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TOPIC 15
TRAVEL CHOICE AND
DEMAND MODELLING

A SP MODEL FOR ROUTE CHOICE BEHAVIOR IN RESPONSE TO TRAVEL TIME INFORMATION WITH MARGINAL ERRORS

SHENGCHUAN ZHAO
Department of Urban Engineering, University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113, JAPAN

YASUNORI MUROMACHI
Department of Urban Engineering, University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113, JAPAN

NOBORU HARATA
Department of Urban Engineering, University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113, JAPAN

KATSUTOSHI OHTA
Department of Urban Engineering, University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113, JAPAN

Abstract

This paper studies car commuter's route choice behaviour in response to travel time information, which is assumed to be provided with two types, ie travel time and travel time with marginal errors. A SP model is developed to examine the effects of the two types of travel time information.

INTRODUCTION

Advanced Traveler Information Systems (ATIS) have become worldwide topics as a modern technology for alleviating traffic congestion in the urban area. By providing real-time travel information regarding traffic conditions, ATIS can enhance drivers' knowledge of the situation in road networks, and may assist drivers' decisions, such as departure time, route choice, destination choice, etc. In response to travel information, drivers' behavior may be affected by their previous experience, provided information and other factors. However, the interaction among these factors is not well understood yet, especially drivers' perception process in response to different types of travel time information. Further research in this field is necessary and may obtain some useful insights into understanding the effects of ATIS systems on drivers' behavior. The objective of this paper is to examine car commuters' route choice behavior in response to travel time information. Specifically, the following issues are addressed in this paper:

1. Relationship between provided travel time information and drivers' perceived travel time.
2. Effect of factors such as travel time information type, road type, and drivers' socioeconomic characteristics on drivers' perception process and route choice behavior.
3. Comparison between route choice models with provided travel time information and those with perceived travel time.

The paper consists of seven sections. The second section reviews recent research works on drivers' behavior in response to travel information and outlines a conceptual framework for this study. The third section discusses a theoretical approach to model drivers' perception process and route choice behavior. The fourth section describes details of stated preference (SP) experiments. The fifth section presents some empirical findings from the survey, and measures the relationship between drivers' perceived and provided travel time information through regression analysis. The sixth section discusses the estimation results for route choice models, and presents the analysis results of market segmentation. The seventh section concludes the paper and offers further research topics.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

This section briefly reviews the literature on interaction between drivers' behavior and travel information, and then discusses a conceptual framework for this study.

Literature review

In order to analyze drivers' behavior in response to travel time information or to evaluate the effects of ATIS, efficient data collection is very important. Since ATIS is a new technology and still in development, it is very difficult to collect observational data. On-road trials using prototype equipment, or post implementation study (Bonsall 1992) does provide a powerful tool for data collection, but they are costly and complicated. As an alternative approach, stated preference or laboratory simulation method has been used for the studies. Compared to revealed preference data, stated preference data is easy and cheap in data collection. The hypothesized choice situation can be used to examine drivers' behavior if it is carefully designed. For these reasons, we also use SP method for data collection, and a number of research works using SP data have been done in this field.

Brocken and Van der Vlist (1991) conducted a mail-back survey in Amsterdam to analyze drivers' reactions to a number of hypothetical route choices with attributes include distance, and delay due to congestion. They investigated the tradeoff between distance and delay. Polak and Jones (1993) studied the impact of in-home pre-trip information on travelers' behavior, based on a compute-based survey. The results indicated that even among regular car users, there is a requirement for multi-modal pre-trip information, and travelers are selective in the amount and type of information they request. Khattak et al. (1994) undertook a survey about commuting behavior in the San Francisco Bay area. They collected both reported and stated responses to unexpected congestion and analyzed the route diversion behavior under qualitative, quantitative, and prescription travel information. It was found that, the commuters were sensitive to prescriptive information under incident conditions. In Japan, Taniguchi et al. (1994) developed a SP model to investigate the effects of travel information of time and congestion. The calibrated models showed that travel time information is more effective than congestion information on drivers' route choice behavior.

These studies on drivers' behavior in response to travel information have gained a lot of useful insights into understanding the interaction between drivers' behavior and travel information. One of the important conclusions of these studies is the reliability and type of travel information affect drivers' behavior critically. However, drivers' perception process in response to travel time information remains unexplored. Since drivers' behavior is dependent on their perceptions rather than travel information itself, investigation on drivers' perception process in response to travel information is important into understanding drivers' behavior. Next, we present a conceptual framework to depict drivers' route choice behavior which comprises drivers' perception process.

