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Demand Leakage from a Local Small Airport to a Regional Main Airport

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Abstract: This paper investigates traffic demand leakage from local small airports to regional main airports. To capture the factors that affect the airport choices of passengers, conditional logit analysis was implemented utilizing Japanese micro data. The target of the statistical analysis is the traffic demand of Kitakyushu city that has the Kitakyushu Airport (KKJ), a local one. The choice set of passengers consists of KKJ and the Fukuoka Airport (FUK), which is regional. The main results are as follows: First, 79.3% of passengers utilize KKJ as long as it is directly connected to the destination airport. However, 0.9% only of passengers choose KKJ if it is not. This implies the importance of direct flight services. The second result is ground access time and scheduling costs have negative effects on airport choice, indicating that improving ground access and attracting flight frequency are possible policies that could be utilized to promote the local airport. Utilizing the results of the data analysis, the effects of potential policies was simulated. A one-minute decrease in the access time to KKJ raises the probability that KKJ will be chosen by 1.1% and a one-flight increase on the Tokyo-KKJ route raises the probability by 0.14%.

Keywords: *Airport choice, airport competition, local airport, traffic demand*

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INTRODUCTION

Due to competition, local small airports have suffered losing traffic demand to regional main airports. Even passengers living in the smaller local airport's city utilize the regional main airport instead due to the small number of directly connected destinations and low flight frequency. In other words, catchment areas for local airports are eroded by regional main ones. According to Thelle and la Cour Sonne (2018), small airports with less than five million passengers per year lose 0.4 routes per year, while those with between 10 and 25 million gain 2.4 routes. Lian and Ronnevik (2011) also showed that Norwegian local airports are losing market share to nearby main airports. Demand leakage is a problem for regional main airports as well. Some regional airports now face congestion problem, so demand inflow from local airports can aggravate congestion.

Note that the definitions of "local small airports" and "regional main airports" in this paper are as follows. Local airports are those found at the county or prefecture level that connects only to a few domestic cities. Regional airports serve short haul international (or intra-continental) flights and domestic (or short haul) flights and serve as the air traffic centers of a state or province. In terms of the global hub-spoke network structure, both regional and local airports are treated as spoke airports.

There are three types of studies found in the literature addressing airport competition and choice problems. First, the most popular type is competition between mega hub airports. Within East Asia, Hong Kong International, Incheon in South Korea and Narita in Japan compete for transit passengers who travel between Southeast Asia and North America.

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Park (2003) analyzed the competitiveness of eight major Asian airports, including Hong Kong, Incheon, and Narita. The paper suggested that five core factors (spatial, demand size, facility, management, and service level) influence competitiveness, among which demand size is the most important. Redondi, Malighetti, and Paleari (2011) focused on the deregulated E.U. market and pointed out the centrality of Frankfurt airport. As a theoretical research, Teraji and Morimoto (2014) indicated that smaller airports are aggressively discounting their airport charges to reach hub position or status. In the view point of sea ports, (Czerny, Hoffler, & Mun, 2014) considered the case where two hub ports compete for transshipment cargo from the regions between the ports.

Second, some studies consider passengers' airport choice in multi-airport regions, like the San Francisco Bay Area, which has three airports. Pels, Nijkamp, and Rietveld (2001) and Basar and Bhat (2004) focused on the Bay Area, while (Loo, 2008) targeted the Hong Kong-Pearl River Delta area. These researches showed empirically that flight frequency and access time to the airport have a significant effect on passengers' airport choice behaviors. Methodologies have also been developed to capture various factors that influence passengers' decisions. Furuichi and Koppelman (1994) established a model to measure decisions at both departure and arrival airports. Applying a nested logit model and based on passengers' behavior, Pels, Nijkamp, and Rietveld (2000) investigated strategies of airline companies and airports in multi-airport regions.

