

TIME SERIES ANALYSIS OF DOMESTIC AVIATION PASSENGER TRAVEL PATTERNS IN JAPAN

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Abstract: The domestic aviation passenger transport environment in Japan has been frequently changed due to a number of regulatory/deregulatory aviation policies over the last two decades. Such aviation policies have brought significant changes in operating airlines, changes in airline networks and services, changes in infrastructures capacities and, changes in national and regional travel demand and its characteristics, especially after deregulation in 1986. In this study, we perform general aggregate time series analysis using pooled cross-sectional data of the last two decades in order to explain these changes in the domestic aviation market with some featured case studies.

Key words: Time series analysis, pooled cross-sectional data airline networks and services, domestic aviation passenger demand

1. Introduction

Since the beginning of aviation era in 1952, Japanese domestic aviation industry has been under frequent regulatory/deregulatory aviation policies over the years, which resulted a continuously changing market environment for airports and airlines operating to provide services for domestic travelers. Until 1986, the domestic aviation market was strongly regulated under “45-47 Airline Regulation System” enforced in 1970-1972 (Showa 45-47) also called “Aviation Constitution” (Yamauchi and Ito, 1995). “45-47 Airline Regulation System” defined the specified business rules for the then operating airlines. When the “Aviation Constitution” was abolished in 1986 based on the final report submitted by Council

for Transport Policy to the then Minister of Transport, the deregulation era started. The deregulatory policies were focused on mainly on three aspects. First, Japanese government introduced Double-tracking (D/T) and Triple-tracking (T/T) System to deregulate route entry restrictions based on origin-destination demand of a specific route, continuously relaxed the requirements in 1992 and 1996, and finally abolished the requirements in 1997. Second, Japanese government deregulated the fare system in 1994 to allow relaxed discount fare and introduced flexible fare system with price ranges in 1997. Third, it tried to promote new airlines to enter the market by securing fixed number of flights for new comers in 1994 and increased the arrival and departure slot provisions for new entries in 1997 at major hub airports. However, there were no US-like deregulatory measures and the domestic aviation market in Japan was/is more or less regulated by the government. Nonetheless, there were a number of effects due to the above- mentioned deregulatory policies in domestic aviation sector.

Our research study covers a number of aggregate time series analyses using a large amount of pooled cross-sectional data to depict the actual time series characteristics of domestic aviation passenger transport in Japan. These include the changes in airlines networks and service routes, changes in national and regional travel demand, characteristics of travel demand, changes in the operating airlines and, changes in the modal competitiveness with bullet train and express bus over the years. In addition, it also covers the Japanese government approach to cater the increased demand and/or to address the changing market environments.

However, in this paper, we discuss some of the effects of regulations/deregulations on the airline networks and services and on the travel demand. The effects on airline networks and services include the changes in operating frequencies and operating airline companies due to double-tracking (D/T) and triple tracking (D/T) route entry deregulation system and its requirements over the years. The effects on travel demand include time-series changes in total domestic travel demand, inter-regional travel demand and characteristics of the demand such as trip purpose, gender, age, generation etc.

The result of the study is that these domestic aviation policies (and other factors) yielded a number of changes in the domestic aviation environment, such as, overall increase in travel demand, increase of female travelers, increase of travelers for sight seeing purposes, increase of demand between some regions and decrease in others, increase in frequency of services and so on. Japanese government addressed the increased travel demand by constructing new airport in local areas, upgrading existing airports to make these fit for jet aircrafts and, opening the new runways and increasing the number of slots in major hub airports. By now, Japan has a vast density of airports in every region and almost in all prefectures. The results of

this time series analysis help us to understand the extent of these effects and to formulate future domestic aviation policies.

The remaining part of this paper is arranged as follows. Historical overview of domestic aviation policies has been summarized in Section 2. We analyze the data and discuss the results of the time series analysis in Section 3. Concluding remarks are followed in Section 4.