Conceptual framework

Consider drivers' route choice behavior in response to travel time information. When travel time information is provided, a driver will first perceive that information, integrating his historical or previous day experience, to form perceived travel time. Then, based on the perception and other factors, he decides his travel pattern, for example, he may choose the same route as previous day. When the trip is over, he will review the actual decision, and the results will influence his next trip as a previous day experience. This process can be represented in Figure 1. For the purpose of simplicity, this paper doesn't address drivers' learning process though it affects their route choice behavior very much.

Factors affecting drivers' route choice behavior

Factors which affects drivers' route choice behavior are basically three kinds (Ben-Akiva et al. 1991; Schofer et al. 1993): (1) travel information characteristics, for example, historical, current or predictive information, and accuracy of information, (2) drivers' socioeconomic characteristics such as gender, age, driving experience, or attitudes toward utilization of travel time information, and (3) attributes of trip and road network situation. These three kinds of factors interact with one another, affecting drivers' route choice behavior. This paper examines the influence of factors such as travel time information type (current and predictive travel time information), road type (toll expressway and surface road) and some of drivers' socioeconomic characteristics on drivers' route choice behavior.

Types of travel time information

In this paper, we assume two types of travel time information, type 1 and type 2. Type 1 is current travel time information and provides drivers with the most up-to-date information about current traffic conditions. Type 2 is predictive travel time information with marginal errors, and provides drivers with travel time information concerning expected traffic conditions during subsequent time period when travel can occur, it is given by a minimum-maximum travel time pair (an example is shown in the next section). Here, we use the word of "marginal errors" to represent prediction errors. However, any discussion on travel time prediction method itself is beyond the scope of this paper.

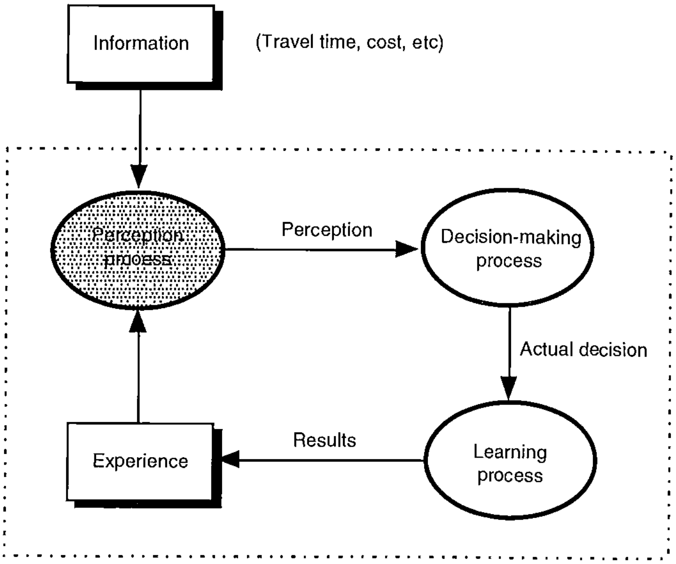

Figure 1 **Conceptual framework of drivers' route choice behavior in response to travel time information**

MODELING APPROACH

This section discusses a modeling approach to analyze drivers' perception process and route choice behavior in response to travel time information.

As shown in Figure 1, a driver's perception process is assumed to be influenced by provided travel time information and his historical or previous day experience. For a given route i, a driver's perceived travel time, could be considered as a function of provided travel time information and his experienced travel time.

$$T_{per,i} = f\,(T_{inf,i},\ T_{exp,i}) \tag{1}$$

where

$T_{per,i}$ = perceived travel time of route i,

$T_{inf,i}$ = provided travel time information of route i,

$T_{exp,i}$ = experienced travel time of route i.

As $T_{exp,i}$ is influenced by driver's socioeconomic characteristics S, so Equation 1 could be approximated as follows:

$$T_{per,i} = f\,(T_{inf,i},\ S) \tag{2}$$

With typical disaggregate methods for estimating travel choice models described by Ben-Akiva and Lerman (1985), we assume that, for a given driver, the utility of each route is dependent upon (1) travel time, (2) travel cost, and (3) driver's socioeconomic characteristics. Thus, the utility can be used in a logit model as follows:

$$Ui = \alpha_1 T_{per,i} + \alpha_2 C_i + \beta' S + \mu_i \tag{3}$$

where

U_i = utility of route i,

$T_{per,i}$ = perceived travel time of route i,

C_i = travel cost of route i,

S = vector of socioeconomic characteristics of a driver,

μ_i = influence of unobserved factors affecting utility of route i,

α_1, α_2, β = set of coefficients to be estimated.

