MODELLING LEARNING AND DYNAMIC ROUTE AND PARKING CHOICE BEHAVIOUR UNDER UNCERTAINTY: A REGRET-BASED PERSPECTIVE

ABSTRACT

Travel decisions in real life are embedded in uncertainty. From route finding to the occupancy levels of public transit, travellers are faced with a constantly changing environment, which is only partially predictable. The very same decision, made at different moments in time, may lead to different outcomes. Good decision-making in such an environment requires individuals to learn from their own experiences and also from external information they may have access to. This accumulated knowledge can be used to anticipate the future states of the world, and hence it allows individuals to choose such as to avoid unfavourable outcomes and the negative emotions possibly associated with them. Such is the case of regret, which arises when a foregone alternative is perceived as having a higher payoff than the chosen one, and which theory (Bell, 1982; Loomes and Sugden, 1982) is built upon the notion that individuals anticipate, previous to the choice, the future emotional reactions to decision outcomes, and choose the alternative that (they believe) will minimize the possibility of negative emotions.

Regardless of the relevance of understanding and predicting travel behaviour under uncertainty, models of decision-making under uncertainty are still relatively scarce in travel behaviour research (Rasouli and Timmermans, 2014). More specifically, when it comes to regret-based models, there is still much room for exploration. Despite the rapid increase in the number of regret-based models of travel behaviour after its introduction in transportation research (Chorus et al., 2008), most applications have been concerned with static and certain contexts, comprising one-shot decisions and assuming travellers hold perfect and complete knowledge of the alternatives' attributes. Exceptions include Ben-Elia et al. (2013) and Chorus (2014). The first explores the effects of regret on route choice behavior when travel times are variable, both when travelers are provided with pre-trip descriptive information on route performance, and when they receive post-trip experiential feedbacks on choice (and in this case also learn via reinforcement). The second study proposes a model of acquisition of ex-post travel information regarding foregone alternatives in a context of repeated choices, to capture the trade-off between ignoring information and avoiding regret relative to the decision taken, and deciding to acquire information to be able to learn from it and therefore prevent regret in future decisions.

In this study, we develop a random regret-based dynamic model of route and parking choice behaviour, incorporating the learning of random attributes (namely travel and parking times) via repeated choices. The model represents daily commuter trips by drivers who have to choose between two routes, each of them giving access to a different pool of (two) parking areas, from which drivers also have to choose. In total drivers are faced with four alternatives, each of them being a combination of route and parking.

The proposed framework models choice behaviour assuming that drivers had never used any of the four options available, and that they learn the attributes travel time and parking time (i.e., their distributions of probabilities) exclusively from their own experience – although the model accommodates the acquisition of initial information previous to the first choice. Following every decision, drivers acknowledge the realizations of travel and parking times for the chosen option,

and update their subjective beliefs regarding the (continuous) distributions of probabilities for the corresponding route and parking area – characterizing the process of learning, which is modelled through Bayesian belief updating. Drivers are assumed to mentally compare the most updated versions of their subjective distributions of travel times, and to do the same for the parking times, giving rise to the anticipation of regret (that they believe could be felt after choosing) in an attribute-by-attribute basis for all four alternatives. Their decision is then driven by their wish to minimize regret, and individuals are assumed to choose the combination of route and parking with the lowest anticipated regret. After the new choice is made, drivers once again acknowledge its outcomes and update their beliefs, characterizing the dynamics of the model.

In order to validate the model, a stated-choice experiment was created to collect empirical data, in a context of daily commuter trips as described in the two previous paragraphs. The travel and parking times faced by respondents in the experiment were drawn from lognormally distributed density functions (six in total), which were selected in a way to allow competition between the two routes, between the two parking areas from a same pool, and between the two combinations of route and parking pool. They were, for travel times: ~ LN (3.43, 0.02) for Route A and ~ LN (3.37, 0.12) for Route B – generating a set of travel times with mean and standard deviation equal to 31 and 0.64 for Route A, and equal to 29.28 and 3.45 for Route B. The density functions adopted for the parking areas of Pool 1 were: ~ LN (0.90, 0.14) and ~ LN (0.32, 0.87) – generating a set of parking times with mean and standard deviation equal to 2.44 and 0.50 for the first area, and equal to 1.78 and 1.50 for the other. For the parking areas in Pool 2 the densities were: ~ LN (1.50, 0.09) and ~ LN (1.32, 0.31) – generating a set of parking times with mean and standard deviation equal to 4.46 and 0.50 for the first area, and equal to 3.88 and 1.19 for the second. The six sets of travel and parking times were uncorrelated and unique across the experiment. Half of the experimental profiles had Route A connected to Pool 1, and Route B connected to Pool 2. For the other half, the combination was inverted. Initial information about travel and parking times was provided to respondents in order to give them an impression of the distributions (and also a starting point for their learning process), but in any way to replace the role of their own experience. For parking times, the same information was used in all profiles, while for travel times the initial information had two levels: half of the sample was informed travel times were on average 30 minutes, but changes in traffic could make the trip up to 5 minutes shorter or longer; the other half was also informed travel times were on average 30 minutes, but the influence of traffic would make their trip up to 10 (instead of 5) minutes shorter or longer. Regarding the realizations of travel and parking times after every choice, half of the experimental profiles showed only the outcomes of the chosen option, while the other half also showed the outcomes of the option with the lowest total time that day (in case such option was not the chosen one) – being the total time the summation of travel and parking time. In total 8 profiles were created, to which 396 respondents were randomly assigned. Each respondent was assigned to only one profile, and performed 50 sequential choices.

The proposed model explores the interplay between learning, anticipating regret and choosing, besides comparing the effects of anticipated and realized regret, and analysing the impact of the initial information provided.

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