2. Historical Overview of Domestic Aviation Policies

Japan Airlines (JAL) was first established as a private company for domestic aviation services in 1952 and it was converted into semipublic corporation to make it as a national flag carrier a year later. A number of airline private companies were also established at the same time, some of them were bankrupted and some other merged. In 1957, two major private companies merged to form All Nippon Airways (ANA). Such ups and downs went on for more than a decade. By the end of 1970, there were four operating airlines in Japan; JAL, ANA, Japan Domestic Airlines (JDA) and Toa Airlines (TA). In 1971, JDA and TA were merged to form Toa Domestic Airlines (TDA) and which was renamed as Japan Air System (JAS) in 1988.

Cabinet Meeting Resolution “Concerning Airlines Operations” was issued in 1970 (Showa 45) and notice from the Minister of Transport came in 1972 (Showa 47) concerning the approval of the business routes for the then three operating airlines; JAL, ANA and TDA. This regulation is also referred as “45-47 Airlines Regulation System” or “Aviation Constitution”, named from the Japanese calendar year when the system was introduced. The business sectors for three airlines are summarized in Table 1.

Table 1 “45-47 Airlines Regulation System”

Operating Airlines	Business Fields
Japan Airlines (JAL)	International routes Domestic trunk routes
All Nippon Airlines (ANA)	Domestic trunk routes Domestic local routes International short-haul charter flights
Toa Domestic Airlines (TDA)	Domestic local routes A portion of domestic trunk routes

In September 1985, the Minister of Transport consulted the Council for Transport Policy to recommend future airline policies. The Council for Transport Policy submitted its final report in June 1986, which contained new aviation policies. These deregulatory policies included:

- Multiple carriers would be allowed for international routes;
- Double-tracking (D/T) and triple-tracking (T/T) system would be used to promote the competitions;
- Japan Airlines (JAL) would be completely privatized.

Upon receiving final report, Japanese government abolished “45-47 Airline Regulation System” and promoted deregulatory measures since then. JAL was privatized in 1987. The time-line of such deregulatory measures is tabulated in Table 2.

Table 2 Time-line of Deregulatory Policies

Deregulations on:	Year	Deregulatory Policies
Route entry restriction [Tracking system: Double tracking (D/T) and Triple-tracking (T/T)]	1986	Requirements for D/T: 700,000 passenger/year Requirements for T/T: 1,000,000 passenger/year
	1992	Double-track (D/T): 400,000 passenger/year Triple-track (T/T): 700,000 passenger/year
	1996	Double-track (D/T): 200,000 passenger/year Triple-track(T/T): 350,000 passenger/year
	1997	Abolition of D/T and T/T requirements
Fare system	1990	Distance-based normal fare for a particular route
	1994	Discount fare system (strategic discount no more than 50%)
	1996	Flexible fare system (within the certain range)
New airlines entry	1994	Report of the Council of Civil Aviation (ensuring fixed number of flights for newcomers)
	1997	Increased arrival and departure slot provisions for newcomers at Tokyo International (Haneda)Airport

In September 1998, Skymark Airlines (SKY) entered into the market for Tokyo-Fukuoka route and Hokkaido International Airlines (Air Do or simply ADO) entered the market for Tokyo-Sapporo route in December 1998. Aviation law was revised in February 2000 to further increase competition in the airline industry. The winners were the Japan’s big three airlines, JAL, ANA and JAS. They strengthen their positions with increased domestic business.

In 2001, JAL and JAS agreed to merge. On October 2, 2002, JAS and JAL established a new holding company, which was called Japan Airlines System, and they were reborn as the new Japan Airlines (JAL) group. Airplane liveries were changed to match the design of the new JAL group. At that time, the new JAL group was the sixth largest in the world by passengers

carried and the third largest measured by revenue. On April 1, 2004, Japan Airlines (old JAL) changed its name to Japan Airlines International and Japan Air System (JAS) changed its name to Japan Airlines Domestic. Japan Airlines System was renamed to Japan Airlines Corporation to make the most of the JAL brand. At the same time, all JAS flight codes, check-in desks and plane were unified into JAL, and the Japan Air System brand officially ceased to exist.

