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Role of schedule delays on passengers' choice of access modes: A case of Japan's international airport

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Abstract

In this paper, we empirically studied passengers' modal-choice behaviors to access an international hub airport from local areas. Through the data collected by using stated preference method and constructing binomial logit model, we found that passengers' modal choices were affected by the level of service variables of access modes, such as travel time, travel cost, waiting time at hub airports and scheduled delay cost. Furthermore, an increase in frequency would reduce waiting time at hub airports. However, when passengers chose available access modes to hub airports in advance provided that the departure time was fixed, they especially considered the timing of departure from home and the timing of arrival at the airport (that is, convenience of schedule), as well as frequency of access modes.

We also calculated the value of scheduled delay. Based on the results of the value of scheduled delay, we proposed the pricing methods to correspond to passengers' various scheduling needs in the last section.

Keywords: Scheduling; Service frequency; Access mode choice; Hub airports; Stated preference; Binomial logit model

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1. Introduction

In this study we empirically examined the determinants of modal choice to access a hub airport from local areas. We adapted a binomial logit model with two alternatives, air and limousine, to find traveler valuations with data from a stated preference survey we designed.

To collect the data, we picked Kansai International Airport (KIX) as a hub airport and Takamatsu and Tokushima as local areas. KIX is the nearest international airport to both local areas. Currently, the main access mode from Takamatsu and Tokushima to KIX is a limousine bus, which takes about 3.5 hours from Takamatsu and about 2.75 hours from Tokushima. Until recently, commuting access flights to KIX were available from both local airports. It took about 30 minutes to access KIX from both airports by jet. Currently the resumption of jet services is pending due to their high operating costs.

In considering passengers' modal choices of access to hub airports, the authors of previous studies have focused on in-vehicle time, travel cost, frequency and access time as main factors of choice, probably because of lack of publicly available data of sufficient quality. However, what seems to be lacking is a consideration of "convenience of scheduling" from the demand side. If this factor is not present, it means that travelers cannot realize their desired arrival time and departure time because of the low frequencies or fixed time scheduling of the services. In this paper we focused on two issues that are part of "convenience of scheduling"

The first issue is arrival timing of access modes for international flights at hub airports. In this situation, flight frequency is important. However, in the case of air travel, we cannot expect sufficient frequency of flights from local airports. From local areas, there are at most 3 or 4 flights per day. Such low frequencies may leave transfer passengers with long waiting times or high rescheduling costs at origins or hub airports. When passengers have to stay at hub airports for as long as three or four hours due to low flight frequencies, the saved in-vehicle time might be offset by this long waiting time. In the case of a limousine bus, even it takes longer to access the hub airport than it takes when traveling by air, if passengers can arrive at a desired time due to relatively sufficient limousine bus departure times, travel by limousine bus will be more convenient than traveling by air. In this case, travelers would face the trade-off of long travel time or long waiting time. This is a crucial point to consider when discussing passengers' behavior when choosing their access mode to hub airports.

Generally, passengers determine which international flight to use at hub airports in advance, and the flight departure time is fixed. Under this situation, they must consider not just the frequency of a given access mode but also the arrival timing at a hub airport to transfer to the international flight. Therefore, to examine determinants of the selection of access mode to hub airports in reflecting the actual passenger decision-making process, we need not look at the frequencies of the access modes; examining the arrival timing of access modes at hub airports should be sufficient.

The second issue is the difference in the value of total travel time savings by departure time at home. Here, total travel time is the accumulated time from departure time at home to flight departure time at the hub airport. It is likely that passengers want to leave home at a time that doesn't require changing their lifestyle. For example, many international flights at KIX depart at around 10 a.m. To take these flights, passengers have to leave home in the early morning. From Takamatsu, for access to these flights, the only choice is a limousine bus departing at 4 a.m. Thus, passengers taking this form of transportation have to depart home much earlier than accommodates their usual life style. To avoid missed connections or changes to their life style, there are risk averters such as staying at a hotel near KIX the night before a flight. In this case, considerable rescheduling cost would be imposed on travelers. Therefore, we assume that the value of total travel time savings would vary based on whether passengers change their lifestyle to access transportation.

To better understand passengers' behavior in choosing an access mode to hub airports from local areas, we felt examining the above two issues concerning the convenience of scheduling were very meaningful. The main contribution of this study was that we examined these two issues via a stated preference survey that we designed and administered. We also estimated that it would be useful to discuss demand reaction in small markets such as the one we focused on in this research.

