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Travel demand function of Korean tourists to Japan: Exemplifying the potential value of utilization of inbound micro-behavior data of foreign tourists.

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Travel demand function of Korean tourists to Japan:
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1. Introduction

Japanese Government started in 2003 the new Tourism Policy: Visit Japan Campaign. They would like to attract 10 million foreign tourists to Japan annually and set it out as the goal that should be attained within 7 years. The policy was devised because there was a big imbalance such that while Japanese tourists visiting foreign countries were 16.5 million, incoming foreign tourists to Japan were just 5.2 at that time. In 2007, foreign tourists who visited Japan have increased to 8.3 million.

If you look at not the whole Japan but a specific region, interesting phenomena have emerged that foreign visitors to the region have increased drastically recent years. Specifically speaking, Kyushu Island is typical such a region. Kyushu Island, the southernmost among the four islands composing Japan, is located near Korea facing with Busan about 200 km apart from each other over Tsushima Strait.

The JR (Japan Railway) Kyushu introduced in 1991 an express sea line connecting Fukuoka and Busan in about 3 hours by jetfoil ship called Beetle.

Since its introduction, the number of passengers both from Japan and Korea has drastically increased. Most of the travelers between Fukuoka and Busan choose not the airline but the sea line. Thus only two daily air flights between them remain in service while four or five air flights once existed daily. It is quite interesting to explore the reasons why Korean tourists to Kyushu region have increased drastically in a way that dispels air flights between Fukuoka and Busan.

With this in mind, we address the problem of how we could have predicted the increase of Korean tourists at the time of 2000 based on data obtained from the survey of inbound micro-behavior of Korean tourists in Kyushu, which was conducted at that time.

This paper also aims to exemplify the potential value of utilization of inbound micro-behavioral data of foreign tourists by showing that we could have predicted with a considerable accuracy a drastic change of inflow of Korean tourists to Kyushu based on such data.

2. Travel demand function: a two-step utility maximization formulation

2.1 The difficulties in questionnaire survey

In this section, we propose a simple method to estimate the travel demand function of Korean tourists to Kyushu using the micro-behavioral data of Korean tourists in Kyushu.

We obtained the data from the survey of behavior of Korean tourist in Kyushu. The survey was conducted in March of 2000 for Korean tourist passengers in the ship of Beetle on their way back to Busan. Questionnaire sheets were distributed, answered on board, and collected in the collection box until their disembarking.

As usual in the questionnaire surveys, it is quite difficult to ask respondents about their income. We did not ask the income in the questionnaire. While most of the question items are concerned with their actual behavior during their stay in Kyushu, we also tried to add the contingent question items, that is, items to ask their intention or willingness. In other words, while the question items for actual behaviors are to obtain revealed preference data, the contingent question items are to obtain the stated preference data. Since we added the stated preference question items in an ordinary questionnaire, also difficult was to ask the respondents about their behavior for every detailed contingency.

To be more specific, we asked the respondents the following:

For each of two travel modes, sea line and air flight, Korean respondents were asked how many times you think you will visit Fukuoka when the round travel charge would decrease to 100,000 and 50,000 won for Beetle and to 150,000 and 100,000 won for air flight. In another questionnaire item, we also asked the respondents how many times they visited Fukuoka in recent two years. Thus we get from respondents the number of their visits to Fukuoka under five cases: two discounted prices for Beetle, two for air flight, and the present case.

Here it should be noted that we have not obtained from respondents the number of their visits to Fukuoka by two travel modes of sea line and air flight separately but obtained the whole number of visits to Fukuoka with either travel mode. If we regard two travel modes as distinct services, we should have asked the respondents the two numbers of their visits to Fukuoka by two travel modes for every contingency of travel charge. But following this procedure would have led to five more question items the respondents are forced to respond to.

To get around this difficulty, we employed the following conceptual framework: Two travel modes jointly provide a composite travel service between Busan and Fukuoka. Thus the responses from the respondents are thought of as their demand for this composite travel service. Based on this framework, the number of visits to Fukuoka regarded as the demand for the composite service changes as the price of the composite travel service changes.

