Journal of the Eastern Asia Society for Transportation Studies, Vol. 6, pp. 1858 - 1872, 2005

COMMUTERS' SWITCHING BEHAVIOR AND TRAFFIC INFORMATION USES

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Abstract: The peak hour congestion is derived by concentration of commuters in a big city. To avoid the traffic congestion, commuting drivers change their original departure time or route based on traffic information and previous experiences, and by doing that, commuters can arrive at workplace on time. In this study, the relative importance of factors influencing on commuters' switching behavior was analyzed using binomial probit model, and the frequency of traffic information uses was analyzed using count models such as negative binomial and Poisson regression model for both the home-to-work and work-to-home trip in Seoul. The estimation results showed that there are remarkable differences from commuters' switching behavior of home-to-work and work-to-home trip, and provided the insight into relative effects of factors on the frequency of pre-route and en-route information uses.

Key Words: Departure Time Change, Route Change, Switching Behavior, Traffic Information

1. INTRODUCTION

Since traffic congestion of large cities during peak period is mainly derived by concentration of commuters' trips, various demand-side approaches such as Intelligent Transport Systems and Transport Management Systems are being implemented to relieve the concentration of commuters. Especially, demand dispersion through providing traffic information has attracted considerable attention. If commuting drivers are provided with traffic information, some of them will change original departure time or route, and consequently the congestion in urban network will be dispersed in wide time interval and in various routes. In that process, various factors such as individual attributes, workplace characteristics, trip characteristics, and traffic information affect drivers' choice. However, many information provision methods reflect only network condition without consideration about those influential factors.

The purpose of this study is to analyze relative importance of factors that influence on commuters' behavior, to model departure time and route change decisions and to model the frequency of traffic information uses for home-to-work and work-to-home trip. To model the commuters' switching behavior such as departure time and route change, binomial probit model was used, and to model the frequency of traffic information uses, a count model such as negative binomial and Poisson regression model was used.

Influencing factors included in the models consist of five parts: individual attribute, trip characteristics, network characteristics, workplace characteristics, traffic information. Data is collected by a survey based on RP (Revealed Preference) approach. Survey targets are drivers that have commuted using a private car in Seoul. The estimation results represent that traffic information and travel time give a significant positive influence on commuters' switching behavior, and there is a remarkable difference between home-to-work and work-to-home trip.

This paper consists of six sections. In next section, previous literatures were reviewed being focused on influencing factors and commuters' switching behavior. The third section presents conceptual structure of commuters' decisions and the influencing factors selected to model the drivers' behavior. Data collection method and the results are explained in the fourth section, and the fifth section describes the applied models and the estimation results. Finally, the sixth section provides the conclusions.

2. LITERATURE REVIEW

2.1 Influence Factors

The factors that influence on commuters' switching behavior are generally categorized as individual socioeconomic attribute, trip characteristics, network characteristics, workplace characteristics, traffic information. The socioeconomic attribute does not directly influence on commuters' switching behavior, but behavioral difference among individuals is caused by the attribute even at same traffic conditions. Age, sex, occupations, number of own car and driving experience are included in this category.

The trip characteristics includes number of in-vehicle person, number of alternative routes and drivers' personality factor. As the number of in-vehicle person increases, flexibility of travel decreases. The number of alternative routes, which represents the variety of paths connecting home and workplace, is an indicator of cognitive maps of drivers and of the perceived alternatives for diversion. (Khattak *et al*. 1991) Personality factor represents drivers' propensity toward risk and exploration. It was expected that drivers who are risk prone and inclined toward exploration may be more willing to divert from their preferred route. (Khattak *et al*. 1991, Khattak *et al*. 1993) The network characteristics consists of factors such as travel time, travel distance, number of intersections, number of turns and level of congestion. In most of the previous researches, the travel time had a significantly positive influence on commuters' diversion behavior. Specially, because of the statistical superiority to the linear specification, the logarithm transformation of travel time was used,

The variables related to workplace characteristics are work start and end time, preferred arrival time and lateness tolerance at workplace so on. Preferred arrival time is an indicator of preferences and risk attitudes, in addition it is a good predictor of a commuter's initial indifference band of tolerable schedule delay, which governs the acceptability of the consequences of departure time and route decisions. (Mahmassani *et al*. 1990) Recently, the traffic information has had a lot of influences on drivers' behavior. Drivers who obtain the traffic information have opportunities to make various decisions and are more willing to divert from their ordinary departure time or route, compared with drivers who use only their travel experiences.

