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Considering the repeated choices problem in a discrete choice application: The preservation of a world cultural landscape

Lina Lourenço-Gomes[a]

Department of Economics, Sociology and Management (DESG)

Centre for Transdisciplinary Development Studies (CETRAD)

University of Trás-os-Montes and Alto Douro (UTAD)

Av. Almeida Lucena, 1

5000-911 Vila Real, Portugal

Tel. +351-259302200

Fax: +351 - 259302249

Email: lsofia@utad.pt

Lígia C. Pinto

Applied Microeconomics Research Unit (NIMA)

School of Economics and Management (EEG),

University of Minho, Address; Campus de Gualtar, 4710-057 Braga, Portugal.

Email: ligiacpinto@gmail.com

João F. Rebelo

Department of Economics, Sociology and Management (DESG) and

Centre for Transdisciplinary Development Studies (CETRAD)

University of Trás-os-Montes and Alto Douro (UTAD)

Email: jrebelo@utad.pt

[a]corresponding author

Abstract

This paper presents the results of a discrete choice experiment study to assess the value of the most important attributes of the Alto Douro Wine region, a cultural landscape, world heritage item since 2001. Further it analyses the principal determinants of participation in a preservation program (versus none option).

Distinctly of the general applications, the paper takes into account the problem of repeated choices prevalent in stated preferences data, by estimating the error components logit model, in addition to the standard multinomial logit model that relies on the independence assumption across choice situations. The analysis is complemented using a standard conservative method and the bootstrap re-sampling procedure to recalculate the standard errors of the respondents' characteristics estimates from the multinomial logit model.

The paper concludes that the error components logit model achieves significant improvements in model fit relative to multinomial logit model, moreover detecting unobserved heterogeneity alternative specific, an omitted issue in multinomial framework. In addition, the heteroscedastic error components logit model produced considerable gains in model fit relative to the homoscedastic, and revealed the same evidence about the statistical significance of the respondents' variables in choosing an alternative with a preservation program (versus none option) as the conservative method and bootstrap procedure. In this perspective, a serious investigation of the heterogeneity of the variance of the error component appears as a fundamental task in the implementation of the error components logit model in the context of DCE applications.

JEL classification: C35; C51; Z10

Keywords: Discrete choice; Error components logit model; Nonmarket valuation

1. Introduction

The assessment of the economic value of cultural public amenities, whose market price does not completely reflect the benefits of conservation or preservation, is crucial to justify public expenditure decisions. The non-market valuation methods (in general) and that of stated preference techniques (in particular) provide a consistent way to measure the benefits provided by cultural heritage goods.

The use of non market valuation techniques on cultural sphere presents certain specificities, imposing new questions and challenges, such as: (1) the conceptual difficulties related to the definition of culture and cultural amenities (Papandrea, 1999; Noonan, 2003); (2) the coexistence of values in a given cultural item (Throsby, 2001); (3) the possibility that a negative value may be attributed to the preservation of heritage items (Morey and Rossmann, 2003; Noonan, 2003), (4) the substantial role played by information in forming the value attributed to cultural goods (Throsby, 2003; Kling *et al*., 2004), (5) the need to consider the formation of preferences and the evolution of tastes (Peacock, 1995).

As in other research areas, including the valuation of environmental amenities, the non-market valuation of cultural heritage has given primacy to the contingent valuation method (CVM), (Navrud and Ready 2002; Tuan and Navrud, 2007). Nevertheless, recently, in a context of multi-attribute valuation, discrete choice experiments (DCE) has been proposed as an alternative tool to CVM (e.g. Mazzanti, 2003).

DCE applications on cultural sphere are focused in: groups of monuments (Morey *et al.*, 2002); cultural institutions (Maddison and Foster, 2003; Mazzanti, 2003; Alberini et al., 2003; Apostolakis and Jaffry, 2005; Snowball and Willis, 2006) and world heritage items (Tuan and Navrud, 2007). The main objective of most DCE studies on cultural institutions is to capture the benefits related to use, whereas the DCE applied on monuments or groups of monuments and world heritage sites embraces non use values too, like benefits derived from its preservation and existence[1].

The DCE, theoretically founded in the theory of Lancaster (1966) and routed in the random utility theory (RUT), sequentially presents to each respondent, in a survey instrument, choice sets consisting of two or

[1] The Appendix summarises the core of DCE applications on cultural items (study object, estimated benefits, DCE design and model specification).

more alternatives. In each choice situation, the respondent is asked to select the most preferred alternative. An alternative corresponds to a combination of attribute levels of the good or program to be valued. In this sense, the DCE obtains information about the preferences through the choices made. The information collected can be used to assess the relative importance of the attributes; to characterize the amenity or program; and to determine a willingness to pay measure, if the price attribute is included. Since the DCE is based on repeated choices, it provides more than one observation per respondent. Data analysis is performed through discrete choice models, the multinomial logistic model (MNL) is the most popular and commonly used (Koppelman and Wen, 1998; Train, 2003, Hensher *et al.*, 2005). Nevertheless, observed non-compliance with the MNL assumptions calls for other models with less restrictive assumptions closer to the observed behaviour, such as the error components logit model (ECL). The ECL may be interpreted as a mixed logit model. The ECL, in addition to incorporating unobserved heterogeneity specific to alternatives and to introducing a general correlation pattern across the alternatives, it relaxes the independence assumption of the error terms across choice situations, which is useful to accommodate the repeated choice problem present in stated preferences methodologies. The problem of repeated choices may lead to the underestimation of standard deviations of the estimated coefficients, however it is ignored in most applications (Ortúzar *et al.*, 2000; Cho and Kim, 2002).

