



Selecting random parameters in discrete choice experiment for environmental valuation: A simulation experiment

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ABSTRACT

This paper examines two tests commonly used to select random parameters in choice modelling: the Lagrange Multiplier (LM) test as proposed by [McFadden and Train \(2000\)](#) and the t -statistic of the deviation of the random parameter. A simulation exercise based on a real case study is carried out assuming cross-sectional data and two panel data settings. These data structures together with different distributional assumptions allow an examination of the empirical size and power of the two analysed tests. The key results indicate that the power of these tests depends on the data structure as well as on the spread and type of the parameter distribution. Furthermore, the LM test is the only one with empirical size not significantly different from the theoretical value.

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1. Introduction

Choice analysis has often been described as a way of explaining variations in the behaviour of a sample of individuals, which is the basis of widely used discrete choice experiments (DCEs). The key focus of model development in this field has been the search for increasing sources of variance, or heterogeneity, in the candidate observed and unobserved influences on choice making ([Greene and Hensher, 2010](#)). In recent years, there has been a large ongoing research programme on how best to model that heterogeneity.

One econometric model usually applied in DCE framework that allows for its parameters to vary across individuals, thereby accommodating heterogeneity, is the Mixed Logit (MXL) model. The inclusion of heterogeneity provides more information regarding the influence of socio-economic and demographic factors in respondents' decision making. The main task when applying this model is to find variables and a mixing distribution able to take into account the other components of utility, which correlate over alternatives or are heteroskedastic ([Train, 2003](#)). In uncovering patterns of tastes and respondents' preference heterogeneity among MXL models, it is important to permit wider variation to uncover more influences affecting respondents' utility.

The selection of random parameters is usually based on one of the following tests: the Lagrange Multiplier (LM) test proposed by [McFadden and Train \(2000\)](#), and the t -statistic of the deviation of the random parameter. [Hensher and Greene \(2003\)](#) and [Hensher et al. \(2005\)](#) describe the LM test for selecting random parameters and propose the use of t -statistic as an alternative. According to [Brownstone \(2001\)](#), the LM test is easy to calculate and appears to be a powerful omnibus test. However, there is still limited information for practitioners regarding the performance of these tests. Thus, the aim of this

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paper is to complete a deeper study about the behaviour of these tests. That is to say, to test the power and empirical size of these tests under different types and spreads of the tested parameter distribution as well as under different data settings, by using a simulation experiment.

The paper is divided into five sections: introduction (Section 1) is followed by the methodology framework and explanations of the different randomness tests (Section 2). Next, in Section 3 the simulation exercise is described. This is then put forward by a presentation of the results and discussion (Section 4). Finally, Section 5 provides with some conclusions.

2. Methodology for selecting random parameters

The analysis of DCE choices is based on the random utility theory as developed by McFadden (1974), which links the deterministic model with a statistical model of human behaviour. In the simple Multinomial Logit (MNL) model (McFadden, 1974; Louviere et al., 2000), the utility to individual n from choosing alternative j is given by

$$U_{nj} = \beta'x_{nj} + \varepsilon_{nj}, \quad (1)$$

where x_{nj} is a K -vector of observed attributes describing the alternative j for individual n . Here, the vector of utility weights β is homogeneous across individuals and the error term ε_{nj} is independently and identically distributed (i.i.d.) as extreme value.

The MXL model is currently quite popular as it allows for heterogeneous preferences while continuing to assume the error term as i.i.d. extreme value. Different types of MXL models have been used in empirical work: the Random Parameter Logit (RPL) and Error Component Logit (ECL) models. The difference between the two specifications is interpretational (Brownstone, 2001), although the RPL and ECL models are equivalent (Train, 2003). The RPL model allows for random taste variations, thereby accommodating unobserved heterogeneity for observed attributes. In RPL the utility to person n from choosing alternative j is given by

$$U_{nj} = (\beta + \eta_n)'x_{nj} + \varepsilon_{nj} \quad (2)$$

here, β is the vector of mean attribute utility weights in the population, whereas η_n is the vector of person n -specific deviations from the mean. The error term ε_{nj} is i.i.d. extreme value.

Applications including a RPL specification can be found across a number of areas, including transport (Amador et al., 2005; Bhat, 2000, 1997; Brownstone et al., 2000), recreation (Hanley et al., 2002; Train, 1998) and health (Persson, 2002) among many others. Moreover, other examples covering the environmental areas include studies done by Colombo and Hanley (2008), Birol et al. (2006a, 2006b), Hanley et al. (2006), Carlsson et al. (2003) and Revelt and Train (1998).

Importantly, the RPL model handles the case of unobserved heterogeneity by assuming that (some of) the weighting coefficients vary in the population according to some distribution and estimating the parameters of those distributions. Thus, to estimate an RPL model it is necessary to make three main decisions: (1) which coefficients are assumed to be random, (2) the type of distributions to use and (3) the economic interpretation for those coefficients (Hoyos, 2010).

As mentioned before, in the DCE literature researchers usually determine the random coefficients in an RPL using the LM test or the t -statistic of the deviation of the random parameter. Nevertheless, there is limited information for analysts about the performance of the tests. This paper aims to encourage researchers to pay more attention to the relevance of randomness assumptions and the limitations of available statistical tests.

2.1. Lagrange Multiplier (LM) test

Prior to estimating the RPL model, it is useful to carry out a specification test to determine whether this treatment is appropriate. From a random sample $n=1, 2, \dots, N$, the test proposed by McFadden and Train (2000) estimates through maximum likelihood the parameters β in the MNL model in a standard way. Thereafter, it constructs artificial variables

$$z_{tnj} = \frac{1}{2}(x_{tnj} - x_{tnc})^2 \text{ with } x_{tnc} = \sum_{k \in C} x_{tnk} P_{nk}, \quad (3)$$

where t denotes the component of x_{nj} suspected to be random, C is the set of alternatives being offered and P_{nk} is the conditional logit choice probability. A Wald or LR test can be used to test the null hypothesis that the artificial variables z_{tnj} should be omitted from the MNL model. The null hypothesis of no random coefficients is therefore rejected if the parameters of the artificial variables are significantly different from zero.

There is a dearth of literature that applies this LM test to specify the model to use. One study that has applied this test is Hoyos et al. (2009), where a choice experiment was conducted in the Basque Country (Spain) to determine the non-market values of the environmental attributes. In this study, 2448 observations in relation to five attributes were considered with the randomness of all the coefficients being tested using the LM test, and it was found that only two attribute parameters were random. Similarly, Liljenstolpe (2008) evaluated animal welfare in relation to Swedish pig production, with seven attributes and using 1250 observations, concluding that six of the tested parameters were random.

Another study carried out by Brey et al. (2007) estimated economic welfare for a forestation programme in the northeast of Spain using six attributes with 730 observations. Only two coefficients were found to be random after the application of the LM test.

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