This paper is organized as follows. We begin with a brief review of prior studies dealing with convenience of scheduling by empirical research in airline markets in Section 2. Next, in Section 3, we explain our research issues and methods, applying them to the Takamatsu and Tokushima to KIX case. This is followed by a presentation of the stated preference survey we conducted and the stated preference data collected in Section 4. In Section 5, actual models are presented and empirical results are to be discussed. Concluding remarks are presented in Section 6.

2. Prior studies on convenience of scheduling in airline markets

Douglas and Miller (1974) wrote the first study on convenience of scheduling as a service variable added to travel time and travel cost to influence airline demand. In prior research, only travel cost and travel time including access time and egress time had been handled as a generalized cost in analyzing airline demand. Besides these costs, Douglas and Miller defined and adopted scheduled delay (SD), that is, the difference between the preferred arrival time (PAT) travelers want and the actual arrival time scheduled in advance, as an additional cost for travelers in their research. This study was significant because it revealed that the apparent level of fares was very high under a regulated airline market at that time, when SD cost was included in travelers' generalized costs. Moreover, a remarkable contribution of their study was to explicitly define and take into account this SD, in other words, convenience of scheduling in service variables, for the first time.

Following Douglas and Miller's work, there were a few empirical studies on airline demand. Morrison and Winston (1985) substituted the SD variable in their mode choice model for mean service interval time for various modes. Morrison and Winston (1989) investigated airline users' preference with an airline choice model that included the SD variable. In this work, a multinomial logit model was used with the SD variable calculated with real data and inserted into Douglas and Miller's formulation (equation). Morrison and Winston found that the value of SD was much lower than the value of total travel time and transfer time.

A more recent study was that of Proussalogou and Koppelman (1999), who examined a flight choice model with Stated preference (SP) data and conducted hypothetical experiments. In their research, SD was defined as the absolute value of the difference presented by flight departure time on choice experiments and preferred departure time for respondents. They found that business travelers were more sensitive to SD than were pleasure travelers, and the value of SD for business travel was higher than that for pleasure travel.

The most recent research was by Lijensen (2006), who examined a flight choice model with SP data in a hypothetical scenario. Lijensen supposed that the preferred arrival time (PAT) for travelers was an unknown parameter, so SD values were based on estimated PAT values that described travelers' evaluation at each time, that is disutility, with a mixed logit model. Lijensen separated SD into two parts, scheduled delayed early (SDE) and scheduled delay late (SDL). SDE was defined as an earlier arrival than the estimated PAT, and SDL was defined as a later arrival than the estimated PAT. This work was the first in which SED and SEL were explicitly taken into account in empirical research using an airline demand model. It was found that travelers were more averse to SDL than to SDE. This result was consistent with other travel demand research that included SDE and SDL.

Rieveld and Brons (2001) examined convenience of schedule at hub airports for travelers to adopt the SD definition in empirical analysis with data from major European hub airports. They hypothesized that the inconvenience of waiting time at hub airports was not simply affected by the number of flights. In general, London Heathrow and Paris Charles de Gaulle have such high frequencies that the mean waiting time is supposed to be short. However, by using a scheduling ratio reflecting the inconvenience of waiting time at hub airports, they found that Amsterdam, with the lowest flight frequencies among European major hub airports, performed better than did its competitors.

As mentioned above, although a few studies included the SD as a service variable, the methods used to define and set this variable in the models were not consistent. Morrison and Winston (1985, 1989) used frequencies data as a substitute variable for the SD variable. This process might not reflect real passengers' decision making as part of scheduling behavior.

As an outcome from Rieveld and Brons (2001), when there are seamless connecting flights in spite of lower frequencies, it is possible that passengers' disutility based on SD cost might be kept at a low level. In this case, when passengers choose access modes to a hub airport, they do not consider what frequencies the access modes have in a week or a day, but rather they consider that the desired arrival time of the access modes depends on the departure time of the international flights they will take from hub airports.

It is natural that the SD can be interpreted as undesired additional time, that is to say as an opportunity cost. To evaluate the opportunity cost that passengers pay, using the monetary value of time would be more appropriate than using the frequency. In considering these points when examining an access mode choice model, it is most suitable to use disaggregate data and include the SD variable as the difference of actual arrival time and desired arrival time.

3. Model approach and issues

The aim of the present study was to gain insight into the demand for access modes to international hub airports from local areas. Given this aim, we examined an access modal choice model with data from a SP survey we designed.

