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WILLINGNESS TO PAY FOR ENVIRONMENTAL ATTRIBUTES OF NON FOOD AGRICULTURAL PRODUCTS : A REAL CHOICE EXPERIMENT

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Willingness to pay for environmental attributes of non-food agricultural products: a real choice experiment

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Abstract

This paper investigates consumers' willingness to pay (WTP) a price premium for two environmental attributes of a non-food agricultural product. We study individual preferences for roses associated with an eco-label and a carbon footprint using an economic experiment combining discrete choice questions and real economic incentives involving real purchases of roses against cash. The data are analyzed with a mixed logit model and reveal significant premiums for both environmental attributes of the product.

Key words

Willingness to pay, environmental attributes, non-food product, real choice experiment, mixed logit

JEL Classification: D12, C9, C25, Q10

1. Introduction

According to a recent European survey, "slightly more than 8 in 10 EU citizens feel that a product's impact on the environment is an important element when deciding which products to buy[1]". Many studies show that consumers are paying more attention to the environmental attributes of the products and may even be willing to pay a premium for green products (Thompson and Kidwell 1998, Loureiro *et al.* 2002, Macguire *et al.* 2004, Batte and Hooker, 2007, Tranter *et al.,* 2009). However, as most of these results apply to food products, there can be confusion between the pro-environmental and the private motivations of consumers. As noted by Bougherara and Combris (2009), it is unsure whether eco-labelled food products are chosen for altruistic (i.e. for the environment) or for selfish (i.e. for perceived health or taste benefits) reasons. Our objective is to investigate whether consumers are willing to pay for the environmental attributes of a non-food agricultural product in order to exclude health-related concerns from their motives. We use a real choice experiment – with real products and actual exchange - to analyse the individual choices of roses with two environmental characteristics: a label certifying eco-friendly cultivation conditions and a carbon footprint indicator.

Green products typically mix private and environmental characteristics. Recent studies have analyzed the determinants of eco-friendly food purchases and generally show that the consumers who are willing to pay a premium for such products are motivated by several conjoint factors like food safety, health benefits, environmental considerations, place of origin and animal welfare issues (Govindasamy and Huang 1996, Gil *et al.*

[1] Eurobarometer 2009

2000, Loureiro *et al.* 2001, Yirodoe *et al.* 2005, Yue and Tong 2009). The literature generally reveals that eco-friendly purchases result from both private (i.e. perceived heath or taste benefits) and public (i.e. pro-environmental) motivations. Nevertheless, no consensus has emerged on the relative importance of these various determinants. For instance, Durham (2007) reports that the choices of organic produce are influenced by the possible health benefits of those goods as well as by the environmentally friendly production they promote. The author concludes however that the private attributes tend to prevail in consumers' motivations. Differently, Bougherara and Combris (2009) find no evidence that consumers' willingness to pay for an eco-labelled orange juice are driven by its perceived sanitary attributes. Insightful results have also been found in studies dedicated to genetically modified (GM) food consumption. In a meta-analysis of this research area, Lusk *et al.* (2005) report that consumers' valuation of GM-free products vary greatly according to the characteristics of the consumer sample, the attributes of the product studied, and the value elicitation method. Nevertheless consumers generally exhibit significant premiums for GM-free products. As noted by Carlsson *et al.* (2007), it is questionable whether such premiums for GM-free food are linked to health worries, environmental concerns, or to other factors. In order to avoid a possible confound between the various choice determinants, our research elicits individual preferences for a non-food agricultural product with environmental attributes but without sanitary attributes.