Third, other literature is related to competition between spoke airports. Even though airports are located in different cities or metropolitan areas, their catchment areas may overlap, so long as they are not too far from each other. As Figure 1 shows, in the case of Japan, Kitakyushu airport (KKJ) is sixty kilometers only from Fukuoka airport (FUK). Despite the ubiquitous spoke airport competition, to the best of my knowledge, only Lian and Ronnevik (2011) and Suzuki, Crum, and Audino (2003) have studied this topic. Lian and Ronnevik (2011) focused on Norwegian airports and indicated that local airports can collect passengers up to thirty minutes away by car, while the catchment area of a regional airport may withstand travel distances of over one hundred twenty minutes, indicating that demand at local airports leaks to regional ones. Suzuki et al. (2003) treated demand leakage from a local airport to a larger airport. Taking Des Moines airport in Iowa (U.S.A.) as an example, leisure travelers are more likely to utilize a larger airport than business travelers.

Figure 1 *Location of KKJ and FUK in Fukuoka Area*

Although the multi-airport problem has been studied since Skinner (1976), the demand leakage problem and relationship between a regional airport and local airports have not attracted the attention of researchers nor recognized as an independent research topic. Even though there exist similarities between the two problems; i) catchment areas of several airports are overlapping and ii) passengers decide which airport to utilize, demand leakage problem has its own characteristic features as summarized in Table 1.

First, competing regional and local airports are located in "different" cities or metropolitan areas, whereas the multi-airport literature involves airports in the "same" area. Second, in most cases, financial deficits due to small traffic volume cause serious problems for local airports. This is why operators of local airports try to increase demand for their airport services. However, airports in mega-metropolitan areas suffer from heavy congestion and slot shortages; hence, new airports have been constructed, leading to the multi-airport problem. Tokyo's Narita airport, constructed in 1978, was built to deal with slot shortages at Haneda, and cities such as Manila (the Philippines), Jakarta (Indonesia), and Istanbul (Turkey) plan to build secondary airports to address growing air traffic. Finally, related to the first and second points, not only local airports but also local governments compete with each other to attract passengers, while multi-airports coordinate and cooperate to optimize overflow traffic. In Osaka, a multi-airport region in Japan, Itami and Kobe airports serve only domestic flights, leaving Kansai airport to concentrate on international flights. The socially optimal operation of the airports in Osaka was investigated by Mun and Teraji (2012). As in other examples, perimeter rules and international flight restrictions are introduced at "old" airports, such as Reagan National Airport in the Washington, D.C. multi-airport region, Gimpo airport in Seoul, Songshan airport in Taipei, and Hongqiao airport in Shanghai.

Table 1 *Differences between Multi-Airports and Demand Leakage Problem*

	Demand leakage problem	Multi-airport problems
Locations of airports	In different areas	In the same area
Problems	Small demand and financial deficits	Congestion and slot shortages
Relation among airports	Competition	Coordination and cooperation

Although significant differences exist between the demand leakage problem and multi-airport problem, the former hasn't been established as an independent research topic yet. Thus, this paper try to clarify the demand structure of completing local airports and captures the reasons behind demand leakage from local small airports to regional main ones, based on the behavior of passengers who can choose among local airports. For this purpose, this paper utilizes micro data, including the origin of a trip, accessibility to airports, and characteristics of passengers, such as gender and age, which may affect passengers' decisions. Furthermore, using statistical analysis, simulation of potential policies that would increase passenger traffic at small airports is implemented.

Section 2 introduces the methodology and data used in the analysis. Section 3 is for the statistical analysis on airport choice of passengers and the estimation of the impacts of access time and flight frequency on airport choice. In section 4, based on the results of the analysis, potential policies that may change the competitive environment is simulated and evaluated. Section 5 contains the concluding remarks.

