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Mode Choice In Interregional Occupational Person Trips

Syo Myojin*, Keiichi Kishino** and Masahito Yamada*

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SYNOPSIS

The paper is a case study mode choice in interregional occupational person trips. Disagregate behavioral model of logit type is applied to the occupational person trips from Tsuyama area in Okayama Prefecture to Osaka area. The model turned out to give asignificant explanation of the interregional mode choice characteristics. Travel time, travelling expenses and " with or without heavy baggage " were found to be significant.

1. INTRODUCTION

Two matters are concerned with in the paper as follows ; one is to test an applicability of disaggregate behavioral model (logit type) to explain mode choice behaviors of those who make interregional occupationl trips and the other is to try to find a reasonable selections of the set of characteristics variables in the model. The latter is connected to estimating choice probability to new prospective mode that has not existed so far in the region under study.

Further and detailed comment is given on the latter, later in the third section, and the following is an explanatory comment on the former.

* Department of Civil Engineering

** Consulting Engineer, Chuo Fukken Consultants Co., Ltd.

Nearly ten years have passed since disaggregate behabioral model was adopted inthis country for analyzing transportation demand including mode choice. It, however, is also fact that most of the transportation researchers who resorted to the model have been intrested in the field of urban transportation [1]. And the model has turned out to be of good aplicability to the field. On the other hand, Morichi et al. [2] is one of a few exceptional cases in Japan that showed a significant applicability of the model (logit type) to mode choice in sight-seeing trips from Tokyo area to some other places. Further case studies are necessary to say something definite as to aplicability of disaggregate bihavioral model to various aspects of interregional transportation. that is one of the reasons why we apply the model to analyze the characteristics of some of interregional trips.

2. SURVEY

2.1 Study Area

A survey was carried out of interregional occupational person trips in Tsuyama area. Tsuyama area, lying in the north-eastern part of Okayama Pref., covers Tsuyama city with fourteen towns and villages arround it. Tsuyama city is 60 and 150 kirometers away from Okayama and Osaka city, respectively, and is nearly two hour's distance to Osaka city via express way which was opened to traffic between Suita in Osaka Pref. and Ochiai in Okayama Pref., in 1975. The opening of the express way brought remarkable industrialization together with the increase in population on Tsuyama area. In this sense, the area is often referred to as one of successful cases of regional development owing to express way service [3].

2.2 Survey

The survey was carried out by Tsuyama Air Commuter Promoting Meeting together with Okayama Institute of Economics [4]. The data used in this paper were obtained from among those surveyed by their permission. One of the key matters for the survey was interregional occupational person trips originating from Tsuyama area and terminating in other regions and vice virsa.

The survey was made on 954 establishments sampled from the whole number (9833) of those in Tsuyama area. Sample rate in the sence 9.4

percent. Questionaires by 23.6 percent of the sampled.

Detailed matters for survey on interregional occupational person trips were trip characteristics and socio-economic ones. Trip characteristics include:

Origin,
Destination,
Departure Time,
Mode,
With or Without Heavy Baggage,
The Number of Party Members
and The Number of Visits in Destination Area .

Socio-economic characteristics include:

Position of Trip Maker in Establishments,
Possetion of Drivers License
and Car Ownership in Household.

The survey covered those occupational trips that originated from the sampled establishments and terminated outside of the area for three days between November 18 and 20, 1986 and those vice versa in the same interval.

In this paper, however, only those trips that terminated in Osaka area are put into analysis.

2.3 Travel Mode

Two ways are available between Tsuyama area and the outside; road and rail. Interregional trunk road network consist of express way and four routes of national highways. Railway network has three lines, named Tsuyama, Kishin and Inbi lines.

