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How does Commuting Behavior Change Due to Incentives? An Empirical Study of the Beijing Subway System

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Abstract

This study examines the impact of incentives on commuters' travel behavior based upon a questionnaire survey conducted on the Beijing Subway System. Overall, we find that giving incentives to commuters, especially fast food restaurant-related services and reduced ticket fares, has a positive influence on morning rush-hour avoidance. Furthermore, using interaction analysis, we discover that the flexible work time schedule has an impact on commuters' behavior and the efficiency of the subway system. Finally, we recommend two possible policies to maximize the utility of the subway system and to reduce congestion at the peak of morning service: 1) a set of incentives including free wireless internet connection service with a coupon for breakfast and a discount on ticket fares before the morning peak, and 2) the introduction of a flexible work time schedule.

Keywords: Behavior, Incentives, Morning Peak, Commute, Beijing Subway System, Flexibility

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1. Introduction and Background

In accordance with rapid economic development and urbanization, transportation-related environmental problems such as congestion, car exhaust pollution, and noise pollution, have plagued many large cities in China. According to the Chinese Academy of Social Sciences, the social cost caused by crowdedness in Beijing was 14.6 billion Yuan, which is more than 1% of the GDP in 2010 (Zhang, 2006).

A subway system is regarded as one of the most effective tools to solve these transportation-related environmental problems (Tang et al., 2008). The subway system has been extensively developed in recent years in China (Jiang, 2008; Jong, et al. 2010). To encourage people to choose the subway for transportation over other means such as automobiles, since Nov 7th, 2007, Beijing has set the price of traveling by subway at 2 Yuan per trip regardless of the distance traveled or the number of times transferred. This price is lower than the price in other cities in China. Nevertheless, this affordable ticket has also resulted in significant crowds during rush hours. In more than 30 stations in the Beijing Subway System, the passenger flow boarding the train is restricted in order to heighten safety and leave enough space for the next stations. Consequently, dozens of commuters choose other ways to commute to their workplaces so that they do not have to wait for a long time or take a crowded train.

However, the load rate of the train is still approximately 135%, which is the same level as Sydney and Osaka. Excess demand on the transportation system and crowding on the platform staircases of subway stations have considerable external costs such as noise pollution, subway user safety, and psychological problems such as commuting stress (Mayeres et al., 1996; Jiang et al., 2009; Sposato et al., 2012; Mahudin et al., 2012).

Although increasing the number of cars and expanding the subway network can be effective ways of enhancing the subway capacity, these solutions are limited due to factors such as the existing lines and space of the system and technical limitations. In addition, such methods require extensive capital investments and time from feasibility studies to accomplish. There are cases in other cities that encourage commuters to take early subway trips, such as Early-Bird-Ticket in Melbourne, Australia, that has been available since 2007 and the Breakfast-Exchange Certificate in Shenzhen, China, that was introduced in 2011. Under these policies, the peak commuter flow has been flattened to some extent. Therefore, promoting off-peak time commuting is considered a quicker method that requires less investment to address this problem.

Encouraging off-peak commuting can be considered a conversion of commuting time and is a type of behavior modification for a commuting individual. Some pricing mechanisms emerge through primary studies for further consideration in managing peak demand for transportation as shown in Table 1, and these mechanisms mostly involve stated preference (SP) experiments:

Table 1 Literature Review

About here

One set of experiments concerns the willingness to pay (WTP) for travel time and the travel time reliability (Bhat & Sardesai, 2006; Hollander, 2006; Whelan & Crockett, 2009). Three types of empirical models designed to capture travel time reliability (the mean-variance model, the scheduling model, and the mean lateness model) are presented, in addition to relevant theoretical issues, experimental design, and practical applications, which show that travel time variability has a significant impact on travelers' decision making.

The WTP mechanism is also used to reduce crowding (Bates et al., 2001; Douglas & Karpouzis, 2005; Li & Hensher, 2011). Three measures are used to evaluate crowding (a time multiplier, a monetary value per time unit and a monetary value-per-trip). While a number of different types of crowding in terms of location are determined (namely in-vehicle, access-way, entrance and platform/ station crowding), the majority of reviewed studies investigate only in-vehicle crowding. The reduction of crowding is important for improving the attractiveness of public transportation.