This paper adopts a DCE to evaluate visitors' preferences for the Alto Douro Wine Region (ADW), a cultural landscape world heritage site (UNESCO, 2001). The extent that the presence of more traditional attributes is threatened by economic pressures and by the development of viticulture in the region, justifies the importance of measuring the value of its preservation. Additionally, this paper aims: (1) to identify the sources of alternative-specific systematic heterogeneity within the assessment of the most significant determinants in the participation decision on a ADW preservation program (versus none option); (2) to detect unobserved alternative specific heterogeneity; (3) to introduce the choice repeated problem, estimating the ECL model in addition to the MNL, that ignores it; (4) to demonstrate how the use of ECL produces significant improvements in model fit relative to MNL and under what circumstances.

The remainder of the paper is organized as follows. Section 2 presents the behavioural and theoretical foundation underlying the DCE. Section 3 describes the DCE application for the ADW, including the description of the stated choice task, a brief description of the survey instrument and of the main sample characteristics, the explanation of the choice models estimated, and the presentation and discussion of the results. Finally, Section 4 presents the main conclusions.

2. Behavioral and theoretical foundation

The modern micro-economic consumer theory or Lancasterian' characteristics approach (1966) and random utility theory (RUT) originated by Thurston (1927) and later developed by Luce (1959) constitute the behavioral and theoretical foundation of the DCE.

According to Lancaster (1966), the consumer utility derives from the attributes that characterize a good. Based on this approach, the DCE defines the goods or services to be valued (alternatives available in each choice set) by the attributes and their respective levels.

The RUT assumes the utility that the consumer *n* derives from the alternative *i*, U_{ni}, as consisting in two components: deterministic or observed by the analyst (V_{ni}) and stochastic or unobserved by the analyst (ε_{ni}), such that $U_{ni} = V_{ni} + \varepsilon_{ni}$. The deterministic component of utility is comprised by the attributes of the alternatives as well as decision maker's characteristics, whereas the stochastic component is represented by a random error term capturing unobservable influences (by the analyst) on individual choice.

In a DCE application, the consumer *n* is faced with a choice between a choice set *C* of *J* alternatives (j = 1, ..,i, ., J). Given the basic assumption of RUT, respondents will choose the alternative that provides the greater perceived utility from the alternatives of a choice set.

Due the presence of the random error term, the probability of alternative *i* being chosen by the individual *n* can be expressed as the probability that its utility exceeds the utility of all other alternatives belonging to choice set C, such that, $P_{ni} = P\left[(V_{ni} + \varepsilon_{ni}) > (V_{nj} + \varepsilon_{nj})\right] \forall j \in C; j \neq i$, or by the probability that the difference in the observed component of utility is greater than the difference in unobserved component utility, such that, $P_{ni} = P\left[(V_{ni} - V_{nj}) > (\varepsilon_{nj} - \varepsilon_{ni})\right] \forall j \in C; j \neq i$. Assuming that random components of the utility are independently and identically distributed (*iid*) extreme value type 1, the choice probability of an alternative from the choice set C (P_{nj}) is given by the Multinomial Logit Model (McFadden, 1974) and can be expressed by $P(U_{ni} > U_{nj}) = \frac{\exp(\mu V_{ni})}{\sum_{j \in C} \exp(\mu V_{nj})}$, where μ is a scale parameter of the unobserved stochastic component (typically assumed to be one).

Due to its closed form solution and analytical simplicity, the MNL is the most commonly used discrete choice model (Hensher *et al.*, 2005). Nevertheless, its underlying assumptions impose a restrictive framework of behavioral choice which is not always possible to satisfy:

i. The MNL relies on the independence of irrelevant alternatives (*IIA*) property (Luce, 1959) according to which the ratio of the probabilities for two alternatives remains constant regardless of the existence of other alternatives in the choice set. When *IIA* property is likely to be verified, has the advantage of allowing the introduction or removal of alternatives without re-estimation (Louviere *et al.*, 2000; Train, 2003). However, this restriction cannot fit to situations without equal attractiveness between all pairs of alternatives. That is, *IIA* property requires equal cross substitution effects between pairs of alternatives (Keane, 1997; Train, 2003; Hensher *et al.*, 2005).

ii. Deriving directly from the *iid* assumption, the MNL cannot identify correlations patterns across alternatives, as it could be the case of a DCE including a status quo option or none-option potentially different of the remaining options involving a change, and across choice situations in a repeated DCE, when the independence assumption is difficult to remain, due the invariance of behavioral structure along the sequential choices.

iii. Through the introduction individuals' variables or observed characteristics of the respondents (creating the interaction terms with the attributes, or introducing them as alternative specific) the MNL framework enables to detect sources of systematic heterogeneity. Nevertheless it doesn't account with random taste variation or unobserved heterogeneity.

