CHANGE IN DRIVERS' PARKING PREFERENCE AFTER THE INTRODUCTION OF STRENGTHENED PARKING REGULATIONS

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ABSTRACT

Illegal parking is one of the factors that cause traffic congestion and traffic accidents. This results in social costs such as loss of time and loss of human resources. Due to these problems, the Japanese Road Traffic Law (RTL) was amended in 2006 with the intent to decrease instances of illegal parking. The main focus of this amendment consigned the role of checking illegally parked vehicles and processing parking tickets to the private sector. The National Police Agency of Japan reported that the number of illegally parked vehicles has decreased, and that use of the parking lots has increased. However, more than 50 thousand vehicles are still illegally parked in Tokyo at any one time. There is still a need to decrease illegal parking substantially. Therefore, this study analyzed drivers' preference for illegal parking before the amendment and after its introduction.
The questionnaire surveys were conducted before and after the amendment. A binary logit model was applied to estimate the parking place choice model. By comparing the elasticity among the estimated models, the difference in drivers' parking place preference was clarified.

Keywords: illegal parking, parking place choice model, parking policy

1. INTRODUCTION

Illegal parking is one of the factors that cause traffic congestion and traffic accidents. This results in social costs such as loss of time and loss of human resources. In June 2006, the

Japanese Road Traffic Law (RTL) was amended with the intent to decrease instances of illegal parking. The main points of the amendment are shown below.

1. The role of checking illegally parked vehicles and processing parking tickets was consigned to the private sector.

2. If a driver does not pay the illegal parking fine, the owner of the vehicle must pay the fine in place of the driver. Furthermore, if the owner doesn't pay the fine, it will be impossible that the vehicle under take the legal inspection.

First, the change in the illegal parking situation must be described. Figure 1 shows the number of vehicles fined for illegal parking in Japan. The number has drastically increased after the amendment of RTL in 2006. Meanwhile, Figure 2 shows the number of vehicles that are parked in restricted areas in Tokyo at any one time. This data indicates that the number has decreased after the amendment of RTL. However, more than 50 thousand vehicles are still being parked illegally in Tokyo. There is still a need to decrease illegal parking substantially. Therefore, this study analyzed drivers' preference to park illegally before the amendment and after its introduction.

In chapter 2, previous studies related to parking behavior and parking policy are reviewed. In chapter 3, details of the questionnaire surveys conducted in this study are described. In chapter 4, differences in parking behavior according to socio-economic attributes and changes in consciousness of illegal parking behavior are analyzed. In chapter 5, the parking place choice model is estimated by applying a logit model, and the change in the preference of parking places is evaluated with an elasticity analysis in chapter 6. Finally, the results of this study are summarized in chapter 7.

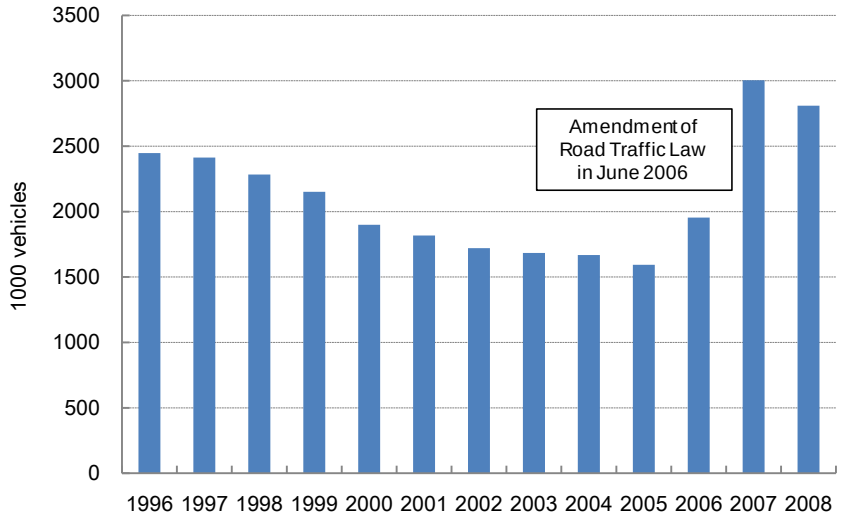

Figure 1 – Number of vehicles fined for illegal parking in Japan

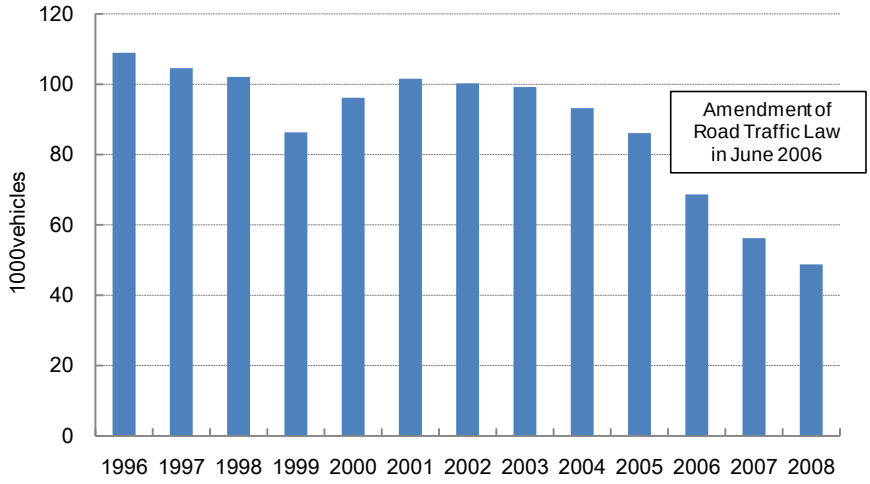

Figure 2 – Number of vehicles simultaneously parked in restricted areas in Tokyo

2. LITERATURE REVIEW

Previous studies that have investigated parking behavior and parking policy are reviewed in this chapter.

