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INFLUENCE OF TRAFFIC INFORMATION ON DRIVERS' ROUTE CHOICE

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Abstract

Drivers' reactions to information displayed on roadside electronic signs were measured and analysed empirically. We estimate several ordered response probit models by introducing the inertia variables and obtain results that the reliability of information is more important for drivers who commute to work than for those who go shopping.

INTRODUCTION

Intelligent Transportation Systems (ITS) is one factor that could radically transform modes of transportation in the 21st century. Among the various systems proposed so far, Advanced Traveler Information Systems (ATIS) have attracted considerable interest as a technology that can contribute to more effective utilization of road networks in urban areas. One issue that must be addressed in order to implement effective traveler information systems is to gain a better understanding of drivers' route choice behavior in response to the provision of traffic information.

In this research, drivers' reactions to information displayed on roadside electronic signs concerning the length of congestion or travel time were measured and analyzed empirically. This study focused on the roadside electronic signs that have been installed along expressways in the Tokyo metropolitan area in recent years.

Analyses were made of data gathered in the stated preference (SP) surveys designed to measure drivers' reactions under a hypothetical situation that assumed they received traffic information from roadside electronic signs. Using the survey data, a study was made of the possibility of dispersing traffic on metropolitan roads by encouraging drivers to change their route through the provision of traffic information. In addition, ordered response probit models were estimated to explore the influence of the type of information, the trip purpose and drivers' travel experience on changes in their intra-trip stated route preferences. Based on the estimation results, the factors influencing their route choice behavior after receiving information were examined.

REVIEW OF RELATED REFERENCES

Many research studies have been conducted so far with the aim of contributing to the implementation of effective ATIS. Two major approaches have generally been employed. One approach involves the use of dynamic traffic simulations to study the potential effect of ATIS on ameliorating road network congestion once these systems have been widely implemented. The other approach is to conduct a basic analysis of route choice behavior using data on drivers' reactions to traffic information.

The simulation systems used in the former approach typically consist of a network flow model and a route choice model. Route choice models are often constructed around hypothetical assumptions owing to the difficulty of obtaining data on driver behavior in response to the provision of information and also on account of the simplification of models. For this reason, the validity of the results obtained with such models has been questioned. Because of such doubts, one focus of research has been to obtain quantitative tendencies for changes in road network congestion as a result of varying the influencing factors systematically. Mahmassani et al. (1991) developed a dynamic simulation system that incorporated a model of drivers' route selection process in relation to real-time traffic information. Their results indicated that congestion could be ameliorated if a small number of drivers had in-vehicle devices for receiving information. Ben-Akiva et al. (1991) proposed a conceptual framework for conducting dynamic simulations involving the provision of real-time information. They suggested that there is a need to create models and study driver behavior on the basis of empirical analysis.

There are two basic objectives of driver behavior analysis. The first objective is to gain useful knowledge concerning the types of drivers who would utilize traffic information effectively and methods of presenting information in an easy-to-understand format, among other things. Research in this connection focuses on intra-trip route choice behavior and attempts to gain a better understanding of the processes involved in drivers' perception of and reaction to information. The second objective is to make clear the long-term effects of ATIS by predicting how drivers' perceptions and behavior might change as these systems come into wide spread use. Research in this connection focuses on inter-trip route choice behavior.

In general, these analyses are based on the use of SP data obtained in measurements of drivers' reactions in hypothetical situations. The SP approach is an excellent method of gathering data at the present time when ATIS have yet to be widely implemented because it allows data to be collected efficiently inasmuch as the test environment can be controlled easily. There are two general methods of gathering data, either through questionnaires or the use of simulators. Simulators use computer graphics to assist the test participants in understanding the questions, making it possible to obtain high quality data systematically. One drawback of simulators is that the number of samples that can be collected is limited by cost and time constraints. In cases where simplicity of the survey is an important consideration, the use of questionnaires is also an effective method.

One example of a research study that focused on intra-trip route choice behavior is the work done by Khattak et al. (1993) who used the revealed preference (RP) and SP approaches to survey automobile commuters in the Chicago area. They examined the effect of radio traffic reports regarding congestion on drivers' route diversion propensity and found that delay time had a large influence on drivers' willingness to change their route. Adler et al. (1993) developed a simulator called FASTCARS and used it to gather sample data from 27 participants. Their results showed that drivers with little experience used the information received more frequently. A simulator called HYSIM, which provides excellent graphic capabilities, has been developed for the purpose of evaluating safe methods of presenting information to drivers via in-vehicle devices (see Walker et al. 1991). Hall (1983) found that, in cases where people either walked or traveled by bus to a place for the first time, the provision of information was not effective unless it was presented in an easy-to-understand format, even though the information itself was of value.