To conduct our research, we picked two access modes to Kansai International Airport (KIX), that is, air and limousine bus. In SP survey, it is important for the reliability of SP data that respondents can imagine a concrete choice process. In Takamatsu and Tokushima, the main access mode to KIX is currently a limousine bus; airline services accessing KIX were supplied in the past from Takamatsu and Tokushima airports. We chose to omit rail and ferry and auto as alternatives in our survey. First, in considering the burden of answering SP questions, we assumed that it was appropriate to limit the case so that passengers need not consider transferring transportation modes on the way to KIX. Second, for simplicity to compare with alternatives, we described a situation in which the travel cost is only the ticket price. In the case of automobile travel, the travel cost is comprised of at least petrol cost and parking cost, and it is complicated to ask respondents to compare alternatives when including this option[1]. Thus, we gave a choice of only two access modes, air and limousine bus, and we dealt with a one-way trip to KIX.

In this study we focused on two issues of “convenience of scheduling“. The first issue is arrival timing of access modes for international flights at hub airports. The second issue is the difference of value of total travel time savings based on departure time from home.

Regarding the first issue, because high frequency would not be expected from local areas to hub airports, convenience of scheduling must not be excluded as a service variable for access modes. And then, due to low frequencies, such a question “three flights per day” as one service attribute, frequency, in SP survey doubt whether this question reflects real traveler’s preferences. If the number of flight per day increase three to four, respondents in SP survey could not make the difference of these questions clear. Moreover, since each passenger only needs a single trip, frequency in itself has no meaning for them. Rather, we assume that connecting times at hub airports will play a more important role for each passenger. Thus, this convenience of scheduling variable has to be defined as the difference between preferred arrival time (PAT) for respondents and the actual arrival time of access modes in the SP survey. Therefore, we designed the SP survey so that respondents can answer in more realistic terms about the modal choice situation.

When transferring at hub airports, passengers need considerable time for check-in and boarding. These procedure times vary by airport and airline. We also assumed that the connecting times passengers needed would vary based on passengers’ familiarity with airport use and the extent of delay for different access modes. For example, passengers with a lot of experience taking business or leisure trips abroad might not need much time to transfer, because they are familiar with procedures for transferring or traveling around hub airports.

Of course, in going abroad, since travelers cannot miss connections at hub airports, the reliability of access modes is very important. To avoid missing connections, it is quite likely that passengers plan their trips to allow for delay or variability of arrival time, and passengers who have experienced substantial delays might make large allowances for transferring. It is possible that passengers plan their trips not on the basis of actual delay probabilities, but on what they perceive, based on their personal experience, delays may be. Given this, it has been difficult to measure passengers’ valuations or perceptions of reliability. Therefore, in our research, to

[1] It is quite likely that travel by automobile is an important alternative when passengers can carpool and use the parking area at KIX. However, computing the total cost is complicated because the parking fee depends on the length of travel, and the petrol cost and other costs of operating an auto would be included in the travel cost. For these reasons we did not include automobile travel in this survey. Actually, 75% of all respondents in our survey in Takamatsu listed the limousine bus as their main access mode to KIX in the past five years.

avoid dealing with this reliability variable directly, we assumed that travelers added extra time to the minimum connecting time needed at hub airports. In addition, we assumed that this extra time varies according to traveler and/or access mode. To overcome the difficulty of differences in the transfer time that respondents need, we define PAT as the time each respondent needed and answered in the SP survey for transferring at KIX with each mode, limousine and air. Thus, PAT has many different values in each traveler, that is respondent in our survey and each mode.

We distinguished the SD variable with SDE and SDL. When passengers arrive at hub airports earlier than they desired, this case is known as "scheduled delay early," or SDE. Scheduled delay has been defined as a measure of convenience related to the difference between preferred arrival time (PAT) and actual scheduled arrival time (AAT). That is, SDE=AAT-PAT. In the case of SDE, travelers have to wait at hub airports unnecessarily. When travelers arrive at hub airports later than they desired, this case is known as "scheduled delay late," or SDL. That is, SDL=PAT-AAT. In this case, travelers feel uneasy, since the longer SDL gets, the higher the risk of missing their connection.

One main contribution of the present study was that we examined an access modal choice model for a hub airport with SD variables distinguished as SDE or SDL, and we clarified that the values given by these distinctions are different.

