An enhanced measurement model of perception of comfort in public transportation

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1 Introduction

Hybrid choice models (HCM) [2, 8] provide an important framework to model complex decision problems. The integration of qualitative aspects such as attitudes, perceptions, lifestyles or habits into a discrete choice model (DCM) has contributed to a more accurate and realistic characterization of choice decisions. However the measurement of such latent variables has raised a number of issues. One of the most important of these aspects deals with the difficulty of obtaining representative indicators of the latent variables. Building upon social sciences survey techniques [7, 6, 1], behavioral researchers have focused on the use of *psychometrics*. So far a common technique consisted in asking survey respondents to indicate their agreement to a statement in relation with the latent variable on a five-point Likert scale. Though these techniques provide important insights into the psychological factors of choice, researchers might fail to completely seize the representation of a respondent's attitude or perception since they are designing the sentences. Recent social science studies [4, 5] have been using a different technique which provides a powerful way to collect information on the respondent's representation of a perception. This method consists in asking individuals to report several adjectives characterizing a variable of interest, e.g. a transportation mode. Since the adjectives are freely reported by the respondents, the bias inherent to the design of the survey is reduced.

The use of such collected data raises two important issues, which are (i) the quantification of the information in the answers to these *semi-open* questions and (ii) its integration into the latent variable model (LVM) component of the HCM which characterizes the perception.

This research is based on a case study whose purpose is to analyze the transportation mode choices of inhabitants of low-density areas of Switzerland. A large-scale revealed preferences (RP) survey was conducted and respondents were asked to report the transport modes they used in one day, along with durations, costs and a wide range of additional information relevant to the trips. In addition, they had to report three adjectives characterizing best various given transportation modes. The adjectives were subsequently classified into themes, such as comfort, flexibility, reliability, environmental impact, etc. As an example, we chose to analyze the impact of the perception of comfort in public transportation on mode choice.

2 Modeling approach

In order to quantify the adjectives, we ask external individuals (the 'evaluators') to rate them on a scale of one of the identified themes, e.g. comfort. We investigate two different types of scale: a *discrete scale*, ranging from -2 to 2, where -2 expresses a total discomfort and 2 a total comfort, and a *continuous scale*, ranging from -1000 to 1000, where -1000 expresses a total discomfort and 1000 a total comfort. Part of the evaluators are asked to indicate their ratings on the first scale and the other part on the second scale.

We obtain a distribution of the score of each adjective reported in the RP survey. Our previous work [3] has shown that when using individually the ratings of different evaluators as measurements of the latent variable, few variations can be observed at the level of aggregate indicators of demand, such as market shares, elasticities or value of time, but that variations occur at the level of disaggregate indicators.

Using information on the socio-economic characteristics of the evaluators, we aim at characterizing the distribution of the score of each adjective in the sample of evaluators. The framework we propose is pictured in Figure 1. Following the notation of the generalized framework developed by [2, 8], latent variables are represented by ovals and observed ones by rectangles. Straight arrows are used for structural relations, dashed arrows for measurement relations and dotted arrows for disturbances.

The proposed HCM involves three components:

- A discrete choice model
- A latent variable model for the perceptional variable
- A quantification model for the indicators of the perceptional variable

This framework extends the measurement model of the generalized framework by assuming that each indicator (i.e. each adjective) has an unobservable score, representing an *indirect measurement* of the perceptional variable. These indirect measurements explain the discrete and continuous ratings reported by the evaluators. Moreover the variation observed in the measured ratings can be explained by the socio-economic information of the evaluators.