Research that has focused on inter-trip route choice behavior includes examples of studies based on experimental approaches in which the results of empirical observations of driver behavior were examined. Mahmassani et al. (1986, 1990) observed driver behavior in simulation experiments that took into account a learning effect; they examined the effect of different types of information on driver behavior, focusing on day-to-day changes in behavior. In another study, Iida et al. (1992, 1994) conducted laboratory experiments in which they analyzed the mechanism whereby drivers estimate travel time and their decision-making process based on travel time estimations.

There are few examples of research studies conducted with actual vehicles. One such example is the Ali-Scout project in which actual driving conditions were recorded with a data recorder and the results were used to analyze the effect of travel time information on drivers' route choice behavior (see Fairclough et al. 1991). Another example is the demonstration of experimental in-vehicle information systems as part of the Vehicle Information and Communications System (VICS) project in Japan (see Sugimoto et al. 1994). Uchida et al. (1994) also analyzed actual route choice behavior based on data gathered in a panel survey among automobile commuters who regularly saw travel time information displayed on electronic signs along expressways in the city of Sakai in Osaka Prefecture, Japan.

This study focused on intra-trip route choice behavior. It can be hypothesized that drivers' choice of a route may be influenced by three major factors in an environment where traveler information systems are in place. These factors are the intended route selected on the basis of previous driving experience and other considerations before receiving information, the degree of congestion encountered on the driver's present route and traffic information received from roadside electronic signs (Figure 1). In addition to these three factors, this study also examined the influence of the trip purpose, the accuracy of information and the driver's travel experience on route choice behavior, based on the results of actual travel surveys and SP surveys.

With ATIS, there are different formats in which information might be presented, including character displays and voiced announcements. There are also various ways of presenting information, such as via radio broadcasts, electronic signs and in-vehicle devices. This study considered character displays of information concerning the length of a queue resulting from congestion and travel time shown on roadside electronic signs, which have been installed along expressways in metropolitan Tokyo in recent years.

