DIFFERENTIATING AND REORGANIZING THE TAXI MARKET AND ITS IMPACT ON USERS' CHOICE AND EVALUATION

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abstract: The current taxi market in the metropolises is composed mostly by small-scale taxi companies. This situation makes it difficult for customers to perceive the difference in service level across taxi companies due to the lack of information. This study aims at evaluating the impact of market deregulation on the freedom of users' choice in the taxi market. A questionnaire survey is conducted to understand users' perception and preference for taxi services and a choice model under risk and information cost is applied to evaluate the inefficiency of current taxi market and also to suggest an optimal number of operators in the market.

1. INTRODUCTION

While taxi service is regarded as supplemental public transport which can meet the increasing demand for mobility in urban areas, its patronage has recently decreased in large cities. One of the reasons lies on the structural characteristics of the current taxi market. The taxi market in large cities in Japan is organized mostly by small-scale taxi companies. In this situation, it is difficult for customers to perceive the difference in quality of service across taxi companies due to the lack of information. Also, we should consider the following characteristics of the taxi market: a) fare structure is set by regulatory authority and therefore price competition cannot work in the market and b) a taxi is engaged mostly by spontaneous contract between the customer and driver, anytime and anywhere along city streets. These aspects bring a serious difficulty in making optimal choice for customers.

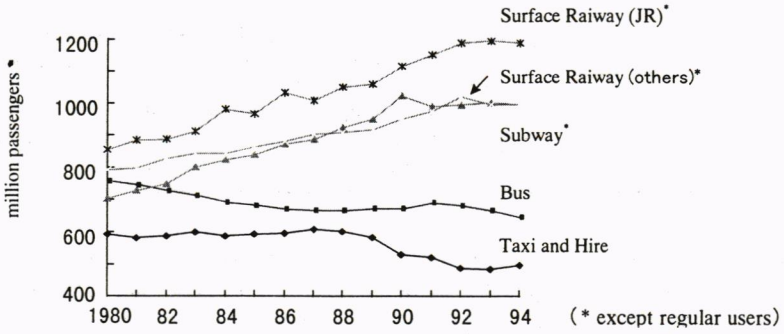


Figure 1 Recent trends in passengers of urban transport in the Tokyo's 23 wards

One of the central objectives of economic deregulation is to increase freedom of customers' choice by promoting free competition in industry. Deregulation of the taxi market has taken the form of eliminating or relaxing restrictions on fare rates, on entry, or on both. It can play a crucial role in the determination of the price level, quality of service and the resulting market equilibrium as shown in the theoretical approach by Douglas(1972), Shreiber(1975), De Vany(1975) and Haeckner and Nyberg(1995). However, little empirical evidence is available on changes in service level after deregulation and changes in the freedom of choice have never drawn much attention in the previous discussion. This study aims at identifying a perceptible choice set for the taxi user and the possibility of choosing it. A measurement model which can quantify the possibility of making adequate choices under risk and information cost is developed and applied to evaluate the inefficiency of current taxi market. It will serve as a basis for evaluation of the effectiveness of conceivable policies of deregulation.

2. USERS' PERCEPTION AND CHOICE SET

2.1 Loyalty and Perception of Taxi Services

A questionnaire survey was conducted to understand users' perception on taxi services provided in the Tokyo Metropolitan Region. As shown in Table1, a total of 23 areas which includes city centers and suburbs in the western part of the region were selected for study areas. In the survey, we made inquiries about users' loyalty to specific taxi companies, their perception and preference on taxi services, current satisfaction level and willingness to pay for adequate taxi services in the differentiated market. In the perception survey, we showed a set of photos of taxi vehicles to users and inquired their cognizance of each operator. Though there are three kinds of market for taxi services, namely, the taxi-stand market, the cruising taxi market and the telephone order market, we focus on the former two markets which are dominant in large cities.

