  $SOC_{sj}$  relates to characteristics of the inquired and their household, such as place of residence, rural experience, gender, age, education and income. In Table 2 a more detailed presentation of all variables used in the model is shown.

The dataset obtained in this survey is clearly a panel dataset, since there are multiple observations (made by each of the participants) on several economic units (type of apple). Each type of apple ( $i = 1, \dots, 9$ ) was classified by each and all participants ( $j = 1, 2, \dots, 231$ ).

**Table 2.** Variables description

Variable	Description
<i>Dependent variable</i>	
WTP	Willingness to pay, measured in euros per kg.
<i>Organoleptic attributes</i>	
App	Rating assigned to the attribute appearance, measured on a scale from 1 to 5.
Text	Rating assigned to the attribute texture, measured on a scale from 1 to 5.
Taste	Rating assigned to the attribute taste, measured on a scale from 1 to 5.
Smell	Rating assigned to the attribute smell, measured on a scale from 1 to 5.
<i>Geographical origin and production technology</i>	
PortLR	Geographical origin of the variety. Takes the value 1 when Portuguese landrace and the value 0 otherwise.
Ext	Danger of extinction. Takes the value 1 when the variety is still traded in the market and the value 0 otherwise.
Org	Production technology. Takes the value 1 when produced in organic farming and the value 0 otherwise.
<i>Respondents and households characteristics</i>	
Res	Place of residence. Takes the value 1 if Lisbon area and the value 0 otherwise.
Rural	Rural experience. Takes the value 1 when respondents lived in rural areas in some stage of their lives and the value 0 otherwise.
Gend	Gender. Takes the value 1 for female and the value 0 otherwise
Age	Age of the respondent, measured in years
Edprim	Primary level of education. Takes the value 1 when the maximum level of education attended by respondents was primary and the value 0 otherwise.
Edhigh	High school level of education. Takes the value 1 when the maximum level of education attended by respondents was high school and the value 0 otherwise.
Eduniv	University level of education. Takes the value 1 when the maximum level of education attended by respondents was university and the value 0 otherwise.
Nhouse	Number of people on the household of the respondent.
Inc0	Level of income. Takes the value 1 when the respondent's monthly net income, measured in euros, is less than 500 and the value 0 otherwise.
Inc1	Level of income. Takes the value 1 when the respondent's monthly net income, measured in euros, is in the range [500;1000[ and the value 0 otherwise.
Inc2	Level of income. Takes the value 1 when the respondent's monthly net income, measured in euros, is in the range [1000;2000[ and the value 0 otherwise.
Inc3	Level of income. Takes the value 1 when the respondent's monthly net income, measured in euros, is not less than 2000 and the value 0 otherwise.

That is why each element has two subscripts: the group identifier  $i$ , for each variety of apples, and a within-group index, denoted by  $j$ , which identifies participants. For that reason, the assumption that errors are independent over all economic units and participants may not be sensible (Koop, 2003: p. 149) and ignore the nature of the panel data by estimating a linear regression model might be overly restrictive and could have complicated error process, such as heteroskedasticity across panel units and serial correlation within panel units (Baum, 2006: p. 219). Therefore, it was decided to estimate the model using panel data techniques.

## Results

With regard to the results, Table 3 shows the WTP and evaluation of the organoleptic attributes for each type of apple presented in the test panel. It is noteworthy that, on average, the most valued variety of apples was 'Bravo', closely followed by 'Tromba de Boi', both regional varieties. The less valued varieties were 'Golden Delicious' and 'Starking', both foreign (Table 3). As showed in Table 4, the overall average WTP was €1.07 kg<sup>-1</sup>, ranging from €0 to 4.00.

In Table 5 we present the estimation results. To decide which technique should be used in estimation,

the Breusch and Pagan Lagrangian multiplier test for random effects (Table 6) and the Hausmann test (Table 7) were applied to compare fixed-effects (FE) and random-effects (RE) estimations. In both tests, the hypothesis of random effects could not be rejected at a 0.01 significance level. Since RE estimation is more efficient and allows a broader range of statistical inference, it was decided to apply that technique in the estimation of the model. To add consistency to the results the estimation of the model using FE and Ordinary Least Squares (OLS) are also showed in Table 5. The comparison between RE, FE and OLS estimations shows that the model is rather stable. Whatever the estimation technique is, the values of the coefficients are very similar and the signs of the parameters do not change.