Few empirical studies have been dedicated to non-food green products. For instance, Nimon and Beghin (1999) estimated hedonic equations from market choices of apparel goods and revealed positive willingness to pay for the products made of organic fibers. Similarly, Casadesus-Masanell *et al.* (2009) analyzed market data from a sportswear brand before and after the introduction of organic cotton and found that consumers were willing to pay a significant premium for this green product. These two studies reveal the existence of environmental premiums for non food green products. However, their results are inferred from market data which are typically characterized by important “noise”, i.e. numerous uncontrolled variables of decision. In order to control for the main variables surrounding consumers’ choices, we implement an economic experiment. Our study provides insight on how consumers value the environmental attributes of a non-food agricultural product by analysing individual choices of eco-friendly roses. Our research has the specificity to focus on two different environmental attributes: a label certifying eco-friendly cultivation conditions and a carbon footprint. We intend to find out whether the nature of the environmental attribute may influence consumers’ behavior. Using a real choice experiment, we estimate the willingness to pay for these two environmental attributes.

Our research implements a discrete choice experiment using real roses and actual transaction against money. Contrary to most previous choice-based surveys that elicit hypothetical preferences, we focus on real consumer decisions in the sense that each choice is likely to lead to an actual purchase. This incentive-compatible procedure avoids the hypothetical bias which may limit the validity of the stated values collected in surveys without real economic consequences for individuals. Many studies have shown indeed that the WTP elicited tended to be greater in hypothetical settings than in incentive-compatible settings (List and Gallet, 2001, Murphy *et al.* 2005, Harrison, 2006). Several instruments like cheap talk or ex-post calibration methods have been developed to mitigate this bias but their efficiency remains unsure (Harrison 2006, Alfnes *et al.* 2010). Instead of relying on such devices, we implement a real choice experiment in an experimental laboratory. The experimental data collected are analyzed with a mixed logit model which provides the advantage to consider heterogeneity across individuals by allowing taste parameters to vary in the population.

The paper is organized as follows. Section 2 describes the products offered to the subjects during the experiment. Section 3 presents the experimental design and the elicitation mechanism implemented. Then, section 4 introduces the econometric model and the results are discussed in section 5. Section 6 concludes the paper.

2. Non- food agricultural products with environmental attributes: roses

The choice of roses as the non-food agricultural product exchanged in our experiment was led by several criteria. First, roses have characteristics that fit well to the experimental economics constraints: they are well known products, not expensive and easily deliverable. Second, the environmental damages resulting from the production of roses have been the object of a growing attention in the media, consumer associations and scientific fields.

2.1. The environmental impact of roses' production

Two environmental aspects of roses' production deserve particular attention. The first one relates to the conditions of cultivation, in which the heavy use of pesticides, fertilizers, water and energy extensively pollutes the soil and water, thus harming the local environment. Some producers have recently adopted alternative cultivation methods to reduce such damage. They are signalled by dedicated eco-labels like the American VeriFlora® "Certified Sustainably Grown" label[2] which guarantees roses grown with the least environmental impact. The European equivalent is the FFP (Fair Flowers Fair Plants) label[3] which certifies the environmental performance of growers in terms of fertilizer use, crop production, energy efficiency, waste management and a number of social requirements. This label is certified by a third-party organization, the Horticultural Commodity Board, supported by the European Community.

The second environmental feature of roses that has recently been discussed relates to their carbon footprint, i.e. the greenhouse gases emissions during their production and transportation. Many developing countries in Africa, South America and Asia have recently intensified their production so that most roses sold in developed countries are now produced in distant places. Airfreight transportation of cut flowers results in large emissions of carbon dioxide and the negative impacts of these "flower miles" – as an equivalent to the concept of "food miles" indicating the distance travelled by food products – have recently been highlighted. Apart from transportation, production conditions are also highly energy consumptive, especially when greenhouses are used to grow roses. A recent scientific report from Cranfield University compares the carbon footprints of roses grown in Kenya with roses grown in Holland (Williams, 2007). It

[2] http://www.veriflora.com/

[3] http://www.fairflowersfairplants.com/

surprisingly reveals that roses grown in Kenya emit globally less greenhouse gases (up to six times less) than do roses grown in Holland. This result is mainly due to the indispensable heating of greenhouses in Holland, which requires much energy. Our experiment was designed to elicit the willingness to pay for these two environmental attributes of roses.