2.2 Switching Behavior

In Mannering (1989) study, as drivers were older and travel time was longer, they were willing to change their departure time. In addition, travel time of alternative routes and the level of congestion as well as travel time of the current route had a strong negative effect on route change. The main asymmetries between home-to-work and work-to-home trip were observed for departure time change in Mahmassani *et al*. (1990) study. Home-to-work route change appeared to be primarily influenced by network conditions rather than by socio-demographic characteristics or rules at the workplace, and home-to-work departure time change is influenced by factors such as lateness tolerance at the workplace and job position. In work-to-home trip, congestion was the main motivator for both route and departure time change, especially drivers were likely to change departure time together with their route. The traffic information captured through the radio traffic reports had a significant positive effect on switching decisions.

Mannering *et al*. (1990) focused on work-to-home departure time choice as an effort to avoid traffic congestion. They modeled the departure time delay choice, the frequency of departure time delays and the duration of departure delays separately. The level of congestion played the dominant role in the delay decision. Hatcher and Mahmassani (1992) also studied on evening commute. They showed that commuters who have at least one routine stop during the evening trip were likely to make fewer switches, because they were constrained by their stop. The remarkable result of this study was that lateness tolerance increased the likelihood of evening departure time switching, even though the variable described the flexibility of work start time.

Table 1. Summary of The Previous Studies on Route Change

	Abdel-Aty et al. (1994)	Mahmassani et al. (1990)	Mannering (1989)	Khattak et al. (1991)	Khattak et al. (1993)	Mannering et al. (1994)
Travel time	+	+	+	+	+	+
Travel speed		–				–
Traffic information	+	+				
Level of congestion			+	+	+	
Stability of traffic state	+					
Number of alternative routes used				+	+	
Availability of alternative routes		+				
Familiarity of alternative routes					+	+
Delay at alternative routes			–	–		–
Personality				+	+	
Study area	LA	Austin	Seattle	Chicago	Chicago	Seattle
Number of observations	238, 443	372, 362	117	286	7588	2182, 2281
Method	RP	RP	RP	RP	SP	RP

+ : positive for route change, **- :** negative for route change
SP = Stated preference approach
RP = Revealed preference approach

De Palma *et al*. (1997) analyzed commuters' departure time decision from a survey of commuters in Brussels, Belgium. They suggested that flextime commuters did not extensively use their flexibility to avoid peak-period congestion, because schedule delay increased even though queuing delay decreased by changing their departure time. This implies that the shortcoming of travel time is not as critical as other reasons, such as personal requirements and convenience in motivating departure time change. Khattak *et al*. (1993) showed that drivers were more willing to divert if the expected delay of the current route would increase, and if the alternative route was unfamiliar or there were many stops, drivers were not willing to divert.

Some researchers analyzed commuters' route behavior change by the traveler information. Polydoropoulou *et al*. (1994) noticed that commuters were likely to change their route when they directly observed that the current traffic state was worse and not to change it when they got traffic reports that the traffic state of the alternative routes was poor. In addition, the stability of traffic condition and the accuracy of traffic information had a significant effect on route change behavior. (Abdel-Aty *et al*. 1994) Table 1 shows influence factors analyzed at the previous studies on route change.

