DECOMPOSING THE VALUE OF RABBIT MEAT. A JOINT USE OF THE CONTINGENT VALUATION AND THE ANALYTICAL HIERARCHY PROCESS.

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ABSTRACT

Our paper makes use of the Analytical Hierarchy Process (AHP) in order to derive the willingness to pay (WTP) for complex goods with a range of attributes and attribute levels. Weights obtained from the AHP are used to decompose the aggregate WTP obtained from Contingent Valuation (CV) in a hypothetical simulated market. The empirical analysis uses consumer-level questionnaires to elicit information regarding consumer attitudes and preferences towards rabbit meat in Catalonia (Spain). Our results demonstrate the convenience of our approach to analyze consumer WTP for complex goods. Furthermore, results demonstrate a higher preference for rabbit meat from the "Catalan" region followed by higher quality certification information

Keywords: AHP, Contingent Valuation, willingness to pay

1. Introduction

Several alternatives are available when analyzing individual stated preferences for product attributes and levels. The Analytical Hierarchy Process (AHP) has been show to be able to assess individual preferences following a hierarchical structure. The AHP allows for the search of relative importance placed on product attributes and attribute levels of the analyzed complex goods. Several studies have compared individual preferences and customer decisions using AHP and other monetary stated preference such the Conjoint Analysis (CA) and the Choice Experiments (CE) (Malvinas, et al., 2005; Scholz, *et al*., 2005; Meißner *et al*., 2008, Moran, *et al*. 2007, Colombo *et al*., 2009 and Kallas *et al*., 2011).

However, the AHP has shown some limitations in introducing monetary attributes in the paired comparison task. As a result, the willingness to pay (WTP) for the product' attributes and levels are hardly derived using only the AHP method. The objective of this study is to cope with this limitation, proposing a theoretical model based on a joint use of the Contingent Valuation (CV) and the AHP in an analogue way to the model developed by kallas *et al*., (2007) in order to derive the individual willingness to pay for level of a product.

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2. The theoretical framework

Let suppose a "choice set" (S_n) with the presence of three hypothetical "alternatives of election" (i.e. hypothetical product) in a simulated market: Alternative "A" (P_1), alternative "B" (P_2) and alternative "neither of them" (*statu-quo* option or opt-out option). In addition, let suppose that consumers are asked in a contingent valuation exercise to choose their preferred alternative and to set their maximum willingness to pay for it.

The contingent valuation assumes that consumers derive utility from two goods, a selected good (P_i) and all other goods treated as a composite good with price (Y). Thus, in an analogue way to the model developed by kallas *et al*., (2007), our valuation question elicits maximum WTP for the chosen product (P_i) consistent with the following indifference situation:

$$U(Y - WTP_{\Delta Pi}; P_i) = U(Y; \textit{statu-quo option}) \quad (1)$$

where $WTP_{\Delta Pi}$ is the willingness to pay for moving from the *statu-quo* option (i.e. the alternative "neither of them" or "do not purchase") to the selected good (P_i).

Rearranging the previous expression, the monetary equivalent of the decision to purchase the good (P_i) rather than keeping the preference toward the alternative "opt-out option" (i.e. the keeping the *statu-quo* situation) can be expressed as:

$$WTP_{\Delta Pi} = U(P_i) - U(\textit{opt-out option}) \quad (2)$$

On the other hand, the product utility can be expressed as:

$$U(P_i) = U(A_1, A_2, ..., A_n) \quad (3)$$

and for the opt-out option as:

$$U(\textit{opt-out option}) = U(A_{1.\text{ref}}, A_{2.\text{ref}}, ..., A_{n.\text{ref}}) \quad (4)$$

Where A_i are the attributes of the product ($i = 1 \ldots n$) and $A_{i.ref}$ are the value of attribute at the reference situation (i. e. value of attributes that describe the opt-out option). Replacing equation (3) and (4) into (2):

$$WTP_{\Delta Pi} = U(A_1, A_2, ..., A_n) - U(A_{1.\text{ref}}, A_{2.\text{ref}}, ..., A_{n.\text{ref}}) \quad (5)$$