2.2. Attributes levels in the choice experiment

Table 1 displays the three characteristics defining the roses offered during the experiment: (i) the FFP eco-label, (ii) the carbon footprint and (iii) the price[4]. The roses offered were either eco-labelled, or unlabelled. They either had a lower carbon footprint, or a higher carbon footprint. Written instructions informed the subjects about the precise criteria certified by the FFP label and about the third party organization (i.e. the Horticultural Commodity Board) monitoring the labelling process. These instructions also mentioned the conclusions of the above-mentioned Cranfield University's report about roses' carbon footprint. In addition to the two environmental attributes, a price attribute was varied on seven levels between €1.50 and €4.50. Rose market prices vary greatly according to their characteristics, their point of sale, the seasons (especially the special events like Valentine's Day or Mother's Day), and so on. Our concern was to avoid that subjects decided to purchase a rose in a store, after the experiment, rather than in the laboratory because they believed that they would pay a lower price. This issue has

[4] The appearance attribute was fixed throughout the experiment. Subjects were invited to observe a rose sample in the beginning of each experiment. They were informed that all the roses offered were alike the sample shown (i.e. red roses categorized A- highest quality grade- by professionals) whatever their environmental attributes (eco-label and carbon footprint). If they did not like the appearance of the rose shown, they always had the option to opt out and were never forced to purchase a rose.

been referred to in the experimental literature as the 'field price censoring' which reflects the fact that the values elicited in the laboratory are censored by the field market price (Harrison *et al*. 2004). Therefore, we defined a price range between €1.50 and €4.50 which is slightly below the market prices usually observed on Valentine's Day.

Table 1. Attributes and levels

Attributes	Attribute levels
Eco-label	
[LABEL]	0 No
	1 Yes
Carbon footprint	
[CARBON]	0 Greater
	1 Lower
Price	
[PRICE]	€1,50
	€2
	€2.50
	€3
	€3.50
	€4
	€4.50

3. The real choice experiment

3.1. Value elicitation mechanism

The individual preferences for the various attributes of roses were elicited with a technique combining discrete choice questions and real economic incentives. Stated choice surveys have been extensively applied to the study of consumer preferences for public and private goods for the last decade. Such surveys typically require consumers to make choices between several alternatives defined by their attributes (see Louviere *et al.*

2000). The discrete choice methodology provides the advantage to vary simultaneously several attributes of a product and to estimate the marginal rates of substitution between these attributes, and especially the WTP for specified characteristics. It provides great flexibility in the sense that many different scenarios can be presented in a single study. However, the choices made by consumers in hypothetical surveys might not reflect their real preferences. It has been proved that participants to hypothetical surveys were generally stating higher WTP for private and public good, leading to the hypothetical bias (see Murphy *et al.* 2005, Harrison 2006).

To overcome this redundant problem, choice experiment can be made incentive compatible by linking participants' decisions to real consequences. Some former studies have applied real incentives to choice experiments. For instance, Lusk and Schroeder (2004) used a real choice experiment to study consumers' preferences for quality attributes of beefsteaks. In this study, consumers had to make several purchase decisions between various types of beefsteaks. One of their decisions was finally drawn and made real: consumers had to pay for the type of beefsteak chosen at the price specified in the choice set drawn. Similarly, Alfnes *et al.* (2006), Oelsen *et al.* (2010) and Gracia *et al.* (2011) analyzed consumers' choices for several characteristics of food products. One of the choices made during their experiments was leading to a real exchange of a product against cash. In the same way, Carlsson *et al.* (2001) investigated individual donations to different environmental programs. A final draw determined one choice and the corresponding amount of money was directly transferred to the chosen organization. In line with these studies, we designed a choice experiment with real economic incentives to elicit individual values for the environmental attributes of roses. Among the several choice tasks completed by each consumer, one led to a real purchase.

The choice task was intended to resemble actual purchase decisions with the inclusion of a "do not buy" option. This feature ensured that subjects were never forced to purchase a rose. As in a real shopping situation, they had the possibility of not purchasing any roses if none of the alternatives suited them in a choice set. Consumers were asked to make twelve different choices displayed on cards as shown in Table 2. All twelve cards were distributed simultaneously so that consumers could make their choices in any order. Individuals were informed from the beginning that one of their decisions would be randomly drawn at the end of the experiment. As the random draw resulted in the purchase of a real rose delivered against actual payment, they had to consider each choice made during the experiment as a real purchase decision.