MATERIALS AND METHODS

The Setting for the Conditional Logit Model

The object of this paper is the home market of a local airport, using the Fukuoka area in Japan (Fig 1) as an example. In particular, the analysis target is the airport choice decision of residents in Kitakyushu city, the home market of KKJ. Passengers from Kitakyushu city may choose between FUK, the regional airport of Fukuoka area, and KKJ, the local airport of Kitakyushu city. FUK serves 18 international and 26 domestic routes while KKJ has only two international and two domestic routes. Thus, passengers face a trade-off between the convenience of FUK and a shorter access time to KKJ.

The Conditional Logit (CL) model developed by McFadden (1973) is utilized to analyze the airport choice of the passengers. The utility of passenger iε{1,2,...I} gained by traveling from airport jε{KJJ, FUK} is given as

$$U_{ij} = V_{ij} + _{ij}$$

V_{ij} is the fixed term and the functional form given in equation (1) is common for all individuals. ε_{ij} is the random error term with Gumbel distribution that captures the heterogeneity of each passenger's preference on the alternatives. The functional form of V_{ij} is

$$V_{ij} = \alpha_j + \beta x_{ij} + \gamma_j y_i. \tag{1}$$

α_j is the fixed attractiveness of airport j including the comfort of terminal buildings, availability of convenience shopping, and waiting time required at security checkpoints. x_{ij} is a vector of "alternative specific variables" whose value depends on the choice of individual i. In this paper, x_{ij} includes the access time of individual i going by car to airport j $(ATIME_{ij})$ and the inverse of the flight frequency at airport j $(IFRQ_{ij})$. As frequency increases, passengers can take flights with desirable departure times. Thus, IFREQ represents scheduling cost. y_i is a vector of "characteristic variables" that represents characteristics of individual i and that consists of $BUSINESS_i$, $MIDDLE_i$, OLD_i, and $EMALE_i$. $BUSINESS_i$ is a dummy variable indicating the purpose of travel, where the value is one if the purpose is for business and zero otherwise. $MIDDLE_i$ and OLD_i are dummy variables that represents 40-64 years old and 65-years and older, respectively. $FEMALE_i$ is also dummy variable that equals one if the passenger's sex is female.

β and $\gamma_j y$ are coefficient vectors of the explanatory variables. Here, note that $\gamma_j y$ captures the preference of each passenger group. For example, if female passengers tend to prefer airport KJJ, the group can gain large utility from utilizing KJJ. Thus, its coefficient, $\gamma FEMALE, KKJ$, is expected to be positive.

Individual i chooses the alternative of higher utility, i.e.,

$$max_j U_{ij} = V_{ij} + \varepsilon_{ij} \tag{2}$$

From the standpoint of observers, the decision of individual i is stochastic because of the randomness of ε_{ij}. Thus, given the fixed term V_{ij}, the possibility that individual i chooses alternative j is obtained as

$$P_{ij} = \frac{Exp(V_{ij})}{\sum j\varepsilon\{KKJ, FUK\} Exp(V_{ij})} \tag{3}$$

Using the data explained in subsection (Micro Data), the coefficients α_j, β and γ_j will be estimated.

There are two types of micro data: "Revealed Preference" (RP) data and "Stated Preference" (SP) data. RP data is gathered from passengers' actual behavior, while SP data is collected from questionnaires or interview surveys, in which respondents choose from hypothetical alternatives. The greatest advantage of RP data is that it captures the real market, and its result is consistent with actual behavior. Because of this advantage, RP data has been utilized since the earliest research about airport choices (Skinner, 1976). However, analyses using RP data are limited to observed objects. Thus, estimation methodologies of SP data have been developed, which make it possible to capture effects of virtual situations, such as renovation of an airport terminal, reduction of waiting time for a security check, and discounts on terminal charges. Hess, Adler, and Polak (2007) proposed a modeling methodology for SP data, and later, Marcucci and Gatta (2011) studied effects of socio-economic factors. de Luca (2012) also utilized SP data to investigate how flight connections and trip duration affect passengers' decisions.

