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Price Perception of Travel Demand with Cashless Payment Mode: Evidence from the Urban Rail Farecard System in Tokyo

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Keywords

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1. INTRODUCTION

With recent advancements in information technology, urban public transport operators have introduced the prepaid farecard system in many cities. One of the most important characteristics of this system is that travelers are not required to pay for a train or bus ride in cash; they become entitled to use these transport services by purchasing the farecard. This system can generally be described as a cashless process. Recently, many cashless services, such as the credit card system and the Internet banking system, have been introduced. These services may essentially impact the consumer's economic behavior. This paper focuses on the price perception of consumers in the cashless process. I consider the difference in consumer perception with respect to travel cost—given different payment methods—in the case of the urban rail service.

Several studies in marketing research deal with consumer behavior by considering various payment methods. Bawa *et al.* (1987) focused on the coupon and analyzed the purchasing behavior between coupon-prone and non-coupon-prone households. They found that coupon-prone households tend to be characterized by a more educated husband and an above average income as compared with non-coupon-prone households. With regard to the credit card, Hirschman (1979, 1982) examined the hypothesis that a consumer possessing only a bank card or a store-issued card will make higher total dollar purchases than a consumer without such a card. A multiple classification analysis was performed using consumer data obtained from interviews conducted in several branches of a department store chain. The conclusion of the study supported the hypothesis. However, since these researches did not consider the price of goods, it is still not possible to determine empirical evidence on the difference of price perception between payment methods. With regard to the relationship between the fare and consumer behavior in the public transport market, empirical analyses considering various payment methods include Hensher (1998) and Gilbert and Jalilian (1991); however, they do not focus on the difference of price perception given the difference in the payment methods.

This paper analyzes a route choice from the urban railway network in the Tokyo Metropolitan area. Rail passengers commuting to the workplace as well as students traveling to school are outside the scope of this study. This is because most commuters in these groups use fixed payment modes such as commuter passes or season tickets. The study focuses on personal travels during the off-peak period of the day. These travels include visits to friends and relatives, shopping trips, and visiting movie theaters. The data used in the analysis is from an original survey conducted in 2001. In this year, the urban railway operators in the Tokyo Metropolitan area provided the following four types of payment modes: commuter passes, farecards, coupon tickets, and normal tickets. The commuter pass is a type of season ticket with which travelers can commute between two fixed origin-destination stations for a given period of time. Travelers can choose the validity period of the commuter pass—one, three, or six months. The farecard is a magnetic card that can store a fixed amount of money but cannot be recharged. The coupon refers to a series of tickets with which travelers can commute under certain given conditions that depend on the operator; for example, operators offer fixed route coupons, fixed fare coupons, and fixed time coupons. Finally, the normal ticket is defined as the ticket valid for one ride on the day it was purchased.

Prior to the empirical analysis, it is important to note the following characteristics of the urban rail service in the Tokyo Metropolitan area in 2001. First, there is one public and twenty-five private rail operators including two subways; they operate a dense rail network with a total length of 2,298.8 km as of 2001. This enables travelers to choose a route as well as an operator from among alternative routes and operators even for a single journey. Second, all the rail operators in Japan have their own fare systems, and thus far, no coordination has existed on standardizing the fare systems between the different rail operators within this area. Travelers can choose their rail route by comparing not only the travel time but also the travel cost of different routes. Third, the rail lines of different operators are connected at several points. Some of them are the "direct-through" connections, in which case passengers are not required to change trains even when they change operators because trains run directly through the two different operators' lines. However, travelers are required to pay two fares for two different operators. This may make the traveler's route choice more difficult. Fourth, coupon tickets are sold at a discount. For example, a traveler can buy eleven coupons for the price of ten normal tickets. This is one of the incentives for travelers to purchase coupon tickets although they are not as convenient as farecards.

In addition, I consider the income effect on travel behavior. Many researchers [for example, Jara-Diaz and Videla, 1989] indicate that the income constraint could be crucial in choosing the payment method when the traveler's income is low as compared to the travel cost. However, the income effect is expected to be extremely small in Tokyo. For example, the average expenditure for public transport constitutes merely 2.75% of the total household income in Tokyo as of 2000 [Statistics Bureau, Ministry of Internal Affairs and Communications, 2000]. Therefore, in the empirical analysis, I ignore the income differences among travelers.