First, the studies that estimated the parking choice model are reviewed in order to obtain information on the explanatory variables of the model. Ergun (1971) estimated the parking place choice model by applying the logit model. It demonstrated that increases in parking fees incentivize illegal parking. Cullinane et al. (1992) showed that enforcement of illegal parking laws was essential to decreasing illegal parking. Meanwhile, Young et al. (1991) analyzed parking behavior in order to establish a parking policy. Furthermore, Norojono (2001) estimated the parking place choice model with the heteroscedastic extreme value model. It indicated that parking fees are an important factor in parking place choice, and it also showed that a 1% increase in parking fees would reduce the probability of using a parking lot by about 1%.

These studies analyzed parking behavior in specific cities; however, some studies compared parking behavior in multiple cities. For example, Hun et al. (1995) examined the characteristics of parking behavior at Pusan, Korea and Osaka, Japan, and they estimated the parking place choice model. The explanatory variables of the model were parking fees, distance between parking lots and destinations, waiting time for parking, frequency of illegal parking enforcement, expected parking time, gender, and occupation. As a result of the analysis, it was concluded that parking fees, distance between a parking lot and a destination, and waiting time were the main factors influencing parking place choice in both cities. Furthermore, Axhausen et al. (1991) analyzed the characteristics of parking behavior in Britain and Germany and estimated the parking place choice model by applying the logit

model. As a result of the analysis, parking lot access time, parking lot search time, egress time, and parking fees were considered to be explanatory variables. It was concluded that search time was the main factor influencing parking place choice. Katayama et al. (2003) considered the existence of illegally parked vehicles on the roadside to be an explanatory variable of the parking place choice model. Moreover, Katayama showed that an increase in the expectation of being fined for illegal parking was a key factor for decreasing illegal parking.

Second, the studies concerning parking policy and its evaluation are reviewed. Matsoukis (1995) introduced the privatization of the parking management system in Greece. Moreover, Matsoukis demonstrated the utility of privatization by comparing the parking situation before and after the amendment. On the other hand, Suzuki et al. (2007) and Hayashi et al. (2008) analyzed the change in parking behavior before and after the amendment of RTL. Suzuki et al. (2007) and analyzed the change in travel and parking behavior after the amendment of RTL. The results showed that the willingness to use public transportation instead of private car increased and that the resistance to paying parking fees and using parking lots far from the intended destinations decreased.

Hayashi et al. (2008) estimated the parking place choice model, which illustrated the change in drivers' consciousness of parking places before and after the amendment of RTL. However, the existence of illegally parked vehicles on the roadside was not considered to be an explanatory variable.

Therefore, this study prepared sufficient explanatory variables for the parking place choice model and investigated changes in drivers' consciousness of parking places before and after the amendment of RTL.

3. EXPLANATION OF SURVEY

Data was collected using questionnaire surveys in 2002 and 2008. These surveys were executed at the same place in Itabashi Ward, Tokyo. Furthermore, the same questionnaires were used to confirm any changes in the behavior and consciousness of drivers. In order to demonstrate the difference in parking behaviors between parking users and nonparking users, questionnaires were distributed to both drivers who parked illegally on the roadside and drivers who parked in off-street parking areas. Table I shows the outline of the survey.

Every respondent was asked to answer four kinds of questions. The subjects of the questions were "recognized causes of illegal parking," "expectation of being fined for illegal parking under given conditions," "driver's preference for parking place," and "driver's socio-economic attributes."

Table I – Outline of survey

Date	Before the amendment		After the amendment	
	Nov. 21– Dec. 2, 2002		Oct. 14 - Oct. 30, 2008	
Segments by parking places	Parking users	Nonparking users	Parking users	Nonparking users
No. of distributed questionnaires	500	500	500	500
No. of responded questionnaires	171	119	124	88
Return ratio	34%	24%	25%	18%

4. PARKING BEHAVIOR AND EXPECTATION OF BEING FINED

4.1 Difference in parking behavior by socio-economic attributes

The relationship between socio-economic attributes and actual parking behavior is examined in this section.

Figure 3 shows the difference in behavior by gender. As shown in Figure 3, male drivers tend to park illegally more often when compared with female drivers. Meanwhile, Figure 4 shows the difference in behavior according to whether a driver has been fined for illegal parking. Drivers that had the experience of being fined tended to park illegally more often when compared with drivers that had not been fine. Figure 5 shows the difference in behavior according to the perceived amount of the fine. The actual amount of the fine for illegal parking is JPY 15000. Drivers that over estimated the fine tended to use parking lots.

