土木学会第45回年次学術講演会（平成２年９月）

IV-204 TEMPORAL TRANSFERABILITY AND UPDATING OF A DISAGGREGATE MODEL SYSTEM FOR THE METROPOLITAN TRAVEL DEMAND FORECASTING

Nagoya Univ. Student Member Liang SU
Nagoya Univ. Regular Member Shogo KAWAKAMI
Nagoya Univ. Student Member Young Suk BAE

1. INTRODUCTION

What could be said to be a major innovation in the past 20 years for the analysis of transportation demand was the development of disaggregate travel demand models based on discrete choice analysis methods. One reason is that a model may be transferred to an entirely different scenario (characterized by a different distribution of the vector of attributes) without recalibration. As an important application of disaggregate models, Kawakami et al[1],[2] proposed a model system for metropolitan areas, which considers two groups of individuals--workers and non-workers--in one system and treats the first three steps of the four-step procedure (traffic generation, traffic distribution, travel mode choice and traffic assignment) for travel demand forecasting, but it is still necessary to analyze the transferability of the model system. Thus, this study is to test the temporal transferability of the model system built by Kawakami et al and to investigate how to update it if it is not transferable.

2. DESCRIPTION OF THE DISAGGREGATE MODEL SYSTEM

In the studies by Kawakami et al, by using the nested logit model, the system incorporated trip generation-type choice (going back home or having a trip of other kinds of trips), trip purpose choice (business or non-business), trip destination choice, travel mode choice, and base choice (returning to work place or home) in the sub-system of workers. In the sub-system of non-workers, trip generation choice, destination choice and mode choice for home-based trips, and trip generation-type choice (carrying on traveling or going back home) and destination choice for non-home-based trips, were calibrated. In the system, a tour is defined as consisting of all trips between any two bases where the base means home or work place. Then in terms of the utility maximization theory, the assumption was made as: a traveler maximizes the travel utility by each trip in a tour, conditional on the trips which have been made in the past and by considering trip chain going to return to his(her) base, which consists of L trips at most. According to the analysis on the person's trip survey of 1981 in the Nagoya metropolitan area, L was taken as 2 for non-workers and 1 for workers, meanwhile the traveler was thought of not changing the mode (car or transit) in one tour.

3. THE METHODOLOGY OF TRANSFERABILITY STUDIES

For a model system, the transferability can be defined at the three levels: a). parameter level--transfer the model system without any change; b). variable level--transfer the model system with the re-estimation of all coefficients, based on the new data, for the old explanatory variables; c). structure level--transfer the model system with the new estimation of all coefficients for the updated variable groups, but without changing of the structure of the travel decision-making tree.

(1) Test of model parameter equality: $t_i=(\theta_{Ai}-\theta_{Bi})/\sqrt{[Var(\theta_{Ai})+Var(\theta_{Bi})]}$ (1)

(2) Disaggregate measures of transferability:

a). Transferability Test Statistic (TTS): $TTS_A(\theta_B)=-2[L_A(\theta_B)-L_A(\theta_A)]$ (2)

b). Transfer Index (TI): $TI_A(\theta_B)=[L_A(\theta_B)-L_A(MS_A)]/[L_A(\theta_A)-L_A(MS_A)]$ (3)

c). Transfer rho-square: $\rho_A^2(\theta_B)=1-L_A(\theta_B)/L_A(MS_A)$ (4)

(3) Aggregate measures of transferability:

a). Root Mean Square Error: $RMSE=(\sum_{m,g}\bar{N}_{mg}REM_{mg}^2/\sum_{m,g}\bar{N}_{mg})^{1/2}$ (5)

b). Relative Aggregate Transfer Error: $RATE=RMSE_A(\theta_B)/RMSE_A(\theta_A)$ (6)

c). Aggregate Prediction Statistic: $APS=\sum_{m,g}\bar{N}_{mg}REM_{mg}^2=\sum_{m,g}(\bar{N}_{mg}-N_{mg})^2/\bar{N}_{mg}$ (7)

where θ_i means the ith parameter, A and B denote the new and old context, respectively. $L_A(\theta_B)$ is the logarithm of the likelihood, which uses the observed data in A, were generated by the model estimated in B; MS means a market share model, in which only alternative-specific constants are taken as the explanatory variable. If letting $\bar{N}_{mg}$ and N_{mg} are the number of persons, predicted and observed respectively, to choose alternative m from group g, then the relative error measure $REM_{mg}=(\bar{N}_{mg}-N_{mg})/\bar{N}_{mg}$.

4. EMPIRICAL RESULTS AND CONCLUSIONS

In this study, to investigate the temporal transferability of the disaggregate model system for the metropolitan travel demand analysis proposed by Kawakami et al., the model system is firstly tested by the person's trip survey of 1971 since the original model system was built upon the 1981's data. As the re-estimations for both workers and non-workers without updating could not be completely carried out, an analysis on the actual state in 1971 was conducted. Consequently, the updating for the model system was completed by using the 1971's data. Then the updated model system were reversely tested on the basis of the 1981's data. As the results, the conclusions can be summarized as follows:

1). For a model system, the transferability can be defined at the three levels: (a). parameter level; (b). variable level; (c). structure level.

2). For evaluating the temporal transferability of a model system, if the model system can not be appropriately re-estimated without updating, by using the data of the application context, the model system can be concluded that it is not transferable as a whole.

3). Being different from a single model, a model system has accumulative errors. At the lower levels, the models may be transferable since the errors are so small that they may be ignored, but they will spread to the upper levels. As the results, the models at the upper levels may become not being transferable. Same thing may also happen to a model for the different levels (parameter level, disaggregate level and aggregate level), for example, the small errors at the parameter level affect the disaggregate level and become a big error which can not be ignored as the result.

4). The sub-system for workers is transferable at the structure level, and the mode choice model and the purpose choice model are transferable at the variable level. This may be caused by that the analyses have not been made in detail, for example, the different explanatory variables should be chosen for the business purpose trips and the non-business purpose trips, respectively, but they had not been carried out for every model. Thus, this can also be stated as the further study to be demanded.

5). The sub-system for non-workers is transferable from 1971 to 1981 at the variable level and partially transferable at the parameter level, in case of from 1981 to 1971, it could not be judged because there was no enough data in 1971 to finish the re-estimation of the sub-system obtained on the basis of the 1981's data. As the reasons of that the sub-system is not transferable at the parameter level, it can be stated that the number of trips in one tour made by non-workers was assumed as 1 in 1971, but in fact it should be taken as 2 for the home-based trips and 1 for the non-home-based trips in 1981. Thus, it is suggested to rebuild the sub-system based on the 1981's data by assuming L as 2 for home-based-trips and 1 for non-home-based-trips and then to investigate its transferability in terms of the data by which the sub-system can be completely re-estimated.

ACKNOWLEDGMENTS The authors are pleased to acknowledge Associate Prof. Y.Hayashi and Dr. T.Isobe for the valuable advice extended.

REFERENCES

1) Kawakami,S., Y.Hirobata, Y.S.Bae, and H.Nakajima: A model system for non-worker's daily travel demand based on disaggregate behavioral model, The 5th World Conference on Transport Research, Yokohama,1989.
2) Kawakami,S., Y.Hirobata, Y.S.Bae, and H.Nakajima: A model system of worker's daily travel demand using disaggregate behavioral model, The 11th Pacific Regional Science Conference, Singapore, 1989.
3) Koppelman,F.S. and Wilmot,C.G.: Transferability analysis of disaggregate choice models, Transportation Research Record 895, pp.18-23, 1982.