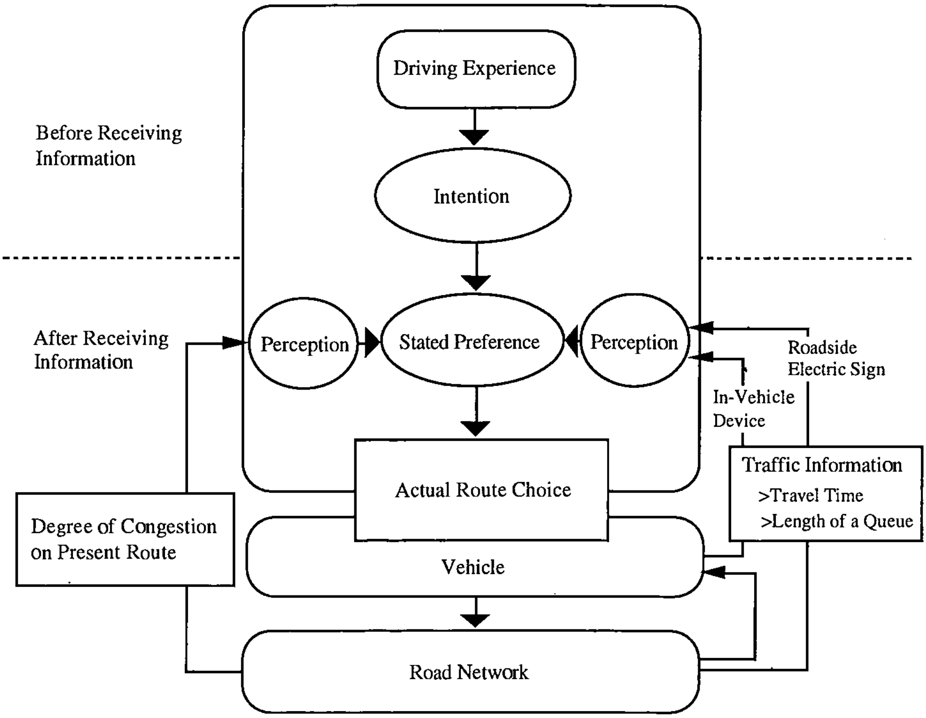


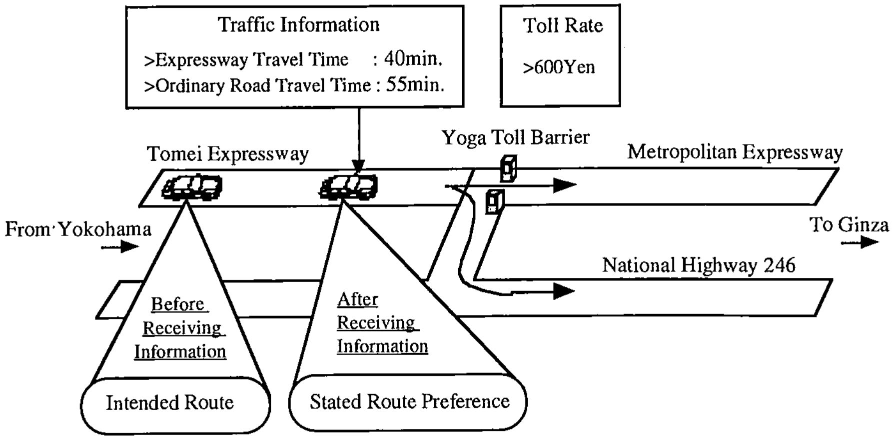
Figure 1 **Drivers' route choice behavior before and after receiving information**

SURVEY OF DRIVERS' STATED PREFERENCES

The results of the travel survey in Tokyo metropolitan area showed that in some instances travel times were shorter on alternate ordinary roads than on expressways in metropolitan Tokyo, contrary to popular belief (Hato and Taniguchi 1994). A survey of drivers' stated route preferences was then conducted to measure their reactions to comparative traffic information on either the travel time or the length of traffic congestion.

Figure 2 outlines the methodology used in investigating stated preferences. The survey assumed a situation in which a subject was driving from the suburbs to downtown Tokyo either on an expressway or on an ordinary road running parallel to it. Hypothetical traffic information (profile) was presented, and the subject was asked to state whether he or she preferred to take Expressway Route No. 3 or an ordinary road (National Highway 246). The subject responded according to a four-level scale by indicating either "definitely take the expressway," "perhaps take the expressway," "perhaps take highway 246," or "definitely take highway 246."

Travel time information and information on the length of the queue caused by traffic congestion. The experimental design method was used in creating both types of traffic information profiles. Based on the fluctuational factorial design technique (see Pearman et al. 1991), three travel time profiles and four traffic congestion length profiles were presented to each respondent. An effort was made to measure changes in route choice behavior as a result of receiving information.



Profile Factors and Levels

Factor	Levels
Trip Purpose	Shopping / Commuting
Present Route	Tomei Expressway / National Highway 246
Traffic Condition on Present Route	Congested / Flowing Smoothly
Expressway Tolls	¥0 / ¥500 / ¥600 / ¥700
Accuracy of Information	±0min. / ±20min.
Travel Time	25min. / 40min. / 55min. / 70min.
Length of Congestion	0km / 3km / 5km

Figure 2 Methodology used in stated preference survey

Respondents were asked to state, for example, their intended route before receiving information, whether they had ever taken either route and their expected travel time. They were asked to respond separately for two trip purposes—commuting and shopping.

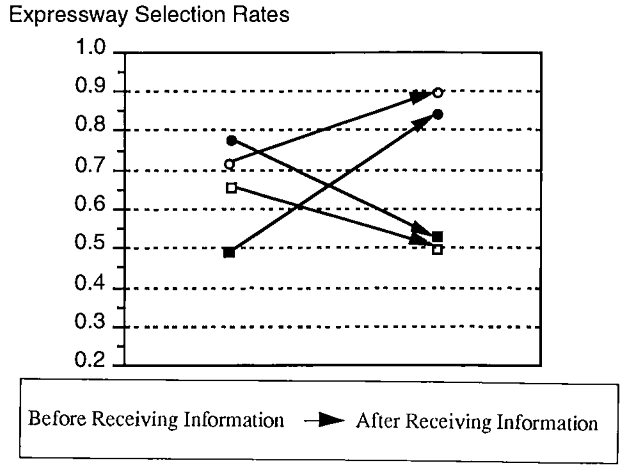
For commuting trips it was assumed that information was received at 7:30 a.m. and that the work day began at 8:30 a.m. In the case of shopping trips, information was received at 11 a.m. The survey was conducted in May 1993 among 1,470 company employees who were working in Tokyo and possessed a driver's license. Survey forms were mailed to the respondents and they were asked to return them one week later. A total of 852 forms were returned for a response rate of 58%. The respondents were 62% male and 38% female, and their average age was 37. The effective sample size available for use in model estimation samples for travel time information and 3,260 samples for information on the length of traffic congestion.