New airlines SKY and ADO have had a difficult time becoming profitable. SKY and ADO set off a price war in their attempts to undercut major airlines when they entered the market. This action was, however, hurt the newcomers more than the big three. After a severe loss in March 2001, ADO has nearly abandoned its target of moving into the black in fiscal year 2002. After two years of losses, the airline entered a code-sharing agreement with ANA, and now has the same general fare structure as the majors. SKY saw somewhat good picture. Cost-cutting efforts by the carrier including handling its own ground operations, have contributed stronger results.

3. Effects of Domestic Aviation Policies

In this section, we analyze the changes in airline networks and services and the changes in demand and its characteristics due to overall policy measures over the time. The domestic network routes depended heavily on phase-wise relaxing for two or more airlines to enter in a specific route based on demand of the route after abolishing “45-47 Airline Regulation System” (discussed in Section 2). Other deregulatory policies also impacted the changes in airline networks and service frequencies. We arranged the data from different five sources listed at the reference section (reference numbers 2-6) at the end of this paper.

3.1 Effects on Airline Networks and Services

3.1.1 Overall Domestic Airline Networks

The number of routes operated by one company, two companies and three or more companies in each year for the last two decades has been plotted in Figure 1. The figure shows that the total number of routes continuously increased from 1985 and almost doubled in 2001 with an exception in 1999. However, after 2001, the total number of routes started to decrease because of the decrease overall travel demanded due to the expansion of other competitive modes of transportations such as high speed rails and highway buses. The figure also shows that the number of routes served by two or more companies has been increased from 1985 until 2003. In 2004, the number of routes served by three or more companies has been reduced possibly due to the merger between JAL and JAS and over all decrease in routes.

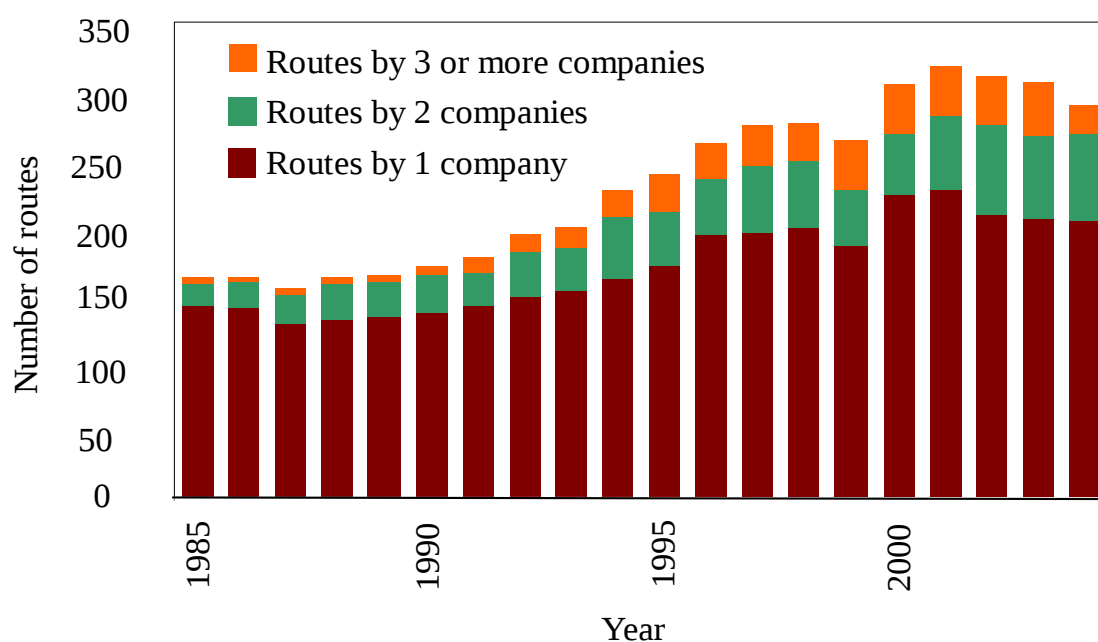


Figure 1 Number of routes and operating airlines

Similarly, during the same time period, a significant number of old routes were removed from the operation and new routes are added. The number of removed routes and new routes are shown in Figure 2. It shows that the number of routes removed were greater than the number of routes added after year 2002 resulting the decrease in the total routes.