Table 1 Outline of the Questionnaire Survey

	Main Survey	Survey on Perception
No. of Distributed Survey Forms	2245	753
No. of Responses (recovery ratio)	694 (30.9%)	253 (33.6%)
Survey Areas	Chitose-Karasuyama*, Ebisu, Kamata, Koenji, Ginza*, Futako-Tamagawa, Jiyugaoka*, Marunouchi, Meguro*, Mitaka*, Nihonbashi, Nishi-Ogikubo*, Ogikubo, Omori*, Roppongi, Shibuya*, Shinagawa, Shinbashi, Shinjuku*, Shinjuku(2), Seijyo*, Tamachi, Yotsuya [* denotes 10 areas for perception survey]	

Figure 2 shows the users' loyalty to the specific taxi operators. The share of users who have some intention to choose taxi companies is no more than 30% in total number, because in the cruising taxi market user's chance of encountering a preferable taxi is low

and in the most taxi-stand market the user faces formal or informal demands to take the first taxi in line. However, heavy users in city centers have comparatively stronger loyalty to specific operators. Factors influencing the taxi choice are shown in Figure 3 with their contribution. Adequacy of driver's manner is most influential to the choice and followed by familiarity with the provider. The previous study reported that the most frequently cited reason for choosing specific operators was familiarity with provider; this factor was cited more than five times as often as low price(Gelb, 1983). The contribution of adequacy of driver's manner is evaluated relatively more than that of familiarity with provider in our study, because users of cruising taxis predominate in the whole market. Differences in fare rates are not considered here since the fare structure has been strictly regulated by the authority until now in Japan as described above.

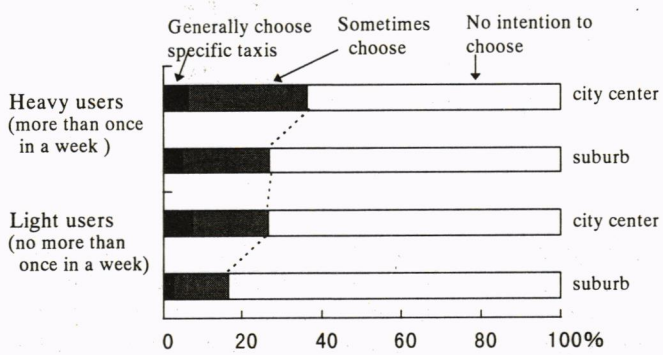


Figure 2 Users' loyalty to specific taxi companies

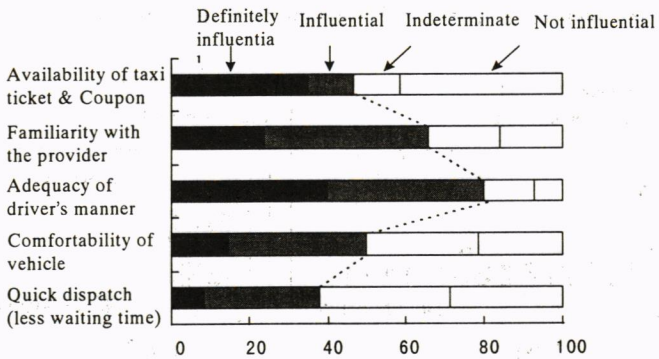


Figure 3 Factors influencing users' choice

2.2 Perceptible Choice Set

Based on a perception survey with presentation of photos of taxi vehicles of each operator, the number of perceptible operators by users is estimated and shown in Figure 4. Here, we define the "perceptible operators" as those who are perceived to be suppliers of high-quality services. It is shown that 60 % of users, including not only light users but a

operators as preferable ones. Almost half of light users can perceive only a single operator, while more than 10 operators are observed to be present in the market in city centers. Therefore, it is not surprising that the share of users who have intention to generally choose specific taxis is so small as already shown in Figure 2.