DYNAMICS OF ROUTE CHOICE BEHAVIOR

Effect of received information on changes in route choice

It is essential to have a good understanding of drivers' route choice behavior in order to enhance the effectiveness of traveler information systems. An analysis was made of the changes in the respondents' route choices, focusing on their route selection before and after the provision of information.

Figure 3 shows the changes in the rates at which respondents selected the expressway for commuting trips before and after receiving information. Data are shown for four different combinations of the respondents' (drivers') expected travel time and the presented travel time for each route. Figure 4 shows the corresponding data for shopping trips.



Legend		Expected Travel Time before Receiving Information →	Travel Time Information Provided
Line 1	○—►○	Expressway is Faster	Expressway is Faster
Line 2	■—►●	Ordinary Road is Faster	Expressway is Faster
Line 3	●—►■	Expressway is Faster	Ordinary Road is Faster
Line 4	□—►□	Ordinary Road is Faster	Ordinary Road is Faster

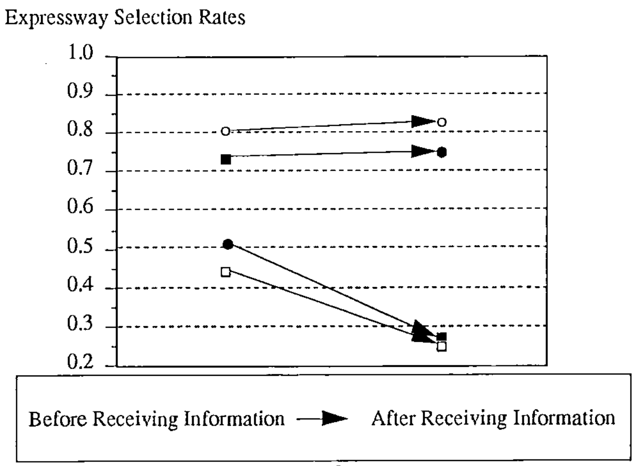
Figure 3 Changes in expressway selection rates on commuting trips

It is seen that their expressway selection rates changed in different ways between the two types of trips. In the case of commuting trips, the selection rates of the two groups that had expected the ordinary road would be faster before receiving travel time information differed considerably. Nonetheless, the expressway selection rates show large changes following the presentation of information, indicating that it had a substantial effect on the respondents' choice of a route.

The expressway selection rate of drivers who had expected the expressway to be faster before receiving information increased by 0.18 (line 1) when information was presented that the expressway was faster. This result indicates that route choices may change even when the information received coincides with drivers' expectations. In the case of drivers who had expected the ordinary road would be faster, the presentation of contrary information that the expressway was faster raised their expressway selection rate by 0.35 (line 2). This suggests that presenting information contrary to drivers' expectations can have a large effect on their route choice.

Among drivers who had expected the expressway to be faster, the presentation of information that the ordinary road was faster changed their expressway selection rate by -0.24 (line 4). That smaller change than the absolute value of the change seen in line 2 suggests that, under the time constraints of commuting to work, there may be a fairly strong tendency for drivers to choose an expressway, even after receiving contrary information. This result indicates that there may be an element of irreversibility to drivers' route choice before and after receiving traffic information.

The data in Figure 4 for shopping trips, on the other hand, show that the expressway selection rate before receiving information was not always high even among those who thought that the expressway was faster. Moreover, among those who thought that the ordinary road was faster, their expressway selection rate was not always low. These results suggest that the expected travel time had little influence on their route choice. Although the information that the expressway was faster did not have a very large effect on changing drivers' choice of a route, it is seen that route changes occurred when drivers were given the information that the ordinary road was faster. The results indicate the opposite trend from that seen for commuting trips. It is thought that this difference indicates the influence of expressway tolls and also that drivers are more sensitive to travel time in the case of commuting trips.