In addition, money or other forms of rewards have been used as an incentive for rush-hour avoidance (Ben-Elia & Ettema, 2011). Different levels and types of rewards were applied and behavior was tracked with the latest detection equipment by Ben-Elia & Ettema (2011). Specific incentives, including socio-demographic characteristics, scheduling constraints and the flexibility of working hours, habitual behavior, attitudes towards commuting alternatives, providing tourist information, and even the weather, have contributed to reducing traffic, encouraging travel during off-peak hours and increasing the stock of public transportation.

There are also some services provided as incentives, such as the availability of grocery stores and childcare near stations (Bhat & Sardesai, 2006). Bhat and Sardesai (2006) show four different travel modes in form for each alternative part. Such services near a station are effective in encouraging commuters to choose railway to a limited extent.

Figure 1 Research Framework

About here

Factors affecting a traveler's traffic time choices are the basis of these studies (see Figure 1.). Due to their complexity, several researchers have divided the complicated factors into three categories: personal

information, travel information and incentives (Ben-Elia & Ettema, 2011; Hollander, 2006; Bates et al., 2001; Bhat & Sardesai, 2006; Douglas & Karpouzis, 2006; Whelan & Crockett, 2009). The same division will be used in this research.

From previous studies, the shift in the departure time of commuters is often strongly influenced by the flexibility of their work schedule. A number of researchers have noted that it might be a good approach to focus on the relationship between work time flexibility and traffic management (Brewer, 1998; Saleh & Farrell, 2005; D'Ariano et al., 2008). Therefore, we need to determine whether commuters are using flexible time schedules and what role it plays in the choice of time shift due to incentives. Additionally, as discussed previously, there are several studies focusing on the utility of monetary rewards (Ben-Elia & Ettema, 2011), time reliability (i.e., Hollander, 2006) and other types of incentives (i.e., Bhat & Sardesai, 2006).

However, these studies have rarely covered the combination of all of the different types of incentives. Thus, it is hard to provide an easy prediction of which one is the best. Overall, we think more people want to take earlier subway trips and avoid the morning peak when they can obtain several incentives. Meanwhile, the performance of each incentive might be different. For instance, commuters might be easily influenced by the commuting allowance in the money case and by the time spend waiting for the train in the time and congestion case. To date, there is still a lack of understanding and knowledge as to how these incentives can be grouped while taking into account their interdependence to form the best combination of policies to smooth the peak hour rush. Hence, the main objective of this paper is to identify the mediating factors and the possible moderators.

The remainder of the paper is organized as follows: Section 2 explains the methodology and modeling of the commuters' choice behavior; Section 3 describes the design of the pilot study and data collection procedures; Section 4 presents the results of the analyses, and Section 5 concludes with suggestions of policy implications and directions for further research.

2. Methodology and Model

Our study examines a set of interrelated conservation practices, in which it is likely that the decision to adopt one practice is correlated to other conservation management decisions. Here, we examine M (Money, including ticket fare before 6.30 a.m. as well as between 6.30 a.m. and 9.00 a.m.), T (Time and Congestion, including time saving, less crowded and having a seat), F (Fast Food Restaurant Service, including free drink, coupon for breakfast and free WIFI, the wireless internet connection service), and C (the combination of all eight incentives).

To determine the relationship between different types of incentives as well as the most significant factor impacting commuters, we need to build a model to make a quantitative analysis. There are previous studies using the Multivariate Probit Model that aim to determine how people respond to congestion mitigation policies due to three travel-related strategy bundles (Choo & Mokhtarian, 2008), how environmental stringency influences adoption of best management practice in agriculture in eight different cases (Kara et al., 2008), or how interviewing impacts the reporting of domestic violence in three cases (Allen, 2009).

In our case, we estimate the following multivariate probit regression model for each commuter "i" choosing different incentives "j",

$$Y_{ij}^{*} = \beta_j^{'} X_{ij} + \varepsilon_{ij}\ ,\ i = 1, \dots, n,\ j = 1,2,3,4$$

$$Y_{ij} = 1\ if\ Y_{ij}^{*} > 0\ and\ 0\ otherwise$$

Here, Y_{ij} is an unobserved variable representing the latent utility of each set of incentives (money, time and congestion, fast food restaurant service, and the combination). X is the matrix of independent variables hypothesized to be relevant factors (i.e., gender, age, income, education, allowance, flexible work schedule, duration of wait, and psychological factors influencing commuters' behavior, such as habit and attitude towards perceived benefits). β_j is a vector of unknown coefficients to be estimated. ε_{ij} denotes the error terms with multivariate normal distribution with a mean of 0 and variance of 1.

