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Uncertainty Aversion and Its Role in Travel Decision Making Under Uncertainty

Zheng Li, School of Logistics and Trade, Xi'an Eurasia University, Xi'an, China

ABSTRACT

Travel time variability is a random phenomenon, and within the presence of it, uncertainty is associated with decision making. When a choice is made in an uncertain situation, the probability distribution is based on the subjective judgments of a decision maker. This paper introduces a psychological perspective to the concept of travel time variability, by embedding a belief-based weighting, so as to better understand decision making under uncertainty. This research argues that a subjective probability approach accounting for degrees of belief should be addressed in order to capture the impact of travel time variability on decision making. Using a simulated choice data set, the author provides an example of modelling uncertainty aversion, and illustrate its impacts on model performance.

KEYWORDS

Degrees of Belief, Subjective Probability, Travel Time Variability, Uncertainty Aversion

INTRODUCTION

Unavoidable fluctuations in travel demand and supply lead to travel time variability. Travel time variability has a significant impact on travellers' decision making, and even the values of travel time savings (see e.g., Small et al., 1999; Bates et al., 2001; Bhat and Sardesai, 2006; Hollander, 2006; Asensio and Matas, 2008). One of the significant milestones is the incorporation of Expect Utility Theory (EUT) into the representation of travel time variability, known as Maximum Expected Utility (MEU) (Noland and Small, 1995), which involves a choice process in which the alternative with the highest value of expected utility is preferred. Since Noland and Small's seminal paper in 1995, this has become the standard approach in travel time reliability studies (see Li et al., 2010; Carrion and Levinson, 2012 for detailed literature review).

Travel time variability leads to uncertainty during the decision-making process. The aim of this paper is to introduce an additional perspective to the concept of travel time variability, by embedding a belief-based weighting. Unlike decision making under risk with a known probability distribution of possible outcomes, when decision making occurs in an uncertain situation, the probability distribution is based on the subjective judgments of decision makers (e.g., the perceived chance of arriving early, on time and late for a commuter).

This paper is organised as follows. The next section provides a brief review and some comments on existing travel time variability studies. This is followed by the introduction of alternative theories and their limitations in understanding decision making under uncertainty. Then, the model which

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addresses uncertainty aversion is presented, as well as the results based on a simulated choice data set. The final section highlights the key findings and conclusions of this study.

SOME COMMENTS ON PREVIOUS TRAVEL TIME VARIABILITY STUDIES

This progress of MEU has led to changes the specification of a utility function that incorporates travel time variability, and also leads to significant innovations in the way that stated choice (SC) experiments have to be designed to capture travel time variability. In recognition that travel time does vary, a series of arrival times, rather than the extent and frequency of delay, have been considered in recent SC experiments (see, e.g., Senna, 1994; Noland and Small, 1995; Small et al., 1999; Hollander, 2006; Asensio and Matas, 2008; Batley and Ibáñez, 2009). However, in stated preference studies not established on RUM, travel time variability is typically presented as the extent and frequency of delay relative to 'normal' travel time (see e.g., Jackson and Jucker, 1982; Small et al., 2005).

In terms of the modelling framework, the mean-variance model and the scheduling model are two dominant approaches in the transport literature; while most stated preference (SP) experiments are similar to Small et al. (1999) (see Table 1) with some slight changes (e.g., some used vertical bars to represent travel times (e.g., Batley & Ibáñez, 2009); some provided 10 travel times instead of five (see e.g., Bates et al. 2001; and some show the departure time explicitly to the respondents (e.g., Holland, 2006). The behavioural paradigm widely used in the MEU model is a mix of Random Utility Maximisation (RUM) and Expected Utility Theory (EUT) (i.e., a linear utility specification with linear probability weighting).

The first (and probably the most crucial) comment on previous travel time variability studies is that the stated choice (SC) experiments cannot fully (or adequately) address the concept of travel time variability. The experiment proposed by Small et al. for example, is a prototype for travel time reliability studies established in an MEU framework as adopted by Bates et al. (2001), Hollander (2006), and Asensio and Matas (2008). The design attributes in this type experiment usually are mean travel time, travel cost, departure time shift, and standard deviation of travel time, while the attributes shown to respondents are a mean travel time, travel cost, and a number of arrival scenarios (early, late or on time) with respect to the preferred arrival time.

One significant limitation of previous travel time variability studies is the lack of a parametric treatment of attitudes, unlike behavioural/experimental economics studies that have statistically estimated the attitude parameter under different functional forms (e.g., Tversky and Kahneman (1992)

Table 1. A choice example from Small et al. (1999)

Please Circle Either Choice A or Choice B	
Average Travel Time **9 minutes**	Average Travel Time **9 minutes**
You have an equal chance of arriving at any of the following times:	You have an equal chance of arriving at any of the following times:
7 minutes early	**3 minutes early**
4 minutes early	**3 minutes early**
1 minute early	**2 minute early**
5 minutes late	**2 minutes early**
9 minutes late	**On time**
Your cost **$ 0.25**	Your cost **$ 1.50**
Choice A	**Choice B**

R&D Productivity in the Pharmaceutical Industry: Scenario Simulations Using a Bayesian Belief Network
F.W. (Ward) van Vierssen Trip, Nam C. Nguyen and Ockie J.H. Bosch (2015). *International Journal of Strategic Decision Sciences (pp. 1-16).*
www.igi-global.com/article/rd-productivity-in-the-pharmaceutical-industry/124770?camid=4v1a

Decision Support for Crisis Incidents
Daniel J. Power, Roberta M. Roth and Rex Karsten (2011). *International Journal of Decision Support System Technology (pp. 44-56).*
www.igi-global.com/article/decision-support-crisis-incidents/53815?camid=4v1a