In this paper, I examine an idea that when travelers pay for a train ride with a farecard, the perception of the fare is different from that when they pay without a farecard. If this premise is established, it can be construed that the value of travel time savings of travelers varies according to the payment modes. To verify this claim, data on the route choice behavior of urban railway passengers in the Tokyo Metropolitan area are collected. This data is analyzed by adopting the multinomial logit (MNL) choice model. Subsequently, the estimated MNL models are statistically tested. Finally, the causal factors of the results are discussed.

2. METHODOLOGIES

2.1. Formulation of Hypotheses

I propose the following two hypotheses for travel behavior with respect to the possession and/or use of rail farecards:

H1: A traveler who possesses a rail farecard has a price perception different from a traveler who does not.

H2: A traveler who uses a rail farecard has a price perception different from a traveler who does not.

Hypothesis 1 indicates that rail users can be segmented into two user groups. The farecard-prone travelers have a different price perception from the non-farecard-prone travelers. Hypothesis 1 is rather similar to the hypothesis of Hirschman (1979); however, the hypothesis in this paper is based on the price perception of demand whereas Hirschman's hypothesis deals with the amount of purchase or the demand itself. Hypothesis 2 indicates that one traveler can have diverse price perceptions under various conditions. This perception is determined by a type of payment method chosen by the traveler. This is based on the fact that a traveler frequently uses more than one travel ticket even when taking a single route within the Tokyo Metropolitan area. Because the season ticket and the coupon ticket can be used only for a fixed section or a fixed origin-destination pair, a traveler is required to use two or more types of tickets when she or he would choose to exit the given section. These two hypotheses are not contradictory. Thus, it is possible that both hypotheses may be proven true.

2.2. Statistical Tests

Working Hypothesis 1

Suppose that there is more than one alternative route from an origin station to a destination station and that travelers can choose from among the farecard, coupon, and normal ticket payment methods. The travelers can be categorized into two groups: farecard holders and non-farecard holders. I assume that the utility function of a traveler in a travel group m (= farecard holder or non farecard holder) is

$$U_i^m = \beta_C^m + \beta_T^m T_i^m + \beta_F^m F_i^m + \varepsilon_i^m = V_i^m + \varepsilon_i^m \tag{1}$$

where U_i^m is the utility of route i of a traveler belonging to the group m, T_i^m is the travel time, F_i^m is the travel cost, β_k^m is a k-th coefficient, ε_i^m is an unobserved random variable, and V_i^m is a deterministic portion of the utility. When assuming ε_i^m to be an identical and independent Gumbel distributed variable, the probability of choosing an alternative route i, P_i^m, is expressed as

$$P_i^m = \frac{\exp\left(\lambda^m V_i^m\right)}{\sum_j \exp\left(\lambda^m V_j^m\right)} \tag{2}$$

where λ^m is a scale parameter related to a variance of the Gumbel distribution.

I now test whether the vector of the coefficients in the utility function of the farecard holders would be equal to that of the non-farecard holders. A null hypothesis

$$H_0^1: \boldsymbol{\beta}^{card} = \boldsymbol{\beta}^{noncard} \tag{3}$$

is set up, where $\boldsymbol{\beta}^m$ is a vector of the coefficients of the traveler group m. To test this hypothesis, I apply a part of the procedure proposed by Swait and Louviere (1993) and Louviere, Hensher, and Swait (2000), which is based on the likelihood ratio test [Ben-Akiva and Lerman, 1985]. This method enables us to compare the parameters of the MNL between the different data sets by using the standard MNL software. The procedure is as follows:

STEP 1: A scale parameter of one traveler group m, λ^{m1}, is set to one. Then, β^{m1} and $\lambda^{m2}\beta^{m2}$ are estimated separately by using the full information maximum likelihood (FIML) estimates, which are obtained by maximizing the following log likelihood function:

$$\underset{\beta^m}{Max}\, L^m = \underset{\beta^m}{Max}\left[\sum_n \sum_i \delta_{ni} \ln P_{ni}\right] \tag{4}$$

where δ_{ni} is the observed choice result for alternative route i and individual n. Then, the maximum log likelihoods of both groups, L^{m1} and L^{m2}, are obtained.