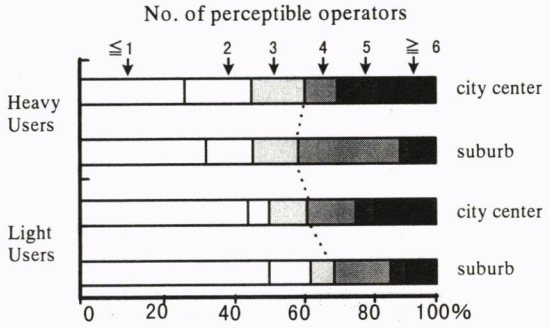


Figure 4 Users' perception of taxi operators(companies)

Recent marketing analyses(Laroche, Rosenblatt and Brisoux(1986), Hauser and Wernerfelt(1990)) report that one can perceive a variety of commodities within the range of 2 to 5 brands. The users' perceptible number of taxi operators also lies in this range. However, due to the structural/organizational particularity of the taxi industry which includes many small-scale operators and due to the uncertainty of taxi services which depend on drivers, customers often suffer more from difficulties in making adequate choices in taxi market than those in the other markets. Figure 5 portrays the mechanism in which a difference in market structure provides a substantial influence on users' perception.

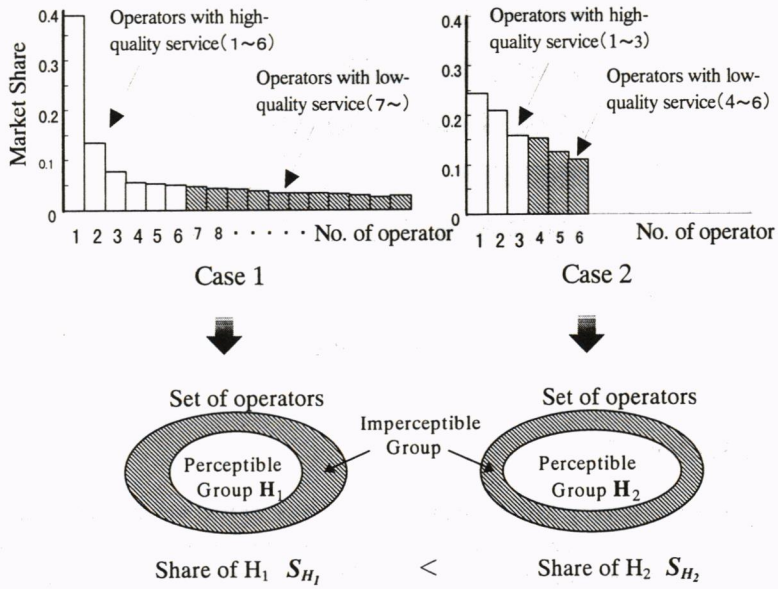


Figure 5 Difference in market structure and its effect on perception

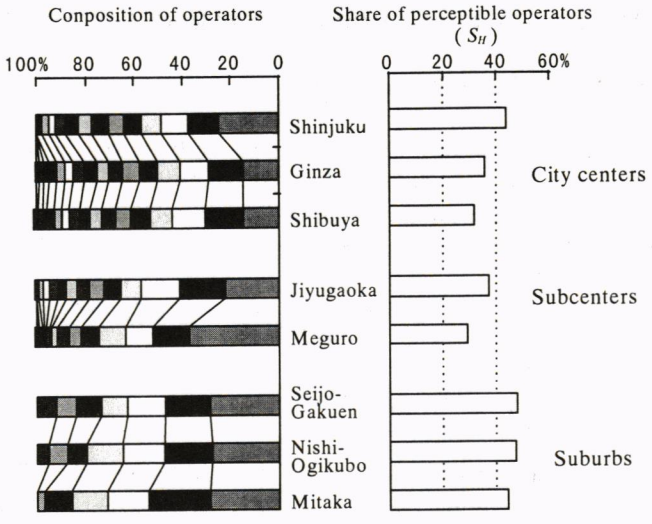


Figure 6 Effect of market structure on users' perception

Figure 5 illustrates a comparison of two cases, the first case shows a taxi market which is composed mostly by small-scale operators and the second one shows an oligopolistic market which includes several operators comparatively equalized in the scale.

