Urban freight distribution and policy assessment: 
dependence vs. independence in stated preference logit models

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Objectives and motivation

Urban freight transport is crucial for cities. In fact, it ensures high standards of livings and produces significant undesirable social costs. Local policy makers have to promote innovative and effective policies in terms of both environmental and economic sustainability. This is a complex task and its success or failure highly depends on the knowledge of stakeholders’ preferences (Gatta and Marcucci, 2014). The appropriateness and the precision of the results obtained via this behavioral approach is directly related to the sophisticated data acquisition strategy used and the advanced model estimation employed (Marcucci and Gatta, 2013; 2014; Marcucci et al., 2015).

The aim of the paper is twofold. The first is to provide empirical evidence on the preferences of stakeholders with respect to policies related to access charging and the supply of loading and unloading bays. An econometric analysis based on the estimation of logit models is carried out. Stated preference data have been collected with the main stakeholders involved (i.e. retailers and transport providers) in the delivery process within the Limited Traffic Zone in the city center of Rome where access restrictions are currently in force (Marcucci et al., 2012). A total of 229 interviews were gathered to accurately estimate the most likely effects of the policy actions investigated.

The second is to assess the finite sample properties of the coefficient estimators that are based on the independence assumption. This assumption is typical in estimation. With stated preference data the assumption is untenable because correlations among random terms across observations by the same individual are likely to exist. Available evidence has focused on the impact of the assumption on the standard errors of the coefficient estimators as well as on the procedures to correct the downwards bias. These include resampling methods such as bootstrapping and jackknife and the sandwich estimator (Cirillo, Daly and Lindveld, 2000; Daly and Hess, 2010).

General description

By composite likelihood theory, the estimators based on independent random terms are consistent estimators for the true coefficients if the true model is the one with random terms correlated across observations and identical logit marginal choices (Bhat, 2011). With finite samples, however, one expects coefficient estimates based on independent random terms to be different from those obtained from likelihood based on the true sequence probability. Scant evidence is available on the bias in the finite sample coefficients estimates. Ouwersloot and Rietveld (1996) and Ortúzar et al. (2000) have investigated probit models and made a comparison between independence estimators and minimum distance estimators that take correlation into account. No evidence exists on the bias that might arise in logit models estimated on the basis of real data. The aim of the research reported in the paper is to contribute to fill this gap.

The approach used is based on the comparison of the independence estimators with the maximum likelihood estimators of the true model that takes correlation into account. Two models have been proposed in recent literature that provide the probability of a sequence of choice in analytic form. This implies that simulation is not needed for estimation. One model constructs the joint distribution of the random terms across observations on the basis of the Farlie-Gumbel-Morgenstern copula (Bhat and Sener, 2009).
This model can take into account low values of the correlation. For binary choices, closed-form, differentiable in the parameters likelihood is available without limitations on the number of observations. Another model is based on the bi-extremal distribution (Delle Site and Salucci, 2015). In this model the correlation varies in the full interval between zero and one. However, the likelihood is available analytically in the case of two observations only and is not differentiable in the parameters. Given the number of observations per interviewee we use the copula-based model. To maximize the likelihood, we use a controlled random search, the Price algorithm (Price, 1978).

Results and conclusions

The coefficients related to the entrance fee, the availability of loading and unloading bays and the probability of finding them free are estimated for the independence model and the model that takes correlation into account. The bias in the coefficient estimates induced by the independence assumption is thus evaluated. Results of the estimation confirm consistency when the sample is sufficiently large.

This result is of practical relevance for stated preference exercises beyond the urban freight application domain. Looking at policy implications, obtaining different coefficient estimates may lead to altered willingness to pay measures. Assuming, for example, a policy intervention aimed at raising the number of loading bays, the “standard” (i.e. independent random terms) model results could suggest to increase the entrance fees more (less) than what stakeholders would be willing to pay (according to the proposed model), translating to significant discontent (less public revenues) and reducing the potential effectiveness of the policy introduced. Results provide also evidence on the correlation that exist among observations in SP datasets.

References


**Keywords:** urban logistics; policy assessment; stated preference; logit; bi-extremal distribution.