In the next section, we will formalize the above conceptual framework in the model of two-step consumer utility maximization.

2.2 A two-step utility maximization formulation

We consider Korean consumers who are facing with making a decision of how many times they travel to Kyushu as tourists for various contingencies, in which only fares of travel modes are possible to change while the attractiveness of Kyushu and the travel time distances of travel modes are assumed to be fixed as it is.

Suppose that a Korean traveler i has the following utility function.

$$U_i = M_i^{\beta} A_i^{\gamma} \quad (2.1)$$

Here M_i denotes a quantity index for the composite service composed of several travel modes, A_i that for a composite good composed of all other goods, and β, γ parameters such that $\beta + \gamma = 1$.

Also suppose that the Korean traveler i has a sub-utility for the composite service of travel modes in such a form that

$$M_i = \prod_{j \in C} m_{ij}^{\alpha_j} \quad (2.2)$$

where C denotes a set of all travel modes, m_{ij} an individual i's demand for travel mode j, and α_j parameters. Let I_i denote the income for individual i.

We assume that traveler i follows the following two-step utility maximization process.

At the first step, traveler i decides how much he spends for the composite travel service to maximize the utility function (2.1) under his income constraint.

Let $\tilde{I}_i$ denote the optimal expenditure for the composite travel service obtained at the first step. Then the Korean traveler i decides the optimal demand m_{ij} for each travel mode j for the composite travel service to maximize the sub-utility function (2.2) under the budget constraint $\tilde{I}_i$. These discussions are expressed as follows.

At the first step, the individual i solves the following utility maximization problem.

$$\max_{M_i, A_i} M_i^{\beta} A_i^{\gamma} \tag{2.3}$$

s.t. $$qM_i + A_i = I_i$$

Here q denotes the price index of the composite travel service while the price of the composite good for all other commodities is set to 1 as a numeraire.

At the second step, the individual i solves the sub-utility maximization problem such that

$$\max_{m_{ij}} \prod_{j \in C} m_{ij}^{\alpha_j} \tag{2.4}$$

s.t. $$\sum_{j \in C} p_j \cdot m_{ij} = \tilde{I}_i$$

where p_j is the price of each travel mode j for the composite travel service.

With some calculation, we derive the following.

As for the first step, we obtain

$$M_i = \frac{\beta I_i}{q} \tag{2.5}$$

As for the second step, we obtain

$$m_{ij} = \frac{\tilde{I}_i}{p_j} \tag{2.6}$$

From these we can derive the following.

$$\tilde{I}_i = \beta I_i \tag{2.7}$$

$$M_i = \prod_{j \in C} \left(\frac{\alpha_j}{\sum \alpha_j} \right)^{\alpha_j} p_j^{-\alpha_j} (\beta I_i)^{\alpha_j} \tag{2.8}$$

$$q = \prod_{j \in C} \left(\frac{\alpha_j}{\sum \alpha_j} \right)^{-\alpha_j} \prod_{j \in C} p_j^{\alpha_j} \beta^{1-\sum \alpha_j} I_i^{1-\sum \alpha_j} \tag{2.9}$$

$$m_{ij} = \frac{\alpha_j}{\sum_{j \in C} \alpha_j} \frac{\beta I_i}{p_j} \tag{2.10}$$

If we assume that $\sum_{j \in C} \alpha_j = 1$, these are simplified as

$$M_i = \prod_{j \in C} \alpha_j^{\alpha_j} \frac{\beta I_i}{\prod_{j \in C} p_j^{\alpha_j}} \tag{2.11}$$

$$q = \prod_{j \in C} \alpha_j^{-\alpha_j} \prod_{j \in C} p_j^{\alpha_j} \tag{2.12}$$

$$m_{ij} = \alpha_i \frac{\beta I_i}{p_j} \tag{2.13}$$

In this case, it should be noted that the solutions m_{ij} obtained from the two-step utility maximization are the same as the ones obtained from the one-step utility optimization.