In order to overcome the limitations of MNL, more flexible models have been developed, partially or totally relaxing the *iid* assumption. One of these models is the error components logit model (ECL) that emerge to capture unobserved individual influences related to the choice of alternatives (Greene, 2007), in addition to capturing unobserved alternative specific heterogeneity. The ECL is identified as a possible interpretation of the random or mixed logit model[2], along its random parameters interpretation[3] (Train, 2003). Ben Akiva *et al.* (2001) designate it as Logit Kernel Model[4], defining it as a discrete choice model that includes random terms *iid* extreme value type 1, like the MNL, and disturbances normally distributed identically to the probit model.

The unobserved heterogeneity is introduced in the model by the inclusion of M additional error components in the alternatives' utility functions $(M \leq J)$, that additionally can be used to induce patterns of correlation between options.

The utility that decision maker *n* obtains from choosing alternative *j* in choice situation *t* is given by (Greene, 2007):

$$U_{njt} = \beta' X_{njt} + \varepsilon_{njt} + \sum_{m=1}^{M} d_{jm} \sigma_m E_{nm},\; j = 1,...,J_n; \cdots t = 1,...,T_n \quad (1)$$

Where:

X_{njt} = vector of observed variables (attributes and characteristics) relating to individual n, alternative j and choice situation t

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2 McFadden and Train (2000), Hensher and Greene (2003), Hensher *et al.* (2005) are excellent references of mixed logit model expositions.

3 The mixed logit model allows incorporating attribute' preference heterogeneity, specifying random parameters, and preference heterogeneity specific to the alternative choices, introducing random error components.

4 For authors the model designation adopted describes the shape of the logistic probability function and takes into account the fact that the model has as its starting point the MNL, extending it by introducing additional error terms.

$\varepsilon_{njt} = (\varepsilon_{n1t},...,\varepsilon_{nJt}) =$ random terms *iid*, extreme value type 1, maintaining the basic assumption of the MNL

E_{nm} =M error components for individual *n*, normally distributed $E_{nm} \sim N[0,1]$. Alternatively is possible to specify an heteroscedastic error component model, such that $\text{var}[E_{nm}] = \exp(\gamma_m h_n)$ where h_n represents the vector of individual characteristics invariant to the choice that produce heterogeneity in the variances of error components

σ_m = standard deviation of effect m

d_{jm} = dichotomous variable equal to 1 if E_{nm} appears in the utility function for alternative *j* and 0 otherwise; (it's possible to induce correlations patterns across alternatives, overlapping the same effect in different utility functions)

Based on Greene (2007: N14-13) the full model is given in Eq. (1). Under the ε_{njt} *iid* assumption, the probability conditioned on the error components follow the standard logistic form:

$$P(y_{nt} = j | E_{1n}, E_{2n}...) = \frac{e^{(\beta' x_{njt} + \sum_{m=1}^{M} d_{jm}\sigma_m E_{nm})}}{\sum_{q=1}^{J} e^{(\beta' x_{nqt} + \sum_{m=1}^{M} d_{qm}\sigma_m E_{nm})}} \qquad (2)$$

The unconditional probability is obtained integrating E_{nm} out of the conditional likelihood function.

$$L_n = \int_{E_{n1}} .... \int_{E_{nM}} \prod_{t=1}^{T(n)} \frac{e^{(\beta' x_{njt} + \sum_{m=1}^{M} d_{jm}\sigma_m E_{nm})}}{\sum_{q=1}^{J_n} e^{(\beta' x_{nqt} + \sum_{m=1}^{M} d_{qm}\sigma_m E_{nm})}} \phi(E_{nM})...\phi(E_{n1})\, dE_{nM} ... dE_{n1} \qquad (3)$$

where, $\phi(.)$ is the normal density function of the error components

The ECL choice probability (Eq. 3) has no closed mathematical form, as in the MNL, being approximated by simulation. The simulated likelihood function for the individual *n* (for the panel of T choices) is expressed by:

$$L_{n,S} = \frac{1}{R}\sum_{r=1}^{R}\prod_{t=1}^{T(n)} \frac{e^{(\beta' x_{njt} + \sum_{m=1}^{M} d_{jm}\sigma_m E_{nm,r})}}{\sum_{q=1}^{J_n} e^{(\beta' x_{nqt} + \sum_{m=1}^{M} d_{qm}\sigma_m E_{nm,r})}} \qquad (4)$$

where $E_{nm,r}$ is the set of M independent normal draws (pseudo-random, Halton sequences, as the most frequently used) and R is the number of replications in the simulation. The parameters are estimated by maximizing the simulated log likelihood $LogL_s = \sum_{n=1}^{N} \log L_{n,S}$.

3. Empirical application

A DCE was conducted to assess the attributes that visitors find most relevant to preserve in ADW cultural landscape, comprising natural and man-made elements.

The area designated by ADW embraces 13 municipalities and is located in the northeast of Portugal. Its acceptance as a UNESCO cultural heritage site was based on the following criteria: i) it's man-made; ii) it's an example of a traditional European vineyard region, having produced wine for over 2000 years, a fact that has been visibly imprinted on the landscape over time; and iii) it has a population whose occupation of the territory is predominantly and intimately linked to vineyard activity. The ADW is thus a complex cultural space in which its different attributes form an inter-connected whole.

Nevertheless, due to its evolving-living nature and economic pressures, the coexistence of the more traditional elements of the cultural landscape has been called into question, with the risk of their disappearance. In this sense, maintaining this item of world cultural heritage requires the design of preservation policies, also taking into account the development of the region.