In the case of provided travel time information type 1 and type 2, the above model changes to Equations 4 and 5, respectively.

$$U_i = \alpha_{11} T_{inf,i} + \alpha_{12} Ci + \beta_1{}'S + \mu_i \qquad (4)$$

$$U_i = \alpha_{21} T_{infa,i} + \alpha_{22} T_{infb,i} + \alpha_{23}\, C_i + \beta_2{}'S + \mu_i \qquad (5)$$

where

$T_{inf,i}$ = provided travel time information of route i (type 1),

$T_{infa,i}$ = provided minimum travel time information of route i (type 2),

$T_{infb,i}$ = provided maximum travel time information of route i (type 2),

α_{11}, α_{12}, α_{21}, α_{22}, α_{23}, β_1, β_2 = set of coefficients to be estimated, other variables are same as in Equation 3.

SP EXPERIMENTS

In order to examine the above approach, we conducted a mail-back SP survey in the Tokyo metropolitan area at the end of 1994. The sample was composed of 111 car commuters who had used any route of Tokyo metropolitan toll expressway. Each respondent gave a detailed account of his usual travel pattern, including most familiar toll expressway and its alternative surface road, minimum and maximum travel times of each route. The respondent was then asked to select his most familiar route among the eight typical toll expressway routes from suburban to the central area of Tokyo. These questions were followed by a number of stated preference (SP) questionnaires. Finally, each respondent was asked to answer socioeconomic questions on: age, gender, driving experience, profession, utilization frequency of toll expressway, and perceived accuracy of the existing travel time information provision service.

The SP experiments were designed to measure drivers' perceived travel time and route choice results. For each respondent, two questionnaires were devised for each type of travel time information. Travel time information and travel cost regarding each toll expressway route and its alternative surface road one are provided (distance of each route is fixed with 15 kilometers, and travel cost of surface road route is free), and each respondent was asked to give his route choice results among the two routes, and to write down his assumed (perceived) travel times for each route. Table 1 shows the attributes and their levels used in the SP experiments.

Table 1 Attributes and levels of the SP experiments

Attributes	Attribute levels
Travel time information of toll expressway route (in minutes)	15, 30, 45, 60
Travel time information of surface road route (in minutes)	25, 40, 55, 70
Travel time information prediction errors* (in percentage)	0%, ±10%, ±20%, ±30%, ±40%
Travel cost of toll expressway route (in yen)	400, 700, 1000, 1300

Note: *Level of 0% is only used for current travel time information (type 1).

Figure 2 is an example of the SP questionnaire with respect to predictive travel time information (type 2). The question is as follows:

Suppose two routes are available for you to choose, predictive travel time information and cost regarding each route are provided as below:

Travel time	Toll expressway route	Surface road route
Travel time (in minutes)	27~63	38 ~72
Cost (in yen)	700	0

Which one do you choose? ( ) ( )
(please mark with 0)
and in selecting the route, how many minutes did you assume for each route?

Toll expressway route:	Your assumption was:	minutes
Surface road route:	Your assumption was:	minutes

Figure 2 An example of SP questionnaire

SOME EMPIRICAL FINDINGS FROM THE SURVEY

Distribution of difference between perceived and provided travel time information

We compare the difference between drivers' perceived travel time and provided travel time information, and identify the factors which affect drivers' perceived travel time.

Let T_{inf}, T_{per} denote provided travel time information and drivers' perceived travel time, respectively. In the case of type 1, T_{inf} represents provided current travel time information, while in the case of type 2, for the purpose of convenience, T_{inf} represents the average of provided predictive travel time information. Thus, $(T_{per}-T_{inf})/T_{inf}$, represents the relative difference between perceived and provided travel time information. We analyze this difference between two types of travel time information in case of toll expressway and surface road, respectively. In addition, in respect to current travel time information, we also investigate the impact of drivers' socioeconomic characteristics on drivers' perceived travel time in case of toll expressway. The following figures present the graphical analysis results (sample size is 95 respondents).

Figure 3 shows the effect of road types on drivers' perceived travel time. The difference between perceived and provided travel time information tends to be distributed on the right-hand of the center of provided travel time information of both types. In respect to the difference of effects between current and predictive travel time information, most of drivers perceive the former with 30 to 50 percent extra and the latter with -10 to 10 percent extra in case of toll expressway, while most of drivers perceive both types of travel time information with 10 to 30 percent extra in case of surface road. The results implicate that, in response to travel time information, drivers' perceived travel times are much dispersed, and drivers' perception process was affected by travel time information type as well as road type.