It is shown that several socio-economic attributes influence drivers' parking behavior. Therefore, these attributes will be considered as explanatory variables for the parking place choice model in this study.

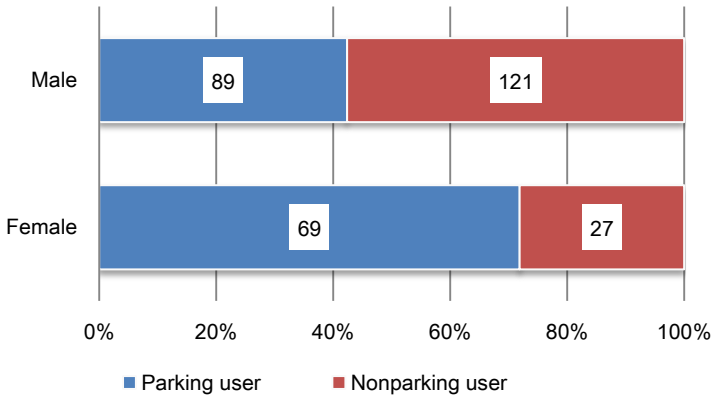

Figure 3 – Differences in behavior by gender

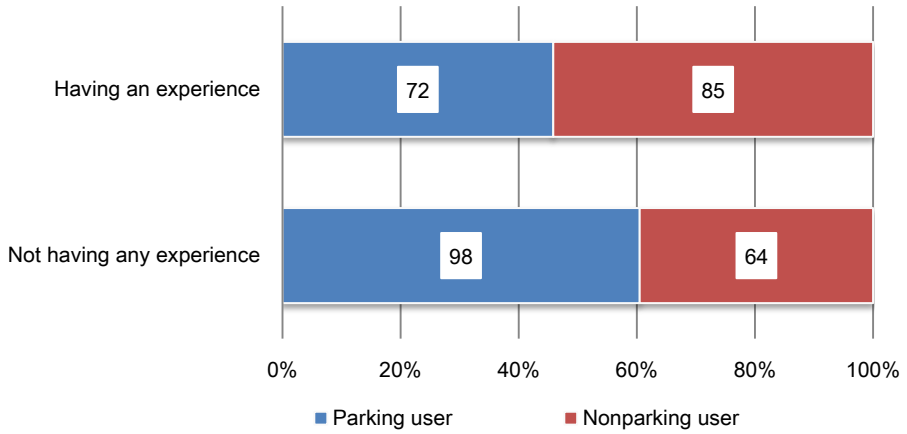

Figure 4 – Differences in behavior according to whether a driver has been fined

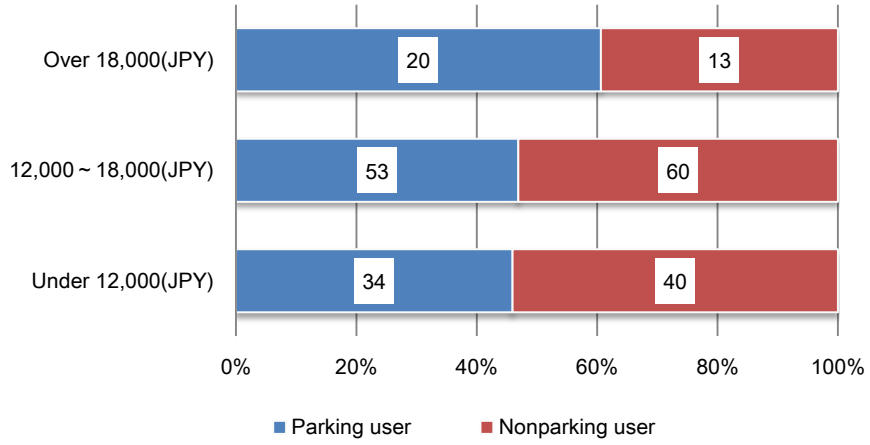

Figure 5 – Differences in behavior according to the perceived amount of the fine

4.2 Recognized causes of illegal parking

In this section, the recognized causes of illegal parking are examined. The level of appropriateness for each cause of illegal parking was evaluated by the respondents in the survey.

Figure 6 shows the results of the evaluation. The most recognized cause of illegal parking is "low expectation of being fined for short parking time," and the second most recognized cause is "long distance from a parking lot to a destination." Furthermore, "ease of parking on the roadside," "difficulty in finding a parking lot", and "expensive parking fees" are recognized as additional causes. Additionally, some drivers recognized "existence of other illegally parked vehicles" as a cause of illegal parking.