While experts in various fields have an important role in deciding what should be preserved or conserved, the public nature of ADW means that these choices should not be independent of the interests of the general population. And because today, the cultural heritage has to meet the needs of a growing demand, this research focused on determining the preferences of the ADW visitors. The results identify the ADW most valued attributes and consequently those that should receive greater political attention or public support. Given its multi-attribute characteristic, an hypothetical preservation program was developed in the format of DCE.

3.1. The Stated Choice Task

The preservation program was conceived taking into account the relevant attributes of the ADW and appropriate levels that were defined considering: the information present on the ADW proposal to be included on the list of the UNESCO world heritage sites, the experience of a previous study of preferences and application of contingent valuation technique (Madureira *et al.*, 2005), the results of a pilot test, the information from personal interviews with ADW experts, and the evolution trends of the landscape.

A total of four attributes were considered relevant: terraced vineyards supported by walls of schist (VIN); landscape mosaic with agricultural diversity (MOS); traditional agglomerations/settlements and the built heritage (AGGLO); Price (€), defined as an annual tax increase per household (TAX). The three landscape attributes' (VIN, MOS, AGGLO) were defined at two levels: one, if the attribute is protected, ensuring its presence in the landscape or zero, if the attribute is not protected implying its absence. The TAX attribute was set to the levels 20€, 40€ and 60€ for the options involving a preservation program and 0€ for the None-option[5] alternative, corresponding to the absence of a preservation program.

Using the software SAS System for Windows, a D-efficient design was obtained[6] (e.g. Huber and Zwerina, 1996; Kuhfeld *et al.*, 1994) through which the above four attributes and their levels were combined in 12 generic and unlabeled alternatives (preservation programs) and simultaneously allocated in 6 choice sets to present to each respondent. In addition to the two experimentally obtained alternatives, each choice set includes the None-option alternative in which all the attributes are set to zero level. Therefore all the six choice sets have a constant size of 3 alternatives (A, B or none).

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[5] The definition of the TAX attribute levels was based on the results obtained in an open-ended question about the willingness to pay for a preservation program for the ADW in a previous pilot study carried out on summer 2006.

[6] Various experimental design strategies were compared, based on the approaches routinely applied in DCE applications in cultural economics and on efficiency measures (D-efficiency) for implementing the MNL with generic alternatives. The experimental design developed by SAS software produced the best results in terms of required information (number of choice sets), D-efficiency and correlations between the effects to be estimated. Detailed explanation about the experimental design phase is available from the authors.

3.2. Data collection

The stated preference survey was conducted in two sites belonging to ADW between May and August 2008. Respondents were visitors over 18 years, randomly selected, and who agreed to complete the survey under the guidance of the authors and trained interviewers.

A total of 189 surveys were considered valid for the study, giving rise to a sample size of 1134 observations or useful choice responses for model estimation (each respondent completed six choice sets). Table 1 reports the descriptive statistics of the data collected and the variables used in the choice models.

Table 1 Descriptive statistics

Variable	Acronym	Codification	Sample average
Alternative	altij	1,2,3	2
Choice	choice	1-choosen alternative; 0-non choosen alternatives	0.333
Attributes of the alternatives			
Terraced vineyards	VIN	0; 1	0.333
Landscape mosaic	MOS	0; 1	0.389
Agglomerations	AGLLO	0; 1	0.333
Price	TAX	0 (*none*); 20; 40; 60 (€)	26.67
Socioeconomic variables, attitude and context			
Gender	GE	1-Male; 0-Female	0.582
Age	AGE	18-75	39.5
Education degree	EDU	1-Primary; 2-Secondary; 3-Pos-secondary	2.4
Monthly household income	INCOME	1 (<1000€); 2 (1000-2000); 3(2001-3000); 4(>3000€)	2.32
Household size	SIZE	1- 6	2.67
Profession	PROF	1- Members of legislative bodies, public companies' managers and intellectual and scientific professions; 0- Others	0.402
Member of a cultural association	MEMBER	1- Yes; 0-No	0.185
Consumption of cultural activities (Number times last year)	CULT	0-389	24.28
Visit the ADW for the 1st time	FIRST	1- Yes; 0-No	0.143
Number of ADW visits (last year)	VISIT	1-60	7.47
Distance between the residence and the ADW	KM	15-622	136.58
Visit purpose	PURPOSE	1- To know the ADW cultural heritage; 0- Others	0.249
Influence of the world heritage classification in decision to visit	LIST	1- Yes; 0- No	0.280
Identifies the more traditional attributes	IDENT	1- Yes; 0- No	0.84
Know the reasons of ADW inclusion in UNESCO list	KNOW	1- Yes; 0- No	0.439
Choice Decision Process	*TRADE*	1- Considered all the attributes presented; 0-Other	0.561
Choice Task	*EASY*	1-Very Easy + Easy; 0-Other	0.61

3.3. The choice models

Discrete choice models are used to analyze the choices made by the respondents among the three generic alternatives in each choice scenario (A, B or none). From a sequential construction process, two indirect utility functions specifications for MNL and three for ECL are presented.