It is hypothesized that the share of operators with high-quality services is actually identical in both cases. In the first case, users are inclined to underestimate the standard of taxi services provided in the market since they cannot easily identify each operator and therefore a certain experience of unsatisfactory use reflects the performance of the whole taxi market. Consequently, the share of perceptible taxi operators with high-quality services in the first case appears to be smaller than that in the second case. The share S_H can be observed in the perception survey(see Table 1). A distinct difference in the share of perceptible operators between central areas and suburbs shown in Figure 6 exemplifies the mechanism described in Figure 5. Certain markets located in the central areas, such as Shinjuku and Jiyugaoka, don't show a small share percentage because a couple of big operators has a strong patronage there and it is not difficult for users to distinguish them from the other small-scale operators.

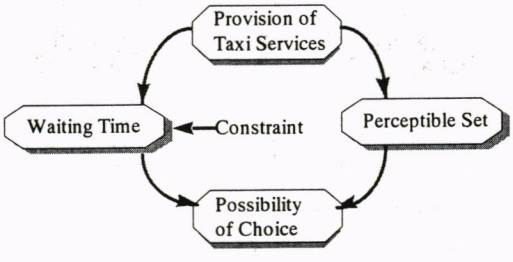


Figure 7 Concept of possibility of choice(freedom of choice)

3. POSSIBILITY OF CHOICE UNDER A CONSTRAINT OF WAITING TIME

3.1 Measurement of the Possibility of Choice

Taxi users who intend to make a choice have to accept a cost in terms of additional waiting time. Figure 7 shows the definition on "possibility of choice" based on the idea of perceptible choice set and constraint of waiting time, namely, time budget. The possibility of choice can be mathematically expressed as follows:

$$P_H(T) = 1 - e^{-\nu(H)T} + e^{-\nu(H)T} \sum_{j \in H} \int_0^{\infty} \{\nu(j) e^{-\nu(j)t} \prod_{k \neq j} e^{-\nu(k)t}\} dt$$

$$= \underbrace{1 - e^{-\nu(H)T}}_{①} + \underbrace{S_H \cdot e^{-\nu(H)T}}_{②} \tag{1}$$

where $\nu(i)$ is the average arrival rate of taxis operated by operator (i), $\nu(H)$ is that of taxis belonging to the perceptible choice set H. It is assumed that the arrival rate of taxis of each operator follows the Poisson Distribution. S_H shows the share of Group H in total number of operators.

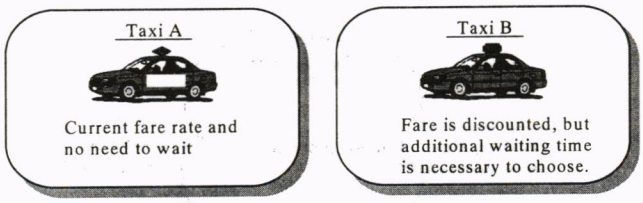
In the above equation, the first part ① represents the possibility to get the taxi of the perceptible set H within the acceptable waiting time T, while the second part ② indicates the possibility to meet them by chance after a waiting time of T.

3.2 Acceptable Waiting Time for Differentiated Fare Rates

For users who intend to choose specific operator's taxi, waiting time not only influences the possibility of adequate choice by giving a time budget, but also plays a role of essential service factor. Therefore, even impatient users may intend to choose operators if a fare reduction and an improvement of other services can compensate for the waiting time. In order to estimate the structure of trade-offs between them, we conducted a questionnaire on the users' intention to wait for the preferable taxi under differentiated fare structures as follows:

Questionnaire Form

"How long can you wait to get a cheaper taxi B under the following difference in fare?"



Case 1: a difference of 100 yen

☐ no intention to wait ☐ at most 3 minites ☐ at most 5 minites ☐ at most 7 minites ☐ at most 10 minites

☐ at most 15 minites ☐ at most 20 minites ☐ more than 20 minites

~Case 4: a difference of 1000 yen

Current fare rate is as much as 650 yen for a trip of 2km. It is clear in Figure 8 that a 10% difference in fare will provides an incentive of a certain waiting time for choice. More than half of users answered that they can wait at least 5 minutes under a 10% difference.

