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Method Article

Discrete choice experiments with multiple price vectors for products sold in a wide price range

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ABSTRACT

The discrete choice experiment is a widely used methodology in consumer studies. However, applying this method to investigate the market of products sold in a wide price range could present issues as to the quality of the estimate of preferences. In fact, for this `type of product, frequently consumers may have different behaviours when faced with different price levels. For example, some market segments may refrain from purchasing products below certain price thresholds, considering them of an unacceptable quality, while others choose only below certain prices. To work around this problem area, we propose a methodology in which each respondent declares his own price interval of reference and consequently participates in a choice experiment with a price vector coherent with his habits. In this manner, we are able to grasp and include in the estimations the heterogeneity of consumers with respect to price and thus obtain more accurate willingness to pay estimates.

- The method describes a procedure to bypass issues related to identifying the price vector in discrete choice experiments that involve products sold in a wide price range.
- We propose a discrete choice experiment with diff`erent price vectors for consumer segments with different price preferences.

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Specifications Table

Subject Area:	Agricultural and Biological Sciences
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Method name:	Discrete choice experiments with multiple price vectors
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Resource availability:	NA

Method details

The Discrete Choice Experiment (DCE) is a method that is widely used in the ambit of applied economics and marketing in order to study consumer preferences. This method consists of creating hypothetical markets by means of questionnaires in which a purchasing decision is simulated among various product alternatives that differ with respect to quality characteristics and price [1] Although the procedures to apply this method are well-established and shared among scholars, the choice of the price vector presents various elements of complexity and has still not been codified [2]. Indeed, to date, the selection of price levels to utilise in the experiment implies that researchers make an educated guess based on an analysis of the prices of products available on the market and similar to the one being evaluated.

This procedure becomes particularly problematic when the product subjected to the experiment presents a very broad price range on the real market, as in the case of electronic devices, health care, and hospitality services. In fact, for these products, there could be diversified behaviours of the consumers with respect to price, in relation to many factors such as income, habits, and involvement. Some consumers, for example, might associate low prices to low quality, which can determine a trend of the utility function along price values first increasing then decreasing [3,4]. In this case, using a price vector that covers the entire surveyed range on the market would determine an estimate of compromise that would fail to grasp the different behaviours of consumers [4].

We propose to implement a procedure that bridges the limits of the conventional approach in order to identify price vectors to utilise in conducting DCEs. In particular, the proposed method strives to improve the estimation of consumer preferences by means of codifying a procedure to define the price vector that can assist DCE practitioners in building the experimental design. This method makes it possible to verify the presence of heterogeneous behaviours of consumers with respect to different price levels and thus obtain more reliable estimates of consumer preferences as well. In this manner, we can indeed consider an important factor of preference heterogeneity in the estimations that would otherwise remain confused in the random component of the estimation model.

The approach we propose is based on the idea that each respondent states his own price interval of reference and consequently participates in a choice experiment with a price vector coherent with his elicited habits. The approach can be divided into 4 steps.

Step 1 – market analysis and identifying price range of products

In the first step, the researcher is called to make a careful market analysis of the good being studied in order to identify the price range in which the product is sold. This phase is necessary to determine the number and breadth of the price intervals that the market is divided into. The choice will have to be effected based on the hypothesis that the various intervals also include different behaviours and that each of these instead contains homogeneity. The number of intervals clearly does not depend solely on the price range in the market, but also on the sample size that one wishes to obtain and on the general objectives of the study.

Step 2 – translating the price intervals identified into price vectors

In step 2, it is necessary to define a price vector for each price interval identified in the previous phase. Translating the price intervals into price vectors presents a critical aspect that consists in identifying the upper level of the price vector. This level must indeed be defined in order to be able to

grasp the monetary sacrifice the consumer is willing to make to obtain certain product characteristics, so as to avoid undervaluing the price attribute.

Step 3 – identifying the method for eliciting respondents' preferences on price intervals

In this step, each respondent must be attributed a price interval that corresponds to his habitual purchasing behaviour. Phrasing the question in the questionnaire to collect the information on behaviour presents several points of attention. In particular, the researcher must evaluate various options that concern both the modality of response (open or closed), and the different phrasings of the question pertaining to the interval of prices. This question can in fact be declined in different ways so that for the product being studied, the consumers have a reference price or a range of prices. In the first case, the researchers could ask for the price at which the respondents generally purchase the product, as well as the preferred price, or the real market price. In the second case, the questions could instead concern the prevalent interval, the average price, the minimum, and/or maximum price at which the respondents make their purchase. Each of these options has different implications on the results, and their choice depends on the specific object of investigation. For example, choosing the minimum price could make it possible to avoid phenomena of attributing a positive utility to increasing prices when dealing with products for which price is a quality cue.