The MNL_1 accounts for homogeneous preferences being estimated through a basic representative utility specification including only the attributes of the alternatives that describe the ADW program and assuming that the representative component of utility of an alternative *i* is linear and additive on the parameters (β) and attributes (X). Additionally, one alternative specific constant (ASC) was used to distinguish between None-Option and the two alternatives involving a preservation program (A and B). This ASC is set to 1 for the None-Option and 0 for the remaining.

The MNL_2 considers a form of systematic preferences heterogeneity, "preference heterogeneity" (Bhat, 1998), by introducing the observed individuals' characteristics as alternative-specific variables in the representative utility function of alternatives A and B (considering the None-Option as the reference alternative). The preference heterogeneity accounts for differences in the preferences for the choice of an alternative across individuals.

We adopt a sequential approach to estimation and estimate three specifications for ECL. In all models, a common error component was included in the utility function of the alternatives A and B, inducing a correlation pattern between these options[7]. In this sense, the ECL_1 has the same representative utility function as MNL_1 and the ECL_2 the same as MNL_2. The ECL_3 introduces the heteroscedastic error components, based upon the same representative utility function as ECL_2. To analyze possible sources of heterogeneity in the variance of the error components, all socio-economic variables, attitude and context were inserted into the vector h_n (Eq. 1). The only statistically significant variable was the education level, and for that reason, the variance of the error component was defined as a function of the EDU variable.

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[7] This procedure is based in the potentially distinct nature of the None-Option in comparison with the two remaining alternatives involving a preservation program.

3.4. Results and discussion

Based on the above specifications, all models were estimated using NLogit 4.0 econometric software (Greene, 2007). The maximum likelihood estimations of the MNL and the maximum simulated likelihood estimations of the ECL (500 Halton sequences) are presented in Table 2.

Table 2 Estimation results from the MNL and ECL

	MNL1	***MNL2***	***ECL1***	***ECL2***	***ECL3***
Variable	Coefficient estimates	Coefficient estimates	Coefficient estimates	Coefficient estimates	Coefficient estimates
VIN	0.85404*** (0.08124)	0.85882*** (0.08164)	0.87886*** (0.08622)	0.879519*** (0.088326)	0.91403*** (0.09142)
MOS	0.91134*** (0.08177)	0.91579*** (0.0821)	0.9431*** (0.0814)	0.941725*** (0.082823)	0.97247*** (0.08533)
AGLLO	0.8762*** (0.08144)	0.8792*** (0.0819)	0.90173*** (0.0787)	0.900578*** (0.08009)	0.93023*** (0.08339)
TAX	-0.0065*** (0.00253)	-0.0063** (0.00255)	-0.00554* (0.0032)	-0.00548* (0.00325)	-0.005598* (0.00323)
ASC	-0.05131 (0.17606)	-1.608* (0.8646)	-16.434*** (5.421)	-24.7024 (18.298)	-6.7955 (14.377)
GE		-0.03912 (0.2524)		-1.25179 (4.2773)	0.43179 (4.8956)
AGE		-0.0358*** (0.0102)		-0.18287 (0.1882)	-0.13595 (0.151)
INCOME		0.69096*** (0.1512)		4.8721 (4.0913)	6.5647* (3.661)
EDU		-0.20919 (0.2235)		-2.992 (4.7536)	3.0827 (3.9958)
SIZE		-0.4137*** (0.1028)		-2.6686 (2.2966)	-3.1535* (1.8791)
PROF		0.05766 (0.2809)		-2.7965 (5.0297)	-5.184 (5.419)
MEMBER		0.10662 (0.3191)		2.2368 (5.4913)	3.5758 (6.3569)
FIRST		-0.5351* (0.3166)		-0.28598 (6.7052)	0.65042 (5.1323)
TRADE		1.515*** (0.237)		8.8035* (4.728)	9.7275** (4.868)
VISIT		-0.0544*** (0.0098)		-0.25498 (0.1836)	-0.341* (0.197)
PURPOSE		0.01884 (0.2593)		0.4036 (4.9269)	0.5832 (5.3432)
LIST		1.4426*** (0.321)		7.4678 (6.0178)	10.97** (5.115)
KNOW		0.1809 (0.25)		1.1563 (4.44)	2.862 (3.874)
IDENT		0.666** (0.278)		2.32185 (5.2145)	3.308 (4.46)
CULT		0.00538 (0.0043)		0.03749 (0.07567)	0.005 (0.058)
KM		-0.0075*** (0.0009)		-0.04523** (0.02284)	-0.0554*** (0.0213)
Error component Std deviation (SigmaE01)			15.6858*** (4.52925)	12.69756*** (5.19582)	1.4393 (1.232)
Heterogeneity around the std of the error components (E01HAB)					0.8379*** (0.299)
Model Fits					
LL ($_{model}$)	-972.562	-877.9285	-696.696	-681.6321	-678.3
LL ratio test=-2[LL_C-LL($_{model}$)]	262.726	451.993	814.4	844.6	851.25
Pseudo $\bar{R}_C^{\,2}$	0.12	0.187	0.364	0.364	0.366
AIC	1.7241	1.585	1.24	1.24	1.2369
Correct Predictions (%)	50.1	53.8	50.1	52.7	54.7
LL(MNL) AIC (MNL)			-972.562 [1.724]	-877.9285 [1.5854]	-877.9285 [1.5854]

Notes:

*Significant at the 0.10 level; ** Significant at the 0.05 level; Significant at the 0.01 level; ( ) standard deviations

$AIC = \frac{-2LL(model)+2p}{N}$, where p=number of parameters, LL(model)= model log-likelihood value, N= number of observations;

$Pseudo\bar{R}_C^2 = 1 - \frac{LL(model)-k}{LL_C - K_C}$,where LL_C = log-likelihood value with only alternative specific constant, and K =number of parameters of the model and K_C=number of constants; Correct Predictions (%)=Predicted choice outcomes for the sample based upon the estimated model versus the actual choice outcomes (Hensher *et al.*, 2005).