3. Model Specification

3.1 Commuters' Switching Decisions

Commuters' decisions on en-route or pre-route switching are performed based on trip experience and traffic information. In other words, the previous experience and the traffic information provide commuters with the recognition on system condition, and then they determine whether they change ordinary route or departure time. Commuters in Seoul usually experience delays that are caused by the concentration of traffic demand in home-to-work and work-to-home trip. They accumulate their previous experience on the system condition continuously and, obtain immediately the traffic information through traffic reports such as a radio, internet and mobile service. Consequently, commuters determine their behavior using the combination of the previous experience and the instant traffic information

Assuming that commuters have the previous knowledge on traffic condition of their route and they recognize the congestion of the route at morning and evening peak period through the previous experience and the traffic information, commuters' switching behavior is modeled.

3.2 Variables Specification

The variables used in this study are categorized as socioeconomic attitude, traveling characteristics, network characteristics, workplace characteristics, traffic information. The socioeconomic variables consist of sex, age, number of own cars, duration of employment, duration of residence. The duration of employment and residence are investigated to know how familiar commuters are with home-to-work and work-to-home routes. Finally the smaller one of the two variables is included in models, to reflect commuters’ unexpected situations such as house moving or office moving. Table 2 summarizes influence factors applied in this study.

The trip characteristics variables include number of average in-vehicle persons, number of alternative routes, frequency of use of private car per week, frequency of use of traffic information and personality factor. The number of alternative routes is used as an indicator both of cognitive maps of drivers and of the perceived alternatives for diversion. To reflect effects of traffic information, the frequency of traffic information uses is included in the models. Personality factor represents drivers' propensity toward risk and exploration. It reflects an expectation that drivers who are risk prone and inclined toward exploration may be more willing to divert from their preferred route.

Table 2. Influence Factors

Category		Factors
Independent variables	Socioeconomic attribute	Age Sex Number of own cars Duration of employment Duration of residence Driving experience
	Trip characteristics	Number of average in-vehicle persons Number of alternative routes Ratio of private car uses per a week Personality (Adventure and discovery factor)
	Network characteristics	Logarithm of average travel time
	Workplace characteristics	Tolerance of late arrival Preferred arrival time
	Traffic information uses	Whether traffic information is used Reliability of traffic information
Dependent variables		Departure time change Route change Frequency of traffic information uses

Logarithm of average travel time is used as a network characteristics variable. The logarithm transformation is needed, because as travel time increases, the sensitivity of travel time change is lower. For example, a 5-min increase in a 10-min travel time does not have the same effect on drivers as adding 5-min to a 60-min travel time. Workplace characteristics variables are expected to have a lot of influence on home-to-work trip, and in this study, preferred arrival time and allowance of late arrival are used as workplace characteristics variables.

Age, duration of employment, duration of residence are used as categorized variables, and number of alternative routes, logarithm of average travel time, personality factor, preferred arrival time are applied as continuous variables. Sex, tolerance of late arrival, traffic information uses are specified as dummy variables. Because the frequency of traffic information uses and the reliability of the information are variables to analyze the frequency of traffic information uses, they are excluded in departure time and route change models, but included only in the frequency models of traffic information uses.

4. DATA COLLECTION

4.1 Data Collection Method

The survey was performed to collect the data needed to model departure time and route change behavior and the frequency of traffic information uses. To model commuters' real behavior, RP approach is applied and the targets of the survey were drivers in Seoul who have commuted recently by cars. The available 143 samples were collected, and proper ones of these samples were selected to construct models. However, some samples that have missing data were used depending on models to be estimated, and the number of samples was a few different among each model.

4.2 Survey Results

4.2.1 Socioeconomic Attribute

Table 3. Socioeconomic Attribute of Samples (%)

Category		Frequency
Sex	Male	81.1
	Female	18.9
Age	Twenties	328.7
	Thirties	48.3
	Forties	15.4
	More than fifties	7.7
Number of own cars	1 car	81.7
	More 2 cars	18.
Duration of residence	Less than 3 years	35.0
	3~10 years	37.7
	10~20 years	16.1
	More than 20 years	11.2
Duration of employment	Less than 3 years	28.7
	3~10 years	47.5
	10~20 years	19.6
	More than 20 years	4.2
Driving experience	Less than 5 years	31.4
	5~10 years	41.3
	10~15 years	20.3
	More than 20 years	7.0

To represent how familiar commuters are their routes from home to workplace, the smaller one between the duration of residence and the duration of employment is used to construct models.