Figure 4 investigates the effect of driver's perceived accuracy of the existing travel time information provision service on drivers' perceived travel time in case of toll expressway and current travel time information. From figure 4, we find that most of drivers of "Almost correct" group perceive travel time information with -10 to 10 percent extra, while those of "Sometimes wrong" group with 30 to 50 percent extra. As for "Wrong" group, none of drivers perceive travel time information with less than -50 percent, but half of drivers perceive it with 30 percent extra

(The sum of "30~50%" group and "50%" group equals to 50 percent). The findings show that drivers' perceived accuracy of the existing travel time information provision service affects drivers' perception process, the more correct the travel time information is, the more drivers will comply with it.

Figure 5 shows the effect of drivers' utilization frequency of toll expressway on drivers' perceived travel time in case of toll expressway and current travel time information. About half of drivers of "Everyday" group perceive travel time information with 10 to 50 percent extra (The sum of "10~30%" group and "30~50%" group equals to 50 percent), while most of drivers of "Others" group with -10 to 10 percent extra. One possible explanation for this finding is, drivers of "Others" group probably obey provided travel time information since they are not familiar with toll expressway compared with drivers of "Everyday" group.

In addition, other socioeconomic characteristics of drivers, such as driving experience and gender, were also found to be effective on drivers' perception process in response to travel time information.

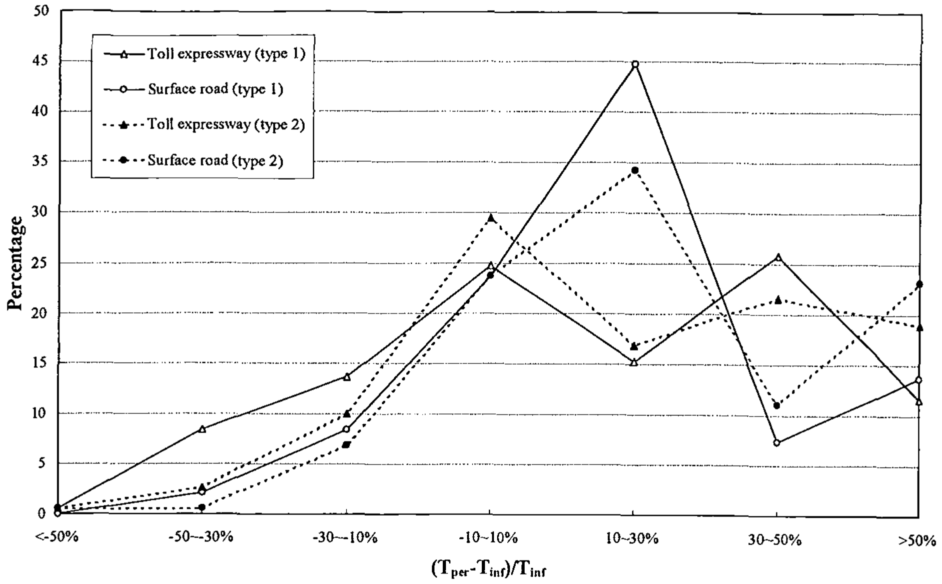

Figure 3 **Comparison of distribution of difference between perceived and provided travel time information of two types**

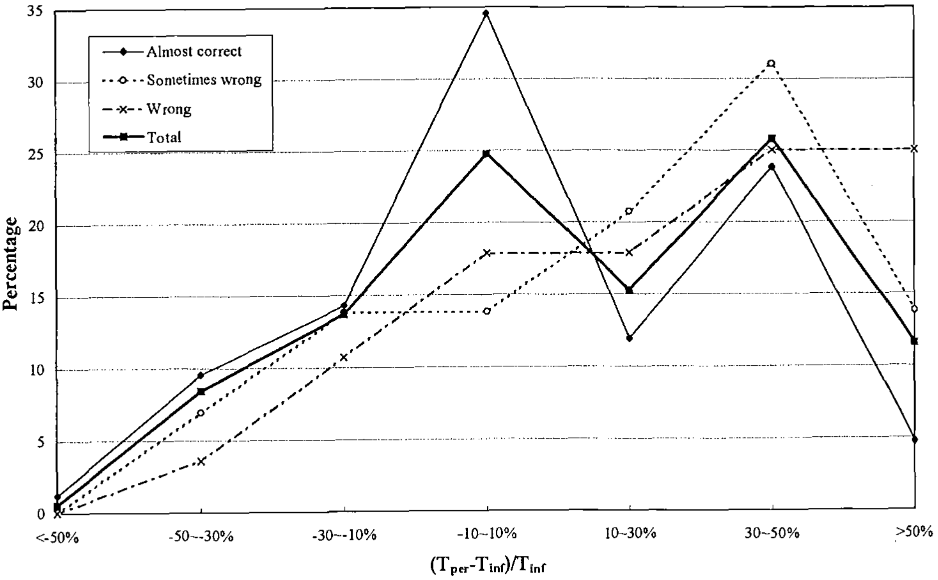

Figure 4 Distribution of difference between perceived and provided travel time information type 1) by drivers' perceived accuracy of the existing travel time information (toll expressway)