The second issue we focused on was the difference in the value of total travel time savings based on the departure time from home. In an earlier study, the MVA Consultancy (1987) estimated the value of time required for long-distance train use. The MVA study results showed that weekday passengers' assessment of the value of travel time in the morning was 15% higher than that in the afternoon or evening. However, this research did not discuss in detail why the value of travel time was different according to the time of day. The authors did point out the possibility that frequency, travel purpose or traffic condition could influence the value of travel time. Also, Mackie et al. (2001) pointed out that the value of travel time was different not only based on travelers' demographic factors such as income or wage rate but also on the time of day travel occurred. However, similar to above research, this study did not examined precisely why the value of travel time would be different based on the time of day.

We chose to focus on activities and time constraints as main factors in the difference of the value of time based on time of day. For example, when passengers use flights that depart in the morning from KIX, they must leave home very early in the morning or stay overnight in a hotel near KIX the night before. In fact, the peak flight time for flying abroad from KIX is around 10 am. Thus, to connect during the peak time at KIX, passengers must board the limousine bus departing at 4:20 a.m. from JR Takamatsu station or at 5:05 a.m. from JR Tokushima station. Naturally this means they must leave their homes even earlier. It is clear why some people would choose to stay at a hotel near KIX the night before going abroad. We cannot ignore or underestimate the additional cost (e.g. hotel fee) and opportunity cost (e.g. sleeping time) that arises as a result of changes to passengers' usual life style.

Generally speaking, activity time at home in the morning, above all the time of waking up, might be fixed every day. In the case of leaving home earlier than usual, travelers need to change their lifestyle so much that scheduling cost cause to arise. On the other hand, when passengers can travel without changing their lifestyle, no additional scheduling costs are incurred.

Although total travel time is the same, it is possible that the value of time might be different in the former case needed to change their lifestyle and latter without.

In this study, we examined the value of total travel time savings by separating examples into flights to departing from KIX before noon and flights departing after that.

4. SP design and data sources

Three service attributes (ticket price, in-vehicle time and connecting time) are selected for the two modes, limousine and air. Ticket price and in-vehicle time are shown in Table 1 and connecting time in Table 2. To define level of services, real information concerning ticket prices and times of the two modes was used as a basis. Information about the level of services for the limousine bus was obtained from real information about existing services. Thus, in this survey, there was no variation with respect to the level of ticket price and in-vehicle time for limousine from Tokushima and Takamatsu to KIX. In the case of air travel, as the services are currently pending in both areas, real information wasn't available. We obtained information from past services on the same routes. Ticket price for air travel was defined in four levels from Tokushima and Takamatsu to KIX. In-vehicle time for air has two levels 30, 45 minutes from Tokushima, 35, 50 minutes from Takamatsu. As shown in Tabale1-2, connecting time has four levels in two patterns in both modes. The data of access time from home to bus stations and local airports was obtained by asking respondents directly in our survey.

To make choice sets, we used an orthogonal main effect fractional factorial model. By applying the fractional factorial design, 16 different scenarios were obtained that had to be evaluated by each respondent. We set out two travel cases, a.m. departure and p.m. departure from KIX, so that each respondent actually would have had to evaluate 36 different scenarios to cover all possible combinations; however, evaluating so many scenarios would be very demanding for respondents, so we divided the scenarios into four blocks randomly assigned to choice sets. Thus, each respondent evaluated 4 choice scenarios in the case of a.m. departure and p.m. departure at KIX. That is to say, each respondent evaluated 8 scenarios in each survey.

Respondents selected their travel purpose, business or leisure, at the beginning of the questionnaire based on their real experience or possibility of going abroad.

We used our survey to collect responses around Takamatsu and Tokushima. For Tokushima, all data was collected by a mail survey. For Takamatsu, in addition to a mail survey, questionnaires were handed out directly to travelers. The available sample was 952 completed surveys in Tokushima and 2617 completed surveys in Takamatsu.

Table 1

Service attributes levels in the SP experiment

		Air	Limousine bus
Tokushima	Ticket price(one-way)	9800, 7800, 5800, 3800 yen	4000 yen
	In-vehicle time (one-way)	30, 45 minutes	2.45 minutes
Takamatsu	Ticket price (one-way)	10000, 8000, 6000, 4000 yen	5000 yen
	In-vehicle time (one-way)	35, 50 minutes	3.30 minutes

Table 2

Patterns of connecting times at KIX（hour.minute）

		Air	Limousine bus
a.m. departure at KIX	Pattern 1	1.40, 2.10, 3, .15	1.15, 2, 2.10, 2.40
	Pattern 2	1, 1.40, 2.30, 3.50	1.30, 1.40, 1.50, 2
p.m. departure at KIX	Pattern 1	1, 1.30, 2.15, 4.30	1.15, 2, 2.30, 3
	Pattern 2	1.40, 1.50, 3.30, 3.40	1.40, 2.30, 2.50, 3.10

5. Demand model

Variables in this model are shown in Table 3.