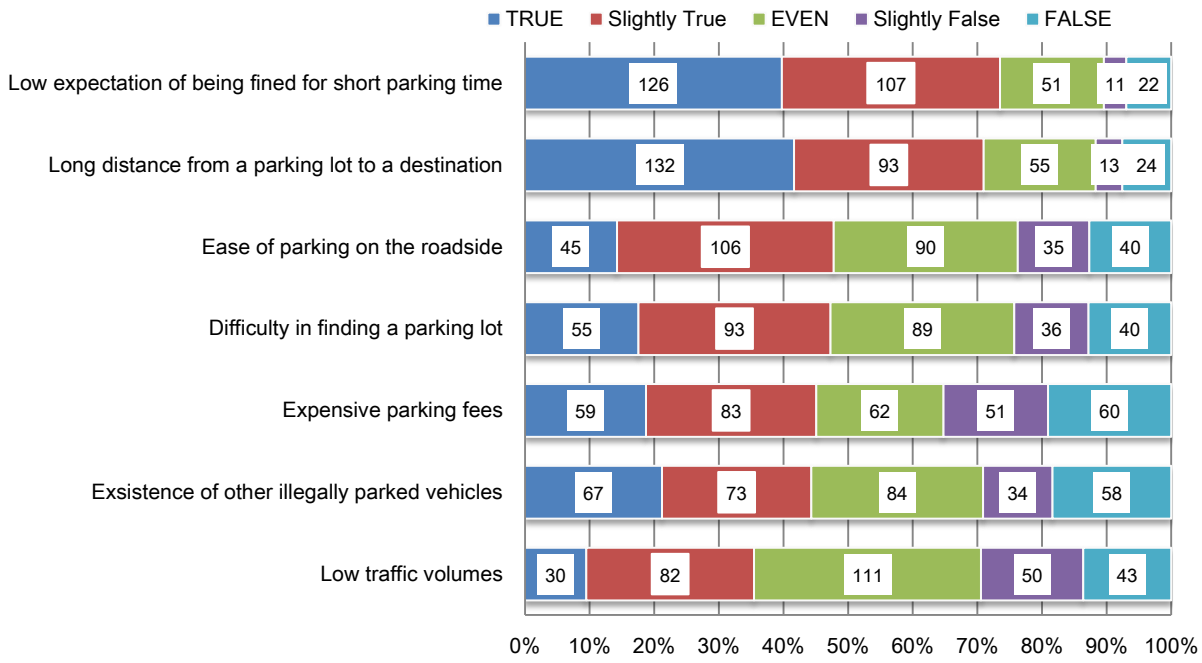

Figure 6 – Recognized causes of illegal parking

4.3 Expectations of being fined for illegal parking

In this section, drivers' expectation of being fined for illegal parking is analyzed. Figure 7 is a sample of a question concerning the expectation of being fined. Two photo montages with different numbers of illegally parked vehicles were shown to every respondent. Figure 8 shows the mean of the expectation of being fined that was derived from the 2008 data. As shown in Figure 8, the expectations rise with the extension of parking time and decrease with the number of illegally parked vehicles.

Table II shows a summary of change in expectations of being fined. The expectations under different conditions in terms of parking time and number of illegally parked vehicles are shown. In each cell of the table, the changes in expectation from 2002 to 2008 are shown. The expectations change according to "length of parking time" and "number of illegally parked vehicle(s) on roadside."
As seen in Table II, the expectation increased after the introduction of strengthened parking regulations.