Between Tsuyama area and Osaka area, which covers Osaka, Kyoto, Nara and Wakayama Prefectures, three modes are practically available as follows; express way driving, express way bus and rail by way of Tsuyama line connected with Sanyo-

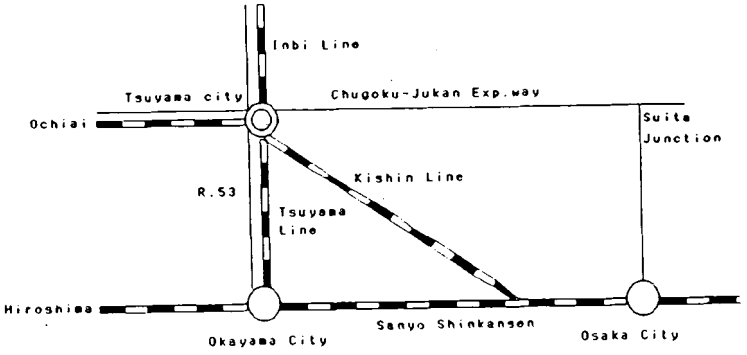

Fig.1 Principal Transportation Network between Tsuyama and Osaka

shinkansen at Okayama city. Indeed, other choices of modes are possible but these can be disregarded because the trip survey showed that these had only trivial percentage of choices. (Fig-1)

Table-1 Sets of Modes valid between Tsuyama and Osaka

Characteristics	Exp.way Driving	Exp.way Bus	Rail
Travel time(hr.)	2.5	3.0	2.3
Fare (YEN)	-	2,200	7,250
Exp.way toll(YEN)	3,100	-	-
Service Frequency (per hr.)	*	2	1

1) As of Oct.1986 2) -;none 3) *;thought of as so frequent

Three modes available between Tsuyama and Osaka areas are shown in Table-1.

3. MODEL APPLICATION

A pretty number of case studies by use of disaggregate behavioral model has been tried on urban transportation and some related aspects. One of the well known models is called logit type that is expressed by

$$P_{in} = \frac{\exp(V_{in})}{\sum_{j \in A_n} \exp(V_{jn})} \qquad (2)$$

where,

P_{in}: probability of n-th person to i-th choice

V_{in}: deterministic part of utility that n-th person gains from i-th choice

A_n: choice set to n-th person

It is well known that the logit model is drawn from two assumptions as follows [5]; an individual is a decision maker who picks up the one of maximum utility from among choices and the entire utility of i-th choice to n-th person is a random variable given by the sum of deterministic part of utility V_{in} above and random one that is assumed to follow Gumbel distribution.

Deterministic part is usually assumed as a function of the level-of-service variables and/or the other characteristics proper to choices. Choice probability P_{in} is culculated through specification of the function for deterministic part. It is, ofcourse, necessary to test the value of choice probability calculated to the one observed.

Now, let's back to the comment left unexplained previously on reasonable selection of the set of characteristics variables. As just

commented, this is connected with a problem to estimate choice probability to new prospective alternative that does not exist in the study area when the function for deterministic part of utility is specified.

By Morichi[6] two methods are expedient to this problem of new alternative. The first one is to divert the function, which had been specified in some other region that was similar to the region under study and had new alternative in question, to the study area. The second is to convert the parameters in the function specified for choices existing in the study area to calculation of choice probability to new alternative. The first is, as it were, a spatial transferability of the utility function. We, however, are not interested in the first method since we have no similar region.

Two procedures are drawn from the second method. One is to pick up the parameters to generic variables alone from among those specified for existing choices and to convert them. The other is to make the utility function specified by generic variables alone and to convert the parameters.

The former has a weak point, as is indicated, that specific variables to new alternative is disregarded. The latter is taken to have two disadvantages. One is that no alternative specific variable is taken into consideration even though it may have any contribution to utility. And the other is that each of the alternative specific variable is likely to have a superficial contribution deformed by being collected in any one of generic variables even though it may have its proper contribution to utility.

Under the existing circumstances we have no choice but to resort to any one of the two procedures in order to estimate choice probability to any prospective alternative. It is in this context that two models (sets of variables) are assumed as follows;

<MODEL1>

alternative specific variables;
- auto-fuel expense
- express way toll
- access to the nearest express way bus stop
- access to the nearest railway station
- the number of party members
- with or without heavy baggage

party generic variable;
- fare

generic variable;
travel time.

<MODEL2>

alternative specific variables;
the number of party members
with or without heavy baggage

generic variables;
travel time
travel expenses
access.

It is of course that the models were assumed after preliminary investigations.

The first fours of alternative specific variables in MODEL1 together with partly generic one (fare), are collected in two generic variables in MODEL2. That is, auto-fuel expense, express way toll and fare are collected in traveling expenses in MODEL2 and the two kinds of access in MODEL1 in access in MODEL2. Further the last twoes in the alternative specific variables in MODEL1 are left untouched, because the twoes are supposed to be specific to express way driving mode alone.

