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THE EFFECT OF TIME PRESSURE ON TRAVELLERS' ACTIVITY-TRAVEL DECISION-MAKING

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ABSTRACT

Although it is widely acknowledged that time pressure is often present when travellers make sometimes very complex choices between competing sequences of activity-travel patterns, no formal model exists that is able to take into account the possible impacts of time pressure on traveller decision-making. This paper aims at integrating the notion of time pressure in discrete travel choice models, by means of introducing an additional error component into the conventional Random Utility Maximization-formulation of discrete travel choice behaviour. This additional error component can be interpreted as a proxy for the noise a traveller encounters to 'compute' utilities for the travel options in his or her choice set. Theoretical analyses are presented to illustrate model properties and to gain insight into how the model predicts that time pressure may affect the (outcomes of) discrete travel choice processes. A synthetic dataset is created to test the model.

KEYWORDS

Time pressure, travel choice, utility noise, random utility, discrete choice

INTRODUCTION

It usually takes cognitive process (therefore, time) for a traveler to make his or her decision on which competing isolated mobility options (like routes) to take, given that he or she doesn't always habitually execute the travel. The cognitive burden (time required to reach a decision) may be expected even higher for a traveller to make sequences of mobility and activity choices for their daily activity-travel agenda, provided a same decision strategy is applied (Shugan, 1980). However, in many cases a traveller may face with a tight time budget to reach his or her decision, and the opportunity cost of not reaching one in due time could be high (Payne and Bettman, 1996). For example, a missed train due to too long a decision time could mean 20 minutes of extra waiting, and thus a strict starting time of the next activity could also be missed. As such, if a traveller is constrained with a time budget to make a decision, we could well argue that at least in the context of multi-modal, multi-activity decision-making, time pressure can exert impacts on him or her, especially when part of the decision-making takes place during the trip. Then it is becoming important to carefully examine these impacts of time pressure in this context.

The majority of studies devoted to time pressure belong to the fields of psychology and consumer research. One branch of literature is mainly concerned with risky choices under time pressure, for example exploring the impact of time pressure on levels of risk aversion (Ben Zur and Breznitz, 1981, Maule et al., 2000, Rothstein, 1986, Busemeyer and Townsend, 1993). Another branch focuses on changes in decision strategies as a result of time pressure. Based on data from choice experiments, these studies have reported a negative effect of time pressure on decision making effectiveness; the pattern of results obtained is mostly homogeneous and consistent across various studies (Ariely and Zakay, 2001).

However, if we try to make an operationalized model to quantitatively study the effects of time pressure according to these observations, we may inevitably incorporate many thresholds in the model so that the specific mechanism of the strategy switching can be captured. As a result, this type of models could become quite complex. Therefore, we propose a simpler model that is based on the conventional random utility maximization paradigm yet allows for the study of the effects of time pressure in a travel-activity decision context, as such facilitates a straightforward extension of existing RUM-based models when the consideration of time pressure is added. The remainder of the paper is organized as follows: the theoretical structure of the model and its properties are presented first. Then the model is tested by using a set of synthetic choice-data. Finally, conclusions are drawn, and recommendations for further research efforts are suggested.

MODEL STRUCTURE

Extension of Random Utility Maximization (RUM) Formulation

The source of the random components of RUM-models traces back to the dichotomy between the notion that human behaviours are inherently probabilistic and the notion that researchers are unable to measure all the factors influencing human behaviour (Ben-Akiva and Lerman, 1985). (Luce and Suppes, 1965) then distinguish between the two notions to the introduction of constant utility approach and random utility approach. The model derived in (Luce, 1959) is a typical example of constant utility models, while (Manski, 1977) formalizes the random utility approach. If we intend to study time pressure in the direction of constant utility models, it may contradict to our intuition about time pressure. A traveller under time pressure may be expected to randomly overvalue or undervalue his or her utility irrelevant to the travel alternatives, as such that suggests the importance of randomness of utility. Therefore, it looks that the notion of random utility approach is more suitable.

Mcfadden further develops the random utility models (Mcfadden, 1973) and they have certainly gained much of popularity ever since. The modern notation of what Mcfadden has interpreted the components of utility function is shown below (Mcfadden, 1973):

$$U_{ni} = V_{ni} + \varepsilon_{ni}$$

n : an individual person n

i : alternative i

U_{ni} : utility an individual n feels

V_{ni} : one nonstochastic part of utility that reflects the representative taste of the population

ε_{ni} : another stochastic part of utility that reflects the ideosyncrasies of the individual taste

It seems that (Mcfadden, 1973) interpreted the error component in the utility function as exclusively concerned with the individual person himself, which is derived from individual person's perspective. However, (Manski, 1973) has also identified four distinctive sources of the random component, including unobserved attributes, unobserved taste variations, messurement errors and imperfect information, and instrumental (or proxy) variables, which are derived from an observer's perspective. No matter which interpretation is used, it could be safe to say that for any individual n, the utility U_{ni} here is deterministic to him or her.

What we are trying to enrich is based on that the very nature of time pressure (that is a traveler is expected unconscientiously aware of the effect of time pressure on their formulation of utility) may deviate his or her original utility U_{ni}. We could well argue that the real utility becomes no longer deterministic but stochastic to the individual n and is deemed to be the aggregate of the original utility U_{ni} and the effect of time pressure (,which is called utility noise here). Therefore, we introduce into utility formulation another error term as a proxy of this noise that person may implicitly encounter. This additional error term makes utility noisy from an individual's standpoint. It has a certain link with risky decision-making (where the utility is risky due to e.g. travel time riskiness, leading to expected utility maximization). Those risks are mainly concerned with the uncertainties of some particular independent variables (e.g. travel time, travel cost). However, our riskiness here is referred to the inability (or ability) of an individual to 'compute' a measure of utility under time pressure. The formulation of the new utility function is shown below:

$$U_{ni} = V_{ni} + \varepsilon_{ni} + \gamma_n$$

γ_n : noise

This formulation shows that the noise term is only concerned with individual n and irrelevant to alternatives. We should be able to suspect that this noise could have a certain distribution with a mean of zero, and that the duration of time for decision could sustain a negative relationship with the variance of the distribution. That is when the duration of time becomes close to zero, the variance would tend to be infinitely large, so that a traveler would make random choice, and when the duration becomes large enough, the variance would tend to be zero, so that the effect of the noise would approach zero and the model would collapse to a normal random utility one without the consideration of time pressure.

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