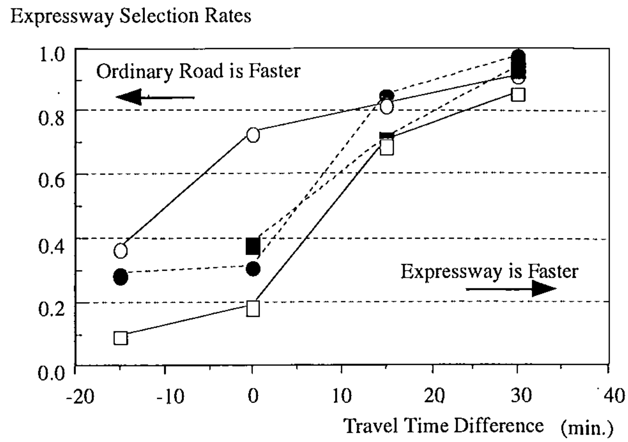
Note: The Legend is the Same as for Fig.3

Figure 4 **Changes in expressway selection rates on shopping trips**

Dependence of route choice on present route's degree of congestion

An analysis was made of drivers' route choices after receiving traffic information. Figure 5 shows the expressway selection rates as a function of travel time differences on the two types of routes and the degree of congestion encountered en route before receiving information.

We will first compare two cases where drivers were traveling either on the expressway or on the ordinary road under a condition where traffic was flowing smoothly. In both cases, drivers were given the information that there was no difference in travel time between the expressway and the ordinary road. The expressway selection rate of drivers traveling on the expressway in smoothly flowing traffic was 73%, whereas that of drivers traveling on the ordinary road under the same traffic condition was 20%. Drivers' route selection rates thus differed depending on their present route of travel even though the same information was given in both cases. Next, we will compare two cases where drivers were traveling on the expressway either in smoothly flowing traffic or in congested traffic. Again in both cases, drivers were given the information that there was no difference in travel time between the expressway and the ordinary road. The expressway selection rate of drivers traveling on the expressway in smoothly flowing traffic was 73%, whereas that of drivers traveling on the expressway in congested traffic was 31%. These results indicate that drivers' choice of a route after receiving information was influenced by the degree of congestion encountered on their present route before the information was provided.



Legend	Present Route of Travel		Traffic Condition	
	Tomei Expressway	Ordinary Road(246)	Flowing Smoothly	Congested
—○—	○		○	
- - -●- - -	○			○
- - -■- - -		○		○
—□—		○	○	

Note:

(1)Travel time difference refers to the difference in travel time information between Metropolitan Expressway Route No.3 and National Highway 246 (ordinary road).

(2)Present route of travel means the driver's route before receiving information.

(3)Traffic condition refers to the degree of congestion on the present route of travel.

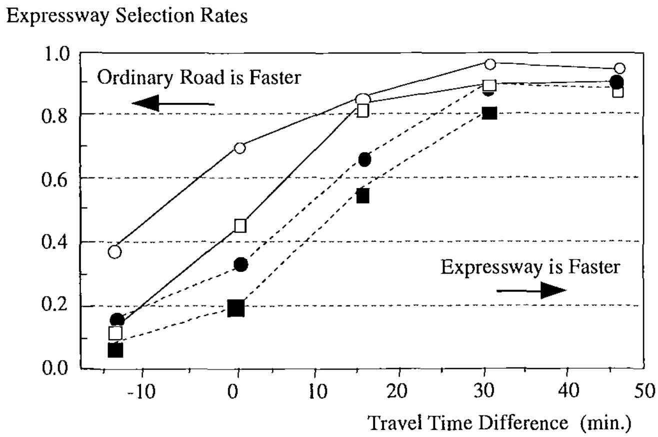
Figure 5 Expressway selection rates in relation to present route of travel and traffic condition

The choice of a route after receiving information thus seems to be dependent on the type of route drivers are traveling on before receiving information and on the degree of congestion encountered. This tendency is especially pronounced in situations where there is no difference in travel time between alternate routes.

Effect of intended route choice before receiving information on subsequent route preference

A study was made to explore whether drivers' intended route choice before receiving information had any effect on their stated route preference after receiving information. Figure 6 shows the expressway selection rates as a function of travel time differences between the expressway and the ordinary road with respect to each trip purpose and initial route choice before receiving information.

A comparison was made of the data with regard to the trip purpose, either shopping or commuting. In both cases, drivers who had intended to take the expressway before receiving information were more likely to choose the expressway after receiving information than the drivers who had intended to take the ordinary road. It is noteworthy that the expressway selection rates differed considerably when there was no difference in travel time. This suggests that drivers' selection of a route after receiving information was strongly dependent on their intended route choice prior to receiving information.



Legend	Trip Purpose		Intended Route	
	Commuting	Shopping	Expressway	Ordinary Road (246)
—○—	○		○	
----●----	○			○
—□—		○	○	
----■----		○		○

Note:

(1) Travel time difference refers to the difference in travel time between Metropolitan Expressway Route No.3 and National Highway 246 (ordinary road).