STEP 2: Under the condition $\beta^{m1} = \beta^{m2}$, a maximum log likelihood L^{λ} is obtained by changing the value of λ^{m2} based on the commuter data of both groups.

STEP 3: The researchers test whether the null hypothesis can be rejected by utilizing the likelihood ratio test statistic

$$\gamma_a = -2\left[L^{\lambda} - \left(L^{m1} + L^{m2}\right)\right] \tag{5}$$

This test statistic is an asymptotic chi-square distribution with (K + 1) degrees of freedom. K is the number of coefficients in the utility function. As Swait and Louviere (1993) indicated, this procedure requires that the MNL model be the true model that is independent from irrelevant alternatives (IIA), and systematic sources of difference across decision makers in the utility function have been accounted for by the inclusion of the appropriate variables in the utility functions.

Working Hypothesis 2

Suppose that a traveler uses two types of payment methods for a route. I assume that the utility function of all travelers is uniform and expressed as

$$U_i = \theta_C + \theta_T\left(T_i^a + T_i^b\right) + \theta_F^a F_i^a + \theta_F^b F_i^b + \varepsilon_i \tag{6}$$

where U_i is the utility of a route i, T_i^j is the travel time of route i with payment method j, F_i^j is the travel cost of route i with payment method j, θ_k is a coefficient, and ε_i is an unobserved random variable.

I test whether the coefficient of the travel cost with the payment method j is equal to that with the other payment method j' in order to determine whether there is a diversity of price perception among payment methods. Consequently, I set up the following null hypothesis on the coefficients of the travel cost between the payment methods a and b:

$$H_0^2 : \theta_F^a = \theta_F^b \tag{7}$$

To test hypothesis 2, I use an asymptotic *t*-test statistic [Ben-Akiva and Lerman, 1985]

$$\frac{\theta_F^a - \theta_F^b}{\sqrt{\mathrm{var}\left(\theta_F^a - \theta_F^b\right)}} \tag{8}$$

and

$$\mathrm{var}\left(\theta_F^a - \theta_F^b\right) = \mathrm{var}\left(\theta_F^a\right) + \mathrm{var}\left(\theta_F^b\right) - 2\,\mathrm{cov}\left(\theta_F^a, \theta_F^b\right) \tag{9}$$

where $\mathrm{var}(\cdot)$ is the variance and $\mathrm{cov}(\cdot,\cdot)$ is the covariance. In this verification, I will test three payment methods—the farecard, the coupon, and the normal ticket.

3. EMPIRICAL ANALYSES

3.1. Data Collection

A paper-based questionnaire survey collected data on the personal travels of urban railway users within the Tokyo Metropolitan area. The survey was conducted in the early weeks of November 2001 by a study team of the University of Tokyo [see Kato, Ieda, and Nakajima, 2002]. Households were randomly selected based on a map of the area. The survey covered data on the origin stations, destination stations, the chosen routes of rail users, and the specific day of the travel. Further, it inquired if the user possessed a commuter pass, a farecard and/or coupon, as well as the reason/s for choosing the type of payment method. Individual socio-economic attributes were also questioned. Finally, the survey collected the revealed preference data on urban rail use from 205 individuals above 18 years of age.

Table 1 shows the three respondent data sets: a data set of all respondents including farecard and non-farecard holders, a sub-data set of farecard holders, and a sub-data set of non-farecard holders. First, we observe that the travel time of non-farecard holders is longer than that of farecard holders. However, the former pay almost the same amount in travel costs as the latter if we consider the travel cost paid with a season ticket as the sunk cost. This could imply that farecard holders are relatively more responsive to saving travel time than non-farecard holders. Second, non-farecard holders pay relatively more in travel costs with a season ticket than farecard holders. This is probably because non-farecard holders use the route the fare for which is covered partly by their season ticket in order to reduce their travel cost even if the travel time is longer. This implies that they have lower value of time. Third, farecard holders purchase normal tickets less frequently than non-farecard holders. This is probably because purchasing a normal ticket requires a higher transaction cost.