Among the two types of data, RP data is more suitable for the analysis because this paper aims to capture and clarify actual demand leakage. The RP data used in this paper was taken from Travel Survey for Domestic Air Passengers, conducted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan. The survey covers all domestic passengers who took flights on October 21st in 2015. Passengers were asked for their Origin and Destination (OD) city pair, OD airport pair, age, sex, purpose of travel, etc. There were 166,791 observations and the response rate was 59.6%.

From the survey data, observations from those who were resident in Kitakyushu city were picked up. Then, samples for those under 15-years old were dropped since they most certainly followed the decisions of others, such as their parents. In the end, 1,413 observations remained.

ANALYSIS OF PASSENGERS' AIRPORT CHOICES

Descriptive Statistics

Table 2 summarizes how the traffic demand of Kitakyushu city leaked from KKJ to FUK. For all the routes, 837 passengers of 1,413 chose KKJ while 576 passengers utilized FUK. That is, KKJ lost 40.8% of the air travel demand from its home market. In terms of the routes served by both airports, there were 1,041 observations and 79.3% of them utilized KKJ. However, if a destination was directly connected to FUK but not to KKJ, then 99.1% chose FUK and 0.9% only opted for KKJ (wherein those passengers took indirect flights). These results imply that passengers prefer to take direct flights even when the airport is further away, such as FUK, compared to taking indirect ones from a nearer airport, such as KKJ.

Table 2 *Summary Results of Passengers' Airport Choice*

Direct flights from		Passengers' choice				
KKJ	FUK	KKJ		FUK		Total
YES	YES	826	79.3%	215	20.7%	1,041
NO	YES	3	0.9%	349	99.1%	352
YES	NO	0	-	0	-	0
NO	NO	8	40.0%	12	60.0%	20
Total		837	59.2%	576	40.8%	1,413

Note that, in case of destinations that are not directly connected to KKJ and FUK, 40.0% and 60.0% of passengers chose KKJ and FUK, respectively. However, these results may not be reliable or generalizable since the number of observations was 20 only.

Conditional Logit Analysis

Utilizing the 1,041 observations whose destination was directly connected to both KKJ and FUK, a CL analysis is implemented as introduced above. Table 3 summarizes the results.

Table 3 *Summary Results of the Conditional Logit Model*

	Coef.	Std. Err	*p*-Value
ATIME	-0.080 **	0.010	0.000
IFREQ	-3.304 **	0.718	0.000
constant term	-0.106	0.354	0.764
BUSINESS	-0.330 *	0.201	0.100
MIDDLE	-0.286	0.193	0.138
OLD	-0.833 **	0.257	0.001
FEMALE	-0.100	0.181	0.581

* Significant at 10% level, ** Significant at 1% level

The coefficients indicate the effects on passengers' utility, V_{ij}, in equation (1). First, ATIME and IFREQ have significantly negative effect on airport choice decisions at the one percent significance level. These results are intuitively understandable. Passengers prefer shorter airport access to save time cost and higher flight frequency to take their flight at the most desirable departure time available.

Next, the focus moves to the constant term and variables pertaining to passengers' characteristics. The constant term represents passengers' relative preference for KKJ over FUK. Thus, a negative value says that FUK may have unobserved attractiveness, such as a larger or better shopping area, more comfortable lounge services, and various restaurants to choose from. The coefficient of BUSINESS is statistically significant at the ten percent level, which means that passengers flying for business are more likely to choose FUK than those traveling for non-business purposes. This result might be related to frequent flyer program of full service carriers. Japan has two full service carriers, JAL and ANA. JAL serves at both KKJ and FUK while ANA serves at only FUK. Thus, to benefit from frequent flyer program, ANA users need to utilize FUK. If this hypothesis is correct, it might effective for KKJ to attract ANA. OLD is also statistically significant at one percent level. In other words, elderly passengers prefer FUK more than younger ones do.

SIMULATIONS AND DISCUSSION REGARDING THE EFFECT OF POLICIES

This section is for a discussion, based on the results obtained in subsection 3, on policy implications from the viewpoint of the local small airport, KKJ, and policy makers of the airport city.