(2) Intended route refers to the driver's initial route choice before receiving information

Figure 6 Expressway selection rates in relation to trip purpose and intended route

MODEL ESTIMATION

The results of the foregoing analyses have shown that drivers' route choice behavior after receiving information is also influenced by factors other than the information itself. Such factors may include the degree of congestion encountered en route, which is something that drivers can observe and confirm visually, or their intended route that was selected on the basis of experience. Models of drivers' route choice after receiving information were estimated to analyze route choice behavior when information was provided.

The models simulated a decision-making process in which drivers chose a route after receiving traffic information. The models took into account certain factors affecting route choice such as the perceived value of travel time information, expressway tolls, degree of congestion confirmed visually by drivers en route and the intended route selected on the basis of drivers' previous travel experience.

The driver's perceived value of travel time information, T_i, in relation to available route choices, i, is defined as a function of the value of travel time information displayed on roadside electronic signs, *t-info*, the accuracy of that information, v_i, and the preferences of individual n regarding information, S_n. This relationship is expressed as

$$T_i = T_i\,(t\text{-}info_i,\ v_i,\ S_n) \tag{1}$$

The variation in T_i due to the driver's information preferences, S_n, is given as

$$T_i = \lambda\ t\text{-}info_i + \mu\, v_i \tag{2}$$

In addition to the value of information displayed on electronic signs, $t\text{-}info_i$, the accuracy of that information, v_i, is considered as an explanatory variable of the perceived value of travel time information, T_i. This makes it possible to ascertain drivers' average perception of the reliability of information.

In line with the foregoing hypothesis and based on the random utility theory, it is assumed that drivers choose a high-utility route on the basis of a consideration of the perceived value of the travel time information, T_i, for each route option and other factors. It is assumed that the utility function here can be expressed in the following form:

$$U_i = \alpha\ t\text{-}info_i + \beta\, v_i + \gamma\, \omega_i + \varepsilon_i \tag{3}$$

The data used here in estimating the models were the answers to paired questions that queried drivers about their relative preference between the two routes. Accordingly, the relationship between the utility difference between the expressway, i, and the ordinary road, j, and the natural order of the drivers' response categories can be expressed by the following equations.

$$\begin{aligned}
&\text{if} && U_i-U_j < 0, && \text{then the natural order} = 1\\
&\text{if} && 0 < U_i-U_j < \theta_1, && \text{then the natural order} = 2\\
&\text{if} && \theta_1 < U_i-U_j < \theta_2, && \text{then the natural order} = 3\\
&\text{if} && \theta_2 < U_i-U_j, && \text{then the natural order} = 4
\end{aligned} \tag{4}$$

where θ is a parameter indicating the thresholds between the natural orders. Then, assuming that the relative error term, ε, has a normal distribution, an ordered response probit model is obtained. The probability, $P(\theta)$, that the drivers' response category will be k ($k = 1, 2, 3, 4$) is given by

$$P(k) = \phi\,(\theta_{k+1} - (V_i-V_j)) - \phi\,(\theta_k-(V_i-V_j)) \tag{5}$$

where V_i is the determiner of the expected utility and ϕ is the cumulative distribution function of the standard normal distribution.

Table 1 shows the results estimated with Equation (5) for each type of information. The traffic information used here was the length of congestion and travel time, and separate models were estimated for each trip purpose.

Every case shows a high likelihood ratio, indicating that the models have a high goodness of fit. The t-statistics of the two parameters—length of congestion and travel time—are significant, which indicates that traffic information plays an important role in drivers' choice of a route. The parameter of information accuracy has a negative value. This indicates that the perceived value of the information is reduced on account of its poor accuracy. If traffic is flowing smoothly on the present route of travel, the parameter shows a positive value, whereas it shows a negative value if traffic is congested. A smooth traffic flow on the present route of travel tends produce an inertia effect, whereby drivers prefer to remain on their present route and dislike diverting to an altemate route. On the other hand, traffic congestion on the present route of travel tends to produce a diversion effect, whereby drivers prefer to divert from their present route to an alternate one. Drivers were divided into different segments on the basis of their travel experience on the routes for which information was provided.