4.2.2 Trip Characteristics

The average number of alternative routes that commuters recognize is 2.0 for the morning trips and 2.2 for the evening trips. A chi-square test indicates that the morning and the evening distributions of the number of alternative routes are not significantly different at any reasonable confidence level. The average number of in-vehicle persons is 1.2, and not different from the morning and the evening trips, which means that most of commuters travel alone. The ratio of private car uses per week, the frequency for commuters who use a car in a commuting trip, is used to reflect the difference from private car users and conditional public passengers who sometimes use public transportation systems. The average of the frequency that they use a private car at commuting trip is 4.2 times per week.

To reflect drivers' propensity, personality is used as a variable. Drivers' attitude toward risk is evaluated by self-assessment questions that were developed in the previous studies, and then the responses to personality questions are analyzed using factor analysis. The questions that contribute to relevant personality factor are reported at Table 4. The sum of scores on these statements is included in the switching models.

Table 4. Adventure and Discovery Factor of Driver Personality

Questions	Average score
I like discovering new routes to get someplace	3.09
I am willing to take risks to avoid traffic delays	2.94
I would rather use only the route that I know well.	2.62

5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree

4.2.3 Network Characteristics

The average travel time of samples is 39.35 minutes at home-to-work trip and 44.48 minutes at work-to-home trip, in addition the number of commuters who have more than 60 minutes travel time is more in evening trips than morning trips. A chi-square test indicates that the morning and the evening distributions in the average travel time are significantly different at 5% confidence level. Generally, commuters make less effort to reduce the travel time at work-to-home trip than at home-to-work trip, because work-to-home trip does not have fixed times for arrival at home and the penalties associated with late arrival at home are substantially different from those associated with late arrival at work. Also, a delay in departure from work to home gives commuters the option of participating in activities, near the work place. This is similar to result of Mannering *et al*. (1990) study that represents work-to-home travel time is longer than home-to-work travel time.

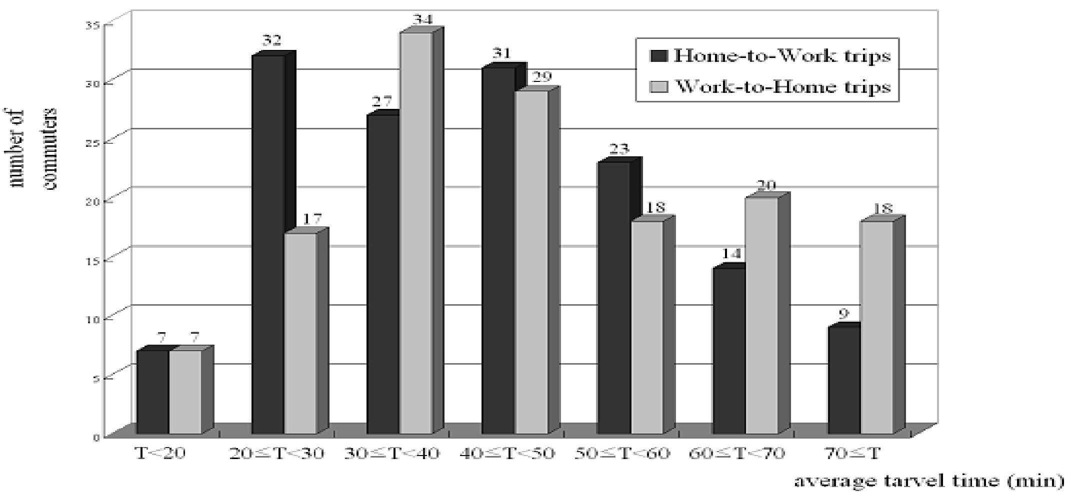

Figure 1. Distribution of Average Travel Time

4.2.4 Use of Traffic Information

Commuters that use traffic information occupy 59.4% of samples. Most of them capture the radio reports and some of them used VMS (variable massage sign) or TV. Commuters obtain the traffic information more frequently at home-to-work trip than at work-to-home trip, and in en-route than in pre-route. Most of those who obtain the pre-route information use the en-route information also. In other words, those who obtain only pre-route information are rare. The ratio of commuters that use traffic information more than 3 times per week is relatively low which shows that commuters who regularly use traffic information are rare, and travel experiences have more influence on their commuting trip.