We have four equations that are individual probit models with the same functional form and the same set of independent variables. The error terms of conservation practices are assumed to be related to each other. In this way, a multivariate probit model can be regarded as a system of four seemingly unrelated probit models.

The simulated maximum likelihood technique (SML) is used to estimate our model. As Greene (Greene, 2002) emphasized, SML estimation has been used by an increasing number of studies (e.g., Cooper, 2001; Belderbos et al., 2004). Following Cappellari and Jenkins (Cappellari & Jenkins, 2003), our multivariate probit models are estimated using the Geweke-Hajivassiliou-Keane (GHK) simulator in Stata. Four dimensional normal probability distribution functions are simulated to evaluate multivariate probit likelihood functions. Multivariate normal probabilities are calculated after several iteration steps of the simulation using the GHK simulator. Similar to the maximum likelihood estimator, the SML estimator is asymptotically consistent. Simulation bias will be minimized as the number of observations and the

numbers of random draws increase (Cappellari & Jenkins, 2003).

3. Data

By conducting field research via the questionnaire survey, we have collected three types of information from commuters: 1) personal information, 2) time information and 3) incentives. The objective of the first part is to obtain personal information from commuters such as gender, age, annual income, commuting allowance and schedule flexibility.

The second part includes travel time information and the reasons for not taking earlier subway trains. The respondents were asked the time they begin work, get up, arrive at the departure station, board the train, and arrive at their workplace. They would be divided into two groups by whether they get on train before 6.30 a.m. or not. Based on the actual situation in Beijing, most commuters take the subway after this time. Then, only those who get on train no earlier than 6.30 a.m. would be asked to answer this multiple choice question about why they do not take an earlier train: hate to get up earlier, have nothing to do if arriving at their workplace too early, no buses or subways if departing too early, and needing to coordinate with other family members. These answers would be listed as alternatives to provide a proof of travel time shifting behavior.

The last part is incentives, which is the core of this research (see Appendix). There are cases in other cities that encourage commuters to take early subway trains such as the Early-Bird Ticket in Melbourne and the Breakfast-Exchange Certificate in Shenzhen. According to prior research and based on the conditions in Beijing, four incentives will be offered in this survey.

Asking too many questions might bore respondents and make them answer questions at random; therefore, we put respondents in four groups to obtain more accurate results. We define several sectors in each type of incentive. Table 2 shows the description of each incentive sector in case M, T, F, and C

Table 2 Description of each incentive sector in case M, T, F, and C

About here

There are 36 passenger-flow-limited stations out of 172 total stations in Beijing as of Dec 30th, 2011. Most of the limited-time is from 7.00 a.m. to 9.00 a.m. Although commuting at peak time includes departure before and after peak time (Ben-Elia & Ettema, 2011), it is difficult to arrive at the work place later without a flexible working system. Hence, respondents who get on the train no earlier than 6.30 a.m. would be asked in this research if they want to take subway to work before 6.30 a.m. Meanwhile, the

incentives of money and services would last until 9.00 a.m. We designed four types of incentive sets for this research: M, T, F, and C (Money, Time & Congestion, Fast Food Restaurant Service and a Combination of all Incentives)

Case M is defined as the differentiation of ticket fare for off-peak and peak time trains. The ticket fare can affect ridership (Voith, 1997; Chen et al., 2009). Because the subway ticket fare is relatively low in Beijing (2 Yuan), we will discuss the effect of an increase in fare, examining whether such an increase will encourage more commuters to use the subway or not. From the perspective of price elasticity, if we decrease the price by 1/2 or increase to 2 or 3 times the original price, it will be easier to determine the influence of the ticket price on commuters when making their transportation choices.

There are two sides of T case: the time spent waiting for trains and the reduction of train congestion. Time is valuable to commuters (Douglas & Karpouzis, 2006; Whelan & Crockett 2009). One of the most significant advantages of the subway system is time reliability. Currently, passengers at the passenger-flow-limited stations have to wait for a long time. Assuring passengers with guaranteed shorter waiting time for trains during off-peak hours might serve as another incentive for them to commute earlier.

Crowding is usually accepted as a possible threat to the health of both the rail industry and the passengers (Cox et al., 2006). Cases can be found in which passengers are willing to pay more in exchange for less congestion and greater comfort while traveling around (Hollander, 2006; Bates et al., 2001, Bhat & Sardesai, 2006).

