Airport Attractiveness Analysis through a Gravity Model: A Case Study of Chubu International Airport in Japan

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ABSTRACT

The growth of hub-and-spoke networks has allowed medium- and large-size airports that limited in passenger demand in the catchment area to become the primary hubs in their respective regions. This article adopts a gravity model to analyze the impacts of international air routes increase on airport attractiveness. Taking Chubu International Airport in Japan as a case and considering several determinants, such as travel time, air fare, population of the destination city, market share of each carrier, etc., We find that if Chubu attracts new flights from 42 Chinese destination cities, which are in five-hour flight radius that normally serviced by narrow body fleets, it would be as attractive as Narita Airport is. Accordingly, we suggest that Chubu Airport needs to promote itself to attract regional airlines or low cost carries from China.

KEY WORDS: airport, competition, hub-and-spoke networks, Japan, potential

1. INTRODUCTION

International air flights from and to Japan are concentrated at major airports. In the winter of 2009, there are 27 Japanese airports handling scheduled international passenger flights. Narita, Kansai, Chubu and Haneda is 84, only 16 per cent go to the rest 23 airports (Travel Journal, 2010). According to the great circle distance, long haul flights (more than 6000 km) dominantly concentrated at Narita, while some of the medium haul flights (3001-6000 km) and short haul flights (less than 3000 km) fly to Kansai and Chubu Airport.

Chubu Airport, which located 35 kms in south of Nagoya city, was opened in 2005 as the "hub of Asia". Taking geographic location advantage, Chubu can service over 142 cities with 0.7 million inhabitants in five-hour flight radius, while China is the main market (Figure 1). Competing with Narita and Kansai International airports, this airport provides the fastest efficient passenger transfer by merging international and domestic terminals at the same building and services flights to 22 domestic destinations-the most intensive domestic routes among the top three Japanese international airports. While Chubu has been aiming to build its position as the hub for medium and haul short international flights, it acts as a regional airport handling spoke-to-spoke flights rather than a hub operating hub-and-spoke networks. In 2008, Chubu handled the airport handled 10.8 passengers and only 1.4 per cent of them were transfer passengers. Therefore, it is important to know to what extend that Chubu could be reach a point that as attractiveness as other hub airports is.

With above in mind, this article aims to illustrate the current potential of Chubu with special attention to international routes, as well as to project the potential of Chubu if China's market effect is considered. We estimated the attractiveness of Chubu with new flights to Chinese's airports, with focuses on narrow body aircraft, such as B738 or comparable. It is typically assumed that Chubu would to be a primary hub if it is as attractive as Narita Airport is. Gravity model has been adopted. Main data used in this study is from Official Airline Guild of 2010.



Figure 1 Passenger traffic and destinations of Chubu Airport

2. MODEL AND DATA 2.1 Model



Figure 2 Gravity model applications in airport attractiveness study

Gravity models are commonly used in transport research (Grosche *et al.* 2007). Doganis (2004) forecasted scheduled passenger traffic at airports by with factors of economy class fare and flight frequency. In this paper, we use the factors of population, travel distance, travel time and airfare as independent variables to project the economic potential of Chubu (Figure 2). Furthermore, we take economic potential of place i as the attractiveness factor. A gravity model is proposed as follows:

$$A^{i} = \sum \left[PP_{j} / \exp(\alpha \times GC_{ij}) \right]$$
⁽¹⁾

Where, A^i is attractiveness factor of origin *i*; PP_j is the amount of potential passengers who are able to travel from the destination city *j*; α is a distance decay parameter, which is estimated by the Eq.(2) (Frost and Spence, 1995; Gutierrez, 2001).

$$\alpha = -\ln(\frac{\mathrm{TP}_{ji}}{O_i D_j}) / \mathrm{GC}_{ji}$$
⁽²⁾

where TP_{ji} is the number of trips between origin *i* and destination *j*; O_i is the size of origin location *i* (e.g. total number of trips to commuters in origin *i*), D_j is the size of destination area (e.g. total number of work places in destination *j*).

 GC_{ji} is the weighted average generalized transport cost from prefecture j to i, which is

measured by

$$GC_{ji} = \sum_{n \in N} s_{ji}^n \cdot (F_{ji}^n + \omega^n \cdot t_{ji}^n)$$
(3)

where *n* denotes air carrier; s_{ji}^{n} is the market share of *n* in the total international flights from between *j* and *i*; F_{ji}^{n} is average air transport fare of carrier *n* from *j* to *i* in JPY; t_{ji}^{n} is travel time of carrier *n* from *j* to *i* in minute; ω^{n} is time value of air transport in JPY/min.

2.2 Data Collection

Table 1 is the introduction of data that used in this paper. There are five kind of data have been used.