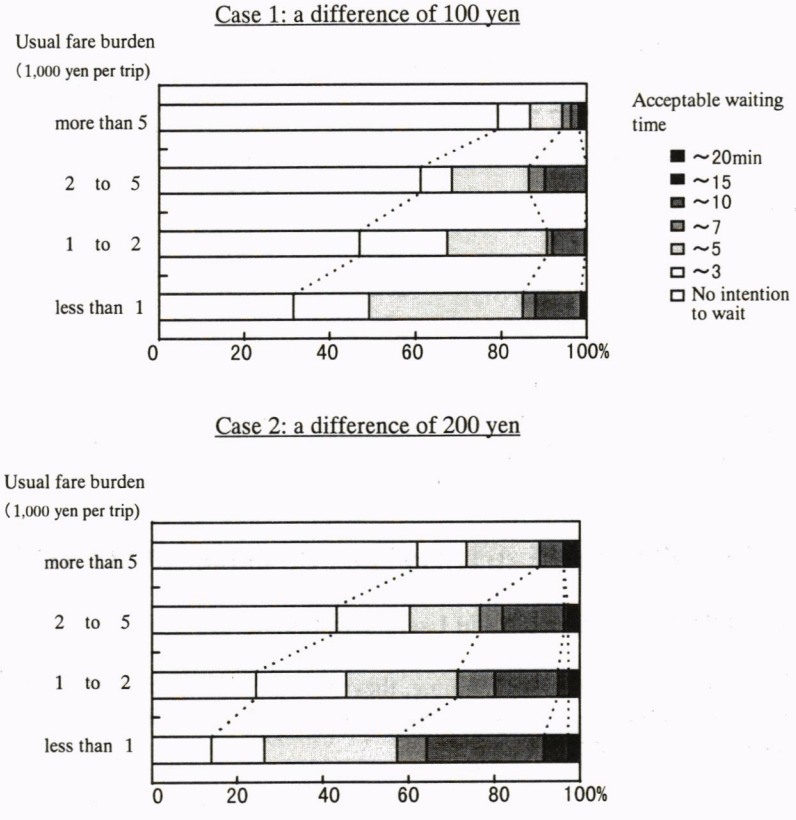


Figure 8 Some results on the trade-off between fare and waiting time

Next, for quantifying the cost of waiting time, we set the following generalized cost :

$$C_i = \theta_1 \cdot F_i + \theta_2 \cdot W_i \quad , \qquad i=\text{A, B} \tag{2}$$

where F_i and W_i are fare rate and waiting time of alternative i respectively. coefficient parameters θ_1 and θ_2 are estimated by applying the following binary logit model which is derived by applying cost minimizing criterion to users' choice.

$$P_B = \frac{1}{1+\exp\left[\theta_1(F_A - F_B) + \theta_2(T_A - T_B) + \theta_0\right]} \tag{3}$$

where P_B shows the probability that the cheaper taxi is selected by each user and θ_0 is a

constant parameter. Table 2 shows the estimated results of parameters in eq.(2) for several purposes such as commuting, business, shopping and leisure and returning home. Both fare and waiting time have expected sign and enough significance in the model. Here, the cost of waiting time for users is given by the ratio θ_2 / θ_1 which lies within the range of 45 to 60 yen /min.

Table 2 Estimated results of parameters

	Commuting	Business	Shopping & Leisure	Returning Home
Fare (100yen)	-0.325	-0.331	-0.382	-0.318
	(-4.37)	(-5.11)	(-11.1)	(-4.57)
Waiting time (min)	-0.151	-0.184	-0.182	-0.193
	(-5.85)	(-7.24)	(-15.0)	(-7.96)
Constant	-0.172	-0.270	-0.225	-0.753
	(-0.716)	(-1.20)	(-2.05)	(-3.26)
No. of obs.	47	51	59	231
Likelihood Ratio	0.119	0.153	0.155	0.154
Hit Ratio(%)	66.9	66.5	68.4	69.9