Case F focuses on the fast food restaurant service at the arrival station. Adapting from the case in Shenzhen, it might be helpful to cooperate with fast food restaurants to offer special service to those who depart before peak time near the subway stations in Beijing. In this research, they can receive a free drink, a coupon for breakfast (only available this morning) and free WIFI until 9 a.m.

Case C analyzes the combination of all incentives. In this case, we choose four or five incentives and make the strength of all of the choices similar to respondents by adjusting their levels (like 30%, 50%, and 70% discount of coupon).

In this study, each respondent would be asked to answer four difficult cases (Money, Time & Congestion, Fast Food Restaurant Service and Combination of all Incentives). Respondents need to answer if they would change their time of day for commuting on each question (see the last question in the Appendix).

Commuters who are taking the subway to their workplace are the targets of this research. Because the network of the Beijing subway system is not extremely large and it is hard to smooth the passenger flows by only focusing on a few stations or one line, the questionnaires have been set to include all of the stations of Beijing subway system.

We will use an Internet-based method to conduct this experiment. The data can be entered through the questionnaire survey website and the link posted on some other subway-related sites and forums. A total of 742 valid samples were collected from 2,099 website views from February to May 2012. The collection rate is 35.35%. Additionally, 689 out of the 742 persons who depart after 6.30 a.m. provided valid responses to be used for analysis in this research.

Table 3 and Table 4 show the descriptive statistics on personal information, travel information and incentive choices. More than half of all respondents consider the most difficult thing for them to take earlier subway trips is that they dislike getting up earlier. On the contrary, fewer people think it is hard for them to change their habits. Generally speaking, more people want to take earlier subways to avoid the morning peak if they can receive incentives.

Table 3 Descriptive Statistics on Personal information and Travel information

About here

Table 4 Descriptive Statistics on Incentive Choices

About here

4. Results and Discussion

Table 5 shows the estimation results. Basically, the older male subjects with less education are easily influenced by the incentives. Commuter departure time is hard to shift in cases M and C because commuters can receive the commuting allowance from their workplace. People with a flexible time schedule are not attracted by the incentives more than others as they feel they receive few benefits from this shifting.

Table 5 Multivariate probit analysis of each case: no interactions

About here

From Table 4, we find that the preference on each type of incentive group is F (64%)>C (61%)>M (59%)>T (44%). Commuters prefer fast food restaurant service rather than other services. As we have predicted in Hypothesis 1, case F is so attractive that commuters prefer it to the combination case which makes the fast food restaurant less significant and the other types of incentive more substantial. With today's faster pace of life, a growing number of Chinese people eat their breakfast out instead of at home.

There are many different breakfast carts and restaurants providing fast food in the morning in Beijing. Thus, offering a set of fast food restaurant services can be considered an effective incentive. Money-related incentives always become an important factor for people's activity (Ben-Elia & Ettema, 2011); however, this effect is not so obvious in Beijing. That is because the ticket fare in Beijing is relatively low compared with other cities. Because of this, even increasing the ticket fare to three times its original price is not a heavy expenditure for dozens of commuters. Only the time and congestion case is preferred by less than half of the respondents. Although it is time consuming to wait for the train in the hall, commuters are still able to know the total time it may take to arrive at the workplace. In addition, because the average waiting time for a train is 8.23 minutes (see table 3), which is not high, commuters do not seem to mind the wait. As a high-capacity mode of transportation, a subway system is built for high passenger flows. Thus, commuters often do not expect they will be comfortable in most cities in the world.

The variables "mafter_bef" and "cafter_bef" stand for whether it is more attractive to change ticket fares after 6.30 a.m. rather than before 6.30 a.m. in case M and case C (similarly hereinafter). From the coefficient number and p-value, we know that it is not more attractive to change the ticket fare after 6.30 a.m. (until 9.00 a.m.) than before 6.30 a.m. in case M, but there is no clear connection in case C. It is said that the ticket fare in Beijing is too low to make the market mechanism work smoothly. However, our results do not suggest that increasing the ticket fare during the morning peak (from 6.30 to 9.00 a.m.) is a good method. At first, our results show that people are more motivated when given something as a reward rather than a punishment. Moreover, some passengers might tend to use another mode of transportation for commuting instead of taking an earlier subway trip, which would be a negative result for morning transportation.

The relationship between the waiting time and reduction of crowdedness is not significant in case T. A decrease in the waiting time and degree of crowdedness could be considered as contradictory factors. If people want to save time waiting for the train, they have to share the train with more people during the morning peak. In this study, neither of these factors gains preference, as this type of incentive is not attractive to commuters for time shifting.