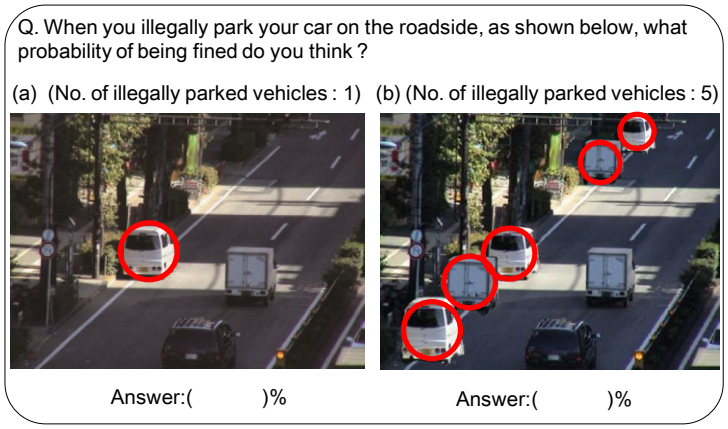

Figure 7 – Question on the expectation of being fined for illegal parking

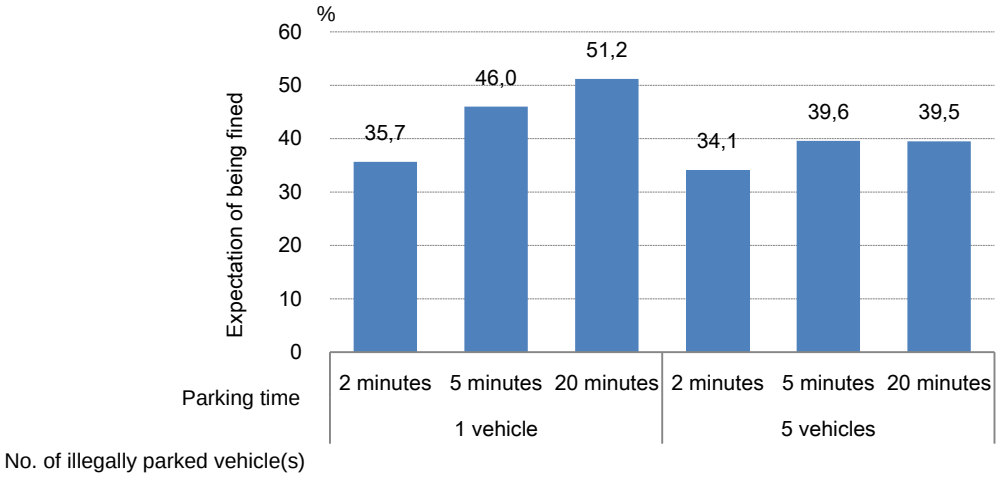

Figure 8 – Mean of the expectation of being fined

Table II－Change in expectations of being fined

		Parking time	
		5 minutes	20 minutes
No. of illegally parked vehicle(s) on the roadside	1	31.2% ⇒ 46.0% (47%)	37.0% ⇒ 51.2% (38%)
		**	**
	5	31.3% ⇒ 39.6% (26%)	32.0% ⇒ 39.6% (24%)
		*	-

Note:

Expectation in 2002 ⇒ Expectation in 2008 (change rate)
Statistical significance (*:5%, **:1%)

5. MODELING PARKING PLACE CHOICE BEHAVIOR

5.1 Stated preference survey

In this chapter, drivers' parking place preference is analyzed using stated preference data. Figure 9 is a question used in the survey. The respondents were asked to choose from two alternative parking places—off-street parking or illegal parking. Evaluation items were 1) parking fees, 2) walking time from the parking lot to the destination, 3) waiting time for parking, and 4) the number of illegally parked vehicles on the roadside. Table III shows the setting values for each evaluated item. Through the experimental design, eight questions with different setting values were prepared. All respondents were asked to answer these eight questions.

Figure 10 shows the flow of data preparation. The expectation of being fined is considered to be a factor in parking place choice. The same photo montages used in the fine expectation question was used in the SP survey. Thus, the answered expectation was used as an explanatory variable of the choice model.

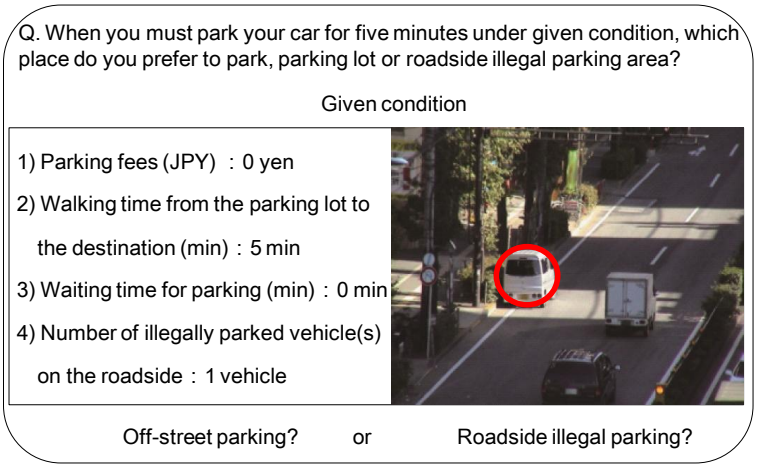

Figure 9 – Question of parking place preference

Table III – Level of each variable

Evaluation items	Unit	No. of levels	Level		
Parking fees	JPY	2	0	200	
Walking time from the parking lot to the destination	minutes	3	0	2	5
Waiting time for parking	minutes	2	0	5	
Number of illegally parked vehicle(s) on the roadside	vehicles	2	1	5	