In both models (MNL and ECL) the sequential enrichment of the representative utility functions of the alternatives produced considerable improvements in terms of the value of LL at convergence, AIC criterion and proportion of correct predictions, with the consequent gains in terms of understanding the behavior underlying the choice process.

Additionally the ECL produced significant enhancements in model fit relative to MNL, considerably improving the converge value of LL in all presented specifications.

3.4.1. The basic specification (MNL_1 and ECL_1)

Bearing in mind the basic utility specification, the ECL_1 clearly outperforms the MNL_1. The statistic evidence of the LL ratio test and AIC criterion support the choice of the ECL_1. Additionally, the data don't satisfy the *IIA* assumption on which the MNL relies, when alternative B is removed from the analysis (the p-value=0.04 indicates the significance of the Hausman–McFadden test, suggesting the violation of *IIA* assumption, for the confidence level of 95%). Nevertheless both of the models show that all alternatives' attributes are significant at the 5% level and signed as expect a priori. The preservation of the attributes VIN, MOS and AGLLO have a positive influence on the utility of an alternative whereas the negative signal of the cost attribute reflects the reverse effect. Distinctly from MNL, the ASC has a negative and significant coefficient suggesting disutility in choosing the None-Option alternative comparatively to alternatives A and B, involving a preservation program. The standard deviation parameter associated with the error components for alternatives A and B is statistically significant, suggesting that these alternatives share common features that are not captured by the attributes included in the model. This result indicates the presence of unobserved, alternative specific preferences heterogeneity.

3.4.2. The final specification (MNL2, ECL2 and ECL3)

To test the presence of "preference heterogeneity", sixteen individuals' variables or respondents characteristics (Table 1) were introduced in the representative utility function of the alternatives A and B. The MNL_2, ECL_2 and ECL_3 models were sequentially estimated. This procedure resulted in remarkable improvements in model fit, being the ECL statistically superior to MNL[8].

Additionally, the calculated statistic (6.6642) of the LR test (critical value of 3.84) indicates the statistical superiority of the ECL_3 comparatively to ECL_2. The AIC criterion also suggests the choice of ECL_3. In this sense, the variability analysis of the error component, ECL_3, has improved the adjustment in terms of the convergence value of LL, criterion AIC and correct predictions proportion.

Selecting ECL_3 as the model that best explains the individual choices, the coefficients of the alternatives' attributes still statistically significant and maintain the expected sign, keeping the evidence of the previous basic models (MNL_1 and ECL_1), as well as, of the ECL_2 and MNL_2. Nevertheless, while retaining the negative sign, the ASC is no longer being statistically significant in ECL_3.

Concerning the influence of respondents' characteristics to explain the choice of a preservation program alternative versus the None-Option, the INCOME and household SIZE are statistically significant. In line with the results of other cultural valuation applications (Pearce *et al.*, 2002; Morey *et al.*, 2002; Morey and Rossmann, 2003; Pollicino and Maddinson, 2002; Mazzanti, 2003; Tuan and Navrud, 2007), INCOME has the expected positive sign. Alternatively, the negative sign of household SIZE indicates that the utility of choosing an alternative with a preservation program is lower for larger households. One explanation for this result is that the contribution to a preservation program could mean a greater burden on the budgets of the larger households that have more expenses. The remaining socio-economic variables included in the regression (GE, AGE, EDU and PROF) are not statistically significant.

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8 As pointed out in literature (e.g. Hensher *et al*., 2005), the refinement of the systematic utility function of the alternatives solved the initial problems with the verification of the *IIA* assumption in MNL_1. According to the specification test of Hausman and McFadden (1984), the MNL_2 exhibits the IIA property, removing any of the alternatives A, B or the none-option.

Regarding attitude and context dimensions, four variables are significant to explain the choice of a preservation program alternative: number of visits to ADW in last year (VISIT), the influence of world heritage status on visit decision (LIST), distance between the residence site and the ADW (KM) and the decision process variable (TRADE).

In spite of empirical findings suggesting the use or consumption of the amenity as one of the positive determinants of the value of preserving cultural items (e.g. Pearce *et al.*, 2002), the negative and significant sign for the VISIT coefficient indicates that the utility of a preservation program is lower for the respondents that visited the ADW more times in the last year.

The positive sign for LIST coefficient means that the utility of choosing an alternative with a program is higher for the respondents whose visit decision was influenced by the inclusion of the ADW in the UNESCO list. This relationship can be understood as a consequence of the status of world heritage, and by its effects on the demand and on the importance of contributing to the ADW preservation.

Additionally, the distance coefficient (KM) is negative and significant, suggesting that the value of choosing an alternative involving a program is lower to the respondents who live farther from the ADW. Given the slightest familiarity and proximity to the ADW, this evidence is consistent with our expectations.