Table 2. Example of a choice set

	Rose A	**Rose B**	
Eco-label	Yes	Yes	
Carbon footprint	Lower	Higher	
Price	€3.50	€3	
Circle your choice	***I buy Rose A***	***I buy Rose B***	***I don't buy any of these roses***

Implementing real incentives also supposed to deliver exactly the type of rose the participants chose during the experiment. All the different types of roses offered during the experiments had to be available on the market. Because of their specificities, some of the roses offered (especially the eco-labelled roses) were difficult to find in local shops at the time of the experiment and had to be ordered to wholesalers in advance. The experimental sessions were conducted the week before Valentine's Day so that we could know exactly the quantity and the types of roses to order. Subjects could choose among several places in the city to pick up their rose on Valentine's Day. They paid their flower the day of the experiment and received a confirmation letter indicating the place and time it would be made available to them[5].

3.2. Choice sets design

Various experimental designs have been used in previous real choice experiments. For example, in the study conducted by Lusk *et al.* (2004), all choice sets included the five alternative branded beefsteaks with variable prices and a "no steak" option. The five alternatives were fixed and their prices varied in the choice sets. Alfnes *et al.* (2006) used a different design in the sense that the alternatives were not branded and were not all present in every choice sets. Each set included two scenario-specific salmon fillets defined by their attributes (including a price) and an opt-out option. More recently, Yue and Tong (2009) designed choice sets involving pairs of unbranded fresh produce defined by a combination of two attributes (locally grown and organically grown) and a price. Similarly, our real choice experiment is unlabelled (or unbranded) in the sense that the alternative roses have generic titles (A or B) so that they can only be differentiated

[5] Note that all participants who purchased a rose during the experiment came to pick up their flowers at the place and time specified on Valentine's Day.

according to their attribute combinations. In other words, the choice between a ‘Rose A’ and a ‘Rose B’ can only be explained by their respective attributes (label, carbon footprint and price) but not by their title (A or B).

Each choice task required participants to pick one among three possible options consisting of two alternative roses described in terms of their attributes and a "do not buy" option. Random design techniques were used to allocate subsets of choice sets to subjects[6]. The two levels of the two environmental attributes could be combined in four different manners defining four types of roses. A type of rose can be described by a specific combination of environmental attributes. The different types of roses were presented by pairs in the choice sets given to subjects. Six different pairs were possible. The various types of rose were randomly allocated to a title A or B. Then, prices were randomly allocated to the alternatives and to the choice sets by a computer program generating random prices in the defined array of prices (every €0.50 point between €1.50 and €4.50). We asked each subject to face twice the six possible pairs of roses but the prices of the roses as well as the price combinations in choice sets were random. To sum up, the participants faced the same choices in terms of the environmental attribute combinations but with different price scenarios.

4. Econometric model

Consumers' decisions are frequently analyzed with the discrete choice modelling framework which assumes that consumers associate each alternative in a choice set with

[6] We note that a more efficient design could have been created using dedicated software like ngene.

a utility level and choose the option that provides them with the greatest utility. The general estimation framework of the Random Utility Model (RUM) proposed by MacFadden (1974) provides the opportunity to estimate the effects of product attributes and individual characteristics and to compute willingness to pay indicators.