It is simulated how ground access improvement and increases in flight frequency change passengers' behaviors. The method to capture these effects is as follows. First, using equation (4), it is possible to calculate passengers' utilities before and after the improvement, respectively. Then, using equation (5), the probability can be obtained that passenger i would choose airport j. Finally, taking the averages of the probabilities for all the passengers, the expected market shares are derived as:

$$E[S_j^b] = (\sum_i P_{ij}^b)/I \tag{4}$$

and

$$E[S_j^a] = (\sum_i P_{ij}^a)/I \tag{5}$$

Here, I is the number of passengers and subscripts b and a represent before and after, respectively.

As an example, a case is simulated where access time to KKJ is shortened by one minute for all the passengers. The results are $E[S_{FUK}^b] = 20.7\%$ and $E[S_{FUK}^a] = 19.6\%$, which can be interpreted that demand leakage from KKJ to FUK decreased by 1.1% points. If access time is shortened by five minutes, $E[S_{FUK}^a] = 15.4\%$ and the demand leakage decreased by 5.3% points.

Next, the effect of an increase in flight frequency going to Tokyo (HND) is also simulated. The flight frequency of KKJ-HND and FUK-HND are 18 and 50, respectively. These routes are utilized by 980 passengers. If the flight frequency of KKJ-HND increases from 18 to 19, $E[S_{FUK}^b] = 19.29\%$ and $E[S_{FUK}^a] = 19.15\%$, indicating that the demand leakage decreases by 0.14% points only.

Finally, to check the effect of adding a new route, the case where KKJ succeeds to add a new destination that is already connected to FUK is considered. According to Table 1, the probability that a passenger would choose KKJ is 0.9% only when KKJ does not have the route, while rising to 79.3% when KKJ does. This change of 78.4% points is much stronger than either access improvement or an increase in flight frequency. Therefore, although this analysis is not rigorous, and the effect is limited to the newly added route only, attracting a route would seem to provide the greatest positive effects desired to prevent travel demand leakage from KKJ to FUK.

CONCLUSION

This paper shed light on competition among a regional main airport and local airports, then simulated possible policies for a local airport or a local government of the airport city. Especially, the paper investigated the demand leakage from a local airport to a regional main airport based on passengers' decision. The result indicated that 79.3% of passengers departed from KKJ so long as it was directly connected to the destination. However, 0.9% only of passengers utilized KKJ when it was not. This outcome implies the importance of direct flight services. According to the CL analysis, access time to the airport and flight frequency has significant effects on passengers' decisions. Furthermore, based on the estimation results, impacts of potential policies of the local airport were simulated and it was shown that, among those policies, attracting a new route induces a relatively drastic change in passengers' decisions.

This paper leaves tasks for further studies. The biggest one is airfare that is expected to have great explanatory power. Policy makers and airport operators can influence airfare by subsidizing airlines or lowering airport charges. Thus, it is important to capture the effects of airfare in order to evaluate these policies. To consider airfare, the Stated Preference survey, in which respondents of a questionnaire choose from hypothetical alternatives, might be useful. Entrances and the existence of low-cost carriers are also expected to affect passengers' choices. Pels, Njegovan, and Behrens (2017) pointed out the positive effects of LCCs on secondary airports in multi-airport regions. Thus, it might be interesting to investigate the effects of LCCs on competitions among regional and local airports. Which regional or local airport takes advantage of the existence of LCCs?