Table 5. Commuters' Characteristics of Traffic Information Uses (%)

Contents	Home-to-Work	Work-to-Home
Ratio of commuters that use traffic information		
Pre-route information	32.2	23.1
En-route information	52.4	48.3
Frequency of traffic information uses per week		
No use	37.5	47.1
1~2 times	39.5	29.8
3~4 times	6.7	13.5
More than 5 times	16.3	9.6

The reliability of traffic information is investigated, with respect to accuracy, concreteness, updating interval and relation to driver's trip. The score of the reliability of traffic information is approximately neutral as shown in Table 6.

Table 6. Reliability of Traffic Information

Questions	Average score
The contents of information is accurate	3.50
The contents of information is concrete	3.13
The updating interval of information is short	3.06
The contents of information is related to own trip	3.43

5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree

4.2.5 Workplace Characteristics

Table 7. Workplace Characteristics (%)

Contents		Frequency
Work hour	Fixed work hour	83.9
	Flexible work hour	16.1
Tolerance of late arrival	Never	62.9
	Sometimes	22.4
	Always	14.7

75% of sample work for 6 days per week, and most of the rest work for 5 days, and 83.9% of samples have fixed work hour. The average preferred arrival time is 20.24 minutes, which means that the commuters who anticipate in the survey prefer to arrive at workplace before about 20 minutes.

4.2.6 Switching Results

The commuters who anticipate in the survey switch route and departure time more frequently in work-to-home trip than in home-to-work trip, especially they change more frequently route rather than departure time. The switching results are summarized in Table 8. The results of the chi-square test show that the distribution of departure time and route switching frequency are significantly different at 1% confidence level. Figure 2 presents the distributions of departure time and route switching frequency.

Table 8. Results of Switching (%)

Responses		Frequency
Route change	Home-to-work trip	58.7
	Work-to-home trip	67.4
Departure time change	Home-to-work trip	58.0
	Work-to-home trip	58.7

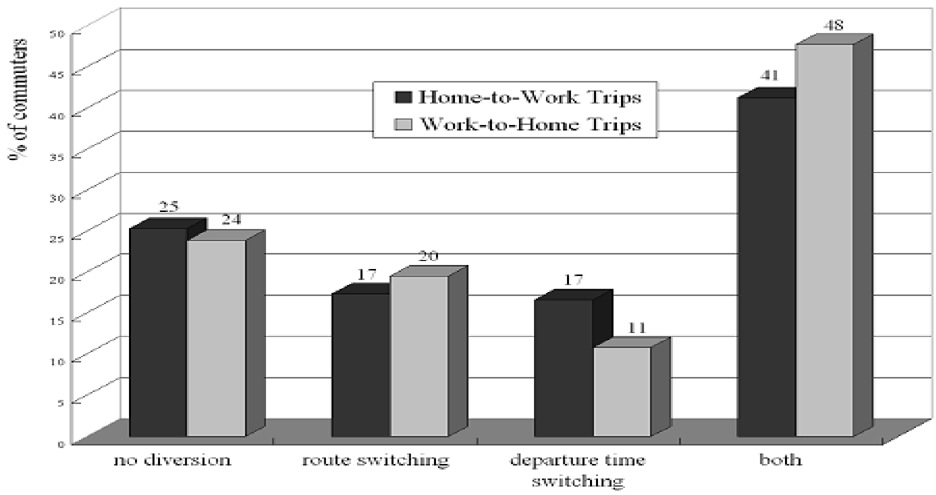

Figure 2. Switching Distribution of Commuters

5. MODEL ESTIMATION

5.1 Model Structure

5.1.1 Binary Choice Model

To model the departure time and route change behavior, binary choice model is used. The typical binary choice models are a logit and a probit model that are based on probabilistic utility theory. In this study, the probit model is applied, because the probit model that can reflect the covariance between variables is statistically better than the logit model. Under the assumption that term $\varepsilon_{in} - \varepsilon_{jn}$ is normally distributed with mean zero but with variance $\sigma_i^2 + \sigma_j^2 - 2\sigma_{ij} = \sigma^2$, the form of the probit model is,