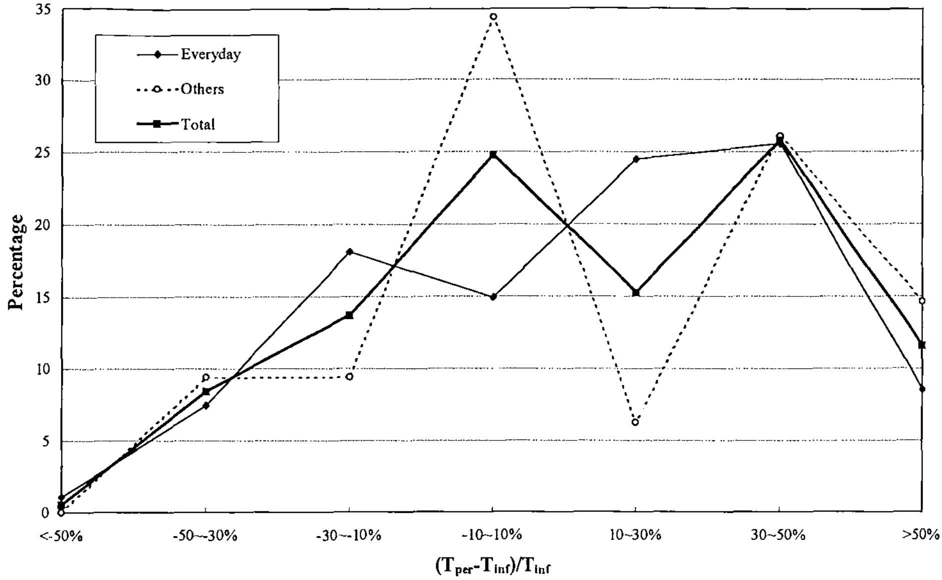

Figure 5 Distribution of difference between perceived and provided travel time information (type 1) by drivers' utilization frequency of toll expressway (toll expressway)

Regression analysis

In order to measure the relationship between drivers' perceived travel time and provided travel time information quantitatively, we conduct regression analysis in this section. For simplicity, we assume that, for a given route i, driver's perceived travel time is statistically dependent on provided travel time information, and the relationship between them is linear, thus,

$$T_{per,i} = a_0 + a_1 T_{inf,i} + \varepsilon_i \qquad (6)$$

$$T_{per,i} = b_0 + b_1 T_{infa,i} + b_2 T_{infb,i} + \varepsilon_i \qquad (7)$$

where,

$T_{per,i}$ = perceived travel time of route i,

$T_{inf,i}$ = provided travel time information of route i (type 1),

$T_{infa,i}$ = provided minimum travel time information of route i (type 2),

$T_{infb,i}$ = provided maximum travel time information of route i (type 2),

a_0, a_1, b_0, b_1, b_2 = set of coefficients to be estimated,

ε_i = error term of route i.

The estimation results are given in Table 2.

Table 2 Regression analysis results (t-statistics in parentheses)

	Type 1		Type 2	
Variable	Toll expressway	Surface road	Toll expressway	Surface road
Intercept	1.338 (0.619)	7.065 (2.613)	2.488 (1.299)	9.978 (3.076)
$T_{inf,i}$	1.081 (20.891)	1.039 (20.140)		
$T_{infa,i}$		0.243 (2.345)	0.225 (1.830)	
$T_{infb,i}$		0.756 (11.277)	0.692 (8.892)	
R-square	0.6989	0.6833	0.7608	0.5799
Number of respondents	95	95	95	95
Number of observations	190	190	190	190

The regression analysis results in Table 2 could be concluded as follows.

1. In respect to current travel time information (type 1), drivers perceive it around 10 percent extra.
2. In respect to predictive travel time information (type 2), except minimum travel time of surface road route, all other minimum and maximum travel times are significant at 95 percent level, and coefficients of maximum ones are larger than those of minimum ones. The results implicate that drivers prefer maximum travel time to minimum one when they perceive predictive travel time information.
3. As for the difference between surface road and toll expressway, intercepts in the case of surface road are larger than those in the case of toll expressway, and R-squares in the case of surface road are lower than those in the case of toll expressway. This means that, in the case of surface road, drivers perceive travel time information with larger safe margin, and drivers' perceived travel times are more dispersed, compared with the case of toll expressway. It also implicates the difference of perception mechanism between toll expressway and surface road exists.