However, individual values cannot be assigned to A_i without further assumptions about the shape of the utility function *U*. Multicriteria analysis (in particular The Analytical Hierarchy Process, AHP) helps. Assuming a linear and additive utility function specification, AHP allows us to estimate weights (w_n) as follow:

$$U(P_i) = (w_1 A_1 + w_2 A_2, ..., w_n A_n) \quad (6)$$

and

$$U(opt - out) = (w_1 A_{1.\text{ref}} + w_2 A_{2.\text{ref}}, ..., w_n A_{n.\text{ref}}) \quad (7)$$

Combining equation (5), (6) and (7) we obtain:

$$\begin{aligned} WTP_{\Delta Pi} &= (w_1 A_1 + w_2 A_2, ..., w_n A_n) - (w_1 A_{1.\text{ref}} + w_2 A_{2.\text{ref}}, ..., w_n A_{n.\text{ref}}) \\ &= w_1(A_1 - A_{1.\text{ref}}) + w_2(A_2 - A_{2.\text{ref}}) + \ldots + w_n(A_n - A_{n.\text{ref}}) \end{aligned} \quad (8)$$

In the case of the opt-out option, the reference values of attributes describing this alternative ($A_{n.ref}$) are set to zero, since the alternative "neither of them" does not contain any product descriptors. Therefore, we can state that the WTP for an individual attribute of the good is as follow:

$$WTP_{An} = w_n \, WTP_{\Delta Pi} \quad (9)$$

Following the above mentioned model, the WTP of the hypothetical products (P_i) can be decomposed into the WTPs of their attributes and levels. In this line, our theoretical framework relies on a joint use of three techniques:
To build up an array of different "choice sets" (S_i) that contains several hypothetical products (P_i). This can be reached by using the "experimental design" techniques.
The Contingent Valuation (CV) exercise to estimate the WTP for passing from the *statu-quo* option to the chosen hypothetical product ($WTP_{\Delta Pi}$).
The Analytical Hierarchy Process (AHP) to estimate the weights (w_n) of product descriptors (attributes and levels) within each hypothetical product.
The first step is to construct the array of the hypothetical products (i.e. the choice sets; S_i) in order to valuate product in a further step using the contingent valuation.

2.1 The Creation of choice sets of the hypothetical products

To ensure a valid representation of attributes and levels, they should be included within the hypothetical products in a balanced and equilibrated way. Among the available experimental designs, the "factorial design" is one of the most used. It ensures that each level of each attribute is combined with all level of all others attributes (Cochrane and Cox, 1957 and Winer, 1971). The total combination of levels and attributes of a product (full factorial design) requires a consideration of LA possible "choice alternatives", where L is the number of levels and A is the number of attributes. The full factorial design has the advantage, from a statistical point of view, in ensuring that all main and interaction effect among attributes and levels are independently estimated (the orthogonality property). Despite this advantage, it suffer from the problem of the generated number of "hypothetical products" which increases exponentially with the number of attributes and levels, reaching numbers beyond the capacity and ability of a respondent to choose among them. As a solution to this difficulty, a fraction of this general factorial design is usually used. This new design is a selection of some "choice alternatives" from the all possible combinations. In the process of selecting the desired number of "choice alternatives", orthogonality property should be respected. The identification of the orthogonal fractional factorial design allows creating different and independent "choice alternatives" (i. e. hypothetical products). In a following step, we need to identify which combination of the created "hypothetical products" should be within "choice sets". To create the alternatives within each choice sets the "swapping" procedure (Street and Burgers, 2003), known also as "shifting" (Bunch, et al., 1996, and Huber and Zwerin, 1996) is usually used.