For a decision-maker *i*, the utility of choosing option *j* ('Rose A' or 'Rose B' or 'do not buy') is a function of the characteristics of the alternatives *j*. Utility functions U_{ij} are composed of a systematic part V_{ij} and a random part ε_{ij} standing for all unobserved variables: $U_{ij} = V_{ij} + \varepsilon_{ij}$

The systematic part of the relative utility function of individual *i* associated with alternative *j* is modelled as a linear function:

$$V_{ij} = \alpha_{i,BUY} + \theta_{BUY,\mathrm{Sex}}\mathrm{Sex}_i + \theta_{BUY,Age}\mathrm{Age}_i + \theta_{BUY,Income}\mathrm{Income}_i + \theta_{BUY,Org.Habit}\mathrm{Org.Habit}_i$$
$$+ \beta_{\mathrm{Price}}\mathrm{Price}_{ij} + \beta_{\mathrm{i,Label}}\mathrm{Label}_{ij} + \beta_{\mathrm{i,Carbon}}\mathrm{Carbon}_{ij} + \beta_{i,\mathrm{Label}\times\mathrm{Carbon}}\mathrm{Label}\times\mathrm{Carbon}_{ij}$$

where *j* = 'Rose A', 'Rose B', 'do not buy'.

$\alpha_{i,BUY}$ is a dummy variable capturing the effect of choosing to buy a rose (Rose A or Rose B) with respect to the 'do not buy' option[7]. θ is the vector of coefficients associated with individual characteristics. Individual characteristics are assumed to affect utility for the two 'buy' cases compared with the 'do not buy' case. Finally, β represents the effects of the alternatives' attributes. Our data are analysed with the mixed logit model which relaxes the Independence from Irrelevant Alternatives (IIA) hypothesis of the

[7] Given the random process determining the title A or B of each rose and the unbranded nature of our choice experiment, an ASC associated with each rose type has no sense (see Hensher *et al.,* 2005). We nevertheless introduced a dummy variable in order to distinguish the 'buy' cases (Rose A or Rose B) from the 'do not buy' case and to introduce heterogeneity in the preferences for the roses.

multinomial logit by allowing the random components of the alternatives to be correlated, while maintaining the assumption that they are identically distributed (Greene, 2008). Hence, some parameters of the vector β and α are assumed to be randomly distributed in the population rather than fixed as in the usual multinomial logit model (see Hensher and Greene 2003 for a detailed presentation of the mixed logit model). Furthermore, the mixed logit model takes into account the repeated nature of the choices made by respondents. Finally, McFadden and Train (2000) have shown that any discrete choice model can be approximated by a mixed logit model, including the multinomial logit model. It has been previously used to analyze choice experiment data (see for example Lusk and Schroeder, 2004 or Rigby and Burton, 2005).

In our case, random taste heterogeneity is expected in response to the eco-label and the carbon footprint attributes of the roses. As in Bernard and Bernard (2009), we introduce the cross-product as a random parameter in order to test the effect of the simultaneous presence of an eco-label and a low carbon footprint. The normal distribution is used to specify the distribution of the random parameters associated with the roses' attributes. Hence, four random parameters are to be estimated: the 'buy dummy' variable which captures heterogeneity in consumers' preferences for a rose, and the three parameters associated with the eco-label, the carbon footprint and their cross-product. Given that the normal distribution is symmetric and unbounded, we make the *a priori* assumption that both positive and negative values may exist in the population (Hess *et al.*, 2005). Following Revelt and Train (1998), we assume the price coefficient to be fixed in the population. Fixing the price coefficient ensures that all respondents have a negative price coefficient so that the estimated WTP will be normally distributed.

The willingness to pay (WTP) for a product and the premiums for a unit change of a given attribute of the product can be computed as the marginal rates of substitution between the quantity expressed by the attributes and the price (Louviere *et al.* 2000). Since utilities are modelled as linear functions of the attributes of the roses, the marginal rate of substitution between two attributes is the ratio between the coefficients[8]. The WTP for a rose is:

$$WTP = \frac{\partial V / \partial \alpha_{BUY}}{\partial V / \partial \text{Price}} = \frac{-\alpha_{Buy}}{\beta_{\text{Price}}}$$

The premiums for the FFP label or for the low carbon footprint (when a rose exhibits only one of these signals) are expressed as:

$$\text{Premium}_k = \frac{\partial V / \partial X_k}{\partial V / \partial \text{Price}} = \frac{-\beta_k}{\beta_{\text{Price}}}, \text{ with } k\text{= label, low carbon footprint}$$