The disutility of the traveler (U) under each alternative (air and limousine bus) is as follows.

$$U_{air} = V_{air} + \varepsilon_{air} \quad (1)$$

$$U_{bus} = V_{bus} + \varepsilon_{bus} \quad (2)$$

The disutility can be partitioned into a systematic component (V) and a random component (ε). The parameters β are unknown. This study treats the individual idiosyncrasies of taste as random under random utility theory. The following linear specification in the parameters is that used in estimation of the logit model:

$$V_{air} = Const + \gamma Income + \beta_1 Accesstime_{air} + \beta_2 Traveltime_{air} + \beta_3 Travel\cos t_{air} + \beta_4 SDE_{air} + \beta_6 SDL_{air}$$

$$V_{bus} = \beta_1 Accesstime_{bus} + \beta_2 Traveltime_{bus} + \beta_3 Travel\cos t_{bus} + \beta_4 SDE_{bus} + \beta_6 SDL_{bus}$$

(3)

The following probabilistic function is estimated:

$$\Pr^n(Air) = \Pr(V^n_{air} - V^n_{bus} \geq \varepsilon^n_{bus} - \varepsilon^n_{air})$$
$$= \Pr(AirC^n_{air} + \gamma Income^n_{air} + \beta_1(AT^n_{air} - AT^n_{bus}) + \beta_2(TT^n_{air} - TT^n_{bus})$$
$$+ \beta_3(TC^n_{air} - TC^n_{bus})\beta_4(SDE^n_{air} - SDE^n_{bus}) + \beta_5(SDL^n_{air} - SDL^n_{bus}) \geq \varepsilon^n_{bus} - \varepsilon^n_{air})$$

(4)

Pr(Air) is the dependent variable that indicates the estimated probability of choosing air as a travel option, where *n* is the individual.

Thus, the binary logit model arises from the assumption that ε_{bus}^n and ε_{air}^n are independent and identically Gumbel distributed. The probability of choosing the air travel option is as follows:

$$\Pr^n(Air) = \exp(V^n_{air}) / (\exp(V^n_{air}) + \exp(V^n_{bus})) \quad (5)$$

The criterion of optimality that is applied is the maximum likelihood estimation procedure. The Newton-Raphson method is used to maximize the likelihood function with respect to the parameter vector. Expected signs are Access time<0, Travel time<0, Travel cost<0, SDE<0, SDL<0, Income>0.

6. Estimation results

Table 4 shows the results of estimations using our model, separated by trip purpose (business or leisure) for Takamatsu and Tokushima.

On business trips, all variables were statistically significant and all the estimated signs were as expected. We obtained a robust value of 0.27 on ρ^2, which indicates the degree of explanation for this model. The value of the estimated parameter of IVT in this model was relatively higher than other parameters. Since it is possible that values of parameters would be considered as relative degrees of significance on the access mode choice, this result indicates that business travelers take much shorter IVT into account than do others when choosing the access mode.

For leisure trips, we did not obtain a robust value on ρ^2; its value, 0.18, was not bad to explain for this model. Although the estimated sign of the IVT parameter was positive, this was statistically insignificant. In the leisure trip case, we could not obtain significant values with respect to time variables such as access time and IVT. Jara-Díaz (2000) suggested that variables relevant to time might be influenced more than cost by unobserved variables that are difficult to set in models. This would be one reason why we obtained such a result for leisure trips. That is, leisure travelers might place importance on service attributes not included in the access mode choices listed in our questionnaire.

We want to emphasize that in this model SDE and SDL were statistically significant for both trip purposes. In particular, the value of the SDE parameter, which shows disutility of waiting too long at KIX, was higher than that of other variables for both business and leisure travel. This result suggested that the SDE variable was important for business and leisure trips in access mode choice. In prior studies, above all, the choice model of departure time by auto for work-trip, the assumption that the value of SDE parameter would be smaller than that of SDL is now widely accepted. However, our result was contrary to this. We can interpret this result as follows. It may be that respondents could not imagine the risk of missing connections at KIX because of the hypothetical context in the SP questionnaire. Another possibility is that respondents might rate the reliability of limousine and air travel higher in this area than that of modes in other areas. Moreover, when respondents answered their PATs with a large allowance they added in advance for connection time in case of missing a connection or unexpected trouble, they might consider the risk of missing a connection low by this much allowance time and evaluate their needed connect time as shorter. Since we could not clarify these points, we need to examine them more carefully in future studies.