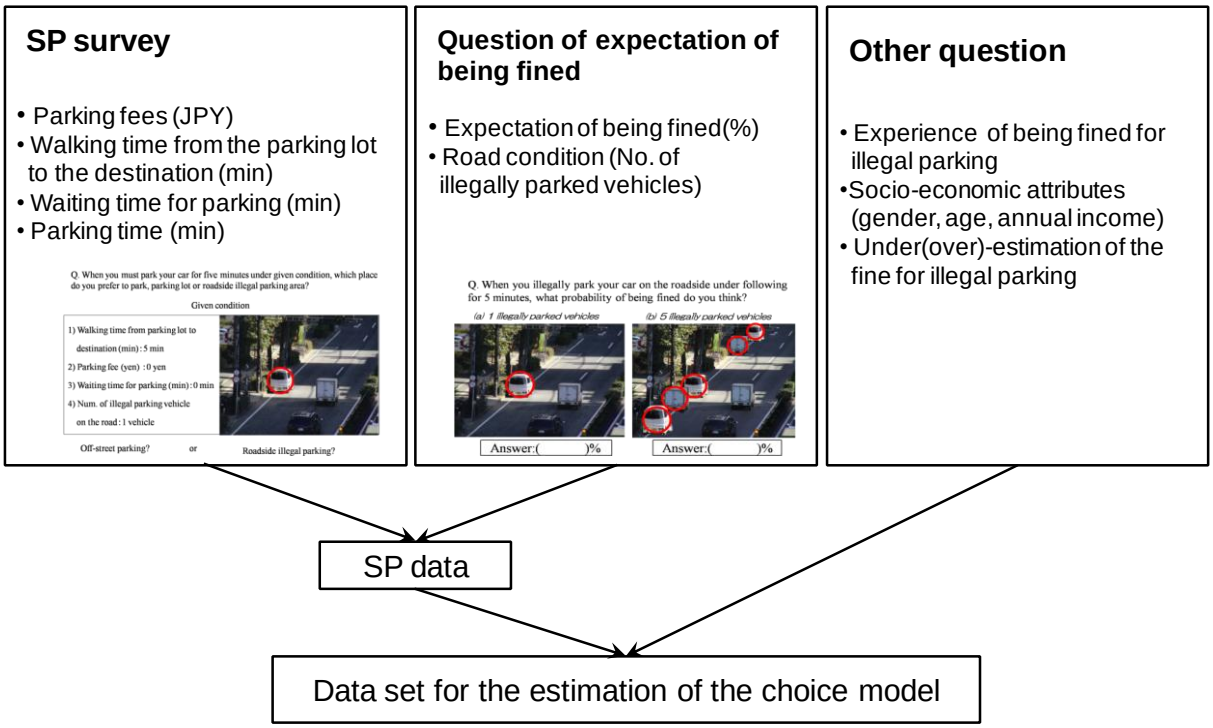

Figure 10 – Data preparation flow

5.2 Results of parameter estimation

Parking place choice model was estimated by applying a logit model. The model can describe the probability of a parking lot being chosen. Table IV shows the parameter estimation results. These models were estimated by each group segmented by surveyed year and actual parking place.

First, the signs of several parameters were verified. Since the signs of "parking fees," "walking time from a parking lot to a destination," and "waiting time for parking," are negative, increases in the values of variables concerning these parameters incentivize illegal parking.

Since the signs of "expectation of being fined" and "parking time" are positive, increases in the values of variables concerning these parameters incentivize legal parking. Therefore, the sign condition is reasonable.

Table IV – Parking place choice model

** : 1% significance , * : 5% significance

Explanatory variables	Parking user		Nonparking user	
	Before (in 2002)	After (in 2008)	Before (in 2002)	After (in 2008)
Parking fees (JPY 100)	–0.412**	–0.236**	–0.612**	–0.466**
Walking time from a parking lot to a destination (min.)	–0.081	–0.048	–0.146**	–0.132**
Waiting time for parking (min.)	–0.145**	–0.277**	–0.231**	–0.142**
Road conditions (Number of illegally parked vehicles)	–0.052	–0.128**	–0.058	–0.011
Expectation of being fined for illegal parking (possibility:0~1)	1.880**	1.192 **	2.017**	2.195**
Parking time (min.)	0.039**	0.049**	0.010	0.046**
Dummy variable concerning experience of being fined for illegal parking (1: Had the experience, 0: Not had the experience)	0.630**	0.319	0.313	–0.527**
Gender (1:female, 0:male)	–0.490	–0.105	0.309	0.549
Age (10years)	0.085	0.212**	–0.086	0.078
Annual income (JPY million)	–0.128	–0.020	0.026	0.010
Dummy variable concerning under-estimation of the fine (1: under JPY 12,000, 0: others)	0.181	–0.273	–0.009	–0.399
Dummy variable concerning over-estimation of the fine (1: over JPY 18,000, 0: others)	0.925**	–0.438	1.286**	0.729
Constant	0.667	0.989*	0.322	–0.120
Number of sample	448	720	616	528
Likelihood ratio	0.315	0.395	0.174	0.148
Hit ratio (%)	73.2	71.7	71.4	68.2

6. ELASTICITY ANALYSIS

In this chapter, changes in parking place preference before and after the amendment are examined. One implicit assumption for parameter estimation is that the variance of a dispersion parameter is 1. However, there is no guarantee that dispersion parameters are the same among different estimations. Therefore, it is impossible to compare the estimated parameters directly. Thus, elasticity is examined to confirm changes in the preference for parking place choice. The conditions of the elasticity analysis are set as shown in Table V.

Table V – Condition of elasticity analysis

Variables	Set value
Parking fees	JPY 200
Walking time from a parking lot to a destination	5 minutes
Waiting time for parking	0 minutes
Road conditions (Number of illegally parked vehicles)	5 vehicles
Expectation of being fined for illegal parking	0.1
Parking time	10 minutes
Dummy variable concerning experience of being fined for illegal parking	1
Dummy variable concerning under-estimation of the fine	0
Dummy variable concerning over-estimation of the fine	1
Age	30s
Gender	Male
Annual income	JPY 4 million

Figure 11 shows the elasticity concerning "parking fees." In the figure, there are four bars that respectively indicate elasticity for "parking user" and "nonparking user" at different times. It demonstrates that the elasticity concerning "parking fees" decreased after the amendment of RTL. This means that the resistance to paying parking fees decreased. Moreover, comparison of the elasticity between "parking user" and "nonparking user" was verified. Regarding "nonparking user," the absolute value of the elasticity is larger than that of "parking user." This means that "nonparking user" has a strong resistance to paying parking fees, unlike "parking user."