$$P_n(i) = Pr(U_{jn} \le U_{in}) = Pr(\varepsilon_{jn} - \varepsilon_{in} \le V_{in} - V_{jn})$$
$$= \Phi\left(\frac{V_{in} - V_{jn}}{\sigma}\right) = \Phi\left(\frac{\boldsymbol{\beta}(\mathbf{X}_{in} - \mathbf{X}_{jn})}{\sigma}\right) \quad (1)$$

where, $\Phi()$ denotes the standardized cumulative normal distribution, and $U_{an} = \boldsymbol{\beta}\mathbf{X}_{an} + \varepsilon_{an}$ $(a = i, j)$.

5.1.2 Count Model

The Poisson and negative binomial models are applied to model the frequency of traffic information uses. The negative binomial model, as the extended form of Poisson model, permits the difference from the mean and the variance. In a Poisson model, the probability of driver i using the traffic information n_i times per week (where n_i is a non-negative integer) is

$$P(n_i) = \frac{\exp(-\lambda_i)\lambda_i^{n_i}}{n_i} \quad (2)$$

where λ_i is the Poisson parameter for driver i, which is equal to driver i's expected number of information uses per week (i.e., $E(n_i)$). Poisson regressions are fitted to date by specifying the parameter λ_i as follows,

$$\lambda_i = \exp(\boldsymbol{\beta}\mathbf{X}_i) \quad (3)$$

where, $\mathbf{X}_i$ is a vector of the independent variables and $\boldsymbol{\beta}$ is a vector of estimable parameters.

In the analysis of the frequency of traffic information uses, because there is a maximum of the frequency that drivers use traffic information per week, the right truncated model should be applied. The right truncated Poisson model is written as

$$P(n_i) = [\lambda_i^{n_i} / n_i!] \Big/ \left[\sum_{m_i=0}^{r} (\lambda_i^{m_i} / m_i!)\right] \quad (4)$$

where m_i is the number of information uses per week, and r is the right truncation (in this case, 6 times per week)

Because the Poisson distribution has the property that restricts the mean and variance of the distribution to be equal, the analysis error occurs. If this equality does not hold, the data is regarded as overdispersed, and unless corrective measures are not taken, the parameter vector will be biased. The solution to this is to add a Gamma distributed error term, ε, to equation 3 such that,

$$\ln \lambda_i = \boldsymbol{\beta} \mathbf{X}_i + \varepsilon_i \quad (5)$$

The addition of this term produces a negative binomial model allows the mean to differ from the variance such that

$$Var[n_i] = E[n_i][1 + \alpha E[n_i]] \quad (6)$$

where α, over-dispersion rate, is an additional estimable parameter. Unless α is significantly different from zero, the data is not overdispersed and the simple Poisson model is appropriate.

5.2 Estimation Results

Parameters of the models were estimated using an econometric tool, LIMDEP 7.0.

5.2.1 Departure Time and Route Change

Departure time and route change models were estimated for only commuters who have fixed work hour because flextime commuters were not sensitive to peak period congestion. Table 9 shows the results of the model estimation. The sign of the all constants is negative, reflecting a preference for not diverting, which is expected even if there is a delay on the usual route, drivers are likely to stay on it. The number of alternative routes has significant positive value at the route change models, which imply that as drivers are familiar with alternative routes and have a lot of the perceived alternative routes for diversion, the probability of route change is higher. Personality also has a significant positive effect on route change behavior. It is expected that drivers who are willing to take risks and interested in discovery and exploration are more likely to divert.