From all the variables included in the model, we concluded that all of those related with the intrinsic characteristics of apples (appearance, texture, taste and smell) have strong statistical significance. For a significance level of 1% the model also shows that the WTP for traditional Portuguese varieties is higher. With lower significance level ( $\alpha = 10\%$ ), it also seems that the production technology affects the consumers WTP.

In contrast, the variable «ext», related to threat of extinction, is not statistically significant in explaining the WTP. The variables related to socio-economic characteristics of respondents and their households have not statistical significance either.

**Table 3.** Willingness to pay and evaluation of the organoleptic attributes for the apples presented in the test panel (mean, median and standard deviation)

		Apple varieties <sup>1</sup>								
		A	B	C	D	E	F	G	H	I
Willingness to pay (€ kg <sup>-1</sup> )	Mean	1.17	1.03	0.85	1.15	0.91	1.20	1.05	1.19	1.09
	Median	1.10	1.00	0.80	1.10	0.95	1.10	1.00	1.05	1.00
	Std	0.47	0.52	0.37	0.42	0.34	0.47	0.37	0.48	0.42
Appearance	Mean	3.77	3.14	3.16	4.08	3.65	3.73	3.67	3.86	3.37
	Median	4	3	3	4	4	4	4	4	3
	Std	0.88	0.86	0.91	0.79	0.963	0.83	0.86	0.87	1.00
Texture	Mean	3.96	3.63	3.15	3.84	3.18	3.82	3.61	3.96	3.71
	Median	4	4	3	4	3	4	4	4	4
	Std	0.82	0.97	1.00	0.87	0.96	0.84	0.86	0.92	0.86
Taste	Mean	4.01	3.39	3.01	3.56	3.20	3.92	3.49	3.80	3.76
	Median	4	4	3	4	3	4	3.5	4	4
	Std	0.89	1.22	1.00	1.06	0.96	0.97	0.96	1.06	1.06
Smell	Mean	3.32	3.32	2.81	3.29	3.05	3.51	3.17	3.37	3.12
	Median	3	3	3	3	3	4	3	3	3
	Std	0.94	1.11	0.89	0.95	0.91	1.01	0.96	1.04	0.96

<sup>1</sup> A...I: see Table 1.

**Table 4.** Descriptive statistics

Variables	Observations	Mean <sup>1</sup>	Standard deviation <sup>1</sup>	Min.	Max.
WTP	2,050	1.0725	0.4471	0	4
App	2,065	3.6024	0.9345	1	5
Text	2,063	3.6524	0.9522	1	5
Taste	2,062	3.5708	1.0690	1	5
Smell	2,058	3.2182	0.9932	1	5
PortLR	2,079	0.6667	—	0	1
Ext	2,079	0.3333	—	0	1
Org	2,079	0.3333	—	0	1
Res	2,078	0.5500	—	0	1
Rural	1,997	0.6014	—	0	1
Gend	2,015	0.4774	—	0	1
Age	2,006	37.7782	14.0587	16	73
Edprim	2,006	0.0698	—	0	1
Edhigh	2,006	0.2154	—	0	1
Eduniv	2,006	0.7148	—	0	1
Nhouse	1,961	3.0724	1.4697	1	11
Inc0	1,718	0.1129	—	0	1
Inc1	1,718	0.2800	—	0	1
Inc2	1,718	0.4971	—	0	1
Inc3	1,718	0.1100	—	0	1

<sup>1</sup> For binary variables the mean corresponds to relative frequency; standard deviations are omitted.