Figure 12 shows the elasticity concerning "walking time from the parking lot to the destination." The figure indicates that the elasticity for "parking user" decreased. This means that the resistance to using parking lots far from the intended destinations decreased. Meanwhile, the elasticity for "nonparking user" wasn't verified. This means that nonparking users resist using parking lots that are far from their destination.

Figure 13 shows the elasticity concerning "waiting time for parking." The figure indicates that the elasticity for "nonparking user" decreased. This means that for "nonparking user," resistance to waiting for parking decreased. Figure 14 shows the elasticity concerning "expectation of being fined." The figure indicates that the elasticity for "nonparking user" increased. Figure 15 shows the elasticity concerning "parking time." The figure indicates that the elasticity for both types of users has increased.

A sensitivity analysis was performed using certain variables whose estimated coefficients are statistically significant. The results are shown in Figures 16 and 17. Curves in these figures indicate the elasticity for choosing off-street parking under the given condition. Four curves respectively show the elasticity of four segments divided by the actual parking place and the time of the survey.

Figure 16 shows the sensitivity of elasticity concerning "parking fees." It demonstrates that the curves for parking users and nonparking users before and after the amendment of RTL have changed. In particular, it shows that the elasticity of both types of users decreased. This means that the resistance to paying parking fees decreased. By comparing the curves of "parking user" and "nonparking user," it becomes clear that the elasticity of nonparking users is higher than that of parking users. This means that nonparking users have a strong resistance to paying parking fees.

Figure 17 shows the sensitivity of elasticity concerning "expectation of being fined." The figure indicates that the elasticity of nonparking users decreased after the amendment of RTL.

Through the sensitivity analysis, it becomes clear that drivers' parking preference changed after the amendment of RTL.

Furthermore, it can be concluded that strengthened parking regulations is an effective measure for decreasing illegal parking in Japan.

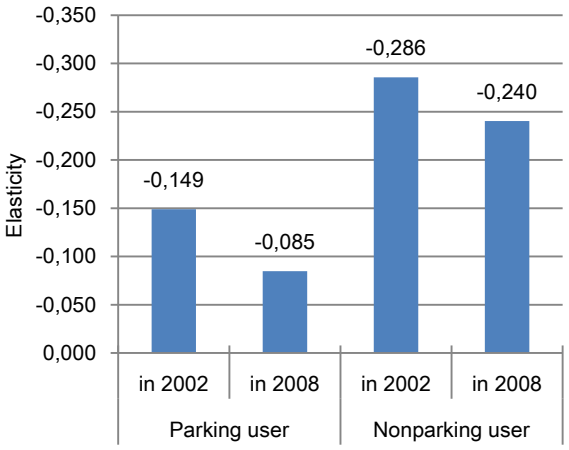

Figure 11 – Elasticity concerning "parking fees"

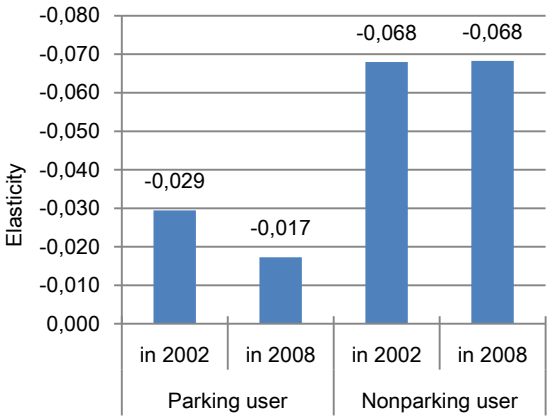

Figure 12 – Elasticity concerning "walking time from a parking lot and a destination"

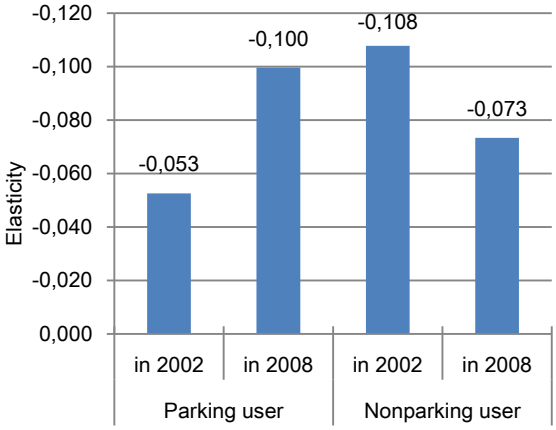

Figure 13 – Elasticity concerning "waiting time"

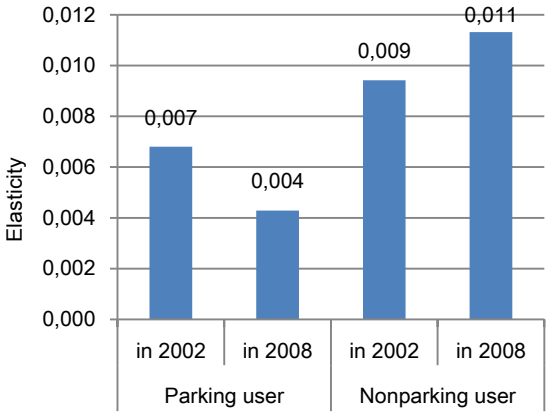

Figure 14 – Elasticity concerning "expectation of being fined for illegal parking"