It is well known that if a utility function has a special form like the above, the two-step utility maximization becomes identical to the usual utility maximization. More specifically, suppose consumers have a utility function U of some group of commodities x and a composite good z for all other commodities. Assume that the utility function has a separable form such that $U = U(v(x), z)$ and the sub-utility function $v(x)$ is homothetic[3]. Then there exist a price index $e(p)$ and a quantity index $v(x)$ for the composite good x and the usual utility maximization becomes equivalent to the two-step utility maximization in which consumers maximize $U(v, z)$ under the price $e(p)$ at the first step to obtain the optimal expenditure $e(p)\tilde{v}$ and at the second step maximize sub-utility function $v(x)$ under the budget constraint $e(p)\tilde{v}$ to obtain the optimal consumption $\tilde{x}$.

In the above example, both $U(v, z)$ and $v(x)$ are Cobb－Douglas utility function with the sum of exponents equal to 1. Thus they satisfy the separable and homothetic conditions. (Cf. Varian[9] pp.151-152)

3 Estimating travel demand function without income data

3.1 Estimation method

In this section, we discuss the method to estimate foreign travel demand function without income data based on the previous results.

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[3] Let $h(\cdot)$ be a strictly increasing function. Let $g(x)$ be a function of homogeneous of degree 1. Then the function $h(g(x))$ is called a homothetic function.

For simplicity, hereafter we only consider the two travel modes of sea line and air flight.

As stated above, we do not have data corresponding to m_{ij} but the respondents' responses should be regarded as their demand M_i for the composite travel service between Busan and Fukuoka.

Let 1 represent Beetle and 2 Airline. From equation (2.8), demand M_i for the composite travel service by consumer i is expressed as follows.

$$M_i = \left(\frac{\alpha_1}{\alpha_1+\alpha_2}\right)^{\alpha_1}\left(\frac{\alpha_2}{\alpha_1+\alpha_2}\right)^{\alpha_2} p_1^{-\alpha_1} p_2^{-\alpha_2} \beta^{\alpha_1+\alpha_2} I_i^{\alpha_1+\alpha_2} \tag{3.1}$$

Here p_1 and p_2 denote the prices of Beetle and Air Flight between Busan and Fukuoka respectively.

Corresponding to the cases for stated preference questions, we consider five cases of prices of two travel modes including the present case and distinguish them by suffix k. Let $k=0$ represent the present case and $k=1,\ldots,4$ four other contingent cases. Let M_{ik}, p_{1k}, and p_{2k} represent demand for the composite travel service, Beetle's price, and Air Flight's price corresponding to five cases respectively.

Now to eliminate the income term from (3.1), we contrive a method to make the ratios of M_{ik}, $k=1,\ldots,4$ to M_{i0} for the present case. This leads to the following.

$$\frac{M_{ik}}{M_{i0}} = \left(\frac{p_{1k}}{p_{10}}\right)^{-\alpha_1}\left(\frac{p_{2k}}{p_{20}}\right)^{-\alpha_2} \tag{3.2}$$

This expression shows that we can estimate the parameters α_1, α_2 by the following linear regression model.

$$\log\frac{M_{ik}}{M_{i0}} = -\alpha_1 \log\frac{p_{1k}}{p_{10}} - \alpha_2 \frac{p_{2k}}{p_{20}}\log + \varepsilon_{ik} \tag{3.3}$$

3.2 Estimated results

Price data used for five cases are listed below.

k=0: $p_{10} = 170,000$ won, $p_{20} = 245,600$ won; the present case as of March 2000

k=1: $p_{11} = 100,000$ won, $p_{21} = p_{20}$

k=2: $p_{12} = 50,000$ won, $p_{22} = p_{20}$
k=3: $p_{13} = p_{10}$, $p_{23} = 150,000$ won;
k=4: $p_{14} = p_{10}$, $p_{24} = 100,000$ won;