2.2. The Contingent Valuation

Once choice sets are created, CV question is introduced by asking consumers their maximum willingness to pay (WTP) for their preferred "hypothetical product" from each choice set. The multiple payment format can be a convenient way as it combines the advantages of open-ended formats (elicitation of point information of WTP) and closed formats (ease of cognitive burden on interviewees) whereas minimizing the risk of ''starting price bias''. For more detailed information about the CV theory see among other Mitchell and Carson (1989), Arrow *et al.*, (1993) or Carson, (2006). Following the format of multiple payments, in each choice set a question about WTP is included with several monetary options as can be seen in Figure 1. Respondent are asked to choose from the available values their WTP for the preferred product from each choice set

Choice set # 1	**Product "X"**	**Product "Y"**	**Opt-Out Option**
Attribute1 … **Attribute *n***	Combination "X" of different levels	Combination "Y" of different levels	Neither of them
Please select from the values below your maximum WILLINGNESS TO PAY for your preferred product: € WTP_1 € WTP_2 € WTP_3			

Figure 1: Description of a choice set for the Contingent Valuation experiment

2.3. The Analytical Hierarchy Process (AHP)

The AHP is a multi-criteria decision-supporting method in discrete environments (Saaty, 1977; 1980). It aims to decompose a complex decision problem in a hierarchy into smaller constituent sub-problems. In order to implement the AHP, first product attributes (A_n) and levels ($L_{n.m}$), where n is the number of attributes ($n=1,..., N$) and m is the number of levels within each attribute ($m=1, ..., M$), should be identified to create the simulated market of the hypothetical products. In a subsequent step, a survey is needed to ask individuals about the relative importance or weights (w) of the different attributes (A_n) and levels ($L_{n.m}$) obtained from pairwise comparisons following a hierarchical structure. Following the AHP estimation procedure the local (attribute) and Global (levels) weights within the hierarchical results can be obtained.

3. The Joint use of CV and the AHP

As a result of applying the abovementioned three stages, the WTP (from the CV) can be decomposed using weights of levels (from the AHP) following equation 9 to estimate the WTP of levels as can be seen in Table (shadowed cells).

Table 1: Joint use of AHP and CV

Attributes	**Choice set #1**		
	Product "X"	**Product "Y"**	
Attribute 1 ***(A_1)***	Local weight of attribute A_1 w_{A1}	Local weight of attribute A_1 w_{A1}	
	Local weight of levels *m* of A_1 $w_{L1.m}$	Local weight of levels *m* of A_1 $w_{L1.m}$	
	Global weight of levels: $w_{G\_L1.m} = w_{L1.m} \times w_{A1}$	Global weight of level $w_{G\_L1.m} = w_{L1.m} \times w_{A1}$	
	WTPs of levels: $WTP_{L1.m} = w_{G\_L1.m} \times WTP_X$	**WTPs of levels:** $WTP_{L1.m} = w_{G\_L1.m} \times WTP_Y$	
⋮	⋮	⋮	
Attribute n ***(A_n)***	Local weight of attribute A_n w_{An}	Local weight of attribute A_n w_{An}	
	Local weight of level *m* of A_n $w_{Ln.m}$	Local weight of level *m* of A_n: $w_{Ln.m}$	
	Global weight of levels: $w_{G\_Ln.m} = w_{Ln.m} \times w_{An}$	Global weight of levels $w_{G\_Ln.m} = w_{Ln.m} \times w_{An}$	
	WTPs of levels: $WTP_{Ln.m} = w_{G\_Ln.m} \times WTP_X$	**WTPs of levels:** $WTP_{Ln.m} = w_{G\_Ln.m} \times WTP_Y$	
	Total WTP of "X" WTP_X	Total WTP of "Y" WTP_Y	**Neither of them**