Model1 may have little applicability to the case of new

Table-2 Estimation

< MODEL 1 > Characteristic variables		θ	t-value
alternative specific valiables:			
auto-fuel expence	(YEN)	1.75×10^{-3}	2.40
Exp.way toll	(YEN)	-1.49×10^{-3}	-2.61
access to the nearest Exp.way bus stop(Km)		-6.62×10^{-2}	-0.76
access to the nearest railway station (Km)		-9.22×10^{-2}	-1.20
the number of party member (persons)		-6.06×10^{-1}	-2.14
with or without heavy baggage (1or0)		2.48	2.44
party generic valiable;			
fare	(YEN)	-3.57×10^{-4}	-2.81
generic variable:			
travel time	(min.)	-2.28×10^{-2}	-3.53
Hit ratio (Sample size)	Exp.way driving	80.0% (90)	
	Exp.way bus	52.6% (57)	
	Rail	36.4% (33)	
	over all	63.3% (180)	
$\overline{\rho^2}$-value		0.24	

< MODEL 2 > Characteristic variables		θ	t-value
alternative specific valiables;			
the number of party member (persons)		-1.07×10^{-1}	-0.54
with or without heavy baggage (1or0)		3.52	2.38
generic variable;			
travel time	(min.)	-1.19×10^{-2}	-2.44
travel expense	(YEN)	-3.12×10^{-4}	-3.05
access	(Km)	7.80×10^{-3}	0.10
Hit ratio (Sample size)	Exp.way driving	72.2% (90)	
	Exp.way bus	49.1% (57)	
	Rail	36.4% (33)	
	over all	58.3% (180)	
$\overline{\rho^2}$-value		0.22	

alternative to come because it includes only one generic variable with many nongeneric ones, while MODEL2 may have better applicability through collection of variables. One of the additional interests is in the difference between hit ratioes of the models that may be caused by the difference in variable.

Utility function is assumed as follows,

$$V_{in} = \theta_k X_{ink} \qquad (2)$$

where,

X_{ink}; k-th characteristics variable to n-th person with i-th choice

θ_k; parameter.

Table-2 shows the results estimated by use of the data surveyed.

4. CONCLUDING REMARKS

From viewpoints of overall hit ratio and $\bar{\rho}^2$-value both models give in a whole a significant explanation of the mode choice characteristics under the existing conditions because the overall hit ratioes of MODEL1 and 2 are 63.3 and 58.3 percent, and $\bar{\rho}^2$-values are 0.24 and 0.22 respectively, through not necessarily significant to choice of each mode.

Commonly to both models t-values are significant to travel time, those related to expense and with or without heavy baggage, but not to access. It follows from this result that access in the sense of our models may not be a principal factor to mode choice in interregional occupational trips. In MODEL1, positive parameter is estimated to auto-fuel expense against expectation. It is left unrevealed whether it was caused by close correlation between auto-fuel expense and express way toll or not. The number of party members is unstable in significance.

An answer to additional interest in the differnce between hit ratioes of the two models is that no significant difference can be found.

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REFERENCES

[1] Some of those are
Ruiter,e.r. and M.E.Ben-Akiba: Transportation Research Record, 673(1978), 121, 136.
R.Kitamura: Transportation Research, 15A(1981), 473, 486.
Y.Sugie: Traffic Engineering, 16, 6(1981), 3, 11. (in Japanese)

[2] S.Morichi,T.Tamura and J.Kondo: Kotsugakukenkyu, (1984), 46, 51. (in Japanese)

[3] R.Murakami: Expressway and Automobiles, 25, 1(1982), 46, 51. (in Japanese)

[4]Tsuyama Aircommuter Promoting Meeting: Preliminary Survey of Feasibility of Aircommuter in Tsuyama Area, (1987), (in Japanese)

[5] K.Ohta: Dissagregate Behavioral Model, Theory and its Application, JSCE, (1984), 9, 23. (in Japanese)

[6] S.Morichi; Disaggregate Behavioral Model, Theory and its Application, JSCE, (1984), 121 ,147. (in Japanese)