The estimated results are shown in Table 3.1 and 3.2. The estimated equation turns out as follows.

$$\log \frac{M_{ik}}{M_{i0}} = -\underset{(-32.989)}{1.625} \log \frac{p_{1k}}{p_{10}} - \underset{(-30.490)}{1.955} \log \frac{p_{2k}}{p_{20}} \qquad (3.4)$$

$R^2 = 0.8163$

Table 3.1 Analysis of Variance

	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	993.126	496.563	1008.981	0.0001
Error	454	223.433	0.492		
Uncorrected Total	456	1216.559			

Root MSE	0.70153	R-Square	0.8163
Dependent Mean	1.43771	Adj R-Squar	0.8155

Table 3.2 Estimated Parameters

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Beetle $-\alpha_1$	1	-1.6250	0.0493	-32.9890	0.0001
Air Flight $-\alpha_2$	1	-1.9546	0.0641	-30.4900	0.0001

Note that we did not employ the explanatory variables other than prices of travel modes. Hence there are no explanatory variables that represent behaviors and characteristics of respondents. However, the R-squared value takes a considerably high value so that the model fitted very well to the actual data.

4 How accurate were the estimated results?

4.1 Forecasting method

1) Predicting the annual number of visits to Fukuoka for individuals

For prediction of individual's annual number of visits to Fukuoka, we transform equation (3.4) into the following form.

$$\hat{M}_{ik} = \bar{M}_{i0}\left(\frac{p_{1k}}{p_{10}}\right)^{-1.625}\left(\frac{p_{2k}}{p_{20}}\right)^{-1.955} \qquad (4.1)$$

Here $\bar{M}_{i0}$ denotes the present annual number of visits to Fukuoka for individual i as of 2000. The left hand side of $\hat{M}_{ik}$ is the annual frequency of visits to Fukuoka for the individual i when the prices of Beetle and Air Flight are changed to p_{1k} and p_{2k} respectively.

2) Predicting the aggregate number of Korean visitors to Fukuoka

To predict the total annual number of Korean visitors to Fukuoka, we have only to multiply the average of annual frequency of visits to Fukuoka for all individuals by the net total number of Korean visitors coming to Fukuoka. From the survey data, the average of annual numbers of visits for all individuals was obtained as $\hat{M}_{i0} = 1.1491$. In other words, the average number of visits to Fukuoka for all Korean respondents is 1.1491 times per year. If the prices of Beetle and Air Flight were changed to be discounted to the above four cases, the average number of visits to Fukuoka, $\hat{M}_{ik}, k = 1,...,4$ would increase to 2.722, 8.395, 3.021, and 6.654 times per year respectively for the cases from k=1 to 4. Hence the aggregate annual total number of Korean visitors to Fukuoka also would increase 2.722, 8.395, 3.021, and 6.654 times as large as the present annual net total number of Korean visitors to Fukuoka respectively for the above corresponding cases from k=1 to 4.

4.2 Could we have predicted the drastic increase of Korean visitors to Fukuoka?

Now we predict the number of Korean visitors to Fukuoka in recent years from 2000 to 2009 based on the model estimated at the time of 2000.

To do this first we need the annual net total number of Korean visitors to Fukuoka at the beginning of the year 2000. From the published data, we have 140 thousand visitors from Korea to Fukuoka in the year 1999.

While it seems that this number will do for the net total number, the number includes the same person who visited Fukuoka more than once a year so that we need to correct the double counting. As stated above, according to the survey data, the average number of visits to Fukuoka per year is 1.1491 times for all the respondents. Hence we must divide the number of total visitors to Fukuoka, 140 thousands by this average number of visits, 1.1491. As a result, the annual net total number of Korean visitors to Fukuoka at the beginning of year 2000 turns out to be 122(=140/1.1491) thousands.

