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主 論 文 の 要 旨

論 文 題 目: Two-Stage Discrete Choice Models for Numerous Alternatives in Travel Decision Contexts
選択肢が多い交通行動意思決定における二段階離散選択モデルに関する研究

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論 文 内 容 の 要 旨

Choice behavior analysis is an important research area in transportation research filed. It would help researchers to understand how decision-makers makes decisions, the preference on each alternative's attribute. The prediction of future situation would be done by the current choice analysis, and it would be helpful in many areas, such as helping government to design policy to improve the traffic situation.

Discrete choice models are always applied in the choice behavior analysis in the transportation area. During the model estimation process, we assume decision-makers choosing from a choice set. In other word, decision-makers will evaluate all alternatives in the choice set and then make a choice. However, there is an issue in the choice behavior in transportation area is that the number of available alternatives is always huge. For example, in route choice context, the possible routes from an origin to a destination would be hard to be counted if the road network is dense and the distance is long. Therefore, it is not reasonable to make the assumption that decision-makers will evaluate all alternatives in the choice set to make a decision.

In this study, we assume the decision-maker will firstly screen all alternatives in the choice set and include qualified alternatives into a new choice set called the consideration set, then choose the choice alternative from the consideration set. This is call two-stage choice including consideration set formation stage and choice making stage. However, researchers always do not have the information about decision-makers' consideration set and only have the observed choices information. Therefore, the two-stage choice model should be estimated with only the observed choice information.

The objective of this study is applying the two-stage choice context in the transportation choice analysis. Models with different mechanisms will be assigned to different choice behaviors. The difference between two-stage model and models with only choice-making stage will be compared.

In Chapter 1, we give a brief introduction of the choice behaviors in transportation research area and introduce some basic choice models. The research objective is given and the outline of this dissertation is also presented.

In Chapter 2, a probabilistic choice set (PCS) model is applied to route choice analysis. Route choice behavior is treated as a two-stage process consisting of a choice set generation stage and a choice making stage. In the choice set generation stage, drivers include the routes that satisfy their spatiotemporal constraints into an individual choice set from which an actual route is selected in the following stage. In the choice making stage, drivers choose the route with maximal utility. The data used in this research is 2011 probe vehicle data collected in Toyota city, Japan. This data gives information about drivers' choices in the choice making stage, but lacks any information about the choice set generation stage. In carrying out the computation, models for both stages are estimated simultaneously based on only drivers' choice information. The estimation results demonstrate that the PCS model performs well compared with the multinomial logit (MNL) model, a result that also indicates the validity of viewing route choice behavior as a two-stage process.

In Chapter 3, we modeled the vehicle purchasing behavior as a two-stage choice process. In the first stage, a household specific consideration set is drawn from the all possible vehicles, and then a discrete choice model is applied to model the final choice based on consideration sets. The hazard-based choice set formation model is utilized in the first stage, and the accepting probability for each vehicle to be considered by each household is decided by the vehicle's price, vehicle's fuel cost and household's socioeconomic attributes. Then, the consideration set for each household is randomly drawn according to each vehicle's accepting probability, and vehicle with higher probability will have bigger chance to be included into the consideration set. Then, a multinomial logit (MNL) model is applied to the final selection step with the consideration sets. In order to investigate the advantage of using consideration set as choice set, MNL models with the universal set which includes all possible vehicles, and a pseudo-random

selected choice set for each household are also estimated separately. Estimation results indicate the priority of using consideration set in vehicle purchasing behavior analysis.

In Chapter 4, we try to estimate the two-stage choice model in a Bayes approach with the same data in Chapter 3. The applied Hierarchical Bayes model can avoid the issue of an indifferentiable and irregular likelihood surface caused by thresholds and discontinuities, and the data augmentation and Markov-chain Monte Carlo estimation methods make it possible to estimate two stages simultaneously using only the information about the consumers' actual choices. We tried different screening rules and then compare the average consideration set size to find out the best one. And then, we also compare choice models in both Chapter 3 and Chapter 4 in constructing the consideration set and prediction accuracy. The result indicate that Bayes model with a good screening rule is better the model in Chapter 2. Finally, we analyze the consumers' behavior under different choice scenarios. If the consumer is intend to buy the first and only vehicle, the compact vehicle, sedan, wagon and SUV are preferred comparing to the consumer who intends to buy an additional vehicles.

In Chapter 5, a conclusion is presented. The two-stage choice model shows the advantage in choice with many possible alternatives in the transportation research area. The biggest difficulty in two-stage choice estimation is in modelling the consideration set formation process, due to the lack of information and the limit of the estimation method. Therefore, in the future, in one hand, it is better to try different estimation methods with the limit information; in the other hand, it is meaningful to compare the consideration set generated by models and the real consideration sets from decision-makers if applicable.