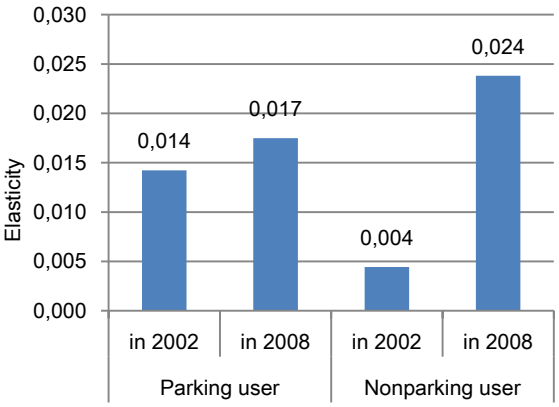

Figure 15 – Elasticity concerning "parking time"

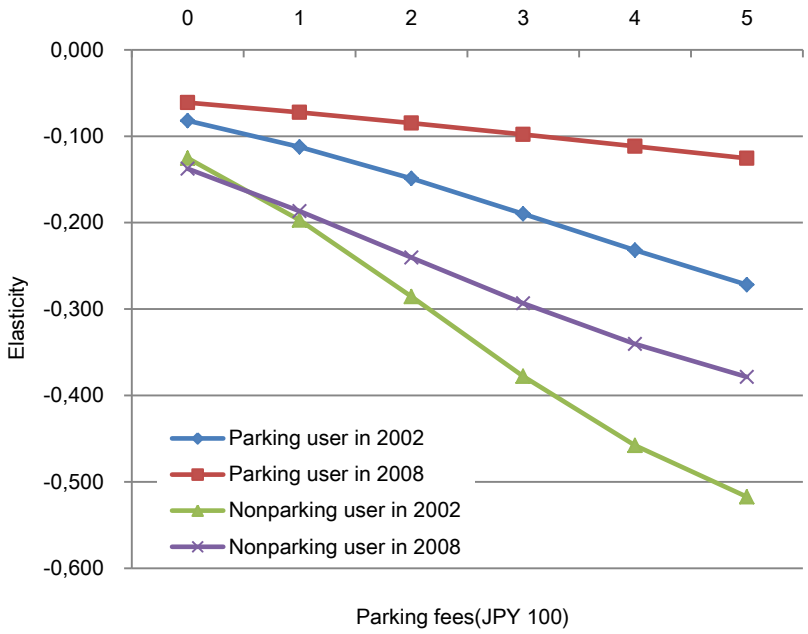

Figure 16 – Sensitivity analysis of elasticity concerning "parking fees"

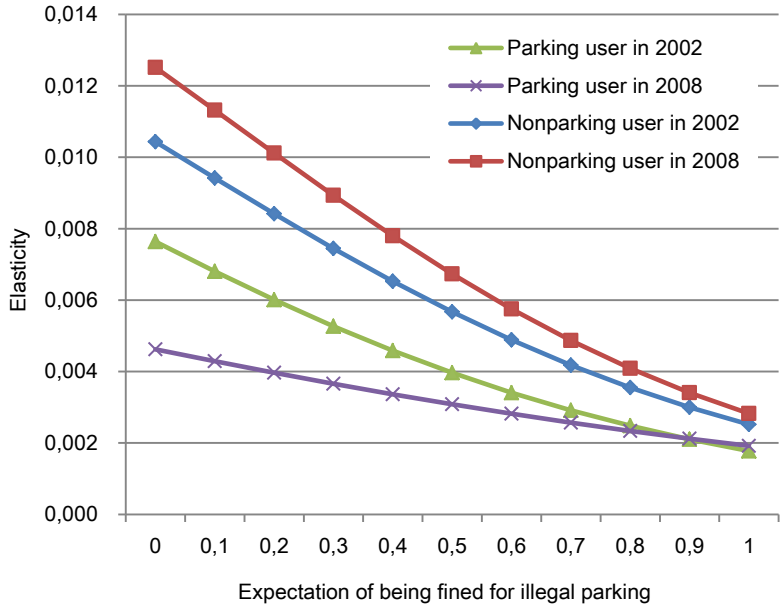

Figure 17 – Sensitivity analysis of elasticity concerning "expectaion of being fined"

7. CONCLUSION

In this study, questionnaire surveys were conducted before and after the amendment. A binary logit model was applied to estimate the parking place choice model. According to the estimation results, "parking fees," "walking time from parking lots to destinations", and "waiting time for parking" have an influence on parking place choice behavior. In addition to

those factors, "the expectation of being fined," "parking time," "experience of being fined", and "over-estimation of the fine" influence parking behavior.

Moreover, the elasticity was examined to confirm changes in the preference for parking place choice before and after the amendment of RTL. Through the elasticity analysis, it was observed that enforcement of illegal parking control affected drivers' consciousness of illegal parking. Judging from the results, parking behavior showed an obvious change after the amendment of RTL. However, a large amount of illegal parking still occurs everywhere in Japan. Thus, it is necessary to continue to study more comprehensive measures to reduce illegal parking.

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