4. The Empirical application

For the empirical application we have selected the rabbit meat consumption sector in Catalonia (Spain) to realize our exploratory study. This study will focus on consumers' preference and attitudes toward a quality brand of rabbit meat. Data used in this analysis were obtained from face-to-face questionnaires with consumers carried out during February 2009. The questionnaire collects extensive information on consumer's characteristics and their attitudes and perceptions toward rabbit meat. The final sample consists of 113 consumers mainly located at Barcelona province. To mitigate the order effect in realizing

the AHP and CV exercises, we followed a design based on ordering change, both within and between techniques as advised by Charzan (1994). We have split our sample into four sub-samples, generating four versions of the survey differentiated by different orders between and within methods such as attributes, levels, choice sets and pairwise comparisons. For the identification of attributes and levels of fresh rabbit meat, the elements that consumers take into consideration when purchasing this product need to be clearly defined, including the quality brand as an attribute of interest. The final set of attributes was: origin, format and price beside the brand attribute. In the same context, a pilot questionnaire was applied where no posterior problems were identified. The final attributes and levels are shown in Table 2.

Table 2: Attributes and levels for rabbit meat preference

Attributes	**Levels**
Origin	Foreign (**$L_{1.1}$**), Spain (**$L_{1.2}$**), Catalonia (**$L_{1.3}$**)
Format	Boneless (**$L_{2.1}$**), Pieced (**$L_{2.2}$**), Entire (**$L_{2.3}$**)
Brand	Unbranded (**$L_{3.1}$**), Commercial (**$L_{3.2}$**), Quality (**$L_{3.3}$**)
Price	€5.50 (**$L_{4.1}$**), €7.00 (**$L_{4.2}$**), €7.50 (**$L_{4.3}$**)

5. Results

Results obtained from the AHP are shown in Figure 3. The "Catalan" origin is the most important level (60.7%) followed by "Spain" (26.8%) and "Foreign" (12.5%). Within the "format" attribute, the highest weight is assigned to the "entire" level (52.1%) followed by the "pieced" (31.8%) and the "boneless" rabbit meat (16.0%). Finally, in relation to the "brand" attribute, the most important weight is associated, as expected, to the "quality brand" (57.4%), followed by the "commercial brand" (22.1%) and the "unbranded" levels (20.4%). Global weights of levels are also reported in Figure 3. These values can be compared between all levels for all attributes since they are normalized with their corresponding attribute' weight. Results show that consumers prefer in the first place the "entire" rabbit meat (25.0%), produced in "Catalonia" (18.6%). The third preferred level is "pieced" rabbit meat (15.3%) followed by "quality brand" (12.2%). Results show that the "ideal" product is "entire" or pieced" rabbit meat produced in "Catalonia" with "quality brand".

The results of the joint use of the CV and AHP are summarized in Figure 3. Results show that for the "origin" attribute, consumers are willing to pay 1.016 (€/Kg) for the Catalan origin of the rabbit meat, 0.236 (€/Kg) for the Spanish origin. Theses value decrease drastically to 0.086 (€/Kg) in the case of foreign level. For the "format" attribute, the entire level receives the highest WTP (1.380 €/Kg) followed by the "pieced" (0.720 €/Kg) and Boneless (0.432 €/Kg) meat. Finally, for "brand" attribute is the less valued attribute. Consumers have a WTP of 0.483 (€/Kg) for "quality" level, 0.154 (€/Kg) for "commercial" brand and 0.156 €/Kg for the "unbranded" level.

5. Conclusions

Our paper try to assess the WTP of attribute' levels of an Agro-food product on the basis of a joint use of the CV and the AHP. We develop a theoretical model that try to decompose the aggregate WTP of a product into the WTPs of his descriptors. The CV allow to obtain an aggregate value of the WTP of the product in a holistic way, whereas the AHP allow for decomposing this value according to the relative weights of levels obtain from consumers' pair wise comparisons.

For the empirical application, consumers' preference and attitudes toward a quality brand of rabbit meat are analyzed. Data used in this analysis were obtained from face-to-face questionnaires with 113 consumers located at Barcelona province. The joint use of the AHP and CV show that the ideal product is the "entire" or pieced" rabbit meat produced in "Catalonia" preferably with a "quality brand". In this context, the AHP show its capacity to be a valid complement technique to decompose the WTP obtained from a monetary valuation technique such as the CV on the basis of an additive utility function.