Information gathered in this manner also allows us to verify the need to break down the price range. In fact, the presence of a significant percentage of the sample in the different price intervals proves the heterogeneity in consumer behaviour with respect to price.

Step 4 – making DCEs with multiple price vectors

Based on the information gathered, each respondent will perform the choice experiment with a price vector that represents his habitual behaviour. In other words, the DCE will be equal for the entire sample with respect to the levels of all the attributes except for the price attribute levels. As a final result, we shall have as many sub-samples as we have price vectors utilised in the experiment. We can thereby analyse the various sub-samples and find differentiated preferences and willingness to pay for each price interval.

Method validation

In order to validate our methodology, we carried out a DCE on a sample of 400 Italian consumers of red wine in 0.75 L bottles. Wine affords a valuable case study since it presents extremely variable prices [5]. The market study on the product pointed out an overall price range between € 2 and € 14, with a median value of approximately € 5.00 (IRI-Infoscan data).

On the basis of this information, we asked respondents to indicate in which of two price intervals, they habitually orient their wine purchases: *(i) "less than or equal to € 5.00 per bottle"* or *(ii) "more than € 5.00 per bottle"*. This is, of course, one of the possible ways to elicit consumer behaviour with respect to price. Identifying two price intervals is indeed functional to the present case study, but in other contexts it might be more appropriate to define a greater number of intervals and/or to phrase the question so that it points out behaviour with respect to price differently from the way we have used.

In the following step, the two sub-samples participated in an identical DCE but with two different price vectors with four levels each. The first one, called "low price" with the levels € 2.00, € 3.50, €5.00 and € 6.50 was assigned to those that stated they habitually purchased wine at prices lower than € 5.00. The second vector, "high price" with the levels, € 5.00, € 8.00, € 11.00, and € 14.00 was assigned to all the others. The other attributes included in the experiment are: organic, no sulphites added, and wine geographical indications.

The group that chose the interval with prices lower than € 5.00 represents 62.5% of the sample (250 individuals), while the other group measures 37.5% (150 individuals). This result confirms the presence of two consistent groups of consumers with heterogeneous behaviours with respect to the different price levels, and it shows the effectiveness of the price intervals we have identified in representing consumer behaviour.

In order to allow for preference heterogeneity, we estimated a Random Parameter Logit (RPL) model. Accordingly, the utility of the i-th consumer when he selects a bottle of wine j in the choice task t can be written as:

$$U_{ijt} = ASC + \alpha PRICE_{ijt} + \boldsymbol{\beta}'_i \boldsymbol{X}_{ijt} + \varepsilon_{ijt} \quad (1)$$

Where ASC is an alternative-specific constant that represents the no-buy option. PRICE represents the price levels offered to the respondent to purchase a bottle of wine; $\boldsymbol{\beta}_i$ is the vector of the utility parameters for participant i; $\boldsymbol{X}_{ijt}$ is the vector of wine attributes, ε_{ijt} is an unobserved random term.

The hypothesis that we have significant effects in estimating the parameters by changing the price vector used in the choice experiment is tested with a likelihood ratio (LR) test:

$$LR = -2\left(LL_j - \sum_{i=1}^{M} LL_i\right) \quad (2)$$

which is distributed χ^2 with K × (M−1) degrees of freedom, where LL_j is the log likelihood value for the pooled data (low price + high price), LL_i are the log likelihood values for the different restricted models (low prices, high prices), K is the number of parameters (10 in our case), and M is the number of groups (two in our case).

Table 1 shows the log likelihood of the two models plus that of the pooled model. The LR value is 134.40 with 10 degrees of freedom. This value is higher than the critical value for the χ^2 statistic at 5%, equal to 18.31. We thus reject the null hypothesis and accept the alternative hypothesis, i.e. the parameters of the two models are statistically different. Therefore, the choice of price range affects the estimation of preferences. Moreover, to assess the robustness of the results on the econometric specification and to work around potential scale issues [6], we repeated the LR test specifying the utility model in WTP space instead of in preference space. Using this different specification, we confirm that the results for the two sub-samples are different.