ESTIMATION RESULTS FOR ROUTE CHOICE MODELS

We estimate the logit models discussed in section 3, with drivers' perceived travel time and provided travel time information. As shown in Figures 4 and 5, perceived accuracy of the existing travel time information provision service and utilization frequency of toll expressway of the drivers affect their perception process, and these should be included in the specification of the logit models. Tables 3 and 4 show the estimation results for travel time information type 1 and type 2, respectively.

All the coefficient estimates have expected sign and expected relative values. The value of time is between 1270 yen/hr. and 1670 yen/hr., which is in agreement with the results from similar calibrated models in Japan. In addition, the goodness-of-fit measures are also quite high.

Table 3 Estimation results for Type 1 (t-statistics in parentheses)

Variable	Travel Time Information	Perceived Travel Time
Toll expressway constant (t)	0.1516 (0.209)	0.1238 (0.181)
Travel cost (C_i)	-0.0038 (-4.840)	-0.0041 (-5.214)
Provided travel time information ($T_{inf,i}$)	-0.0987 (-7.006)	
Perceived travel time ($T_{per,i}$)		-0.0867 (-6.840)
Utilization frequency of toll expressway dummy (specific to t)[1]	1.079 (2.021)	0.992 (1.958)
Perceived accuracy of the existing travel time information provision service dummy (specific to t)[2]	1.369 (2.142)	1.156 (1.906)
ρ^2	0.5748	0.5474
Log-likelihood at convergence	-55.99	-59.60
Percent correctly predicted	88.95	85.79
Number of respondents	95	95
Number of observations	190	190

Note:

[1]: 0 if utilization frequency of toll expressway is "Others", 1 otherwise.

[2]: 0 if perceived accuracy of the existing travel time information is "Wrong", 1 otherwise.

Effect of socioeconomic characteristics

In the model with current travel time information (type 1), two specific dummy variables are significant at 95 percent level in the case of provided travel time information, and 90 percent level in the case of perceived travel time. However, in respect to predictive travel time information (type 2), two specific dummy variables are not significant at 95 percent level in both cases. The results indicate that, in response to current travel time information, drivers' socioeconomic characteristics such as perceived accuracy of the existing travel time information provision service and utilization frequency of toll expressway affect drivers' route choice behavior, and they may not be effective for other types of travel time information.

Performance comparison between models

As we discussed above, drivers' route choice behavior is actually dependent on drivers' perceptions rather than information itself, the models with drivers' perceived travel time should behave better than those models with provided travel time information. In Table 4, it was found that, in respect to predictive travel time information (type 2), rho square of model with perceived travel time is higher than that of model with provided travel time information, though the improvement is marginal. Unfortunately, estimation results in respect to current travel time information (type 1) do not support this finding. A possible reason is mentioned in the following section. In addition, rho squares in the case predictive travel time information (type 2) decreased, compared with those in the case of current travel time information (type 1). The decrease of rho squares may result from prediction errors. Since prediction errors are included in predictive travel time information, drivers' perceived travel time as well as predictive travel time information itself became more dispersed, compared with those in the case of current travel time information.

Table 4 Estimation results for Type 2 (t-statistics in parentheses)

Variable	Travel Time Information	Perceived Travel Time
Toll expressway constant (t)	0.032 (0.050)	0.399 (0.790)
Travel cost (C_i)	-0.0020 (-3.433)	-0.0025 (-4.709)
Provided minimum travel time information ($T_{infa,i}$)	-0.0229 (-1.444)	
Provided maximum travel time information ($T_{infb,i}$)	-0.0327 (-2.869)	
Perceived travel time ($T_{per,i}$)		-0.0563 (-6.107)
Utilization frequency of toll expressway dummy (specific to t)[1]	0.3425 (0.929)	0.3425 (0.927)
Perceived accuracy of the existing travel time information provision service dummy (specific to t)[2]	0.7946 (1.773)	0.5892 (1.340)
ρ^2	0.2853	0.3248
Log-likelihood at convergence	-94.13	-88.92
Percent correctly predicted	78.42	79.47
Number of respondents	95	95
Number of observations	190	190

Note:

[1]: 0 if utilization frequency of toll expressway is "Others", 1 otherwise.

[2]: 0 if perceived accuracy of the existing travel time information is "Wrong", 1 otherwise.