The premium for the simultaneous presence of the FFP label and the low carbon footprint (considering crossed-effects) is:

$$\text{Premium}_{sim} = \frac{-(\beta_{label} + \beta_{carbon} + \beta_{carbon \times label})}{\beta_{\text{Price}}}$$

In absence of correlation between the premium for a label, the premium for a low carbon footprint and the premium for their cross-product, and given the fixed price coefficient

[8] It should be noted that the derivative of the unobserved part of the utility function is supposed to be zero with respect to the price and the product attributes.

and the normally distributed attributes' coefficients, the premiums are normally distributed, as linear combinations of normal random variables.

5. Results

5.1. Descriptive results

Nine experimental sessions were conducted with a sample of 102 consumers described in Table 3. All experiments took place in February 2008. Each subject completed 12 decisions, so that we could collect 12*102=1224 observations. 33 observations were dropped from the dataset because no response was provided (no option was circled on the choice card). The option to buy a rose was chosen 804 times (67.5% of the choices) while the option not to buy any roses was chosen 387 times (32.5% of the cases). Descriptive results also show that consumers more frequently chose roses with a better environmental quality. They opted more frequently for roses with a lower carbon footprint (79% of the roses chosen) than roses with a higher carbon footprint (21%). They also tended more frequently to select roses with the FFP label (69% of the roses chosen) rather than roses without the FFP label (31%).

Table 3. Sample description *(N=102)*

Variable	Definition	Mean	Std	Min	Max
SEX	Female = 0 and Male = 1	0.49	0.50	0	1
AGE	Age in years	39.74	18.89	18	85
INCOME	Personal income in €1000 range from less than €1000 (1) to more than €5000 (6)	2.15	1.22	1	6
ORGANIC	0 = never buy organic products and 1 = regularly buy organic products.	0.65	0.45	0	1

5.2. Mixed logit results

Mixed logit models are usually specified with uncorrelated coefficients. In our case, we introduce correlation between the normally distributed coefficients[9]. Indeed, the estimated variance-covariance matrix indicates a significant and positive correlation between the label and carbon footprint coefficients, but no significant correlation between the 'buy dummy' and the two environmental attributes. As a result, we present estimates of the variance-covariance matrix of the correlated random parameters.

Table 4 presents the results of the mixed logit model[10]. The 'buy dummy', the label and the carbon footprint are random normal parameters in the mixed logit model whereas the price coefficient is fixed as previously explained. Estimates show that male and frequent

[9] The joint significance of the off-diagonal elements of the covariance matrix is tested with a likelihood ratio test. The null hypothesis of uncorrelated coefficients is rejected (p-value<0.001; LR = 2*(718.383-699.425) = 37.916).

[10] Following McFadden *et al.* (1977), we test the IIA assumption by testing the joint hypothesis that all cross-attribute effects are zero. Given the likelihood functions values (LR_{uni} = -932.323 with the universal logit and LR_{cond} = -937.427 with the conditional logit), the IIA assumption is rejected (χ^2=10.208, p<0.05). This test confirms that the conditional logit model does not fit our data.

organic purchasers have a higher probability to buy a rose. Parameter estimates of the eco-label, the carbon footprint and the price attributes all have the expected signs and significant effects on choices. The two environmental attributes do have a significant impact on the probability of choice: a rose is more likely to be chosen if it has an eco-label or if its carbon footprint is lower. The price coefficient indicates that subjects are unsurprisingly more prone to purchase a rose with a lower price. The 'buy dummy' has a positive sign and is strongly significant, indicating that consumers receive higher utility when they buy a rose than when they don't. This last result strengthens our belief that the incentives used in the experiment were effective. Consumers could indeed decide to keep the whole monetary reward by choosing the 'do not buy' option in all choice sets. Our results show that they did not. Finally the estimated standard deviations are all significant. It reveals a significant heterogeneity in consumers' preferences for the label and carbon footprint attributes as well as for the product itself.