The sign of the allowance of the late arrival and preferred arrival time is positive, which indicates if the late arrival is allowed and preferred arrival time is earlier, drivers are more inclined to change departure time at home-to-work trip. The logarithm of average travel time has positive sign at all of models, which indicate that if the trip took longer, then drivers were more likely to divert. Also, the traffic information use has significantly positive influence on drivers' diversion. Specially, drivers who obtain the pre-route information are willing to change the departure time and drivers who obtain the en-route information are inclined to change the route.

The traffic information and the travel time a strong influence on all the models commonly. In home-to-work trips, departure time change is mainly influenced by workplace characteristics such as preferred arrival time, tolerance of lateness, and route change is mainly influenced by the trip characteristics such as the number of alternatives routes and the personality. In case of work-to-home trip, departure time change is mainly influenced by the duration of same route use. Drivers who have used the same route for long time are not willing to change the departure time at work-to-home trip. The route change model at work-to-home trip has the pattern that is similar to the route change model at home-to-work trip. However, the goodness-of-fit of work-to-home models is lower than that of home-to-work models, for the reason that an evening trip often includes other activities not home based activities and the time pressure of an evening trip is weaker than that of a morning trip.

Table 9. Models of Departure Time and Route Change

Variables	Home-to-Work		Work-to-Home	
	Departure time change	Route change	Departure time change	Route change
Constant	-5.0979(-3.636)*	-5.5882(-3.892)*	-2.5373(-2.063)*	-3.3189(-2.300)*
Duration of same route use (year)			-0.4270(-2.223)*	
Driving experience (year)				-0.2070(-1.238)
Number of alternative routes		0.3983(2.418)*	0.2246(1.542)	0.3602(2.070)*
Ratio of private car use per week				-0.6048(-1.305)
Personality (score)		0.1876(3.145)*		0.1307(2.065)*
Logarithm of average travel time	2.5857(3.167)*	1.7818(2.479)*	1.7716(2.461)*	1.5916(2.084)*
Tolerance of late arrival (tolerable: 1, otherwise: 0)	1.2164(3.678)*	0.5639(1.759)		
Preferred arrival time (minute)	0.02788(2.426)*			
Use of pre-route information (use: 1, no use: 0)	0.53344(1.792)		1.0311(3.089)*	
Use of en-route information (use: 1, no use: 0)		0.5881(2.195)*		0.7214(2.501)*
Number of observations	117	114	112	113
Initial log-likelihood	-72.21729	-74.46663	-73.56515	-66.39024
Restricted log-likelihood	-54.35112	-59.17910	-61.81719	-52.95998
Rho-squared	0.25	0.21	0.16	0.20

*: satisfied at significant level 5%
Age (year): (A<30: 2, 30 ≤ A<40: 3, 40 ≤ A<50: 4, 50 ≤ A<60: 5, A ≥ 60: 6)
Duration of a same route use (year): (N<3: 1, 3 ≤ N<10: 2, 10 ≤ N<20: 3, 20 ≤ N: 4)
Driving experience (year): (N<5: 1, 5 ≤ N<10: 2, 10 ≤ N<15: 3, 15 ≤ N: 4)

5.2.2 The Frequency Model of Traffic Information Uses

The frequency models that they used the traffic information at commuting trip were developed for all commuters who had fixed and flexible work hour, differently from modeling departure time and route change. The frequency had the range from 0 to 6 because it means the number of information uses per a week, therefore to model the frequency of information uses, right truncated distribution was applied. Table 10 shows the estimation results of the frequency of the traffic information uses.

The sign of the all constants is negative, reflecting a preference for not using traffic information. The flexibility of work hour has significantly positive effects on pre-route and en-route information use at home-to-work trip. This indicates that commuters who have fixed work hour use traffic information more often than ones who have flexible work hour. Specially, en-route information use is influenced by network and trip characteristics such as driving experience, the number of alternative routes, the ratio of private car use per a week. Also, travel time does not have significant effects on home-to-work trip, contrary to work-to-home trip and the sign of preferred arrival time is negative only for home-to-work trip. This implies that traffic information use at morning trip is not influenced by travel time, and those who are willing to arrive at the office earlier do not have to use traffic information.

