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Context-driven regret-based model of travel behavior under uncertainty: a latent class approach

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Abstract

Understanding variability in observed travel behavior has been one of the major research topics in travel behavior analysis and travel demand modeling. Differences in outcomes of travel decisions can be attributed to observed and non-observed differences between travelers and different situations and contexts in which decisions are made. The majority of studies in transportation research have estimated the effects of observed socio-demographic profiles on choice probabilities under certainty. Unobserved heterogeneity in utility functions has been typically examined using mixed logit or latent class models. The focus of the current paper concerns the effect of context and personality traits on decision-making under uncertainty, a combination of factors that has received not much attention in transportation research to date. Using route choice in an activity context as an example, we estimate a latent class random regret-minimization model, which takes into account the travel time and therefore arrival time uncertainty that people face when making route choice decisions. In addition, it incorporates the effects of personality traits, socio-demographic profiles and contextual factors, which increase or decrease travelers' feelings of regret. The model is estimated based on a stated choice experiment, which was administered through a Web-based survey. Results suggest the existence of three latent classes underlying differences in regret-driven choice behavior.

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1. Introduction

There is a growing body of literature that recognizes the pivotal role of behavioral mechanisms and processes in understanding and predicting activity-travel choices. A multitude of theories and models, derived from social sciences and behavioral economics, have been formulated to better understand travel-related decisions. This amount of effort does not come as a surprise, since the decision process that individuals go through each time they make a choice, is potentially complex in nature and involves anticipated situations, feelings, and particular decision-making strategies. Therefore, it is essential for any behavioral model to try and capture the core principles, mechanisms and conditions, affecting the decision making process.

The present paper focuses on the random regret minimization model, which has emerged in travel demand modelling as an alternative to utility maximization as the dominant decision principle. Regret arises when an individual experiences the chosen alternative and realizes that a higher payoff could have been achieved if a foregone alternative had been chosen. It has been shown in various studies that (anticipated and experienced) regret highly affect decision making in both risky and riskless choices (e.g., Zeelenberg and Pieters, 2007). Random regret minimisation models have been applied to a range of choice problems, including travel choice (Chorus et al., 2008b), leisure-related decision-making (Thiene et al., 2012), driver crash avoidance maneuvers (Kaplan and Prato, 2012), automobile fuel choice (Hensher et al., 2013) and shopping center choice behavior (Rasouli and Timmermans, 2016; Jang, 2016). These studies show small, albeit significant, differences in model fit between the two models, the best fitting model depending on the specific dataset. In general, the choice between the two models is driven by different factors, including choice context, dataset and framing of the survey (Hess et al., 2014). Specifically for this study, we contend that the importance of regret in the decision-making process depends on the choice context. Our study intends to highlight cases in which minimization of anticipated regret is particularly important. These cases relate to the activity that needs to be conducted and the nature of the relationship of the decision-maker with the persons who will be met to conduct the activity.

Several key factors should be considered when modelling activity-travel decisions. First, since urban transportation systems are in a constant state of flux, decision makers face uncertainty about travel times, delays, etc. Various studies have provided empirical evidence that travel time uncertainty strongly influences travel behaviour (e.g., Noland and Polak, 2010; Hensher et al., 2011). Thus, modelling decision-making under uncertainty is of paramount importance for route choice decisions. Second, as highlighted in Ben-Akiva et al. (2012), more emphasis should be put on explicitly modelling the choice context and process. Third, individual differences may also influence decision-making. Several studies in psychology (e.g. de Bruin et al., 2007) emphasize how people's choice behavior co-varies with socio-demographics. In addition, personality traits and attitudes may play a significant role (Hurtubia et al., 2014). Moreover, Hensher (2008, 2009), Zhu and Timmermans (2010) and others have highlighted the importance of allowing for heterogeneity in decision-making strategies. Particularly, there is a growing interest in the application of latent class modelling, as an alternative approach to the mixed logit model, to represent respondent heterogeneity (e.g., Boxall and Adamowicz, 2002; Back-Jin et al., 2003; Greene and Hensher, 2003) and differences in decision making processes (e.g. Hess et al., 2012).

In this paper, we examine heterogeneity and context dependency in the context of regret-based choice models. The model accounts for conditions of uncertainty and the analysis aims at the probabilistic assignment of respondents to latent classes, which differ in terms of their regret functions and observed and non-observed personal characteristics, dependent upon choice context. Particularly, we analyse whether travellers anticipate varying degrees of regret associated with their route choice decisions, dependent upon the activity that is involved and their relationship with the people with whom they conduct the activity.

In the remainder of this paper, we first derive the formulated random regret-minimizing model. Next, the data collection process and sample characteristics, including the details of the stated choice experiment that was administered to investigate the choice problem of interest are reported. This is followed by a discussion of the results of the estimated regret-minimizing latent class model. Both the estimated coefficients of the regret function and the class membership function are discussed. The paper is completed with discussion of main conclusions. Due to the limited available page number, the discussion is necessarily relatively condensed.

2. The random regret minimization model

Consider the decision problem of individual n which route $i \in I$ to choose to conduct a particular activity at a particular destination. Because travel times of routes and, therefore, arrival times vary, this is a decision-making problem under uncertainty. Let X_i denote the arrival time of route i . $X_i > 0$ denotes early arrival times, while $X_i < 0$ represents late arrival times. Assume X is stochastic, formalized in terms of a set of discretized states $X_{i(j)}, j = 1, 2, \dots, J$. Each state represents an arrival time interval.

Regret has been introduced recently as a central concept in modeling choice behavior under uncertainty (Chorus et al., 2008a). Different operational definitions have been suggested (Chorus 2010; Chorus 2014; van Cranenburgh et

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