Market segmentation analysis

As shown in the previous section, in response to travel time information, drivers' perceived travel times are very much dispersed. It may neglect drivers' heterogeneity and lead to erroneous results to estimate the models across the whole data set. Therefore, it is necessary to employ a market segmentation approach (Ben-Akiva and Lerman 1985) to classify drivers into smaller subgroups, and within each subgroup, drivers share similar pattern of perceptions to travel time information, and estimate the models for each subgroup.

According to the difference between drivers' perceived travel time and provided travel time information, we summarize drivers into three subgroups as follows:

1. Risk-averse: A driver is said to be risk-averse if his perceived travel time is larger than provided travel time information.
2. Risk-neutral: A driver is said to be risk-neutral if his perceived travel time is equal to provided travel time information.
3. Risk-prone: A driver is said to be risk-prone if his perceived travel time is smaller than provided travel time information.

For a given driver, he may perceive travel time information oppositely between surface road and toll expressway. For the limitation of samples, we classify drivers into risk-averse, and risk-neutral and risk-prone subgroups based on their perceptions in the case of toll expressway. In this way, we have 42 risk-averse risk-averse drivers, and 34 risk-neutral and risk-prone drivers, according to the difference between driver's perceived and provided travel time information (type 1) in the case of toll expressway. Then, we assume the same models specification across each subgroup and re-estimate the models. Table 5 presents the estimation results.

Table 5 Estimation results for Type 1: market segmentation analysis (t-statistics in parentheses)

	Risk-averse		Risk-neutral and risk-prone	
Variable	**Travel Time Information**	**Perceived Travel Time**	**Travel Time Information**	**Perceived Travel Time**
Toll expressway constant (t)	0.1934	0.2608	-0.1835	-0.0254
	(0.167)	(0.215)	(-0.143)	(-0.023)
Travel cost (C_i)	-0.0031	-0.0037	-0.0034	-0.0040
	(-2.798)	(-2.957)	(-2.727)	(-3.283)
Provided travel time information	-0.0950		-0.1029	
($T_{inf,i}$)	(-4.496)		(-3.946)	
Perceived travel time ($T_{per,i}$)		-0.0876		-0.0898
		(-4.419)		(-3.891)
Utilization frequency of toll	1.004	1.277	0.5345	0.3769
expressway dummy (specific to t)[1]	(1.247)	(1.457)	(0.565)	(0.446)
Perceived accuracy of the existing	1.228	1.136	1.136	0.836
travel time information provision service dummy (specific to t)[2]	(1.342)	(1.339)	(0.952)	(0.797)
ρ^2	0.5540	0.5884	0.5486	0.4755
Log-likelihood at convergence	-25.97	-23.97	-21.28	-24.72
Percent correctly predicted	88.10	86.90	88.24	80.88
Number of respondents	42	42	34	34
Number of observations	84	84	68	68

Note:

[1]: 0 if utilization frequency of toll expressway is "Others", 1 otherwise.

[2]: 0 if perceived accuracy of the existing travel time information is "Wrong", 1 otherwise.

It was found again in Table 5, models with perceived travel time are statistically the same as models with provided travel time information for each subgroup. One possible explanation for this result is that, drivers' perceived travel time difference between surface road and toll expressway may have a constant relationship with provided travel time information difference between surface road and toll expressway, as a result, estimation results for model with perceived travel time are statistically the same as those for model with provided travel time information.

In order to examine our assumption, we conduct a regression analysis to compare drivers' perceived travel time difference between surface road and toll expressway, denoted as D_{per}, with provided travel time information difference between surface road and toll expressway, denoted as D_{inf}. It was found that, in response to current travel time information (type 1), as a whole, D_{per} is 4 minutes larger than D_{inf} (R-square = 0.81). In addition, D_{per} is 1.16 times of D_{inf} plus 1 minutes (R-square = 0.90) in the case of risk-averse subgroup and D_{per} is 0.80 times of D_{inf} plus 10 minutes (R-square = 0.68) in the case of risk-neutral and risk-prone subgroup. Figure 6 shows the relationship between D_{per} and D_{inf} in the case of risk-averse subgroup.

As shown in Figure 6, D_{per} is equal to, or has the same proportion to D_{inf} in most cases. Also, similar results are in the case of risk-prone and risk-neutral subgroup. The findings confirm our assumption above.