Table 4.1 Exchange Rate of Won to Yen

year	KRW/JPY	ratio to 1999
1999	10.485	1.000
2000	10.486	1.000
2001	10.614	1.012
2002	9.950	0.949
2003	10.292	0.981
2004	10.592	1.010
2005	9.254	0.882
2006	8.206	0.782
2007	7.898	0.753
2008	10.726	1.023
2009	14.364	1.370

(Source: http://fx.sauder.ubc.ca/)

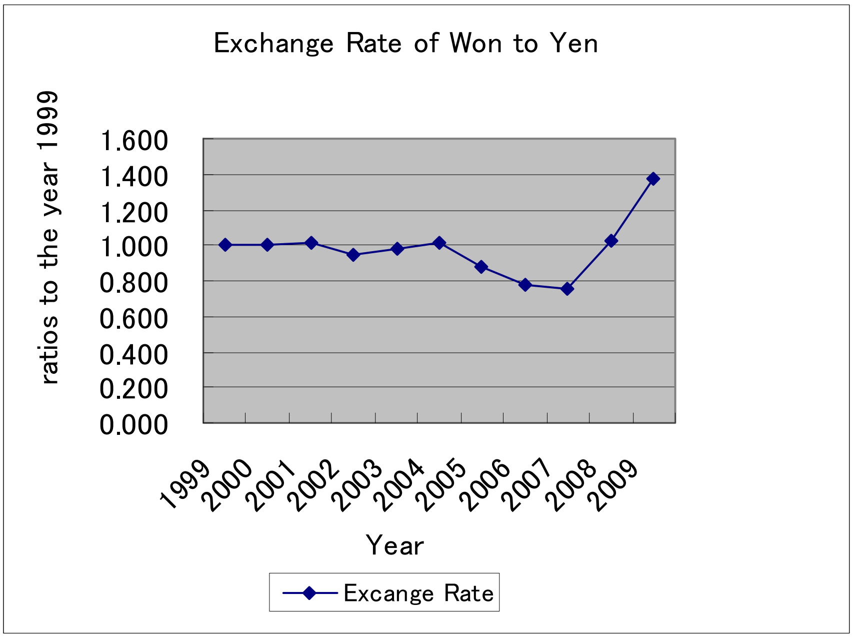

Figure 4.1 Exchange Rates of Won to Japanese Yen
Ratios to 1999

Next we need to know how prices of Beetle and Air Flight have changed through

2000 to 2009. Two main causes of changes should be considered. One is the discount by package tours. The other is the change of exchange rate.

The movement of exchange rate of Japanese Yen to Korean Won is shown in Table 4.1 and Figure 4.1.

In Table 4.1, the figures express the value of Japanese Yen in terms of Won. We see that Korean Won attained its highest value in 2007 taking 25% rise from 2000's price. We also see that the recent sharp drop of value of Korean Won due to the crisis of world economy. (Figure 4.1)

Table 4.2 shows the transport cost included in the typical package tour from Busan to Fukuoka and its discount ratio to the regular fare 170,000 won for Beetle.

We assume that the air flight regular fare 245,600 won has not been discounted during the period from 2000 to 2009.

Table 4.2 Transport Cost in Package Tour Price
from Busan to Fukuoka

Year	Transport Cost in Package Tour (won)	Discont ratio*
2000	160000	0.9412
2001	160000	0.9412
2002	160000	0.9412
2003	130000	0.7647
2004	130000	0.7647
2005	130000	0.7647
2006	130000	0.7647
2007	130000	0.7647
2008	140000	0.8235
2009	140000	0.8235
(*) Ratio of Transport Cost to Regular Fare, 170,000 won by Beetle		

Source: Interview to Net Japan Co.

With these preparations, we have forecasted the annual total number of Korean visitors to Fukuoka from 2000 to 2009. The result is shown in Table 4.3 and Figure 4.2.

Figure 4.2 demonstrates that with just the information of changes of travel cost we almost accurately have forecasted the movement of recent drastic increases of Korean visitors to Fukuoka.