We estimated the monetary value of time savings with respect to IVT, SDE and SDL. In the discrete choice model, the value of travel time savings (VOTTS) could be obtained from ratios with estimated parameters of time by estimated parameters of travel cost if the utility function was linear. These values could be interpreted as travelers' willingness to pay for saving units of time, which is called the subjective value of saving time.

Table 3

Definitions of explanatory variables

Variables	Unit	Description
Total time	min	From departure time at home to time of taking off at KIX, including access time, travel time, check-in-time at bus terminals and local airports in Takamatsu or Tokushima, allowance time and connecting time at KIX.
Access time	min	Travel time from home to local airports or bus terminals in Takamatsu and Tokushima (asked directly in this survey)
Travel time	min	In-vehicle time setting in this survey.
Travel cost	yen	Ticket price setting in this survey.
SDE	min	PAT-AAT max(0,SDE) if SDE<0,SDE=0
SDL	min	AAT-PAT max(0,SDL) if SDL<0,SDL=0
Income	yen	Annual household income (in 0000s yen) Calculated as the mid-point of the income interval in this survey

Table 4

Estimation results of the binary logit model for choice of access modes to KIX

	Business traveler				Leisure traveler			
	Parameter		s.e.	t-ratio	Parameter		s.e.	t-ratio
Constant	-2.52299	***	0.85023	-2.97	1.109570	***	0.39252	2.83
Income	0.00095	***	0.00014	6.57	0.000509	***	0.00008	6.11
Access time	-0.01047	*	0.00544	-1.93	-0.003134		0.00218	-1.44
Travel time(IVT)	-0.02023	***	0.00495	-4.08	0.000004		0.00228	0.002
Travel cost	-0.00017	***	0.00004	-4.36	-0.000228	***	0.00002	-11.34
SDE	-0.01168	***	0.00149	-7.85	-0.011662	***	0.00078	-14.92
SDL	-0.00684	**	0.00318	-2.15	-0.005525	***	0.00144	-3.83
L(β)	-423.77				-1542.37			
L(0)	-583.63				-1890.21			
ρ^2	0.27				0.18			
$\bar{\rho}^2$	0.26				0.18			
Subjective values of time (¥/h)								
IVT	7140.0				—			
SDE	4122.2				3068.9			
SDL	2414.1				1453.9			
n.Observations	842				2727			

***Coefficient is significant at the 1% level, **at the 5% level, *at the 10% level.

For business trips, the value of IVT was highest in three time variables, IVT, SDE and SDL[2]. This result implies that business travelers want to arrive at hub airports as fast as possible to save no productive time to use such as IVT. Prior studies also showed that the value of IVT for long business trips was higher than the values of other time variables[3].

Comparing values of time for business and leisure, the value of SDE and SDL for business was higher than that for leisure by 1000 yen. These results are identical with those of prior studies in that business travelers' willingness to pay for time is higher than that of leisure travelers. Comparing values of SDE and SDL, SDE was higher for both business and leisure. Though there are few studies of transfers at hub airports in which the SDE and SDL variables are set separately in the demand models, some studies that do not focus on transfers such as departure time choice models by auto on highway show a contrary results, which are the value of SDL was higher than that of SDE. Thus there is room for reconsidering precisely why SDE is higher in our research. However, as Wardman (2001) indicated, there was a problem in estimating the value of travel time in earlier studies that did not distinguish disutility of transfer, check-in time or waiting time individually. Rather, considering disutility of transfer was given by our research design and check-in time and waiting time were separated by setting SDE and SDL variables in our model, our results might be reliable.

We examined the difference in value of total travel time savings based on departure time from home. Table 5 shows the estimated results by estimating the cases of before or after noon separately. For both business and leisure trips, all estimated parameters except for

[2] In this study, we did not survey individual access cost from home to local airports or bus terminals, so we did not estimate the value of access time.

[3] For example, Winston (1985), Wardman (1998).

constants were statistically significant and signs were as expected. What is more, for business trips, we obtained a robust value 0.26 on ρ^2. On the other hand, for leisure, we could not obtain a robust value. As mentioned above, this result might indicate that leisure travelers would consider other service attributes than those we presented in this model. It is not easy to know what caused this result; we need to examine the data and/or model specifications more precisely.