Table 1 Estimation results for route choice model

Explanatory Variables	Commuting			Shopping		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Length of Congestion (km)	-0.238(-17.3)			-0.195(- 15.2)		
Travel Time (min.)		-0.035(-19.6)	-0.045(-15.3)		-0.032(- 11.8)	-0.046(- 9.3)
Accuracy of Information (Relative Error)			-1.326(- 4.8)			-1.406(- 3.2)
Expressway Toll (¥100)	-0.207(-14.9)	-0.085(- 7.6)	-0.096(- 8.3)	-0.145(- 12.5)	-0.124(- 6.8)	-0.133(- 7.2)
Dummy Variable 1	0.157(0.9)	0.377(5.8)	0.385(5.9)	0.173(0.5)	0.451(4.4)	0.155(1.2)
Dummy Variable 2	0.087(0.5)	-0.313(- 3.2)	-0.104(- 1.0)	-0.376(- 3.5)	-0.780(- 5.3)	-0.810(- 5.5)
Stated Preference before Receiving Information	0.468(12.5)	0.349(9.7)	0.336(9.4)	0.505(16.2)	0.473(9.7)	0.493(10.0)
Constant of Expressway	1.404(8.3)	0.036(0.3)	0.079(0.6)	0.236(2.4)	-0.367(- 2.3)	-0.364(- 2.2)
θ_1 (Threshold)	1.030(40.8)	0.807(33.1)	0.811(33.1)	1.007(49.4)	0.948(28.8)	0.953(28.9)
θ_2 (Threshold)	0.991(48.4)	0.942(46.3)	0.948(46.0)	0.931(46.9)	0.982(34.6)	0.986(34.5)
Sample Number	1629	1633	1633	1631	819	819
L(0)	4167.2	3799.8	3754.4	4917.4	2170.7	2148.6
$L(\hat{\beta})$	1618.7	1766.8	1755.6	1935.2	896.7	891.7
$\bar{\rho}^2$	0.529	0.523	0.530	0.568	0.529	0.580

Notes:

1 Figures in paretheses ( ) are t statistics
2 Dummy variable 1 has a value of 1 if the driver is travelling on the Thomei Expressway in smoothly flowing traffic before receiving information, and vlaue of 0 if otherwise.
3 Dummry variable 2 has a value of 1 if the driver is travelling on National Highway 246 (ordinary road) in congested traffic before receiving infromatio, and a value of 0 otherwise.
4 Route preference before receiving information is expressed in terms of a four-level scale of stated preferences.

Table 2 shows the results estimated with Equation (5) for each segment in the case of commuting and shopping trips. Letting 1 represent the value of the expressway toll parameter, γl, calculations were made of the parameter ratio of travel time information, α (ie $\gamma l/\alpha$). In the case of commuting trips, the parameter ratio of travel time information was found to be 33.0 yen/minute for drivers without any experience, 50.6 yen/minute for drivers with experience and 58.6 yen/minute for drivers with much experience. As drivers' experience increased, the contribution of information to their route choice after receiving information increased.

These results can be interpreted as follows. Drivers without any travel experience on the routes involved cannot make use of information received to divert to alternate route, because they do not know the way to the destination. In contrast, the more experience and familiarity drivers have with the routes about which information is provided, the better able they are to use that information to choose a route freely. The corresponding results for shopping trips were 50.6 yen/minute for drivers without any experience, 31.7 yen/minute for drivers with experience and 30.1 yen/minute for drivers with much experience. These results can be explained by the fact that drivers on shopping trips, where there are no time constraints, do not attach as much importance to travel time information as drivers on commuting trips.

Table 2 Estimation results for route choice model in relation to drivers' experience

Explanatory Variables	Commuting			Shopping		
	No Experience	Experience	Much Experience	No Experience	Experience	Much Experience
Travel Time (min.)	-0.038(- 4.6)	-0.044(-11.2)	-0.051(- 9.4)	-0.044(- 3.3)	-0.044(- 6.3)	-0.060(- 6.3)
Accuracy of Information (Relative Error)	- 1.600(- 2.0)	-1.144(- 3.1)	-1.305(- 2.5)	-2.300(- 1.9)	-0.889(- 1.5)	-1.996(- 2.6)
Expressway Toll (¥100)	-0.115(- 3.3)	-0.087(- 5.8)	-0.087(- 5.8)	-0.087(- 1.9)	-0.139(- 5.5)	-0.137(- 3.9)
Dummy Variable 1	0.434(2.4)	0.414(4.8)	0.404(3.4)	0.173(- 0.5)	0.208(1.2)	0.216(0.9)
Dummy Variable 2	0.328(0.9)	-0.213(- 1.5)	-0.156(- 0.8)	-0.735(- 1.4)	-1.830(- 5.5)	-1.455(- 4.7)
Stated Preference before Receiving Information	0.202(2.3)	0.357(7.2)	0.322(4.9)	0.341(2.5)	0.488(7.3)	0.572(0.6)
Constant of Expressway	0.549(1.7)	-0.066(- 0.4)	0.299(1.3)	0.896(19.9)	-0.523(- 2.7)	-0.621(- 2.0)
θ_1 (Threshold)	0.860(13.0)	0.787(25.1)	0.848(17.3)	0.341(2.5)	0.896(20.0)	1.109(15.2)
θ_2 (Threshold)	0.982(19.0)	0.953(35.0)	0.926(22.4)	1.021(26.1)	1.022(26.3)	0.984(18.4)
Sample Number	214	923	486	109	461	244
L(0)	572.8	2180.2	1052.5	311.9	1169.4	645.9
$L(\hat{\beta})$	254.0	1028.8	485.5	134.7	493.4	243.3
$\bar{\rho}^2$	0.537	0.524	0.530	0.529	0.570	0.609