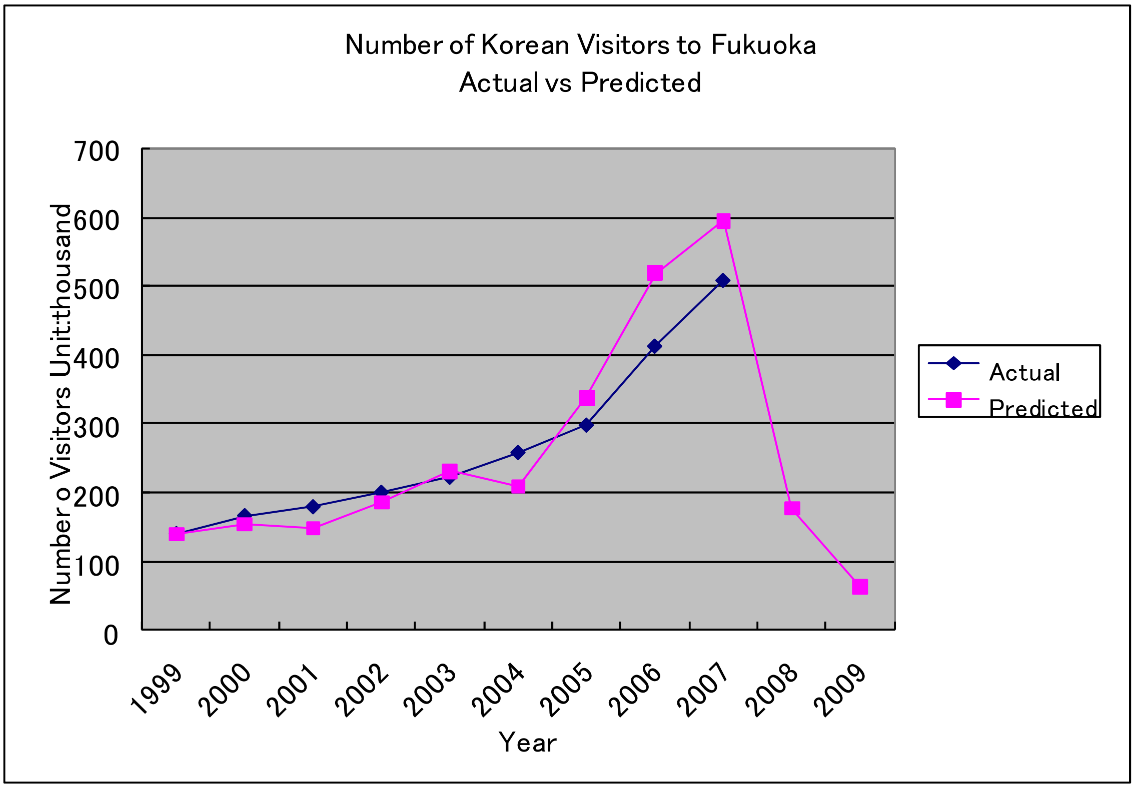

Figure 4.2 Numbers of Korean Visitors to Fukuoka
Actual vs. Predicted

Table 4.3 Numbers of Korean Visitors to Fukuoka
Actual vs. Predicted (unit thousand)

	Numbers of visitors from Korea		
	Actual	Predicted	error %
1999	140	140	
2000	166	154	7.48
2001	179	148	20.99
2002	200	186	7.37
2003	222	231	−3.97
2004	258	209	23.65
2005	298	338	−11.80
2006	413	519	−20.42
2007	509	595	−14.43
2008		177	
2009		62	

error=(Actual-Predicted)/Predicted*100

It should be noted that most of the changes of inflow of Korean tourists to Fukuoka can be explained by the changes of transport charges. While it is of quite importance to design the various tour products, the ratio of the transport charges to the total travel cost still is to be a key factor for designing the attractive tour products.

5 Conclusion and further researches

We have shown that based on the survey data of inbound behaviors of foreign tourists we can construct a model to estimate a travel demand function of Korean tourists for visiting Fukuoka without using income data and detailed stated preference questions.