It is more effective to assure a seat for commuters than reduce the crowdedness in the train in case C, but there is no clear connection in case T. On the other hand, commuters are attracted by having a seat rather than by reducing the crowdedness only. People do not consider a seat as an important factor for changing time and congestion only, but they do in the combination case including all incentives. When taking trains, having a seat can make passengers feel much better and more comfortable than reduced the crowdedness only (Cox et al., 2006). However, it is a bit difficult for the Beijing subway system to provide

this service via shortening the start interval or designating a special car with an extra ticket like the "Green Car" in Japan, for the limitation of a small number of cars.

We cannot see an obvious difference between offering a free drink with a coupon and giving only a coupon in case F. A small free drink does not create any attraction for commuters. Although people can rest freely in the restaurant after getting the free drink until their work time, they still do not have enough things to do there.

Providing free WIFI with a coupon creates a very good effect in both case F and case C. Since 2011, free WIFI has no longer been offered in fast food restaurants in Beijing. Therefore, free WIFI becomes one of the most attractive incentives to make commuters shift their departure time. It can be regarded as a lounge for commuters to have not only breakfast but also to relax for a moment. Thus, WIFI is an attractive incentive both in the fast food restaurant case and the combination case.

The ρ value shows the relationship between two incentives. For example, if ρ_{ab} is negative, it means people who choose "a" will hardly choose "b". From Table 5, we can see that there are no conflicts among all incentives (all of them are positive). The weakest relationship is between money case and time and congestion case, while the strongest is between the fast food restaurant case and the combination case.

It has been noted that a shift in the departure time of a commuter is often strongly influenced by the commuter's use of a flexible work schedule. Some results are not sufficiently explained without considering the effect of flexibility. Therefore, a new scenario has been conducted in this study by putting interaction variables based on flexibility into the model (see Table 6).

Table 6 Multivariate probit analysis of each case: interactions based on flexibility

About here

We had predicted that commuters are easily impacted by the time spent waiting for the train in the time and congestion case before conducting the questionnaire. However, from the no-interaction results, the time spent waiting for trains is not a significant motivator for commuters to shift their departure time. In contrast to the interaction results, commuters using a flexible schedule are easily impacted by this factor. A reasonable explanation for the negative value is that commuters using flexible work time schedules have already chosen an appropriate travel time to avoid the peak. If they still have to wait for a long time for the train at that moment, it means they are less able to change their time schedule. Thus, the more time they wait, the less the incentive works. It not only gives a reasonable interpretation on this issue but also shows

that making the work time schedule flexible may lead commuters to avoid the morning peak altogether to shorten their time spent waiting for trains.

On the questionnaire, respondents were asked to choose yes or no based on whether they think it is difficult to take an earlier subway because there are no benefits to doing so. Under the no-interaction condition, most people think it is an important factor for them. However, under the interaction condition, people using a flexible work time schedule do not consider the lack of benefits when making a choice because they can start and finish their work earlier without any type of loss.

Similarly, this thought is also partly divided on whether commuters have to coordinate their morning schedule with other family members' time. Commuters using a flexible work time schedule can coordinate with their family members' time far more easily.

5. Conclusion Remarks

In this study, we examined the impact of incentives on commuters' travel behavior based on an empirical analysis of the Beijing Subway System during the morning peak. Although each incentive shows a different characteristic, we find a relatively positive impact on morning rush-hour avoidance when giving commuters incentives. Furthermore, we find that the flexible work time schedule has a significant impact on commuters' behavior, as shown by an interaction analysis.

We already know the subway system is an effective way to solve the crowdedness and transportation-related environmental problems. Nevertheless, only expanding the system but not considering the supporting policies will tend to yield an unsatisfactory result. To achieve the goal of utility maximization on the subway system and smooth congestion during the morning peak, we make the following policy recommendations.

Firstly, free WIFI with a coupon and a discount on the ticket fare could be an attractive set of incentives to commuters. From the results of this study, giving incentives such as a coupon, free WIFI and a discount on ticket fare is a good way to encourage commuters to shift their departure time in Beijing. Because the necessary resources might not be sufficient, the coupon and free WIFI could be offered in a limited quantity to the earlier users depending on the scale of the station and fast food restaurants.