Table 1 Personal travels of urban rail users in Tokyo: farecard holders vs. non-farecard holders

	unit	all respondents	farecard holders	non farecard holders
in-vehicle travel time	minutes / trip	36.4 (19.3)	34.9 (19.3)	38.0 (19.3)
transfer travel time	minutes / trip	13.6 (8.2)	13.2 (7.0)	14.0 (9.5)
number of transfer	times / trip	1.43 (0.66)	1.41 (0.65)	1.44 (0.67)
travel cost paid with seasonal ticket	yen / trip	154.7 (196.9)	136.6 (177.4)	174.7 (216.9)
travel cost paid with farecard	yen / trip	107.4 (168.6)	195.1 (186.1)	- (-)
travel cost paid with coupon ticket	yen / trip	21.3 (68.2)	19.6 (64.3)	23.0 (72.6)
travel cost paid with normal ticket	yen / trip	195.2 (243.9)	107.4 (203.7)	300.9 (246.0)
number of purchasing normal tickets	times / trip	0.56 (0.74)	0.31 (0.55)	0.87 (0.82)
number of respondents		205	112	93

1: () indicates standard deviation.

2: the travel cost of a seasonal ticket is estimated because it has already been sunk by riding the train.

3.2. Analysis: Hypothesis 1

Three models are estimated by FIML based on the three different data sets. The survey provided the following variables in the utility function of the MNL: travel time, travel cost, the number of transfers, and the number of normal tickets purchased. It is assumed that the fare for a section covered by a season ticket is zero. For analytical simplicity, this paper assumes all coupons to be fixed route coupons. This simplification is not expected to influence the results significantly because over half of the coupon users in this area use the fixed route type. The estimated results are shown in Table 2. All the coefficients possess rational signs, and the values of the *t*-statistics are

Table 2 Estimation results of the models for the test of Hypothesis 1

variables		all respondents		farecard holders		non farecard holders	
in-vehicle travel time	minutes	-0.1492	(-5.930**)	-0.1196	(-3.754**)	-0.1913	(-4.629**)
number of transfers	times	-1.7427	(-7.812**)	-1.5149	(-5.391**)	-2.0988	(-5.584**)
travel cost	yen	-0.0058	(-3.752**)	-0.0059	(-3.052**)	-0.0060	(-2.389*)
number of purchasing normal tickets	times	-0.6091	(-2.626**)	-0.5326	(-1.363*)	-0.6498	(-2.155*)
numbers of observations		205		112		93	
fittness ratio	%	60.98		58.93		63.44	
initial log likelihood		-331.38		-181.53		-149.85	
last log likelihood		-215.52		-127.42		-86.77	
likelihood ratio		0.346		0.292		0.415	

** and ** imply significance at the 95% and 99% levels, respectively.*

Table 3 Estimation results when maximum log likelihood is maximized

variables		$\lambda_2 = 1.3$	
in-vehicle travel time	minutes	-0.1345	(-6.006**)
number of transfers	times	-1.5706	(-7.881**)
travel cost	yen	-0.0052	(-3.851**)
number of purchasing normal tickets	times	-0.4982	(-2.503**)
numbers of observations		205	
fittness ratio	%	60.98	
initial log likelihood		-331.38	
last log likelihood		-214.47	
likelihood ratio		0.350	

** and ** imply significance at the 95% and 99% levels, respectively.*

statistically significant. After the scale parameter of the model for the farecard holder is set to one, the log likelihood function for the entire sample data is maximized by changing the scale parameter of the model for the non-farecard holders. Thus, the scale parameter that maximizes the log likelihood is determined to be 1.3. The final estimated results are shown in Table 3. Then, null hypothesis 1 is tested using the chi-square statistic within 5 degrees of freedom. The estimated value is 0.56 when the scale parameter is 1.3. With the statistical results, null hypothesis 1 cannot be rejected.