**Table 5.** Estimation results

Variables	Random effects		Fixed effects		OLS	
	Coefficient	$p >  z $	Coefficient	$p >  z $	Coefficient	$p >  z $
App	0.0711113	0.000	0.0732594	0.000	0.0616773	0.000
Text	0.0593134	0.000	0.0673436	0.000	0.0275919	0.041
Taste	0.1225867	0.000	0.1197765	0.000	0.1329687	0.000
Smell	0.0366221	0.000	0.0373279	0.000	0.0325103	0.002
PortLR	0.0605492	0.001	0.0569372	0.001	0.0747291	0.001
Org	0.0259128	0.083	0.0238893	0.109	0.0349737	0.068
Ext	0.0074062	0.662	0.0067130	0.691	0.0102976	0.638
Res	-0.0107745	0.786			-0.0124978	0.522
Rural	-0.0020837	0.958			-0.0105302	0.599
Gend	0.0228460	0.556			0.0216954	0.254
Age	0.0006749	0.694	0.001953	0.840	0.0006471	0.454
Edhigh	0.0860553	0.290			0.0816004	0.046
Eduniv	0.0862827	0.245			0.0871604	0.020
Nhouse	0.0132505	0.315			0.0138587	0.031
Inc1	-0.0724540	0.322			-0.0622681	0.094
Inc2	-0.0754051	0.323			-0.0741803	0.053
Inc3	-0.0872861	0.371			-0.0769145	0.114
Constant	-1.159565	0.000	-1.180004	0.002	-1.044355	0.000
	Within = 0.4145 $R^2$ Between = 0.0620 Overall = 0.2793 Wald $\chi^2 = 999.74$ $p > \chi^2 = 0.0000$	Within = 0.4147 $R^2$ Between = 0.0409 Overall = 0.2666 Wald $\chi^2 = 125.39$ $p > \chi^2 = 0.0000$	$R^2 = 0.2822$ F(17, 1589) = 36.74 $p > F = 0.000$			



**Table 6.** Breusch and Pagan Lagrangian multiplier test for random effects

	Var	Sd = sqrt (var)
lnWTP	0.1721634	0.4149258
e	0.0741557	0.2723155
u	0.506029	0.2249508
Test: Var(u)=0		
$\chi^2 = 974.75$		
Prob > $\chi^2 = 0.0000$		

Of all variables with statistical significance, the one with greater impact on the WTP is, undoubtedly, taste followed by appearance. On a scale from 1 to 5, the increase of a unit in the evaluation of consumers about the taste of an apple leads to an increase of about 12% in their WTP. Next comes appearance (over 7%), texture (with 5.9%), and smell (with 3.7%).

In what concerns variety origin, it follows that, *ceteris paribus*, consumers are willing to pay 6% more for traditional Portuguese varieties than for foreign varieties of apples, though produced in Portugal. The premium for organic apples is very small, not exceeding 2.6%.

## Discussion

The knowledge of consumers' preference for regional varieties and the level of the price premium they are willing to pay are of great importance. Indeed, it is often heard in both technical and political speech that the reintroduction of regional varieties in the range of varieties grown by farmers may be one of the ways

to face the competition that small farmers, especially those living in less favoured areas, are increasingly facing. At the same time, the recovery of such varieties would respond to the longings of public opinion, more and more concerned about environment, natural and cultural heritage and especially with the diversification of tastes and experiences. However, there are not many studies to confirm the «impression» that taste and preferences of consumers are changing towards traditional varieties and that they truly are disposed to pay more for that kind of products.

The present investigation was designed to contribute to the understanding of factors that influence the price that consumers are willing to pay for different types of apples, particularly for the feature «traditional variety». The results show that, *ceteris paribus*, consumers are actually willing to pay more for regional Portuguese varieties of apples than for foreign varieties. The fact that these varieties may be endangered does not affect that decision. However, the main conclusion to be drawn, and which follows findings from other studies on the subject, is that the factors which determine, in a more evident way, the WTP are the intrinsic characteristics of products, with emphasis on taste and appearance. These results are consistent with those obtained by Pinto *et al.* (2008), which show, for the case of 'Pêra Rocha' pear (a Portuguese variety), that the consumer is not willing to compromise taste in behalf of food safety. Simões *et al.* (2008), using street surveys found out that appearance and taste are the most important factors that explain apples and pears choice by Portuguese consumers. Magnusson *et al.* (2001) also concluded that taste is the most im-