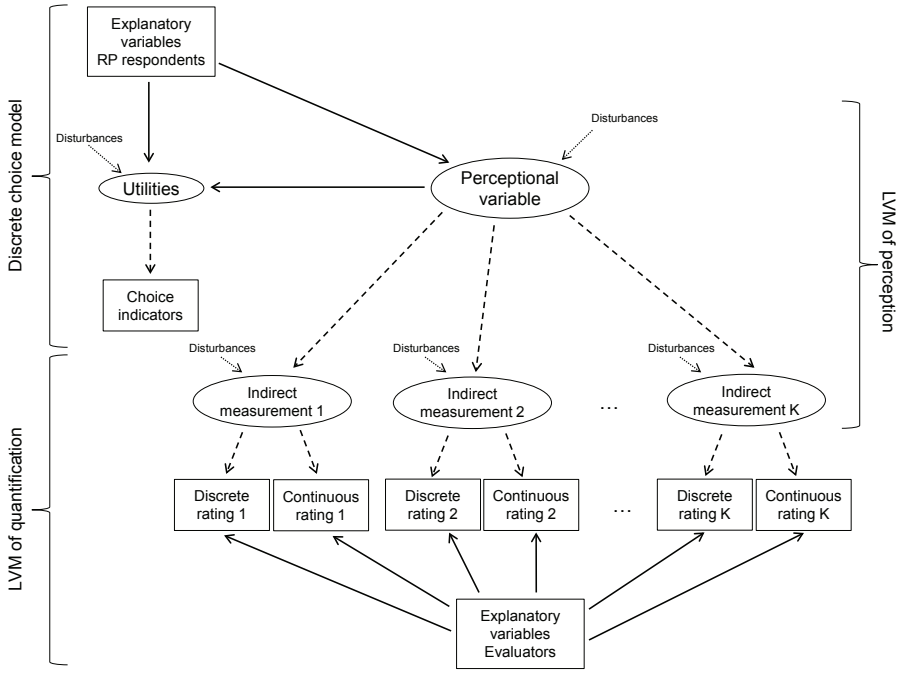

Figure 1: HCM with enhanced measurement model.

The extended measurement model hence allows to obtain both an estimate of the score of each adjective from the ratings given by all evaluators and to explain and capture the variability of this scale among individuals.

3 Perspectives

Perceptions are important factors of transportation mode choices and this research proposes to use different types of indicators to measure them. The advantage of using adjectives over the clas-

sical opinion statements which are usually shown in surveys is that they convey the spontaneous expression of the respondents' perceptions.

The proposed integrated model leads to two important outcomes. First, it allows the quantification of the information contained in the adjectives. We are able to assign a score to an adjective by using the distribution of ratings of the evaluators. Second, it accounts for the subjectivity inherent to the quantification process. Socio-economic factors such as the education level can indeed induce some differences in the reported ratings of adjectives.

References

[1] Bearden, W. and Netemeyer, R., "Handbook of marketing scales: multi-item measures for marketing and consumer behavior research", Association for Consumer Research, Sage Publications, 1999.

[2] Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Bolduc, D., Boersch-Supan, A., Brownstone, D., Bunch, D., Daly, A., de Palma, A., Gopinath, D., Karlstrom, A. and Munizaga, M. A., "Hybrid choice models: Progress and challenges", *Marketing Letters* 13(3): 163175, 2002.

[3] Glerum, A., Atasoy, B., and Bierlaire, M., "Using semi-open questions to integrate perceptions in choice models", *Technical report TRANSP-OR 120325*, Transport and Mobility Laboratory, ENAC, EPFL, 2012.

[4] Kaufmann, V., Jemelin, C. and Guidez, J.-M., "Automobile et modes de vie urbains quel degré de liberté?", Documentation Française, 2001.

[5] Kaufmann, V., Tabaka, K., Louvet, N. and Guidez, J.-M., "Et si les Français navaient plus seulement une voiture dans la tête?", Certu, 2010.

[6] Likert, R., "A technique for the measurement of attitudes", *Archives of Psychology* 22(140), 1932.

[7] Thorndike, E. L., "A constant error in psychological ratings", *Journal of Applied Psychology* 4: 469477, 1920.

[8] Walker, J. and Ben-Akiva, M., "Generalized random utility model", *Mathematical Social Sciences* 43(3): 303-343, 2002.