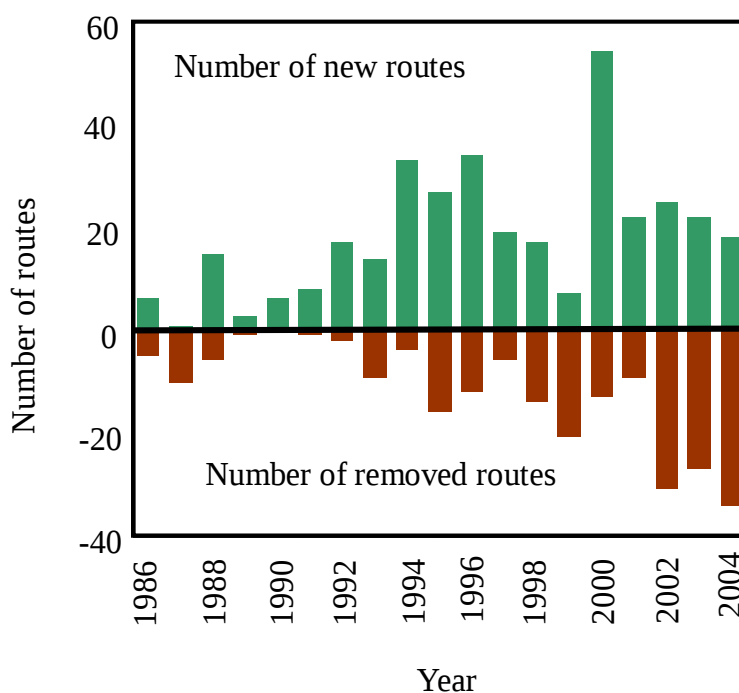


Figure 2 Number of routes removed and number of routes added

3.1.2 Routes from Particular Airports

The initial requirements of D/T and T/T system in 1986 (D/T: 700,000 passengers/year and T/T: 1,000,000 passengers/year) resulted two or more companies operations from Haneda airport to Hiroshima, Miazaki, Kagoshima, Hakodate etc. Easing the requirements in 1993 (D/T: 400,000 passengers/year and T/T: 700,000 passengers/year) resulted two company operations from Haneda airport to Akita and Ashahikawa and three company operations from Haneda airport to Hiroshima, Oita, Kumamoto and Nagasaki. There was no big change after further easing the requirements (D/T: 200,000 passengers/year and T/T: 350,000 passengers/year) in 1996. However, the service frequencies increased substantially than onwards.

There were not many changes in service routes from Osaka (Kansai and Itami) airports until 1995. There were two or more company operations from Osaka to Kyshu and Shikoku routes and a new route was also established after 1995. Moreover, when it began to use Kansai International Airport 1994, Tohoku, Kyushu, and the Shikoku route were established. Most of the flights to the Tohoku route were operated by JAS. After transferring to Kansai International Airport, half of the lines from Itami airport to Kyushu and Shikoku were operated by JAL and ANA due to good connection with international flights

A number of routes were established to local cities during the same period. These routes were of low frequencies, low demand. The flights were mainly served for tourism purposes from Tokyo International (Haneda Airport).

3.2 Effects on Aviation Travel Demand

The aviation passenger travel demand also changed over these two decades. In section discusses the how the domestic and regional travel demand changed by the change in the service level caused by transitions of domestic aviation policies.

3.2.1 Overall Domestic Travel Demand

The total number of seats available as well as total travel demand doubled in the last 20 years from 1985 to 2004. However, both of these values started to decrease after 2003 as shown in Figure 3. This is particularly due to the decrease in population as well as availability of other competitive travel modes such as high-speed rails and highway buses. The number of seats were increased mainly due to enhancement of airports to make them fit for jet aircrafts and operating frequencies.