3.3. Analysis: Hypothesis 2

The estimation results of the models for the test of Hypothesis 2 are shown in Table 4. Although the *t*-statistics of the number of normal tickets purchased is not sufficiently high, the signs of all the coefficients are rational. From the estimated coefficients, I determine that the coefficients of the normal ticket, the farecard, and the coupon ticket possess the highest, second highest, and lowest absolute value, respectively. This implies that the price sensitivity of the normal ticket is the highest while that of the coupon is the lowest. The test to determine whether the price percep-

Table 4 Estimation results of the models for the test of Hypothesis 2

variables		estimated coefficients	
in-vehicle travel time	minutes	-0.1473	(-5.625**)
number of transfers	times	-1.8733	(-7.865**)
fare paid with faracard	yen	-0.0096	(-5.574**)
fare paid with coupon ticket	yen	-0.0058	(-1.786*)
fare paid with normal ticket	yen	-0.0104	(-5.801**)
number of purchasing normal tickets	times	-0.1820	(-0.677)
numbers of observations		205	
fittness ratio	%	64.88	
initial log likelihood		-331.38	
last log likelihood		-193.41	
likelihood ratio		0.412	

** and ** imply significance at the 95% and 99% levels, respectively.*

tion among the payment modes differs shows that null hypothesis 1 can be rejected at the 75% confidence level. With regard to the relationship between the farecard and the coupon as well as that between the normal ticket and the coupon, it was determined that hypothesis 2 can be rejected at the 90% confidence level. In conclusion, hypothesis 2 can be rejected to some extent for the farecard and the coupon as well as for the normal ticket and the coupon. This may also be true for the farecard and the normal ticket since the confidence level is low.

4. DISCUSSIONS

Hypothesis 1 cannot be statistically supported. This implies that the statement “farecard-prone people tend to pay more than the non-farecard-prone people” is false. The rationale for this empirical result may be that the use of the farecard has a rather limited impact on travel behavior. This is because, first, farecards can be used only for urban rail services, whereas credit cards can be utilized for any goods and services. Second, as compared to the income level (the wage rate is approximately 3,100 yen/hour), the price of the farecard is quite low at nearly 5,000 yen (approximately US$ 45). In contrast, the credit card can be used for an almost unlimited amount of goods. Third, the transaction cost of holding the farecard is greater than that of the credit card. Frequent travelers are required to buy a new farecard when they exhaust the credit on the old one because farecards are not rechargeable. This enables travelers to closely monitor their expenditure.

On the other hand, hypothesis 2 is statistically supported at a certain level of confidence. Urban rail users recognize changes in the payment method for a travel. This change is recognized not while they travel but rather when they choose the payment method in advance. The fact that they determine a payment method when choosing their rail routes indicates a high level of sensitivity.

If the perception of travel time is common for the different payment methods but that of fare varies between payment methods, the difference in price perception will imply the difference in the value of travel time savings. The values of travel time savings determined from the estimated model parameters are 921 yen/hour, 1,524 yen/hour, and 850 yen/hour for the farecard, coupon, and normal ticket use, respectively. Because the average wage in the Tokyo Metropolitan area is estimated to be approximately 3,100 yen/hour (as of 2001), these values are extremely reasonable in the case of non-work-related travel. As expected, the value of travel time savings in using the normal ticket is the lowest.

These empirical results may stem from the fact that the transaction cost varies between payment methods. However, Table 4 shows that the *t*-statistics for the null hypothesis on the variable of the number of normal tickets purchased are not significant. Thus, at the least, the transaction cost of purchasing a ticket is not a dominant factor influencing travel behavior.

Finally, I indicate a psychological impact in the use of cashless payment methods. Doran (1991) pointed out that people spend money on purchasing goods with credit cards and even squander it to the point of bankruptcy. The extreme case, wherein consumers lose control over their expenditures, may be attributed to the difference in price perception when paying by cash and by credit card. Cashless payments can lead consumers to misjudge the cost of a service, particularly when less attention is paid to the fare price. This phenomenon may also be observed in travel behavior.

5. CONCLUSIONS

I analyzed the price perception of travelers by using the rail route choice data. The empirical analysis results show that the price perception of travel demand does not differ between farecard and non-farecard holders but differs between the payment methods. This is mainly because the consumers may misjudge the cost of the service when less attention is paid to the fare price. The differences in the transaction cost among the payment modes are not considered to have a significant impact on the above empirical results.