Table 4. Estimates of the Mixed Logit model

	Mixed logit		
Independent Variable	**Coefficient**		**Standard errors**
Fixed parameters			
Sex	1.420	***	(0.399)
Age	0.009		(0.010)
Income	0.057		(0.159)
Organic purchase habits	1.027	***	(0.323)
Price	-1.631	***	(0.130)
Random parameters - Means			
'buy' dummy	2.285	***	(0.743)
Label	2.824	***	(0.318)
Carbon	6.665	***	(1.328)
Label x Carbon	-2.785	**	(1.290)
Standard deviations			
'buy' dummy	3.202	***	(0.319)
Label	2.654	***	(0.317)
Carbon	3.535	***	(1.087)
Label x Carbon	2.711	***	(0.779)
Covariances			
dummy-Label	-0.54		(0.93)
dummy-Carbon	-4.39	**	(2.22)
dummy-(Label x Carbon)	6.17	**	(2.51)
Label-Carbon	8.77	***	(2.88)
Label-(Label x Carbon)	-2.33		(2.77)
Carbon-(Label x Carbon)	-4.82		(5.72)
Log-likelihood		-699.425	

Note: *** indicates a 99% or more statistical significance and ** indicates a 95% statistical significance

5.3. WTP and premiums estimates

Table 5 displays the mean WTP for a rose (with no label and a high carbon footprint) and the mean premiums for the FFP eco-label and for the low carbon footprint. Since the random parameters are correlated, the estimated standard deviations and confidence intervals are obtained using the Krinsky and Robb parametric bootstrapping method (Krinsky and Robb, 1986). 1000 draws are generated from a multivariate normal distribution with the coefficient estimates and the estimated variance-covariance matrix of the random parameters. These 1000 values are then used to calculate the percentiles of the simulated distribution reflecting the desired confidence level. The lower and upper limits of a 95% confidence interval are given by the 26^{th} and 975^{th} sorted estimates of WTP respectively.

Estimated coefficients and standard deviations lead to negative lower bounds of the confidence intervals. The assumed normal distribution of the random parameters is one way to model heterogeneity in preferences. The *a priori* assumption of symmetry of the hypothesised distribution allows the decision-maker to display negative WTP. Discussion about the choice of an appropriate distribution and its impact on the estimated WTP is still in progress in the literature (see for example Hess *et al.*, 2004, 2008, Sillano and Ortuzar, 2005).

Our results show that the mean WTP for a rose with no label and a high carbon footprint is €1.40. Moreover, the mean premium for the FFP eco-label is €1.73 while the mean premium for a low carbon footprint is €4.09. All other things being equal, consumers are willing to pay an average price premium of €1.73 for a rose with the FFP label. Similarly, they are willing to pay an average price premium of €4.09 for a rose with a low carbon footprint. Both mean values of premiums are positive and confirm that the presence of these environmental attributes globally increases the overall utility of a rose. Besides, the negative and significant coefficient of Label x Carbon leads to a premium of €4.11 (i.e. the sum of the coefficients of Label, Carbon and Label x Carbon divided by the Price coefficient). The premium for the two environmental attributes together (FFP eco-label *and* low carbon footprint) is not equivalent to the sum of the two respective premiums. It corroborates results from previous studies revealing that price premiums for specific environmental attributes may be sub-additive (Bernard and Bernard, 2009). Standard deviations and confidence intervals show an important dispersion of both WTP and premiums.

Finally, significant difference is found between the respective price premiums for the environmental attributes (p-value < 0.01). Consumers are willing to pay a price premium for each environmental attribute of the roses but they interestingly value a low carbon footprint more than the FFP Label. This finding suggests that consumers may value differently the environmental characteristics of a product according to their specificities. We discuss this point in next section.