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REFERENCES

Basar, G., & Bhat, C. (2004). A parameterized consideration set model for airport choice: An application to the San Francisco Bay area. *Transportation Research Part B: Methodological*, *38*(10), 889-904. doi:https://doi.org/10.1016/j.trb.2004.01.001

Czerny, A., Hoffler, F., & Mun, S. I. (2014). Hub port competition and welfare effects of strategic privatization. *Economics of Transportation*, *3*(3), 211-220. doi:https://doi.org/10.1016/j.ecotra.2014.06.002

de Luca, S. (2012). Modelling airport choice behaviour for direct flights, connecting flights and different travel plans. *Journal of Transport Geography*, *22*, 148-163. doi:https://doi.org/10.1016/j.jtrangeo.2011.12.006

Furuichi, M., & Koppelman, F. S. (1994). An analysis of air travelers' departure airport and destination choice behavior. *Transportation Research Part A: Policy and Practice*, *28*(3), 187-195. doi:https://doi.org/10.1016/0965-8564(94)90016-7

Hess, S., Adler, T., & Polak, J. W. (2007). Modelling airport and airline choice behaviour with the use of stated preference survey data. *Transportation Research Part E: Logistics and Transportation Review*, *43*(3), 221-233. doi:https://doi.org/10.1016/j.tre.2006.10.002

Lian, J. I., & Ronnevik, J. (2011). Airport competition- regional airports losing ground to main airports. *Journal of Transport Geography*, *19*(1), 85-92. doi:https://doi.org/10.1016/j.jtrangeo.2009.12.004

Loo, B. P. (2008). Passengers' airport choice within Multi-airport Regions (MARs): some insights from a stated preference survey at Hong Kong international airport. *Journal of Transport Geography*, *16*(2), 117-125. doi:https://doi.org/10.1016/j.jtrangeo.2007.05.003

Marcucci, E., & Gatta, V. (2011). Regional airport choice: Consumer behaviour and policy implications. *Journal of Transport Geography*, *19*(1), 70-84. doi:https://doi.org/10.1016/j.jtrangeo.2009.10.001

Mun, S. I., & Teraji, Y. (2012). The organisation of multiple airports in a metropolitan area. *Journal of Transport Economics and Policy (JTEP)*, *46*(2), 221-237.

Park, Y. (2003). An analysis for the competitive strength of Asian major airports. *Journal of Air Transport Management*, *9*(6), 353-360. doi:https://doi.org/10.1016/s0969-6997(03)00041-3

Pels, E., Nijkamp, P., & Rietveld, P. (2000). Airport and airline competition for passengers departing from a large metropolitan area. *Journal of Urban Economics*, *48*(1), 29-45. doi:https://doi.org/10.1006/juec.1999.2156

Pels, E., Nijkamp, P., & Rietveld, P. (2001). Airport and airline choice in a multiple airport region: An empirical analysis for the San Francisco Bay area. *Regional Studies*, *35*(1), 1-19. doi:https://doi.org/10.1080/00343400120025637

Pels, E., Njegovan, N., & Behrens, C. (2017). Low-cost airlines and airport competition. In S. Ison (Ed.), *Low cost carriers* (p. 125-136). London, UK: Routledge. doi:https://doi.org/10.4324/9781315091617-10

Redondi, R., Malighetti, P., & Paleari, S. (2011). Hub competition and travel times in the world-wide airport network. *Journal of Transport Geography*, *19*(6), 1260-1271. doi:https://doi.org/10.1016/j.jtrangeo.2010.11.010

Skinner, R. E. (1976). Airport choice–an empirical study. *Journal of Transportation Engineering*, *102*(4), 871-882.

Suzuki, Y., Crum, M. R., & Audino, M. J. (2003). Airport choice, leakage, and experience in single-airport regions. *Journal of Transportation Engineering*, *129*(2), 212-218. doi:https://doi.org/10.1061/(asce)0733-947x(2003)129:2(212)

Teraji, Y., & Morimoto, Y. (2014). Price competition of airports and its effect on the airline network. *Economics of Transportation*, *3*(1), 45-57. doi:https://doi.org/10.1016/j.ecotra.2014.03.001

Thelle, M. H., & la Cour Sonne, M. (2018). Airport competition in Europe. *Journal of Air Transport Management*, *67*, 232-240.