This paper considers the urban rail farecard system as an example of cashless service. This is undoubtedly not the only case of cashless service even from the transportation planning perspective. Similar phenomena can be observed in other circumstances such as the electrical toll collection system in expressways or the payment of parking fees. The increasing popularity of cashless payment methods can drastically change the consumer’s decision to purchase services. As this paper shows, the change of price perception causes a change in the values of travel time savings. Therefore, transport planners should give greater consideration to this effect.

Finally, I will mention the recent trends in the payment system of the urban railway services in Tokyo. The Eastern Japan Railway Co., the largest rail operator in the Tokyo Metropolitan area, has introduced a smart card system since 2002. This enables travelers to enter a station by touching their cards to a fare-checking device installed at the gate. The smart card is rechargeable and can also be used for purchasing goods in shops located at the station. Other rail and bus operators are planning to introduce this system by 2007. However, despite the integration of the smart card system, an integration of independent fare systems will not be realized in the near future.

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REFERENCES

Bawa, K. and R. W. Shoemaker. 1987. The Coupon-prone Consumer: Some Findings Based on Purchase Behavior Across Product Classes. *Journal of Marketing* 51:99-110.

Ben-Akiva, M. and S. Lerman. 1985. *Discrete Choice Analysis: Theory and Application to Travel Demand*. Cambridge, MA. MIT Press.

Ben-Akiva, M. and T. Morikawa. 1990. Estimation of Switching Models from Revealed Preferences and Stated Intentions. *Transportation Research Part A* 24(6):485-495.

Ben-Akiva, M. and T. Morikawa. 1990. Estimation of Travel Demand Models from Multiple Data Sources, IN: Koshi, M. (ed.). *Transportation and Traffic Theory* 461-476.

Doran, K. J. 1991. *Personal Bankruptcy and Debt Adjustment*. Random House.

Gilbert, C. L. and H. Jalilian. 1991.The Demand for Travel and for Travelcards on London Regional Transport. *Journal of Transport Economics and Policy* 25:3-29.

Goodwin, P. B. 1992. A Review of New Demand Elasticities with Special Reference to Short and Long Run Effects of Price Changes. *Journal of Transport Economics and Policy* 26:155-169.

Hensher, D. A. 1998. Establishing a Fare Elasticity Regime for Urban Passenger Transport. *Journal of Transport Economics and Policy* 31:221-246.

Hirschman, E. C. 1979. Difference in Consumer Purchase Behavior by Credit Card Payment System. *Journal of Consumer Research* 6:58-66.

Hirschman, E. C. 1982. Consumer Payment Systems: The Relationship of Attribute Structure to Preference and Usage. *Journal of Business* 55(4):531-545.

Jara-Diaz, S. R. and J. Videla. 1989. Detection of Income Effect in Mode Choice: Theory and Application. *Transportation Research Part B* 23(6):393-400.

Kato, H., H. Ieda, and Y. Nakajima. 2002. Analysis on Price Elasticities of Urban Rail Users in Terms of Payment Modes. *Journal of Infrastructure Planning and Management*. 695/IV:149-158. (in Japanese)

Louviere, J., D. A. Hensher, and J. Swait. 2000. *Stated Choice Methods: Analysis and Application*. Cambridge, UK. Cambridge University Press.

Morikawa, T. 1994. Correcting Stated Dependence and Serial Correlation in RP/SP Combined Estimation Method. *Transportation* 21(2):153-66.

Oum, T. H. and W. G. Waters II. 2000. Transport Demand Elasticities, IN: Hensher, D. A. and Button, K. J. (ed.). *Handbook of Transport Modeling* 197-210.

Oum, T. H., W. G. Waters II, and J. S. Yong. 1992. Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates: An Interpretative Survey. *Journal of Transport Economics and Policy* 26:139-154.

Statistics Bureau, Ministry of Internal Affairs and Communications. 2000. Yearly Family Income and Expenditure Survey, http://www.stat.go.jp/data/sousetai/2000n/zuhyou/03.xls.

Swait, J. and J. Louviere. 1993. The Role of the Scale Parameter in the Estimation and Comparison of Multinominal Logit Models. *Journal of Marketing Research* 30:305-314.