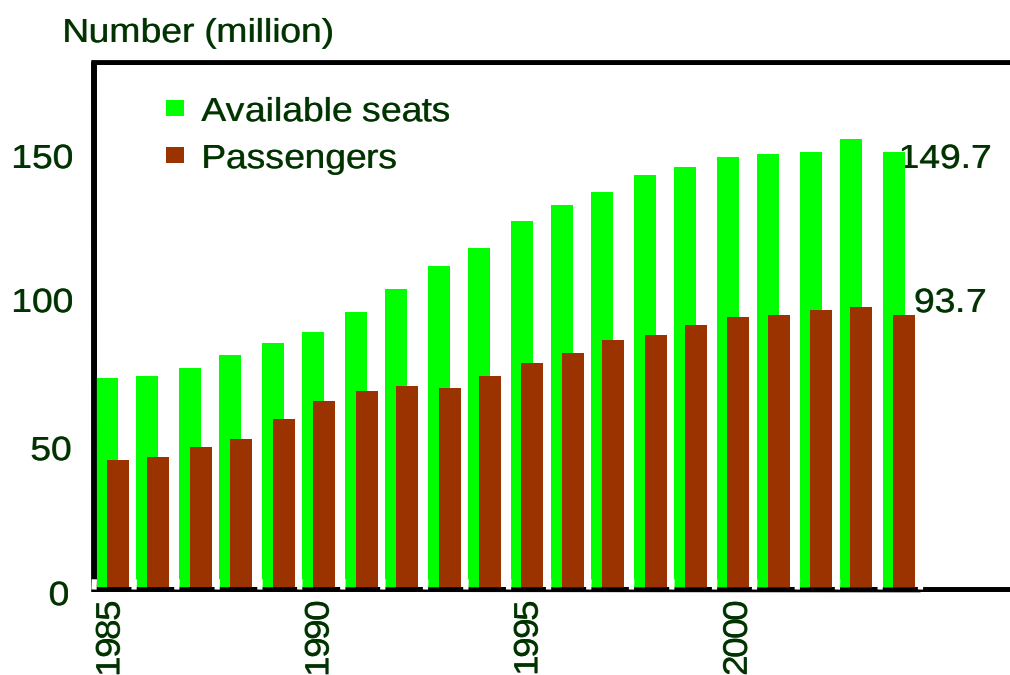


Figure 3 Number of seats available and number of passengers

3.2.2 Regional Travel Demand

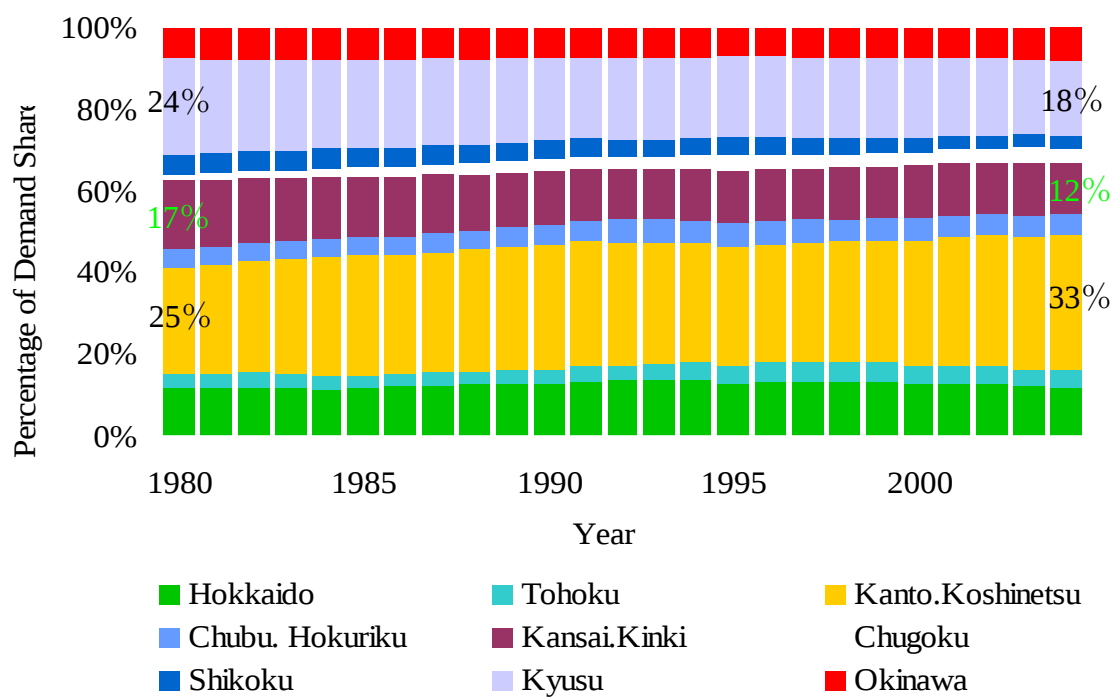


Figure 4 Regional travel demand

The regional travel demand over the same time period has shown mixed trend. The number of passengers in Kanto-Koshinetsu has increased by approx. 8%. Chugoku region also shows the multifold increase in the number of passengers. However, the passengers in Kansai-Kinki and Kyushu region have decreased by 6% and 5% respectively as shown in Figure 4. The increase/decrease of number of passengers for during different time intervals has shown in Figure 5 and rate of increase/decrease in Figure 6.