Considering the decision process in each choice occasion, the positive and significant coefficient of TRADE reveals that the respondents that considered all the attributes are more likely to participate on a preservation program for the ADW than those who relied on another decision-making process. This result may be understood considering the higher cognitive effort[9] underling the process of attributes trade-off. The consequent additional influence may be positively related to concern with the amenity in question and, consequently, with the probability of choosing an alternative involving preservation.

[9] For respondents who considered the choice as a not easy task, about 70% made trade-offs between the attributes of the preservation program, whereas for respondents admitting that the choice task was easy, only 37% made trade-offs between the attributes to make the choice. These relationships confirm the findings in other studies (e.g. Watson et al., 2004) and it suggests that considering all the attributes involves a greater cognitive effort than choosing based on only one.

With respect to the additional estimated parameters, results from ECL_3 exhibit differences in the variance of the error components between educational attainment levels (higher for superior education levels, E01HAB coefficient.) Ceteris paribus, the standard deviation of the error component increases to the extent that the educational level increases, leading to an increase in the preferences heterogeneity of these unobserved effects.

Comparing MNL2, ECL2 and ECL3

It's worth noting that the evidences on the statistical significance of the individuals' characteristics to explain the choice of an alternative involving a preservation program are not precisely the same among the three models under consideration, raising the need to investigate these differences. Specifically, some considerations around the repeated choices problem are introduced, explicitly accounted by the ECL framework.

Collecting more than one observation per person can make unreal the assumption of independence among the choices made by the same respondent, a MNL assumption, insofar as the same structure of preferences is used to make various choices. Ortúzar *et al.* (2000) and Cho and Kim (2002) analyze the problem of repeated choices that, according to them, is ignored in most applications, assuming the independence assumption. Initially, this problem was confined to obtaining higher t statistics, due to underestimation of standard deviations of the estimated coefficients in MNL. The first attempts to correct the bias of t statistics refer to applying a correction factor, for example, by dividing it by the square root of the number of observations per individual (Louviere and Woodworth, 1983, reported in Cho and Kim, 2002). Nevertheless Cho and Kim (2002) refer to the application of this correction factor as a conservative method because it corrects too much or underestimates the t statistics.

Currently, the problem is investigated through the estimation of models with specifications that explicitly estimate terms capturing the correlation between observations or sub-sampling procedures, such as the bootstrap (Efron, 1979).

In this context, the standard deviations of coefficients of the socioeconomic variables, attitude and context of the MNL_2 were recalculated using the bootstrap re-sampling procedure (LIMDEP9.0: R15-1/NLOGIT4.0). Using the data in the sample, X=[x_1, ...,x_n], an estimator, *b*, of a parameter or a vector of parameters β is obtained. This procedure calculates the sampling variance of the estimator, V_{bs}, as $V_{bs} = \frac{1}{R}\sum_{r=1}^{R}(b_r - b)(b_r - b)'$, where R is the number of replications, *br* is β estimate in rth bootstrap sample and *b* is the original estimator.

Table 3 presents the standard deviations of the individuals' coefficients in MNL_2 using the bootstrap technique with 500 replications. A bootstrap correction factor (BCF) is obtained as follows: $sd_{MNL_2} \times BCF = sd_{bootstrap}$

Table 3 Standard deviations of the estimated coefficients of the socioeconomic variables, attitudinal and context (individuals' variables) specific to the alternatives with a preservation program

Individuals' variables	sd_{MNL2}	$sd_{bootstrap}$ (R=500)	BCF	Statistically significant individuals' variables		
				MNL_2	after BCF	After the conservative correction factor (2.45)
GE	0,2524	0,431	1,7	-	-	-
AGE	0,01018	0,0226	2,22	AGE***	-	-
INCOME	0,15119	0,28175	1,86	INCOME***	INCOME***	INCOME *
EDU	0,2235	0,408	1,83	-	-	-
SIZE	0,1028	0,198	1,93	SIZE***	SIZE***	SIZE*
PROF	0,281	0,567	2,02	-	-	-
MEMBER	0,319	0,5399	1,69	-	-	-
FIRST	0,317	0,7238	2,29	FIRST*	-	-
TRADE	0,237	0,43778	1,85	TRADE***	TRADE***	TRADE***
VISIT	0,00975	0,0268	2,75	VISIT***	VISIT**	VISIT***
PURPOSE	0,2593	0,50136	1,94	-	-	
LIST	0,321	0,498	1,55	LIST***	LIST***	LIST*
KNOW	0,25	0,4986	1,99	-	-	-
IDENT	0,278	0,626	2,25	IDENT***	-	-
CULT	0,0043	0,007	1,63	-	-	-
KM	0,00091	0,0022	2,42	KM***	KM***	KM***

As noted in Table 3, the standard deviation of the estimates from the MNL_2, without considering the issue of repeated choices, is underestimated. However, with the exception of the standard deviation of the estimated parameter VISIT, it is always smaller than predicted by the conservative method, applying a correction factor equal to 2.45 (square root of six). Nevertheless, both procedures (BCF and conservative correction factor) identify as statistically significant the following variables: INCOME, SIZE, TRADE, VISIT, LIST and KM. These are exactly the variables with statistical significance in ECL_3.