Thus, an interesting issue arises: if the above results can be believed, is it possible to substitute model with perceived travel time for model with provided travel time information if they are statistically the same? To answer this question, we assume that, for a given driver, he perceives travel time information in either of the following ways: (1) with a certain amount of safe margin, or (2) in proportion to travel time information. If all drivers perceive travel time information with a same amount of safe margin and are indifferent to road types, then the relationship between D_{per} and D_{inf} will be constant. In this case, model with perceived travel time will behave as the same as model with provided travel time information. However, as drivers are heterogeneous and they must perceive travel time information in a mixed way, this assumption will hardly happen. Therefore, we still need to develop model with perceived travel time and compare it with model with provided travel time information, otherwise drivers' route choice behavior may be misunderstood.

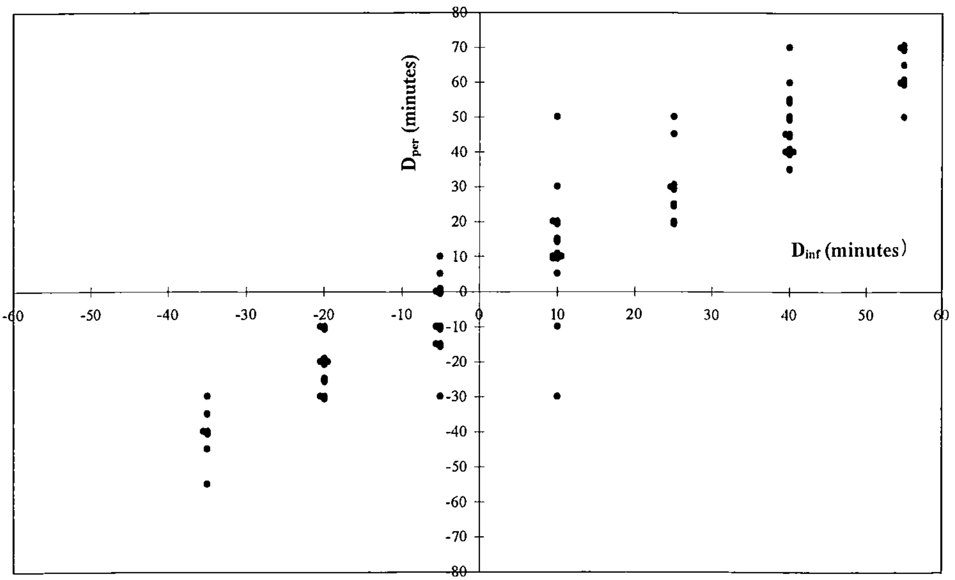

Figure 6 **Provided travel time information difference and perceived travel time difference between surface road and toll expressway in the case of risk-averse subgroup**

CONCLUSIONS AND FURTHER RESEARCH

This paper investigated car commuters' route choice behavior in response to travel time information, which is assumed to be provided by current and predictive travel time information. The following issues were examined:

1. Relationship between provided travel time information and drivers' perceived travel time.
2. Effect of factors such as travel time information type, road type, and drivers' socioeconomic characteristics on drivers' perception process and route choice behavior.
3. Comparison between route choice models with provided travel time information and those with perceived travel time.

Case study was based on the results of a mail-back SP survey of Tokyo Metropolitan Toll Expressway users in 1994. The main findings of this paper are follows:

1. In response to current and predictive travel time information, drivers' perceived travel times were much dispersed, and as a whole, drivers tended to be risk-averse. Driver's perception process in response to travel time information, was affected by travel time information type, road type and driver's socioeconomic characteristics such as driving experience, perceived accuracy of existing travel time information provision, and utilization frequency of toll expressway. The effect of drivers' perceived accuracy of existing travel time information provision on route choice behavior suggests that, by providing drivers with accurate information, ATIS systems could gain drivers' confidence in complying with its guidance.
2. Drivers perceived current travel time information around 10 percent extra, and they preferred maximum travel time to minimum one when they perceived predictive travel time information.
3. The estimated route choice models showed that there were no statistically difference in explanatory power between the models with perceived travel time and the models with provided current travel time information. One possible explanation might be: drivers' perceived travel time difference between surface road and toll expressway had a constant relationship with provided travel time information difference between surface road and toll expressway. Therefore, estimation results for the model with perceived travel time are statistically the same as those for the model with provided travel time information.

In concluding the paper, some issues should be mentioned for further research. The first is, though one of the possible explanations is given for the reason why the models with perceived travel time behaved the same as the models with provided travel time information, other reasons such as data reliability should be investigated also. In order to increase data reliability, we need to conduct a computer-interactive survey to examine whether those findings are appropriate or not. The second is the practical use of the model with perceived travel time for the evaluation of the effects of travel time information provision on the flow of network traffic. If the results in this study are appropriate, it may be possible to develop route choice model based on the drivers' perceived travel time distribution patterns, and then combine this model with network assignment model to analyze the effects of different travel time information provision types on the network traffic flow.

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