Table 5. Mean WTP and premiums for the environmental attributes of a rose and Krinsky-Robb IC

WTP and Premiums	Mean	Standard deviation	95% Interval of Confidence	90% Interval of Confidence
WTP for a rose ***(€/piece)***	1.40	1.96	[-2.47; 5.26]	[-1.83; 4.62]
Premium for Label ***(€/piece)***	1.73	1.63	[-1.45; 4.91]	[-0.93; 4.40]
Premium for Carbon ***(€/piece)***	4.09	2.17	[-0.17; 8.33]	[0.53; 7.66]
Premium for Label + Carbon	4.11	2.98	[-2.45; 10.67]	[-1.37; 9.62]

6. Conclusion

Given the possible confusion between private and pro-environmental motivations in consumers' choices of eco-friendly food products, our study elicits individual preferences for the environmental attributes of a non-food agricultural product. Our results show that consumers value positively the environmental characteristics of a private good even when they do not benefit from associated private advantages. Contrary to the food products used in most previous studies, the products valued in our experiment were not directly associated with private health, nutritional, or gustative benefits. Nevertheless both the local pollution effects from the production of roses and the global carbon dioxide emissions were taken into account in consumer's choices. It is interesting to note that the participants valued differently the FFP eco-label and the carbon footprint attribute. More precisely, they were willing to pay a greater price premium for a low carbon footprint than for a FFP eco-label. This latest result has to be considered given our specific experimental design and model specification. It has thus to be interpreted with caution and confirmed by further studies. Nevertheless, the assumption that consumers value differently the environmental attributes of a given product according to their nature could have implications in the current policy debate about the environmental labelling of products on packaging. In our case, consumers seemed more concerned about the global effects of carbon dioxide emissions than about local (and distant) environmental damages. On the one hand, the price premium for the eco-label could be interpreted as an altruistic behaviour in the sense that consumers living in Grenoble were not directly confronted to the local environmental effects of roses produced in Holland or in Africa. On the other hand, the greater price premium for a low carbon footprint might be related to worries about global climate change whose impact on individuals' well-being has been extensively discussed in the media lately. While the environmental impacts of agricultural products are now commonly labelled, especially in the case of food products, their carbon footprint is not. At best, consumers can infer this carbon impact from the products' origins but their evaluation is likely to be biased because of incomplete information and limited capabilities. Our results support the fact that consumers might be influenced by precise information about the carbon dioxide emissions associated with a product.

Our conclusions are strengthened by a specific experimental design which associates discrete choice questions with real economic incentives. Much literature discusses the validity of the values elicited in hypothetical and experimental empirical studies. It has been shown that the values depend highly on the methods used to elicit them (see for example Lusk *et al.* 2005, Carlsson *et al.* 2007, Gracia *et al.* 2011). Beyond internal validity, researchers are particularly interested in the ability of elicited values to predict store behaviour. In a recent study, Chang et al. (2009) compared the results of three elicitation mechanisms - hypothetical choices, non-hypothetical choices, and non hypothetical rankings - associated with three different discrete choice econometric models. They found that the three elicitation techniques reached a *'reasonably high level of external validity'*. Nonetheless, their results showed that non hypothetical choices were *'a better approximation of "true" preferences than are hypothetical choices.'* They also found that the use of advanced discrete choice models like the mixed logit model can improve in-sample and out-of-sample predictions. This result emphasizes the interest of real choice experiments to study consumers' preferences. Experimental techniques allow a strict control of information which makes it possible to measure individual values for credence attributes –i.e. environmental attributes - that would not be observed on real markets. In other words experimental economics in general and real choice experiments in particular, provide a focus on consumers' valuation process, i.e. how they assign values to the products and their characteristics in a controlled information setting. By combining the control of the lab and relevant field elements, our experiment elicits consumers' values for two environmental attributes *ceteris paribus.* Nevertheless, lab conditions may influence WTP in some extent. In our case, consumer attention was focused on the two environmental attributes rather than on the other rose attributes (for instance, the appearance attribute was fixed throughout the experiments). Given this aspect of our design, the estimated WTP and premiums may not predict real market values. However, they indicate that consumers do include the environmental attributes in their purchase decisions and that they value them positively. Our experimental results could gain more realism by being reproduced in the field. They could also help to calibrate hypothetical surveys that can be addressed to larger samples of consumers.

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