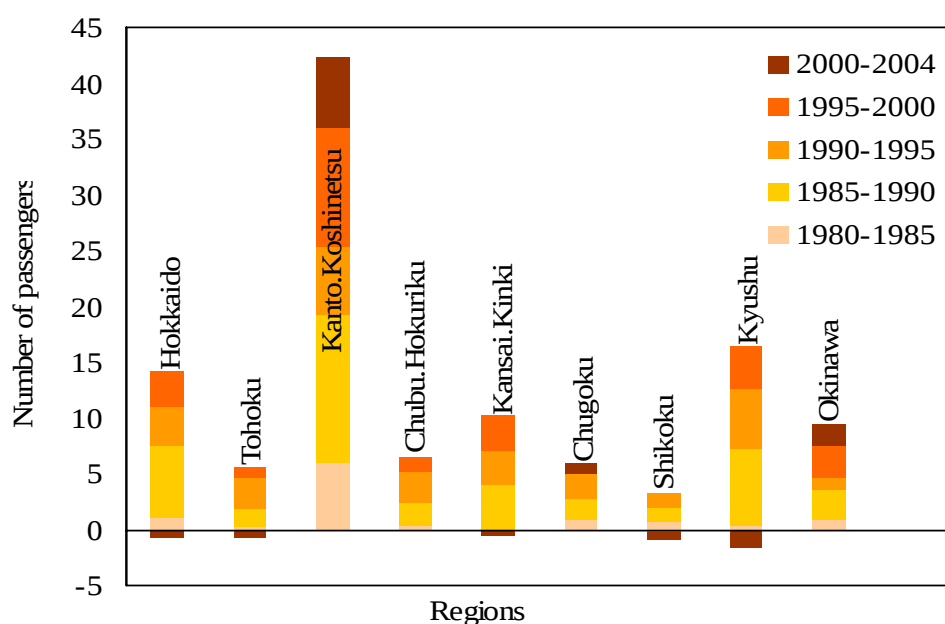


Figure 5 Increase/Decrease in regional travel demand

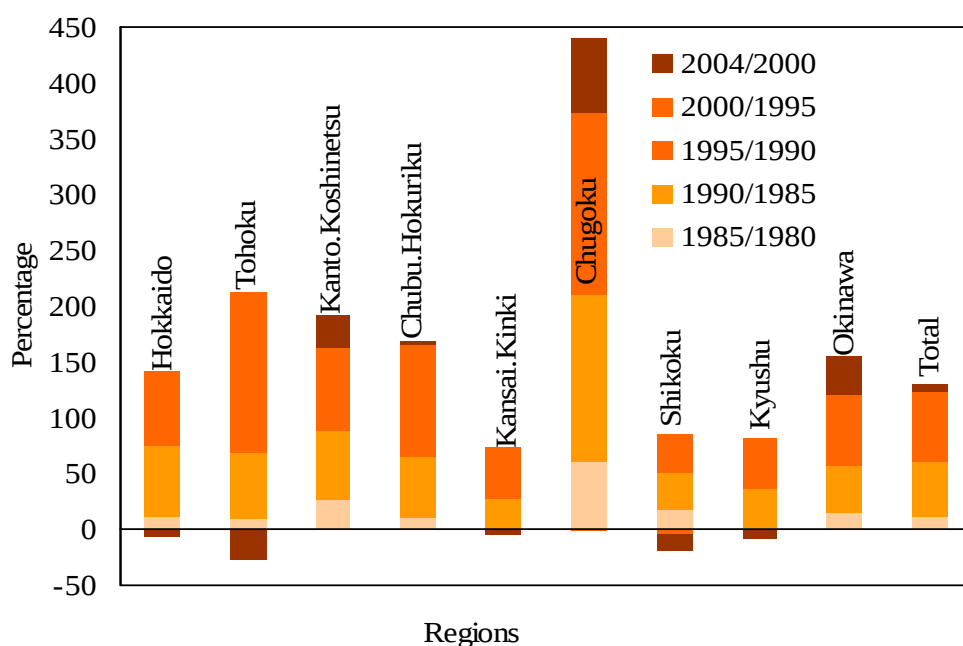


Figure 6 Rate of increase/decrease of regional travel demand

3.3 Characteristics of Travel Demand

There are some significant changes in the characteristics of demand during the same period of time. Figure 7 shows trip purpose of the demand at different time