Notes:

(1) "No experience" refers to drivers who have never driven on either Metropolitan Expressway Route No.3 or Nation Highway 246 (ordinary road).

(2) "Experience" refers to drivers who have driven twice or three times on either Metropolitan Expressway Route No or National Highway 246 (ordinary road), or both roads.

(3) "Much experience" refers to drivers who have driven at least four times on both Metropolitan Expressway Route No.3 and National Highway 246 (ordinary road).

(4) Figures in parentheses ( ) are t-statistics

(5) Dummy variable 1 has a value of 1 if the drive is traveling on the Thomei Expressway in smoothly flowing traffic before receiving information, and value of 0 if otherwise.

(6) Dummy variable 2 has a value of 1 if the driver is traveling on National Highway 246 (ordinary road) in congested traffic before receiving information, and a value of 0 if otherwise.

The relative error of information was significant on commuting trips for all segments. On shopping trips, this parameter did not show a significant value for either the segment without experience or the segment with experience. The influence of the accuracy of information was thus observed in the case of commuting trips, which are subject to time constraints, but it had little influence in the case of shopping trips by drivers who were not familiar with the routes.

The parameter for the smooth flow of traffic on the present route of travel showed a significant value for all segments in the case of commuting trips, whereas the values were not significant for shopping trips. This suggests that on the expressway the inertia effect is strong in the case of commuting trips but weak in the case of shopping trips. The parameter for traffic congestion on the present route of travel was not significant in the case of commuting trips, whereas it was significant in the case of shopping trips for all segments except the drivers having no travel experience on the routes. These results suggest that the diversion effect produced by drivers' desire to avoid congestion on ordinary roads was strong in the case of shopping trips but weak in the case of commuting trips.

CONCLUSION

The SP approach was employed in this study to evaluate the influence of past information (expected travel time and intended route before departure, based on drivers' prior experience with the routes involved), present information (congestion encountered en route) and future information (advised travel time and length of congestion) on drivers' route choice behavior.

In this study it was assumed that drivers were given information via roadside electronic signs concerning the travel time to their destination and length of congestion. The results indicated that their route choice behavior was strongly influenced by the information received.

The intended route, selected prior to departure on the basis of previous experience, had an inertia effect on route choice after the provision of information. What this means is that, for example, if drivers had selected route A as their intended route prior to receiving information, they showed a strong tendency to choose route A even after receiving information. The degree of congestion encountered en route before receiving information also influenced route choice behavior after information was received. A strong inertia effect was seen on the part of drivers traveling on the expressway on commuting trips. Drivers who had been traveling on the expressway from the beginning displayed resistance to changing their route after receiving information, and showed a strong preference for continuing on the expressway. In contrast, drivers who had been traveling in congested traffic on the ordinary road displayed a strong tendency to change their route after receiving information.

Estimation results for an ordered response probit model were used as the basis for calculating the estimated value of information to drivers. The results indicated that the value of information on commuting trips increased in proportion to drivers' experience in traveling on the routes for which information was given. This is thought to stem from the fact that drivers who have never traveled the routes before are unable to make full use of the information received. Accordingly, the provision of travel time information alone to such drivers would not be very effective. The effectiveness of travel time information could be enhanced by also providing geographical information at the same time using a navigation system or some similar device.

When the accuracy of the information received was low, it tended to have a negative effect on the perceived value of the information. This tendency was strongly observed on commuting trips, when drivers are under time constraints and want highly accurate and reliable information.

The results of this study suggest that traffic information plays a large role in drivers' choice of a route. Therefore, the provision of information to drivers may prompt them to divert from congested routes to ones where traffic is flowing more freely, and thereby increase the overall efficiency of the entire road network. It is thought that the benefits to be gained in this way will be even greater if highly accurate information is provided in accordance with the characteristics of drivers' route choice behavior.

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