4. MARKET STRUCTURE AND ITS EFFECT ON USERS' EVALUATION

4.1 Uncertainty of Taxi Services and Users' Evaluation

Even if users accept a certain waiting time, they will not always be satisfied by their own choice since taxi services have a serious uncertainty. In order to consider this uncertainty, we introduce the following idea:

$$CE(\tilde{L}) = L - \frac{\sigma^2}{2c} \tag{4}$$

where $\tilde{L}$ is an uncertain service level of taxi services with mean L and variance σ^2, c is an index which represent user's preference to risk and $CE(\tilde{L})$ is the certainty equivalent of $\tilde{L}$. We apply the above CE index to the evaluation of uncertain taxi services since it can provide the following expected utility of $\tilde{L}$ through a monotonic transformation:

$$EU(\tilde{L}) = EU\{CE(\tilde{L})\} = 1 - \exp\left\{-\frac{1}{c} CE(\tilde{L})\right\} \tag{5}$$

Let the service level in two subsets be distributed by $N(L_H, \sigma_H^2)$ and $N(L_N, \sigma_N^2)$. The expected value of mean and variance of service level are expressed as follows by using the possibility P_H in eq.(1):

$$L = P_H \cdot L_H + (1 - P_H) \cdot L_N \tag{6}$$

$$\sigma^2 = P_H^2 \cdot \sigma_H^2 + (1 - P_H)^2 \cdot \sigma_N^2 \tag{7}$$

Therefore, CE of $\tilde{L}$ can be expressed as follows:

$$CE(\tilde{L}) = P_H \cdot L_H + (1-P_H)\cdot L_N - \frac{1}{2c}\left\{P_H^2 \cdot \sigma_H^2 + (1-P_H)^2 \sigma_N^2\right\} \tag{8}$$

Let the acceptable waiting time be zero. The possibility of choice $P_H(T)$ is equal to the share of perceptible operators S_H and therefore, $CE(\tilde{L})$ is shown in the following form:

$$CE(\tilde{L}) = S_H \cdot L_H + (1-S_H)\cdot L_N - \frac{1}{2c}\left\{S_H^2 \cdot \sigma_H^2 + (1-S_H)^2 \sigma_N^2\right\} \tag{9}$$

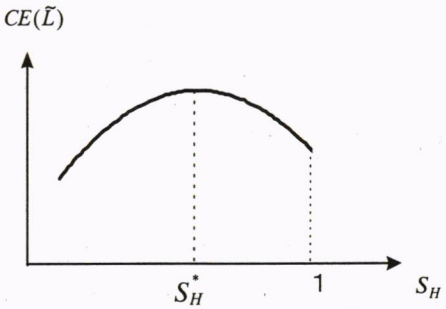


Figure 9 Influence of the share of perceptible operators on $CE(\tilde{L})$

According to eq.(9), the contribution of S_H to $CE(\tilde{L})$ is shown in Figure 9. $CE(\tilde{L})$ is drawn as a convex function of S_H and the optimal share which maximizes the value of $CE(\tilde{L})$ is given by

$$S_H^* = \frac{\sigma_N^2 / \sigma_H^2}{1+\sigma_N^2 / \sigma_H^2} \tag{10}$$

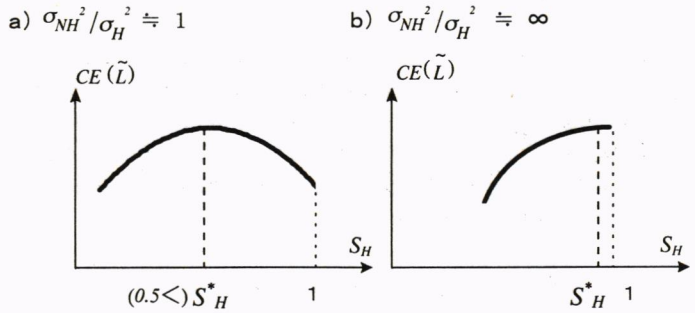


Figure 10 Influence of the variance ratio σ_N^2/σ_H^2 on the form of $CE(\tilde{L})$

under the assumption that there is no difference in average service level between two subsets. When the variance ratio σ_N^2/σ_H^2 is nearly equal to 1, $CE(\tilde{L})$ has a peak around the S_H of 0.5 as shown in Figure 10. The increase in σ_N^2/σ_H^2 shift the value of S^*_H to the right hand side. In any case, it is clear that the increase in S_H which does not exceed the value

of 0.5 always brings an increase in $CE(\tilde{L})$ which represents users' evaluation on uncertain taxi services.