Table 2 shows the results of the RPL models. The parameters are all significant for the low and the high price models. In both models, the organic, no sulphites added, and the designations of origin parameters have a positive sign, while the parameters of the no-buy option always have a negative sign.

The magnitudes of the parameters of each attribute are substantially similar in the two sub-samples except for that of price. In general, the two models describe analogous preferences with respect to the chosen attributes, in line with the literature [7–9].

The price parameters are negative and very significant in both models. However, the magnitude of the two parameters is quite different, that is −0.34 (95% confidence interval equals [−0.40; −0.27]) for the model with the low prices and −0.08 (95% confidence interval equals [−0.11; −0.04]) for the model with the high prices. These results show that the respondents that declared an orientation towards lower prices are more sensitive to variations in price than the respondents that prefer to purchase wine in the higher price range.

Table 3 reports the willingness to pay for the two sub-samples. The 95% confidence intervals are estimated with the delta method. The differences between attribute WTPs are all significant according to a Mann-Whitney U and Kolmogorov-Smirnov test.

In conclusion, the proposed procedure has made it possible to point out two structures of significantly different preferences in price for two important market segments, thus permitting a better understanding of the behaviour of consumers and, in particular, of their willingness to pay.

Table 1
Log likelihood and observations for both scenarios and the pooled model.

Model	Observations	Log likelihood (Preference space model*)	Log likelihood (WTP space model**)
Low price	6000	−1546.792	−1522.536
High price	3600	−897.744	−886.939
Pooled sample	9600	−2511.735	−2463.654

Note: (*) 10 degrees of freedom; (**) 11 degrees of freedom.

Table 2
Estimated parameters from the RPL model for both scenarios and the pooled model.

	Low Price (N = 250)		High price (N = 150)		Pooled sample (N = 400)	
	Coef.	[95% C.I.]	Coef.	[95% C.I.]	Coef.	[95% C.I.]
Random parameters in utility functions						
Organic	0.32*	0.06; 0.59	0.49**	0.20; 0.78	0.34**	0.16; 0.53
No sulphites added	1.98**	2.27; 1.70	1.56**	1.90; 1.22	1.81**	2.02; 1.59
PGI	1.08**	0.76; 1.41	1.20**	0.78; 1.62	1.58**	1.32; 1.83
PDO	1.19**	0.90; 1.48	1.25**	0.93; 1.57	1.40**	1.19; 1.61
Non-random parameters in utility functions						
Price	−0.34**	−0.40; −0.27	−0.08**	−0.11; −0.04	−0.07**	−0.10; −0.04
No-buy	−2.04**	−2.45; −1.62	−1.54**	−2.05; −1.03	−0.92**	−1.19; −0.64
Standard deviations of parameter distributions						
Organic	0.92*	0.67; 1.16	0.63**	0.33; 0.92	0.76**	0.57; 0.95
No sulphites added	1.41**	1.13; 1.70	1.45**	1.11; 1.80	1.41**	1.20; 1.63
PGI	0.83**	0.41; 1.26	0.69**	0.19; 1.19	−0.92**	−1.22; −0.62
PDO	0.98**	0.73; 1.24	0.37	−0.18; 0.92	0.80**	0.60; 1.00

Note: (**) and (*) denote statistical significance respectively at 1% and 5%; N = Sample size; Coef. = Coefficients; C.I. = 95% confidence interval.

Table 3
Willingness to pay in € for both scenarios.

Variable	Willingness to pay estimates (95% confidence interval)		Mann-Whitney *U* Z-score	Kolmogorov-Smirnov D
	Low price	High price		
Organic	0.97 (0.18; 1.76)	6.45 (2.05; 10.86)	−13.03***	0.74***
No sulphites added	5.90 (7.16; 4.64)	20.66 (31.53; 9.79)	−9.94***	0.73***
PGI	3.23 (1.91; 4.54)	15.85 (4.36; 27.34)	−16.75***	0.99***
PDO	3.55 (2.40; 4.70)	16.52 (6.93; 26.11)	−16.75***	1.00***

Note: (***) denotes statistical significance at 1%.

An in-depth discussion of the results and further details about our case study are presented in an article written by Contini et al. [10].

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