Here, comparing the value of the estimated parameter with total time in the a.m. with that in the p.m., we find the value in the a.m. was higher than that in the p.m. for both business and leisure travel. This result shows that travelers in the a.m. case would consider the total time, that is, beginning with the departure time from home, more than would travelers in the p.m. with regard to access mode choice. Contrary to this, the value of the estimated parameter with cost in the p.m. was higher than that in the a.m. for both business and leisure travel. This result implies that the influence of ticket-price is stronger in the p.m. case.

The subjective value of total time savings in the a.m. was higher than that in the p.m., as we expected, for both business and leisure travel. Our results indicate that travelers' willingness to pay for saving time differs between the a.m. and p.m. In this research, since total time is defined as the accumulated time from leaving home to taking off at a hub airport, including check-in time, waiting time, access time to service points and allowance time, this result reflects a more realistic decision-making process of access mode choice than that described in some previous studies. Thus, the result we obtained should be reliable. Since our result was obtained by the SP experiment we designed, the results were not influenced by traffic congestion, which was emphasized in some prior studies. Hence, although we did not consider access travel cost to a bus terminal or local airports, we believe these values we estimated as reliable to some extent.

Table 5

Estimation results of the logit model (depart in the a.m./p.m.)

	Business traveler				**Leisure traveler**			
	Parameter		s.e.	t-ratio	Parameter		s.e.	t-ratio
Constant	-0.42042	*	0.215952	-1.95	0.08170		0.10490	0.78
Income	0.00085	***	0.000142	5.99	0.00052	***	0.00008	6.44
Total time (a.m.)	-0.01039	***	0.001635	-6.36	-0.00990	***	0.00085	-11.60
Total time (p.m.)	-0.00789	***	0.001262	-6.25	-0.00586	***	0.00063	-9.33
Travel cost (a.m.)	-0.00014	***	0.000049	-2.92	-0.00019	***	0.00003	-7.46
Travel cost (p.m.)	-0.00023	***	0.000049	-4.67	-0.00025	***	0.00002	-9.90
L(β)	-429.24				-1554.07			
L(0)	-583.63				-1890.21			
ρ^2	0.26				0.18			
$\bar{\rho}^2$	0.25				0.17			
Subjective values of time (¥/h)								
a.m. departure	4320				3111			
p.m. departure	2066				1422			
n. observations	842				2727			

***Coefficient is significant at the 1% level, **at the 5% level, *at the 10% level.

6. Conclusions

As we have seen, SDE and SDL, reflecting the convenience of transfer, have a strong influence on access modes choice to hub airports for both business and leisure travelers. In particular, for leisure travelers, although SDE and SDL were statistically significant in access modes choice, IVT was not significant in our results. This is inevitable when new access modes are planned from local areas to hub airports. Because leisure travelers are not attracted to such newly flights that make them wait for so long time at hub airports, even though flight time, that is IVT, will get much shorter than that of limousines.

In general, as market sizes of access modes from local areas are small, high-frequency is not expected. It can be inconvenient for travelers to transfer at hub airports, in that SDE might be so long that they must wait for a long time at hub airports. In this case, sufficient demand for new access flight from local airports to hub airports would not be expected when flight price remain high only considering on relatively shorter IVT to existent modes, such as limousines without considering willingness to pay for saving SDE.

On the other hand, our results made clear that business travelers would need to save much time for access travel to hub airports, in that values of SDE, SDL and IVT with respect to time variables were high. Similar to leisure travelers, the value of SDE, leaving them to wait at hub airports, was also high.

Next, for both business and leisure travelers, values of total time saving in the a.m. were higher than that in the p.m. in our research. This result implies travelers' preferences for delaying departure time at home in case they must go home early in the morning. Their willingness to pay will be higher when access modes not making them wake up earlier than usual are available. As air travel can mean a much shorter travel time than limousine travel, using the former can allow passengers to delay their departure time from home. Thus, our result shows that travelers would prefer access flights to KIX with a.m. departures to flights with p.m. departures.

As we have seen, considering travelers' willingness to pay for saving time differs between the a.m. and the p.m., it would be inappropriate that the same price be set on the flights service with different times in a day even though they have the same IVT and service attributes.

Finally, based on our results, we can next present suggestions about access flights to hub airports from local areas. First, considering convenience of connecting, it is very important that access flights connecting well to peak-time flights at hub airports will be provided. Moreover, when such flights will depart from local airports in the morning, the ticket prices can be relatively high, as the dominance of preference for air for express travel is sustained. Second, since passengers connecting to off-peak flights at hub airports have to wait for a long time, even if they use the same access flight, ticket prices should be set to reflect SDE cost.

