An enhanced measurement model of perception of comfort in public transportation

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1 Introduction

In the recent years the development of hybrid choice models (HCM) [2] has provided 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 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 science survey techniques [10, 8, 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 [6, 7] 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 of asking individuals to report three 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 component of the HCM. In this research we propose two different approaches to address these issues.

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.

2 Expert-based approach

The first method we propose is to ask external individuals (so-called 'experts') to rate the reported adjectives on a scale of comfort in public transportation. We investigate two different scales: a *discrete scale*, where -2 expresses a total discomfort and 2 a total comfort, and a *continuous scale*, where -1000 expresses a total discomfort and 1000 a total comfort. We hence obtain a distribution of the scale of each adjective reported in the RP survey. Our previous work [5] has shown that when using individually the ratings of different experts 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 experts, we aim at characterizing the distribution of scales of each adjective in the sample of experts. The framework we are proposing (see Figure 1) builds upon the generalized framework developed by [2]. It extends the measurement model of this generalized framework by assuming that each indicator (i.e. each adjective) has a latent true scale, which itself explains the measured scales reported by the experts. The variation observed in the measured scales is characterized by the socio-economic information of the experts.

This measurement model allows to obtain information on both the average scale of each adjective and on the variability of this scale among individuals.

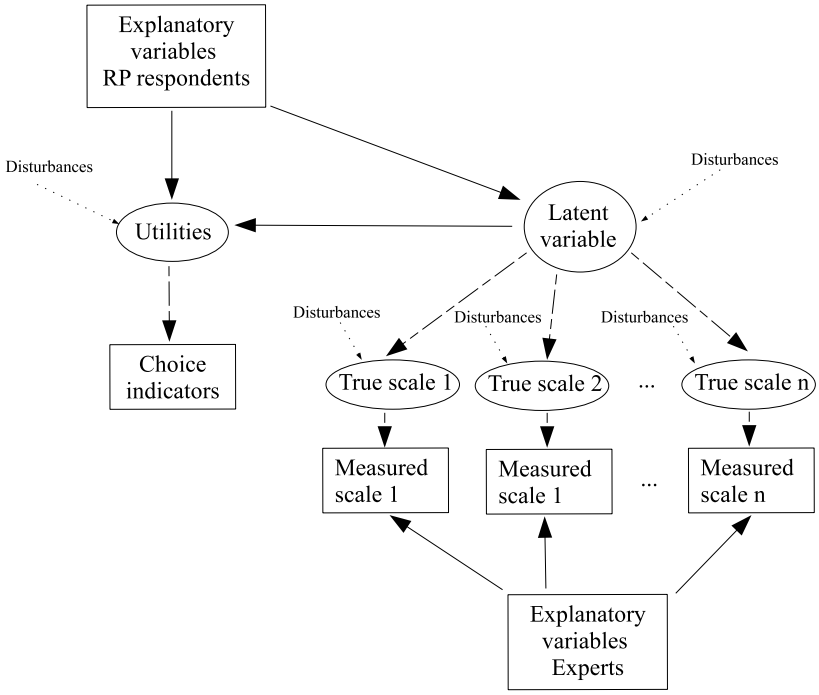

Figure 1: HCM with enhanced measurement model.

3 Computational linguistics approach

Along with the expert-based approach to measure perception which we presented in Section 2, we investigate a second approach based on computational linguistics techniques. Since our goal is to find an objective measure of the latent variable (i.e. comfort in public transportation), we are searching for relationships between the indicator (i.e. the adjective), the latent variable and the context (i.e. transportation).

Measures of semantic relatedness have been developed in the computational linguistics literature [4]. Several of them are based on similarities both in taxonomy and in context. Early research has indeed demonstrated that similarity of meaning is correlated with similarity of context [9]. For example, on a wide range of articles, two synonyms are stastistically surrounded by the same words, which is not the case for unrelated words. Statistics about the context of a word can be obtained using corpora data, which is accessible through the Natural Language Toolkit (NLTK) [3]. We plan to use this tool to define a relationship between the indicator, the latent variable and their context.

4 Perspectives

The two methods described above provide two different approaches to quantify the information contained in the adjectives. The expert-based approach provides an empirical way to determine the scale of an adjective by obtaining a distribution of it across subjects. The approach using computation linguistics leads to a more formal definition of semantic similarity between an adjective and comfort.

This research aims at obtaining a measurement model of an HCM which takes into account the complexity of the relation between a latent variable and its indicators.

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] Bird, S., Klein, E., and Loper, E., "Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit", O'Reilly , Beijing, 2009.

[4] Budanitsky, A., and Hirst, G., "Semantic Distance in WordNet: An experimental, application-oriented evaluation of five measures.", Workshop on WordNet and Other Lexical Resources, North American Chapter of the Association for Computational Linguistics, Pittsburgh, 2001.

[5] 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.

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

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

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

[9] Rubenstein, H. and Goodenough, J. B., “Contextual Correlates of Synonymy”, *Communications of the ACM*, 8(10):627633, 1965.

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