Mode Choice In Interregional Occupational Person Trips

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SYNOPSIS

The paper is a case study mode choice in interregional occupational person trips. Disaggregate 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 a significant 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.

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Nearly ten years have passed since disaggregate behavioral model was adopted in this 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 interested in the field of urban transportation [1]. And the model has turned out to be of good applicability 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 applicability of disaggregate behavioral 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 around it. Tsuyama city is 60 and 150 kilometers 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 versa.

The survey was made on 954 establishments sampled from the whole number (9833) of those in Tsuyama area. Sample rate in the sense 9.4
percent. Questionnaires 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,
- Possession 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-
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)

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

\[
P_{in} = \frac{\exp(V_{in})}{\sum_{j \in A_n} \exp(V_{jn})}
\]

(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 calculated through specification of the function for deterministic part. It is, of course, 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>
<thead>
<tr>
<th>Table-2 Estimation</th>
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<tbody>
<tr>
<td><strong>&lt; MODEL 1 &gt;</strong></td>
</tr>
<tr>
<td>Characteristic variables</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>alternative specific variables:</td>
</tr>
<tr>
<td>auto-fuel expense (YEN)</td>
</tr>
<tr>
<td>Exp.way toll (YEN)</td>
</tr>
<tr>
<td>access to the nearest Exp.way bus stop (km)</td>
</tr>
<tr>
<td>access to the nearest railway station (km)</td>
</tr>
<tr>
<td>the number of party member (persons)</td>
</tr>
<tr>
<td>with or without heavy baggage (lor0)</td>
</tr>
<tr>
<td>party generic variable: fare (YEN)</td>
</tr>
<tr>
<td>generic variable: travel time (min.)</td>
</tr>
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<table>
<thead>
<tr>
<th>Hit ratio</th>
<th>Exp.way driving</th>
<th>80.0% (90)</th>
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</thead>
<tbody>
<tr>
<td>Exp.way bus</td>
<td>52.6% (57)</td>
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</tr>
<tr>
<td>Rail</td>
<td>56.4% (33)</td>
<td></td>
</tr>
<tr>
<td>over all</td>
<td>63.3% (180)</td>
<td></td>
</tr>
</tbody>
</table>

| p²-value | 0.24 |

<p>| <strong>&lt; MODEL 2 &gt;</strong>     |</p>
<table>
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<th>Characteristic variables</th>
<th>0</th>
<th>t-value</th>
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<tr>
<td>alternative specific variables:</td>
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<td>the number of party member (persons)</td>
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<tr>
<td>with or without heavy baggage (lor0)</td>
<td>3.52</td>
<td>2.38</td>
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<td>generic variable: travel time (min.)</td>
<td>-1.19x10^-2</td>
<td>-2.44</td>
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<tr>
<td>travel expense (YEN)</td>
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<td>-3.05</td>
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<tr>
<td>access (km)</td>
<td>7.80x10^-3</td>
<td>0.10</td>
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<table>
<thead>
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<th>Hit ratio</th>
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<th>72.2% (90)</th>
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<tbody>
<tr>
<td>Exp.way bus</td>
<td>49.1% (57)</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>36.4% (33)</td>
<td></td>
</tr>
<tr>
<td>over all</td>
<td>58.3% (180)</td>
<td></td>
</tr>
</tbody>
</table>

| p²-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 ratios of the models that may be caused by the difference in variable.

Utility function is assumed as follows,

\[ v_{in} = \theta_k x_{ink} \]  

(2)

where,

\( x_{ink} \); k-th characteristics variable to n-th person with i-th choice

\( \theta_k \); parameter.

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

4. CONCLUDING REMARKS

From viewpoints of overall hit ratio and \( \hat{\rho}^2 \)-value both models give in a whole a significant explanation of the mode choice characteristics under the existing conditions because the overall hit ratios of MODEL1 and 2 are 63.3 and 58.3 percent, and \( \hat{\rho}^2 \)-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 difference between hit ratios of the two models is that no significant difference can be found.
ACKNOWLEDGEMENT

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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.
    (in Japanese)
    Japanese)
    Application, JSCE, (1984), 121, 147. (in Japanese)