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Accounting for sensation seeking in route choice behavior with travel time information

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ABSTRACT

The purpose of this paper is to demonstrate that latent variables, with the focus on sensation seeking concepts, incorporated in new technique of route choice modeling, improve our analyzing of route choice behavior with pre-trip travel time information. The application of a hybrid discrete choice model framework integrates a latent variable model and a route choice model by combining their measurement and structural equations. The model is estimated based on data from a laboratory experiment and a field study of a simple network. The results show that certain sensation seeking domains (e.g., thrill and adventure seeking) alongside traditional variables (e.g., travel time information) enrich our understanding and provide more insight into route choice behavior. Furthermore, observed personal variables, such as gender and marital status, may serve as causal indicators to sensation seeking variables.

1. Introduction

Advanced traveler information systems (ATIS) or road traffic information (RTI), using pre-trip or en-route real-travel-time information, are rapidly penetrating all modes of transportation. These systems include various technologies and media, e.g., navigation systems with Global Positioning System (GPS), variable message signs (VMS), radio broadcasting, and are well recognized as an efficient mean to realize improved utilization of the transportation network by affecting travel and driver behavior. Drivers may respond to these systems and to the information provided through changing one's departure time, destination, speed, mode, activity, but most common by altering routes (Bekhor, Ben-Akiva & Ramming 2002; Bonsall, 2002; Emmerink, Nijkamp, Rietveld & Ommeren 1996; Kenyon & Lyons, 2007; Koski, 2002; Kwan, Dijst, & Schwanen, 2007; Wachs, 2002).

Drivers' route choice behavior, in particular given relevant road information, involves many aspects and various factors, e.g., behavior modeling, drivers' attitudes towards communication and technology and the systems reliability (Chen & Jovanis, 2005; Emmerink et al., 1996; Polydoropoulou, Ben-Akiva, & Kaysi, 1994). The ultimate route choice decision is inherently a multiple-objective, decision-making process. That is, many factors other than the conventional measurement variables (e.g., travel time and cost, distance) are involved and have a major impact on the driver's decision process (Abdel-Aty, Kitamura, & Jovanis, 1997; Jan, Horowitz, & Peng, 2000; Li, Guensler, & Ogle, 2005; Polydoropoulou et al., 1994; Srinivasan & Mahmassani, 2000). For example, Adler (2001) claimed that the benefits of having route guidance diminished when drivers became more familiar with the travel network. Bogers, Viti, and Hoogendoorn (2005) and Ben-Elia, Erev,

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and Shiftan (2008) constructed simulation experiments to explore the influence of information, learning and habit on choices between two routes.

The several factors affecting route choice behavior are traditionally dealt with by incorporating appropriate variables and complex error structures in random utility models (RUM) (Chorus et al., 2007; Katsikopulos, Duse-Anthony, Fisher, & Duffy, 2002; Prashker & Bekhor, 2004; Prato, 2009). One of the updated established methods is the hybrid choice model, which integrates many types of discrete choice modeling methods (Ben-Akiva et al., 2002; Walker, 2001) to account for both latent and observed variables. Latent features such as habits, familiarity and available information and their impact on route choice were presented in Papinski, Scott, and Doherty (2009) and in Kaplan and Prato (2012), who also discussed the gap between the behavioral paradigm of choice set formation and its representation in route choice modeling. The latent variables were used in the choice set generation phase by revealing constraint thresholds from considered choice sets. Recently, Prato, Bekhor, and Pronello (2012) illustrated a hybrid choice model which integrates latent variables in route choice models and consists of measurement and structural equations. Measurement equations relate latent variables to measurement indicators and utilities to choice indicators. Structural equations relate travelers' characteristics to latent variables and observable route attributes as well as unobservable latent variables to utilities. Their results illustrate that considering latent variables (e.g., memory, habit, familiarity, spatial ability, time saving skills) alongside traditional variables (e.g., travel time, distance, and congestion level) provides insight into and enriches the comprehension of route choice behavior.

A broad array of disciplines (e.g., psychology, economics, marketing, transportation engineering) has shown a general interest in enhancing discrete choice models by considering the incorporation of psychological factors affecting decision making (Ben-Akiva et al., 2002). In this regard, interesting is the notion of sensation seeking, which is commonly used in behavioral science. Sensation seeking is defined as "the need for varied, novel, and complex situations and experiences, and the willingness to take physical and social risks for the sake of such experiences" (Zuckerman, 1994). Sensation seeking also expresses a tendency to maintain current or previous decisions. This is generally represented by travel habit and inertia which explain a significant part of the undertaken trip pattern (Bogers et al., 2005; Golledge, 2001, chap. 3; Mahmassani & Jou, 2000; Srinivasan & Mahmassani, 2000).

Sensation seeking, especially one of its four classic domain formulation – Thrill and Adventure Seeking (TAS) – which reflects sensation seeking in the area of sports and physical activities, was found in numerous studies to be positively related to reckless and risky driving behavior (Dahlen, Martin, Ragan, & Kuhlman, 2005; Jonah, Theissen, & Au-Yeung, 2001; Prato, Toledo, Lotan, and Taubman Ben Ari (2010); Roberti, 2004; Schwebel, Severson, Ball, & Rizzo, 2006; Zuckerman & Neeb, 1980).

Literature shows few attempts to incorporate sensation seeking in route choice behavior. Albert, Toledo, and Ben-Zion (2011) found that individuals who scored higher on the TAS tend to switch their routes more frequently. They also pointed out another domain of sensation seeking – Boredom Susceptibility (BS) – which represents intolerance for repetition and routine of any kind. Individuals who scored higher on the BS were likely to switch their routes more frequently and chose a bypass route more often. Shiftan, Bekhor, and Albert (2011) did not find TAS nor BS to have a significant impact on route choice behavior but indicated that a third domain of sensation seeking – Experience Seeking (ES) – in the sensory and cognitive domain, plays a role in route choice behavior; for individuals with more experience seeking (who prefer new experiences), the probability of using a route with smaller travel time variance decreases. When experience seeking increases (that is, individual prefer new experiences) an individual tends to choose a riskier route in terms of greater travel time variance. While not exhaustive, both studies, which used the traditional types of RUM models, clearly suggest that more attention should be paid on addressing the role of sensation seeking in route choice behavior.

The contributions of the present paper are twofold: the first is further improvement of the line of research reflecting new generation of models of route choice behavior following the hybrid discrete choice model methodology as described in details in Prato et al. (2012). The approach presented here consolidating the hybrid choice model's use and applicability. The second is the introduction of new concepts of latent variables which reflect domains of sensation seeking. According to our hypothesis, these variables play an important role in understanding route choice behavior with pre-trip travel time information. The paper aims to demonstrate that sensation seeking concepts, incorporated in new techniques of route choice modeling, will significantly improve our understanding of route choice behavior with pre-trip travel time information. Furthermore, observed socio-economic and personal characteristics, such as gender and age, may serve as causal indicators to sensation seeking variables (e.g., age is known as negatively related to TAS). These causal indicators not only may improve model fit and add insights into the analysis, but also could be used for route choice predictions.

The rest of the paper is organized as follows: Section 2 presents the data collection and describes the experiment. Section 3 described the framework and insights of the proposed route choice model. Section 4 presents the estimation of route choice models. Section 5 presents the discussion and conclusions.

2. Data collection

The methodology for collecting the data is explained in details in Shiftan et al. (2011) and is briefly outlined here. The data set included two elements: a route choice assignment and a questionnaire which aims to identify observed and latent variables that influenced individual's behavior in the route choice assignment.