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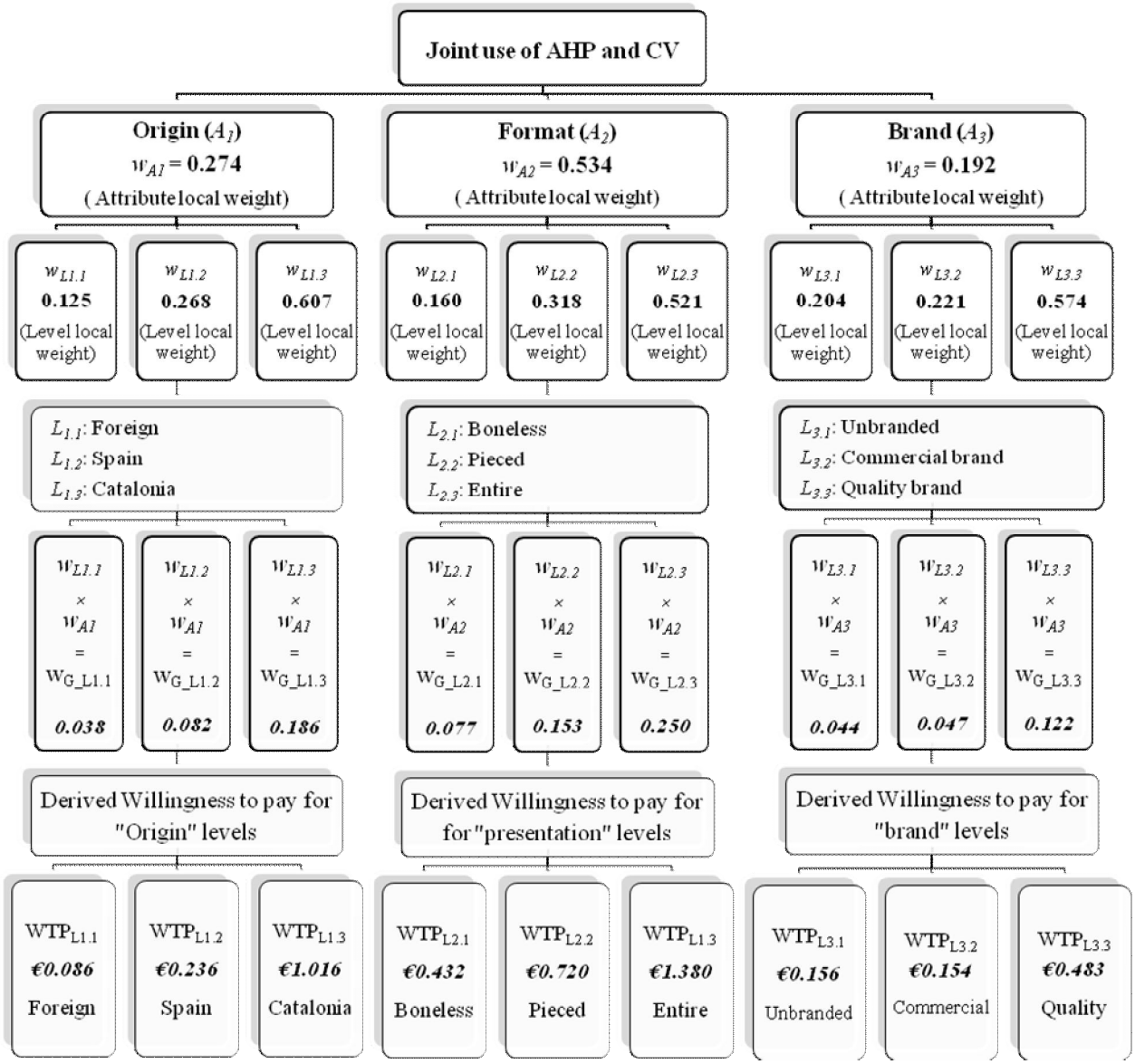

Figure 3: Result of the joint use of the Analytical hierarchy process and CV