periods. “Leisure” trips have been increased significantly compared with other trip purposes whereas there the “personal” and “business” trips are marginally increased.

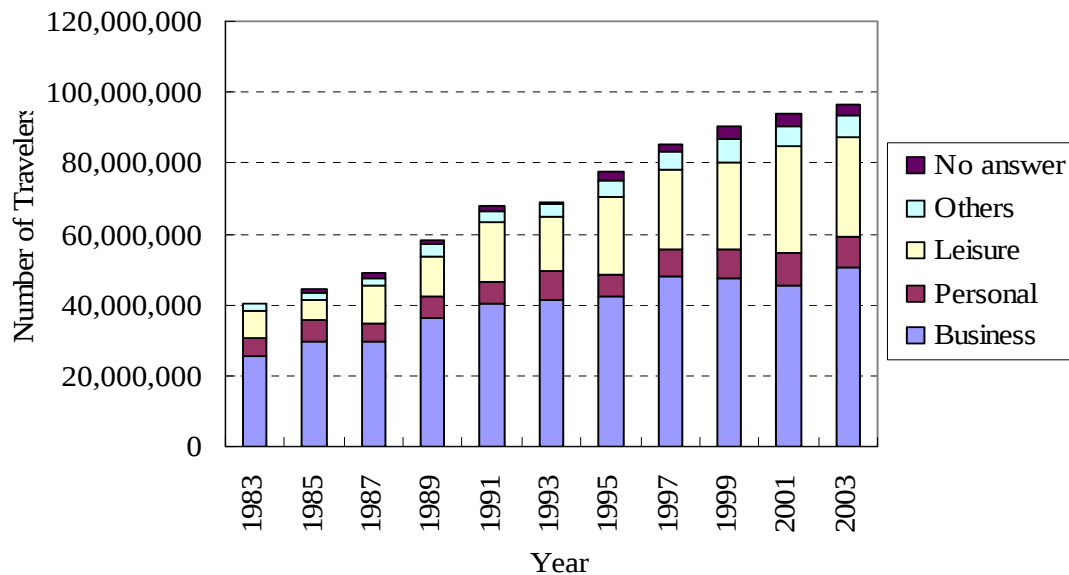


Figure 7 Trip purpose

Similarly, Figure 8 shows the increase of both male and female travelers during 20 years period. However, there is more significant increase of female travelers than male.