Secondly, the introduction of the flexible work time schedule could be another approach to solve this problem. The activity of commuting is strongly impacted by the flexibility of the commuter. By introducing a flexible system, the efficiency of the subway system might become higher than before. Incentives and flexibility are two different ways to solve the same problem of the morning peak in the Beijing subway. Therefore, it may be a good strategy to consider a set of policies incorporating these two opinions.

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Table 1 Literature Review

Study	Incentive(s)	Mode	Location	Trip purpose	SP	Information shown in survey
Hollander 2006	Time	Bus	UK	Commute	SP	Fare, preferred arrival time, travel time variation
Bates et al. 2001	Time	Train	UK	n/a	RP/SP	Fare, scheduled departure time and arrival time, preferred arrival time
Bhat and Sardesai 2006	Time and Service	Multi-modes	US	Commute	SP	Fare, travel time variation, grocery store & child care near station
Douglas and Karpouzis 2006	Congestion	Train	Australia	Commute mainly	SP	Seat (uncrowned or crowded) or stand for a number of minutes
Whelan and Crockett 2009	Congestion	Train	UK	Commute, business, education, other	SP	Number of standing passengers and the proportion seated
Eran Ben-Elia 2011	Financial	Car	Netherlands	Commute	SP	Reward of Money, Yeti(Mobile phone) of rush hour

Table 2 Description of each incentive sector in case M, T, F, and C

	Description
mafter_bef	It is more attractive to change ticket fare after 6.30 than before 6.30 in case M (mafter_bef=1)
ttime_cro	It is more attractive to save time than lessen crowdedness in case T (ttime_cro=1)
tcrowd_seat	It is more attractive to take a seat than lessen the crowdedness only in case T (tcrowd_tseat =1)
fdrink_coupon	It is more attractive to offer free think with coupon in case F (fdrink_coupon =1)
fWIFI_coupon	It is more attractive to offer free WIFI with coupon in case F (fWIFI_coupon =1)
cafter_bef	It is more attractive to change ticket fare after 6.30 than before 6.30 in case C (cafter_bef=1)
ccrowd_seat	It is more attractive to take a seat than lessen the crowdedness only in case C (ccrowd_tseat =1)
fdrink_coupon	It is more attractive to offer free think with coupon in case F (fdrink_coupon =1)
cWIFI_coupon	It is more attractive to offer free WIFI with coupon in case C (cWIFI_coupon =1)

Table 3 Descriptive Statistics on Personal information, Travel Information

Variable	Description	Sample /Mean	Proportion/ SD
Personal Information			
gender	Male(gender =1)	390	57%
	Female(gender =0)	299	43%
age	Age	34.73	8.08
income	Annual income	65809.87	34155.98
education	Under College	202	29%
	College	186	27%
	Bachelor	205	30%
	Over Bachelor	96	14%
allowance	Have(allowance=1)	108	16%
	Not Have(allowance=0)	581	84%
flexible	Flexible Work Schedule(flexible =1)	70	10%
	Fixed Work Schedule(flexible =0)	619	90%
Travel Information			
wait	Time for waiting the train	8.23	3.57
habit	I find it is difficult for me to change my habit(Yes=1)	62	9%
	I find it is difficult for me to change my habit(No=0)	627	91%
nomerit	No merits even if getting up earlier(Yes=1)	76	11%
	No merits even if getting up earlier(No=0)	613	89%
wake	Hate to get up earlier(Yes=1)	352	51%
	Hate to get up earlier(No=0)	337	49%
nothing	Closed or have nothing to do if arrived too early(Yes=1)	148	21%
	Closed or have nothing to do if arrived too early(No=0)	541	79%
match	Need to consider of other family members' time(Yes=1)	171	25%
	Need to consider of other family members' time(No=0)	518	75%

Table 4 Descriptive Statistics on Incentive sectors

Incentive Sectors			
Variable	Description	Sample /Mean	Proportion/ SD
M	Change depart time in Money case(m=1)	404	59%
	Not change in Money case (m=0)	285	41%
T	Change depart time in Time and Congestion case(t=1)	303	44%
	Not change in Time and Congestion case(t=0)	386	56%
F	Change depart time in Fast Food Restaurant Service case(f=1)	439	64%
	Not change in Fast Food Restaurant Service case(f=0)	250	36%
C	Change depart time in Combination of all Incentives(c=1)	420	61%
	Not change in Combination of all Incentives case(c=0)	269	39%