For exemplifying the theoretical relationship between S_H and $CE(\tilde{L})$ of eq.(9), we plotted a relationship between actual value of S_H and users' satisfaction level based on our survey data. Figure 11 shows that higher perception level almost results in higher satisfaction level. As the share of perceptible operators is no more than 0.5 in any survey area, their proportional relationship can be implied as indicated in Figure 10.

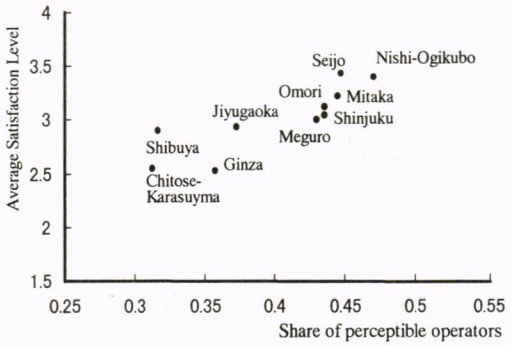


Figure 11 Relationship between users' perception and satisfaction

4.2 Market Structure and Users' Perception and Evaluation

The effect of market structure on users' perception shown in Figure 6 is explicated by the use of the following market concentration index:

$$HK = \left(\sum_{i=1}^{n} s_i^{\alpha} \right)^{1/(1-\alpha)}, \qquad \alpha > 1, \ \alpha \neq 1 \tag{11}$$

where s_i is the share of operator i (=1,..,n) in the total provision of taxi services and α is an elasticity parameter. This index defined by Hannah and Kay implies adjusted number of operators under the assumption that they are identical in their market shares. *HK* index is also associated with users' preference for variety of services. Under the assumption of constant elasticity of substitution among utility elements, the preference for variety can be measured by the following utility function:

$$U = \left(\sum_{i=1}^{n} X_i^{\rho} \right)^{1/\rho} X_0^{\varepsilon}, \qquad 0 \leq \rho \leq 1 \ \textit{and} \ \varepsilon > 0 \tag{12}$$

where X_i is consumption level of service i, X_0 is that of numeraire service and ρ and ε are preference parameters. By substituting consumption level X_i by share of consumption s_i in the total consumption level and omitting the effect of numeraire service, the above definition is modified into the following form:

$$U = X \left(\sum_{i=1}^{n} S_i^{\rho} \right)^{1/\rho}, \qquad \rho \geq 0 \tag{13}$$

where X is a total consumption level. Furthermore, from the comparison between eq.(11) and eq.(13), HK index is given by a monotonic transformation of utility function U as follows:

$$HK = \left(\frac{U}{X}\right)^{\rho/(1-\rho)}, \quad \rho > 0, \ \rho \neq 1 \tag{14}$$

Figure 12 shows a relationship between HK value and the share of perceptible operators in 10 survey areas under the assumption that elasticity parameter α equals to 2, which is often used in previous studies concerning industrial organizations(Curry and George(1983)) . A convex form concerning the influence of HK value on S_H is drawn in the figure and also it is suggested that S_H has a peak at HK value of 5 to 6. The increase in number of operators more than this value does not contribute to increasing the freedom of choice and consequently results in the decrease of users' perception.

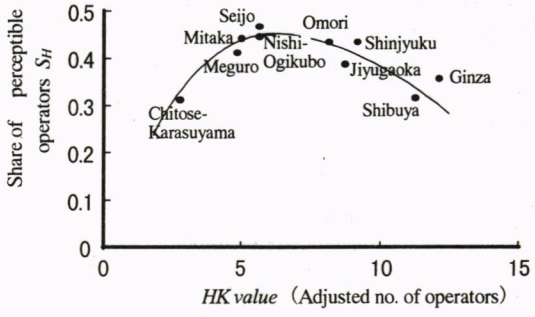


Figure 12 Relationship between market structure and users' perception

Based on Figures 11 and 12, the effect of market structure on users' evaluation is shown in Figure 13. Users' satisfaction level also seems to have a peak at HK value of 5 to 6. It is shown that the increase in variety of operators does not always lead to the increase in users' satisfaction level. Under the current taxi market without differentiation in fare rate and quality of service, the optimal amount of operators seems to be 5 to 6 in adjusted