Through showing this, we believe that we have demonstrated a way to solve the two inherent problems usual questionnaire surveys have; that is, one is the difficulty to get income data and the other the time limitation to perform detailed stated preference questions.

To avoid detailed stated preference questions, we conceptualize respondents' responses to the price changes of each of two travel modes as the changes of demand for the composite travel service composed of sea line and air flight. Based on this conceptualization, we have estimated a travel demand function for the composite travel service from Busan and Fukuoka. To enable us to estimate the travel demand function without income data, we made ratios to cancel out the income term in the travel demand function.

The estimated result clearly shows that we could have predicted the recent surges of Korean tourists to Fukuoka almost accurately at the time of 2000.

The fact that the estimated demand function can correctly reproduce the recent drastic changes though it uses only the information of prices of two travel modes implies that most of recent drastic increases of Korean visitors to Fukuoka can be explained by the transport cost. Thus the model is simple as it is but a significant one for explaining the changes of tourism.

There remain many topics we should address in further researches.

In this paper we have considered only the factor of transportation expenses. We have assumed that there are no changes both in travel time distance and in the attractiveness in Kyushu. However, it is obvious that the distances and attractiveness of destination should be included in travelers' utility function. Also important is to account for travelers' heterogeneous preferences for designing promising tour products in Kyushu.

The value of utilizing micro-behavior data obtained from survey of inbound behaviors of foreign tourists is huge in these further researches. In fact, we need to know how foreign tourists assess each component of tour products, that is, hotels, cultural heritages, natural scenery, city or rural tourism, shopping, and various activities.

Another potential value of the micro-behavior data is that we can estimate the economic impacts of inbound behaviors of foreign tourists to regional economies.

As shown in this paper, a deliberate use of micro-behavior data can be applied to policy study at macro level. Hence the utilization of micro-behavioral data should be explored further.

References

[2] Fujita, M., Krugman, P., Venables, A. (1999), *The Spatial Economy: Cities, Regions, and International Trade*, MIT Press.

[3] Motomura, H. and Saito, S. (2007), "Estimating Travel Demand Function with Inbound Destination variables", A paper presented at the 44th Annual Meeting of Japanese Regional Science Association. (in Japanese)

[4] Saito, S. Ed. (2000), *Report on the Survey of Consumer Shop-around Behavior at Central Commercial District of Fukuoka City–with focusing on Underground Space and Comparison of Attractiveness of Japanese and Korean Cities*, Institute of Urban Science, City Government of Fukuoka (in Japanese).

[5] Saito, S. and H. Motomura (2001), "A Study on Shopping and Sightseeing Behaviors of International Tourists", *Studies on Strait Area between Korea and Japan*, Vol.1, pp.41-61, (in Japanese), pp.51-77 (in Korean).

[6] Saito, S. and H. Motomura (2001), "The Number of Korean Tourists to Fukuoka and Transport Cost: A Simple Method to Estimate Travel Demand as a Composite Good of Different Travel Modes and its Applications", *Proceedings of the 38th Annual Meeting of Japanese Regional Science Association*, pp.333-340, (in Japanese).

[7] Saito, S., H. Motomura and M. Kakoi (2002), "A Study on Shopping and Sightseeing Behaviors of International Tourists II (Part 1): Analysis of Japanese Tourists' Behaviors in Korea and their Evaluation of Attractiveness of Japanese and Korean Cities", *Studies on Strait Area between Korea and Japan*, Vol.2, pp.26-41 (in Japanese), pp.36-52 (in Korean)

[8] Saito, S., and H. Motomura (2002), "A Study on Shopping and Sightseeing Behaviors of International Tourists II (Part 2): The Number of Japanese Tourists to Busan and Transport Cost", *Studies on Strait Area between Korea and Japan*, Vol.2, pp.42-50 (in Japanese), pp.52-63 (in Korean)

[9] Varian, H. (1992), *Microeconomic Analysis* 3rd Edition, W. W. Norton & Company