When there are insufficient passengers to access flights from local areas, airlines may be able to improve their load factor and not be unfair to passengers by setting prices based on passengers' willingness to pay.

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References

Bates, J., Polak, J., Jones, P., Cook, A., 2001. The valuation of reliability for personal travel. Transportation Research E 37 (2), 191-229.

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

Douglas, G. W., Miller, J. C., 1974.[a] Quality competition, industry equilibrium, and efficiency in the price-constrained airline market. American Economic Review 64, 657-669.

Douglas, G. W., Miller, J. C., 1974.[b] Economic Regulation of Domestic Air Transport: Theory and Policy. The Brookings Institution, Washinton, D. C.

González-Savignat, M., 2004. Competition in Air Transport: The Case of the High Speed Train. Journal of Transport Economics and Policy 38 (1), 77-108.

Harvey, G., 1986. Study of airport access mode choice. Journal of Transportation Engineering 112 (5), 525-545.

Jara-Díaz, S. A., 2000. Allocation and valuation of travel time savings. In: Button, K. J., Hensher, D. A., (Eds.), Handbooks of Transport Modeling. Pergamon Press, Oxford, Chapter18, 303-319.

Jones, P. M., Dix, M. C., Clarke, M. I., Heggi, I. G., 1983. Understanding Travel Behaviour, Gower Publishing, Aldershot, England.

Lam, T. C., Small, K. A., 2001. The Value of time and reliability: measurement from a value pricing experiment. Transportation Research E 37 (2), 231-251.

Lijensen, M. G., 2006. A mixed logit valuation of frequency in civil aviation from SP-data. Transportation Research E 42 (2), 82-94.

Louvirere, J. J., Hensher, D. A., Swait, J. D., 2000. Stated Choice Methods: Analysis and Application, Cambridge Univercity press, UK.

Mackie, P. J., S. Jara-Díaz, Fowkes, A. S., 2001. The Value of travel time savings in evaluation. Transportation Research E 37 (4), 91-106.

Morrison, S. A., Winston, C., 1985.[a] An econometric analysis of the demand for intercity passenger transportation. Research in Transportation Economics, Brookings Institution 2, 213-237.

Morrison, S. A., Winston, C., 1985.[b] The Economic Effects of Airline Deregulation, Brookings Institution, Washington, DC.

Morrison, S. A., Winston, C., 1989. Enhancing the performance of the deregulated air transportation system. Brookings-Papers-on-Economic-Activity. Special Issue 0 (0), 61-112.

MVA Consultancy, Institute for Transport Studies University of Leeds, and Transport Studies Unit University of Oxford., 1987. The Value of Travel Time Savings, Policy Journals, Newbury, Berks.

Noland, R. B., Small, K. A., 1995. Travel-time uncertainty, departure time and the cost of the morning commutes. Transportation Research Record 1493, 150-158.

Noland, R. B., 1997. Commuter responses to travel time uncertainty under congested conditions: Expected costs and the provision of information. Journal of urban economics 41 (3), 377-406.

Noland, R. B., Small, K. A., Koskenoja, P. M., Chu, X., 1998. Simulating travel reliability. Regional Science and Urban Economics 28 (5), 535-564.

Noland, R. B., Polak, J. W., 2002. Travel time variability: a review of theoretical and empirical issues. Transport Reviews 22 (1), 39-54.

Pels, E., Nijikamp, P., Rietveld, P., 2003. Access to and competition between airports: a case study for the San Francisco Bay area. Transportation Research A 37 (1), 71-83.

Proussaloglou, K., Koppelman, F.S., 1999. The choice of air carrier, flight, and fare class. Journal of Air Transport Management 5 (4), 193-201.

Rietveld, P., Brons, M., 2001. Quality of hub-and-spoke networks: the effects of timetable co-ordination on waiting time and rescheduling time. Journal of Air Transport Management 7 (4), 241-249.

Small, K. A., 1982. The scheduling of consumer

activities: Work trips. The American Economic Review 72 (3), 467-479.
Wardman, M., 1998. The Value of travel time: A review of British evidence. Journal of Transport Economics and Policy 32 (3), 285-316.
Wardman, M., 2001. A review of British evidence on time and service quality valuations. Transportation Research E 37 (2), 107-128.
Wardman, M., 2004. Public transport values of time. Transport Policy 11 (6), 36.