Assuming the evidences of the previous analysis, it seems that the homoscedastic error components model (ECL_2) underestimates the significance of the invariant individuals' characteristics recognizing only the effect of the TRADE and KM variables to explain the decision of participation on a preservation program (versus the None-Option). Probably it captures some effect of the systematic heterogeneity as a source of unobserved influences specific to the alternatives, specifically in the error component (the standard deviation associated with the error component suggests a statistically significant correlation between the unobserved factors common to alternatives A and B). In this context, the serious investigation of the heterogeneity of the variance of the error component appears as a fundamental task in the implementation of the ECL model.

4. Concluding Remarks

This paper presents the results of a DCE application regarding the visitants' preferences for a hypothetical program to preserve the main attributes of Alto Douro Wine Region, world heritage site.

In order to analyse the choices among a finite set of three mutually exclusive alternatives, logit discrete choice models were employed. Starting with the estimation of MNL, the analysis was extended to the ECL, entering in the domain of opened form models, one of the possible interpretations of the mixed logit model. Both models were estimated firstly considering a simpler specification of the alternative representative utility function, including only the program attributes, and subsequently considering the introduction of individuals' variables specific to the alternatives involving a preservation program, in order to detect and model the existence of systematic heterogeneity. The sequential process resulted in substantial improvements in LL value at convergence, in the criterion of correct predictions and in the AIC for all estimated models.

Regarding the relative importance of the attributes to preserve, all estimated models suggested the landscape mosaic of the ADW as the most important, followed by agglomerations, and by vineyards terraced with schist walls, respectively. The analysis demonstrated the utility of preserving all attributes included in the preservation program.

The use of ECL achieved significant improvements in model fit relative to MNL model. Additionally the ECL detected unobserved heterogeneity alternative specific, an omitted issue in MNL framework. Considering the homoscedastic ECL, the estimated standard deviation of the error component was statistically significant in all specifications, indicating the existence of correlation between unobserved individual factors in the choice of alternatives involving a preservation program. The heteroscedastic ECL revealed the presence of heterogeneity in the variance of the error components between educational attainment levels, increasing to the extent that the educational level increases.

This paper considers the problem of repeated choices, estimating the ECL, recalculating the standard errors of the respondents' characteristics estimates from MNL using the standard conservative method and the bootstrap re-sampling procedure (BCF). In this specific application, the MNL underestimates these standard deviations, as postulated in the literature. Additionally, regarding the influence of respondents' variables to explain the choice of an alternative with preservation program versus the None-Option, both procedures (BCF and conservative correction factor) identify as statistically significant the same variables with statistical significance as in the heteroscedastic ECL. Specifically, there is evidence that the utility of participating in a preservation program is positively determined by the income level, by the status of ADW' world heritage list, and by the choice decision process, being superior for those who pondered all attributes. Moreover, this utility is negatively influenced by household size, by the number of visits and by the distance between the residence and the ADW. Compared to MNL, ignoring the fact that we have more than one observation per respondent, the variables AGE, IDENT and FIRST are no longer statistically significant. When the aim is to assess the determinants of the decision to participate in a preservation program, the interpretation of these variables as significant can be understood as a consequence of neglecting the problem of repeated choices, by assuming independence between occasions of choice under the MNL framework.

For the particular case of ADW, considering the final alternative utility specification, the analysis of the heterogeneity of the component error' variance in the ECL was statistically preferable to homoscedastic ECL, in line with the results in existing literature. Consequently, serious investigation of the heterogeneity of the variance of the error component is a fundamental task in the implementation of the ECL model. The extent to which this result applies to other studies should be investigated.

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Appendix DCE applications on cultural sphere

Authors	Study object	Estimated benefits	Attributes (levels)	Tasks /respondent (n)	Choice Sets Size	Model Specification
Morey et al. (2002)	100 marble monumentsWashington D.C.	Society' benefits from a reduction in the rate of injury	2 (4 x 9)	10 (259)	2	LM
Maddison and Foster (2003)	British Museum	Valuing Congestion Costs	2 (3 x 4)	2 (400)	1+ sq	LM
Mazzanti (2003)	Galleria Borghese Museum, Rome	User preferences concerning services supplied by cultural institutions	4 (2^2 x 3^2)	3 or 4 (185)	2 + sq	MNL
Alberini et al. (2003)	St. Anne's Cathedral Square (Belfast) vs an abstract square	People's preferences for urban regenera-tion projects	4 (2 x 3^2 x 4)	5 (254)	2	MNL RPL
Apostola-kis and Jaffry (2005)	2 Greek heritage attractions	Tourists' preferences for cultural heritage attractions	6 (3^6)	3 (253)	3	MNL
Snowball and Willis (2006)	South African National Arts Festival	To assess the value of the different elements of an Arts Festival	6 (4^5 x 5)	3 (78)	2	MNL; HEV; RPL
Tuan and Navrud (2007)	My Son world cultural heritage site, Vietnam	Social benefits of restoration/ preserva-tion projects	4 (4 x 2^3)	7 (225 + 221)	1 + sq	MNL RPL

MNL – Multinomial Logit Model; LM- Binary Logit Model ; RPL - Random Parameters Logit Model ; MM-Mixture Model (combining RPL and Classic heterogeneity); HEV- heteroscedastic extreme value model; sq- status quo

[a] Information reported by the author.