Data	Year	Source	Remark
Air fare	2010	Internet booking system of various airlines	We selected the lowest and available fare (both of economic and business class) for roundtrip departed from Narita or Chubu on September 3rd, 2010. Priced on 9th July 2010.
Distance	2010	OAG, 2010	Distance for O/D without non-stop flight are based on route: Nagoya – Dalian, Beijing or Shanghai – destination, and shortest one was selected
Flying time	2010	OAG, 2010	Flying time for O/D without non-stop flight are based on route: Nagoya – Dalian, Beijing or Shanghai – destination, shortest one was selected
Population	2010	UN	World Urbanization Prospects: The 2009 Revision Population Database (UN 2010)
Seat supplement	2010	OAG, 2010	

Table 1 Data used in this study

3. RESULTS

3.1 Chubu with Current Routes in 2010

The result the current attractiveness of Narita is 1.8 times higher than Chubu (table 2). This is probably due to following facts. Firstly, the distance and flying time from Chubu to Asian is shorter than from Narita. For example, the distance from Narita to Seoul, Shanghai and Beijing are 1160 km, 1777 km and 2093 km, while the distances from Chubu are 928 km,

1509 km and 1872km. Taking the primary geographic position, flying time from Chubu to Asian, is averagely 30 minutes shorter than from Narita. Secondly, in Narita, the air fare elastic is resulted from fierce airline competition. Taking routs to Singapore as an example. There are five airlines operating non-stop flights from Narita to Singapore: JL, MH, SQ, UA, and DL. The cheapest round-trip fare during was JPY 25, 000 that provided by DL. In Chubu, SQ operates the non-stop flights from Chubu to Singapore at a price of JPY 64,000. Thirdly, the centralization of long-haul routes from/to US has increased the transfer rate at Narita significantly; however, these flights contribute few in increasing the attractiveness.

4.2 Chubu with New Routes to China

In order to optimize the air traffic networks of Chubu to increase airport attractiveness, three air networks were modeled. For the existing routes, distances and travel time are obtained from OAG 2010, while the annual average fare assessed from airlines. For the

	Narita International Airport			Chubu International Airport		
	Short	Medium	Long	Short	Mediu	Long
	Haul	Haul	Haul	Haul	m Haul	Haul
Destinations	21	19	51	16	5	4
Average Distance (kms)	2,083	4,742	8,926	1,788	4,260	8,482
Average flying time (hours)	3.6	7.3	11.5	3.3	6.6	10.3
Average Fare (thousand/JPY)	65	10	126	62	78	158
Attractiveness	45997	19713	26509	43896	7376	867

Table 2 International routes and attractiveness: Narita v Chubu in 2010

modelling route, we calculate distance, flying time and fares with various considerations, such as air route, entrance ports to China, domestic fare and so on. With the respect to the fact that Chinese regional airlines or LCCs seldom operate wide-body aircraft, narrow-body fleet Boeing 738 is selected as the standard one.

Firstly, 70 airports (excluding current destinations) to are selected to model the network A. We pick the airports located in mega-cites with more than 0.7 million population of people, plus four more tourism airports: Jiuhuang, Lijiang, Sanya and Xishaungbanna which have serviced more than 1 million passengers in 2009 (Civil Aviation Administration of China 2010). Secondly, we select 36 airports, which handled more than 1 million air passengers in 2009 to model the network B. Thirdly, 42 airports which service more than 1 million populations are used to calculate the impacts of network C. Table 3 is the result of each network.

We recommend network C as the most suitable one for following reasons: (1) all the destinations are located in 3,000 kms great circle distance that could be serviced by narrow body fleets; (2) most of the destinations are located in developed eastern area. Therefore, it can assume that economic potential of Chubu would be as massive as Narita if the airport attracts new flights from 42-selected Chinese's cities. Newly established regional Chinese Airlines and LCCs are the potential carriers as they only operate narrow body-aircraft but wish to enter Japanese international market.

	New destinations					Attractiveness of
	Destination in distance*		Total	Increase of attractiveness	Chubu with new	
	<2000	2001-3000	>3000	destinations		destinations
Network A	17	38	15	70	70613	122752
Network B	10	16	10	36	49586	101725
Network C	10	30	2	42	57026	109165

Table 3 Chubu with new routes

* Refer to great circle distance in kilometre

5. DISCUSSION AND CONCLUSION

In this paper, we estimate the current attractiveness of Chubu in 2010 by comparing international passenger traffic with Narita. Then, we project future of Chubu with new short-haul routes to China. The elements, such as fewer noise restrictions, shorter distance to Asia or Europe, and less marketing competition, bring Chubu some advantages. The separation of distance indicator into short haul, middle haul and long haul flights, enable an effective evaluation of route's performance. Our estimates of potential change indicate that Chubu could be developed sustainable if attract enough short haul flights.

The results suggest that attractiveness difference between Narita and Chubu is not as massive as seats supplement. It seems that Chubu could increase its accessibility dramatically, by boosting short-haul services from Asian countries, especially from China's market which is keeping on growth in both economic and international tourism. The main market implication of study results is that airports, which recognized limitation of its catchment area and aimed to be hubs, need to develop short-haul routes priority. The increase of short-haul flight certainly brings both aeronautical and non-aeronautical income, such as landing fee or duty-free shop. More important, it might further enhance an airport's attractiveness for long haul carriers by providing good flights connectivity and efficient passenger transfers. Slot's shortage in Narita and aviation liberalization could encourage long haul carriers to make use of Chubu, such as

the capacity constraint at Frankfurt has forced new and independent carriers to make use of Munich airports since 1990s.

It is important to note that we take the total population in destinations as the potential passengers. Therefore, for future study, we plan to improve the model to analyse economic, business and industry factors of destinations with the consideration of population characteristic. Furthermore, further research should base on a full panel of data since 1990s.

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