Table 5 Multivariate probit analysis of each case: no interactions

	Money			Time and Congestion			Fast Food Restaurant			Combination		
	Mean	SD		Mean	SD		Mean	SD		Mean	SD	
Personal Information												
gender	-0.012	0.107		0.211	0.101	**	0.412	0.099	***	0.424	0.100	***
age	0.032	0.008	***	0.006	0.007		0.027	0.007	***	0.019	0.007	***
income	5E-6	2E-6	**	-3E-6	2E-6		3E-7	2E-6		-1E-6	2E-6	
education	-0.260	0.065	***	-0.125	0.065	*	-0.045	0.060		-0.112	0.062	*
allowance	-0.413	0.150	***	0.025	0.144		-0.159	0.138		-0.480	0.140	***
flexible	-0.784	0.180	***	-0.485	0.187	***	-0.326	0.173	*	-0.543	0.172	***
Travel Information												
wait	0.040	0.015	***	-0.019	0.015		0.016	0.015		0.026	0.015	*
habit	-0.241	0.200		-0.342	0.189	*	-0.580	0.180	***	-0.270	0.179	
nomerit	0.639	0.192	***	0.268	0.162	*	0.449	0.176	**	0.425	0.176	**
wake	-0.119	0.123		-0.015	0.119		0.259	0.121	**	0.170	0.117	
nothing	0.007	0.141		0.584	0.137	***	0.359	0.140	***	-0.077	0.134	
match	0.247	0.140	*	0.442	0.132	***	0.638	0.143	***	0.228	0.134	*
Incentive Sectors												
mafter_bef (cafter_bef)	-0.709	0.110	***	-	-	-	-	-	-	-0.159	0.146	
ttime_cro	-	-	-	-0.054	0.117		-	-	-	-	-	-
tcrowd_seat (ccrowd_seat)	-	-	-	0.059	0.145		-	-	-	0.356	0.146	**
fdrink_coupon	-	-	-	-	-	-	-0.191	0.128		-	-	-
fWIFI_coupon (cWIFI_coupon)	-	-	-	-	-	-	0.379	0.117	***	0.446	0.204	**
ρ_{21}							*0.224* ***					
ρ_{31}							*0.577* ***					
ρ_{41}							*0.495* ***					
ρ_{32}							*0.615* ***					
ρ_{42}							*0.419* ***					
ρ_{43}							*0.655* ***					

Note: *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

Table 6 Multivariate probit analysis of each case: interactions based on flexibility

	Money			Time and Congestion			Fast Food Restaurant			Combination		
	Mean	SD		Mean	SD		Mean	SD		Mean	SD	
Personal Information												
Gender	-0.008	0.108		0.246	0.103	**	0.439	0.101	***	0.438	0.101	***
Age	0.031	0.008	***	0.005	0.007		0.028	0.007	***	0.019	0.007	***
Income	5E-6	2E-6	**	-3E-6	2E-6		6E-7	2E-6		-8E-7	2E-6	
education	-0.277	0.066	***	-0.135	0.066	**	-0.052	0.062		-0.120	0.062	*
allowance	-0.436	0.156	***	0.009	0.150		-0.252	0.143	*	-0.537	0.144	***
flexible	0.290	0.475		-0.301	0.613		0.952	0.478	**	-0.150	0.467	
Travel Information (No Interactions)												
wait	0.053	0.017	***	-0.009	0.016		0.021	0.016		0.030	0.016	*
habit	-0.106	0.223		-0.513	0.214	**	-0.535	0.205	***	-0.390	0.200	*
nomerit	0.737	0.228	***	0.311	0.181	*	0.833	0.223	***	0.515	0.201	***
wake	-0.048	0.135		-0.101	0.126		0.410	0.138	***	0.194	0.126	
nothing	0.029	0.157		0.606	0.147	***	0.516	0.162	***	-0.088	0.145	
match	0.257	0.147	*	0.361	0.138	***	0.674	0.156	***	0.193	0.139	
Travel Information (Interactions with Flexible)												
flx_wait	-0.083	0.044	*	-0.139	0.060	**	-0.072	0.045		-0.046	0.042	
flx_habit	-0.622	0.586		0.959	0.522	*	0.209	0.459		0.828	0.446	**
flx_nomerit	-0.619	0.447		-0.867	0.530		-1.581	0.448	***	-0.581	0.418	
flx_wake	-0.475	0.378		1.065	0.463	**	-0.676	0.379	*	-0.319	0.352	
flx_nothing	0.086	0.408		-0.079	0.451		-0.403	0.422		0.284	0.390	
flx_match	0.574	0.568		1.379	0.730		3.509	83.773		0.853	0.588	
Incentive Sectors												
mafter_bef (cafter_bef)	-0.707	0.111	***	-	-	-	-	-	-	-0.137	0.147	
ttime_cro	-	-	-	-0.019	0.118		-	-	-	-	-	-
tcrowd_seat (ccrowd_seat)	-	-	-	0.025	0.147		-	-	-	0.356	0.147	**
fdrink_coupon	-	-	-	-	-	-	-0.176	0.130		-	-	-
fWIFI_coupon (cWIFI_coupon)	-	-	-	-	-	-	0.452	0.120	***	0.434	0.205	**
ρ_{21}						*0.223* ***						
ρ_{31}						*0.572* ***						
ρ_{41}						*0.490* ***						
ρ_{32}						*0.629* ***						
ρ_{42}						*0.419* ***						
ρ_{43}						*0.650* ***						