Table 10. Frequency Models of Traffic Information Uses

Variables	Home-to-Work		Work-to-Home	
	Pre-route	En-route	Pre-route	En-route
Constant	-3.8252(-2.517)*	-5.3511(-2.945)*	-6.0426(-3.428)*	-7.9666(-7.130)*
Sex (mail: 1, female: 0)			-0.6616(-1.792)	
Driving experience		0.5378(2.078)*		0.4042(4.041)*
Number of alternative routes		0.3654(1.569)		0.2210(2.984)*
Ratio of private car use per a week		1.4175(1.916)	1.4246(2.223)*	0.8745(2.707)*
Logarithm of average travel time			1.0400(1.307)	2.125(4.165)*
Flexibility of work hour (fixed: 1, flexible: 0)	2.1993(2.105)*	1.2531(2.145)*	1.7262(1.681)	1.2749(2.406)*
Preferred arrival time (minute)	-0.04870(-1.576)			
Reliability of traffic information (score)	0.8068(2.037)*	0.5336(1.342)	0.3174(1.206)	0.4185(2.852)*
Alpha	2.2666(2.965)*	1.1315(2.922)*		
Number of observations	122	122	122	122
Initial log-likelihood	-142.7849	-183.6593	-91.16554	-201.8337
Restricted log-likelihood	-122.1372	-166.6283	-81.66185	-158.6271
Rho-squared	0.14	0.10	0.10	0.21

*: satisfied at significant level 5%
Age (year): (A<30: 2, 30 ≤ A<40: 3, 40 ≤ A<50: 4, 50 ≤ A<60: 5, A ≥ 60: 6)
Driving experience (year): (N<5: 1, 5 ≤ N<10: 2, 10 ≤ N<15: 3, 15 ≤ N: 4)

It was reasonable to use negative binomial model to model the frequency of traffic information uses at the home-to-work trip because α was significant value. However, in case of the work-to-home trip, because α was not feasible at significant level, Poisson regression model was used.

In work-to-home trip, the sign of the logarithm of average travel time was positive, implying that if travel time was long, drivers used more often pre-route and en-route information. Driving experience and the ratio of private car use had positive sign at the frequency model of work-to-home trip but they had negative sign at the switching models of work-to-home trip. This indicates that commuters who have many driving experience and use private car more frequently, even though they obtain traffic information often, are not willing to divert.

6. CONCLUSION

In this study, the relative importance of factors influencing on commuters' switching behavior such as departure time and route change was analyzed using binomial probit model, and the frequency that commuters use traffic information was analyzed using count models such as negative binomial and Poisson regression model. The factors were categorized into five types such as individual attribute, trip attribute, network characteristics, workplace characteristics and traffic information.

The main advantage of this research is that it can directly know differences from commuters' switching behavior for home-to-work and work-to-home trip, and provide the insight into relative effects of factors on the frequency of traffic information uses. The findings are summarized as follows.

- The traffic information has significantly positive influence on commuters' switching behavior. Drivers who obtain pre-route information are willing to change the departure time.
- In home-to-work trip, departure time change is mainly influenced by workplace characteristics, which indicates that departure time change in home-to-work trip is determined by restrictions of workplace rather than a delay on the ordinary route.
- The route change is mainly influenced by trip characteristics such as the number of alternative routes and personality as well as network characteristics.
- In the frequency model of traffic information uses, commuters who have fixed work hour use traffic information more often than ones who have flexible work hour. Especially, commuters who have many driving experience and use private cars more frequently are not willing to divert, even though they obtain traffic information.

The insight into departure time and route change in commute trip provides the important hints to disperse peak time concentration temporally and spatially. In addition, by understanding commuters' characteristics of traffic information uses, it may be possible to apply ATIS to real traffic conditions efficiently.

ACKNOWLEDGEMENTS

This research was aided by the Engineering Research Institute of Seoul National University.

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