**Table 7.** Hausman test

	Coefficients			Sqrt[diag(V_b-V_B)]
	(b) fix	(B) ran	(b-B) difference	
App	0.0732594	0.0711113	0.002148	0.0014373
Text	0.0673436	0.0593134	0.0080302	0.0022844
Taste	0.1197765	0.1225867	-0.0028102	0.0015897
Smell	0.0373279	0.0366221	0.0007058	0.0022731
PortLR	0.0569372	0.0605492	-0.0036119	—
Org	0.0238893	0.0259128	-0.0020235	—
Ext	0.006713	0.0074062	-0.0006932	—
Age	0.001953	0.0006749	0.0012781	0.0094942

b: consistent under Ho and Ha; obtained from xtreg. B: inconsistent under Ha, efficient under Ho; obtained from xtreg. Test: Ho: difference in coefficients not systematic.  $\chi^2(8) = (b-B)'[(V_b-V_B)^{-1}](b-B) = 19.32$ . Prob >  $\chi^2 = 0.0132$ . (V\_b-V\_B is not positive definite).

portant criterion in food decisions by Norwegian consumers.

As shown on Table 3, traditional varieties performed better in sensory score, although, as referred before, one must keep in mind that, in the absence of blind valuation, those scores may be influenced by the previous knowledge about the variety origin. In this sense, the actions of diffusion and marketing of traditional varieties, to be carried out by the Government or producing organizations, should mainly focus on the inherent pleasant taste of these fruits. This is the only possible way to overcome the resistance to change that characterizes food purchasing behaviour. As mentioned earlier in this article, several authors cited by Grankvist and Biel (2007) point out that the purchase of food is an almost daily task, often performed without a cognitive assessment and mainly guided by habit. However, the presence of fruit with different and unfamiliar characteristics may lead consumers to break this cycle and make choice a more reflected process. For this to happen, differences must be clear and consumers must be aware of them.

Another important remark is that the difference of about 6% that consumers are willing to pay for regional Portuguese varieties may not be enough to compensate producers for lower productivity and greater production variability, usually related with this type of fruit varieties. This means that, if agro-biodiversity conservation is perceived by society as an important task, probably a public effort must be made in order to compensate producers for the social service they undertake. As pointed out by Smale and Bellon (1999), conservation is not a moral obligation of farming communities. For crop genetic resources to be conserved on-farm, their maintenance must be advantageous to farmers. The need of policies aimed to support the protection of regional varieties depends on the relationship between two variables: attractiveness to producers of such varieties and public interest on their conservation, derived from their potential to contribute for future genetic diversity. The higher the private profitability of a variety, the lower the need to develop policy measures for its conservation, since markets will reward farmers for conservation. At the same time, the more a variety significantly contributes to genetic diversity, the higher the importance of its conservation. In this case, and if markets are not available, production will cease, unless other type of incentives are offered to farmers. Even for varieties traded in the market, currently attractive for producers and consumers, in-

centives for conservation on farm may be needed, since «changes in the exogenous technological, socio-economic and cultural parameters», may have a strong effect on farmers' choice of varieties (Smale and Bellon, 1999: 401). In addition, changes in policies, not only in those that explicitly affect the conservation of biodiversity but also in those that directly and indirectly influence farmers' decisions, may change the conditions for varieties profitability.

The lack of statistical significance for the socio-economic features suggest that consumers' WTP depends more on the product attributes than on the personal characteristics of those who consume them. This result is somehow unexpected, particularly with regard to income, and may be explained by three types of reasons. The first, of methodological nature, relies on the fact that the investigation was conducted on a panel test context, probably leading to an overestimation of aspects connected to sensorial characteristics. The second, more theoretical, is that apples are products with low weight in households expenditure and income level may not actually have great explanatory power on the price consumers are willing to pay for such goods. Finally, since individuals in the sample have income levels above national average, price may be less important in their choices.

Although this study gives pertinent information about the behaviour of consumers who have a higher purchasing power and higher education, usually associated with a greater propensity to purchase products with specific qualities we must stress, as mentioned earlier, that the generalization of these findings to Portuguese consumers must be cautious because the sample used in this study suffers from some bias. It is also noteworthy that the results of the study were obtained under controlled conditions, with no guarantees that in a real situation the purchase decisions would be the same. In fact, it has been widely shown that the correlation between self-assessed attitudes, using stated preference methods, and actual consumption behaviour may not be high.

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