Note: *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively

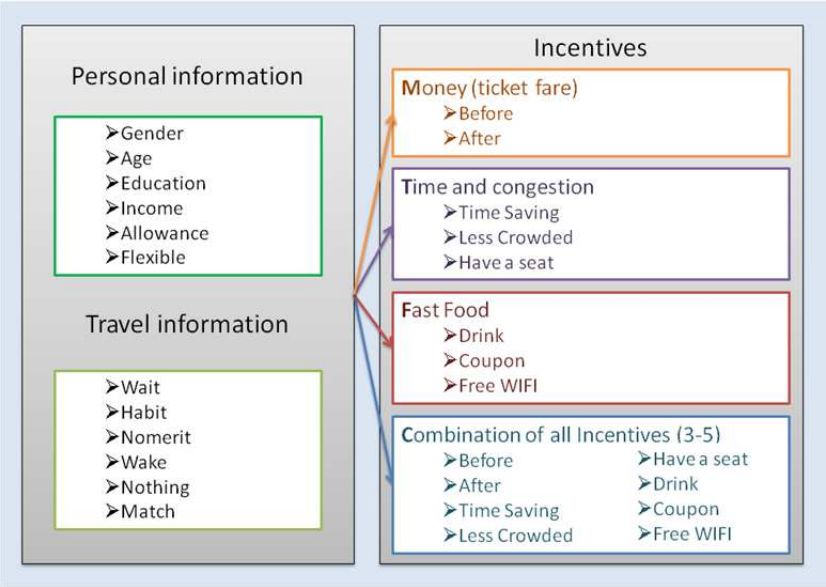

Figure 1 Research Framework

Appendix

Questionnaire Survey (Group 1, Brief Version)

1Your Gender □M □F

2Your Age _____

3 Your Occupation □Government and institution personnel □Business management personnel

□Project management personnel □Enterprise staff

⑤Worker ⑥Freelancer

⑦Other_____

4 Your Education Background □Under College □College □Bachelor □Over Bachelor

5 Your Annual Income _____

6 Does your workplace provide commuting allowance? □Yes □No

7 Does your workplace use flexible work schedule? □Yes □No

8 Name of departure station _____; Name of arrival station_____

9 Please write down the time you…

Begin to work	Get up	Arrive at subway station	Get on train	Arrive at workplace
Number of days you work every week	Number of days you commute by the schedule	Are the two days above accordance?		
1 2 3 4 5 6 7 Not fixed	1 2 3 4 5 6 7 Not fixed	Yes No, using cars No, taking buses No, riding bike or walking No, different schedule in different days No, not regularly No, other_____		

10 Your reason for not taking earlier subways (Please choose all that apply)

□I find it is difficult for me to change my habit □No benefits even if getting up earlier □Hate to get up earlier

□Workplace is closed or have nothing to do if arrived at workplace too early ⑤No earlier bus or subway available

⑥Need to take into account of other family members ⑦Other _____

11 Please indicate whether you will take subway before 6.30 am in each of the following cases. □Yes □No

Code	Ticket fare before 6.30	Ticket fare from 6.30 to 9.00	Time of Waiting for train	Congestion	Free drink from fast food restaurant (FFR)	Coupon for breakfast that morning in FFR	Free WIFI until 9.00 in FFR	Yes or No
T2222000	￥2	￥2	50% Saving	Have a seat	No	No	No	
C2400051	￥2	￥4	No	No	No	50% discount	Yes	
M2600000	￥2	￥6	No	No	No	No	No	
F2200130	￥2	￥2	No	No	100ml	70% discount	No	