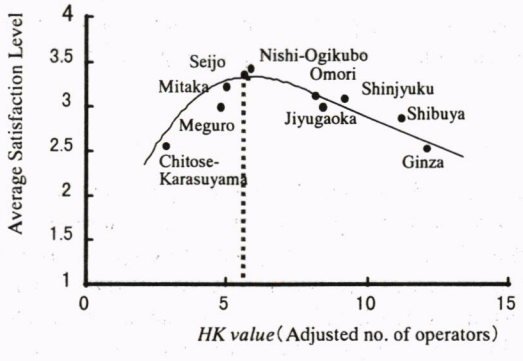


Figure13 Market structure and its effect on users' evaluation

number. Most of city centers, particularly Ginza and Shibuya have excessive number of operators, while some suburban areas such as Nishi-Ogikubo, Seijo and Mitaka have achieved the adequate number.

New entry of operators has been strictly regulated in Japan by setting some standards on the minimum size of company and restrictions on the service area, but these regulations are going to be eliminated or relaxed to promote free competition across operators. What will happen after the deregulation? The above results indicate that free entry will not always bring a preferable consequence on users' freedom of choice and some arrangements will be required for making users' perception easier.

4.3 Impact of Reorganization of the Taxi Market

The above discussions suggest that scale economies can work even in the taxi industry and users' patronage seems to be strongly influenced by the industrial organization. Based on the convex curve shown in Figure 13, it is directly demonstrated that the increase in market concentration will lead to the increase in users' evaluation in city centers as shown in Figure 14. On the other hand, free entry without market reorganization will result in the decrease of users' evaluation.

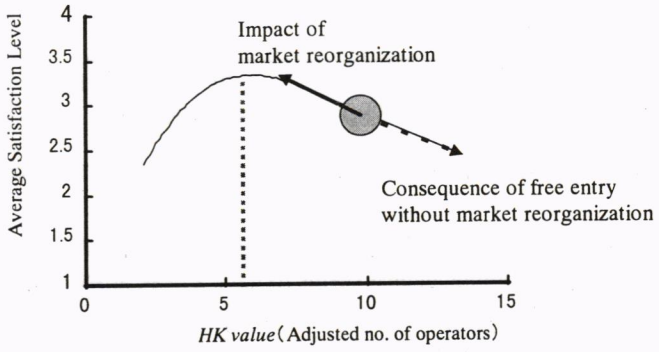


Figure 14 Impact of reorganization of the market

Not only visible familiarity but also perceptibility which is associated with fare structure and dispatch system are essential factors in reorganizing the taxi industry.

5. CONCLUSIONS

The analysis presented here indicates that users' perceptibility should attract more attention in considering deregulation policies of the taxi industry. Although economists have predicted that the elimination of entry and pricing controls would lead to the increase in users' patronage, excessive number of taxi operators and the uncertainty of taxi services cause customers much difficulties in making adequate choices under the current situation. The increase in variety of taxi services which cannot be perceived by users may lead to the increase in market imperfections. In this context, we should

adequately examine the market environment and industrial organization for taxi services from users' viewpoint.

In this paper it is clarified that the number of taxi operators identified by users is at most 3 and due to the excessive number of small-scale operators, the users' perceptibility remains low particularly in city centers. By quantifying the uncertainty of taxi services based on the idea of certainty equivalent, it is confirmed that the perceptibility is the dominant factor in determining users' possibility of choice or freedom of choice. Also, the optimal market structure for users' choice is suggested in terms of adjusted number of operators by the *HK* index which can be regarded as a measure of preference for variety. It is concluded that under the current taxi market without differentiation in fare rate and service quality, the optimal number of operators is 5 to 6 in each area.

Furthermore, based on the analysis on a trade-off structure between fare rate and waiting time, it is shown that differentiation of fare rate provides users with significant incentives for choice.

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