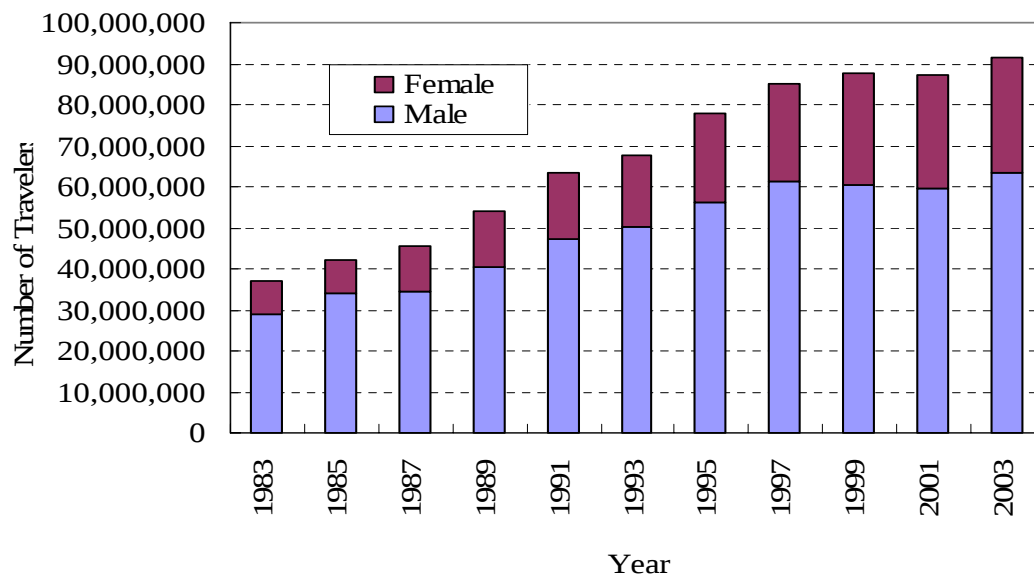


Figure 8 Gender

Figure 9 shows the changes in travel behavior by generation. For example, there were more

travelers of age 30's and 40's in early 1980s. However, there were more travelers of age 40s and 50s in 1990s. This trend shows that there is a significant increase of older travelers in recent times. This trend matches with the increase of aging population of Japan.

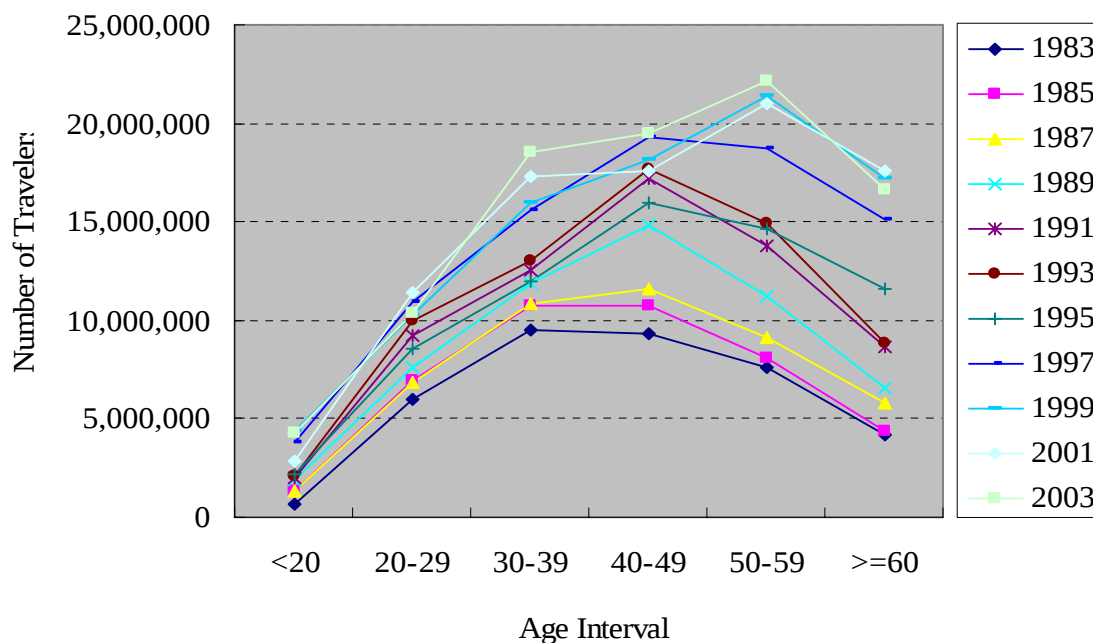


Figure 9 Generation

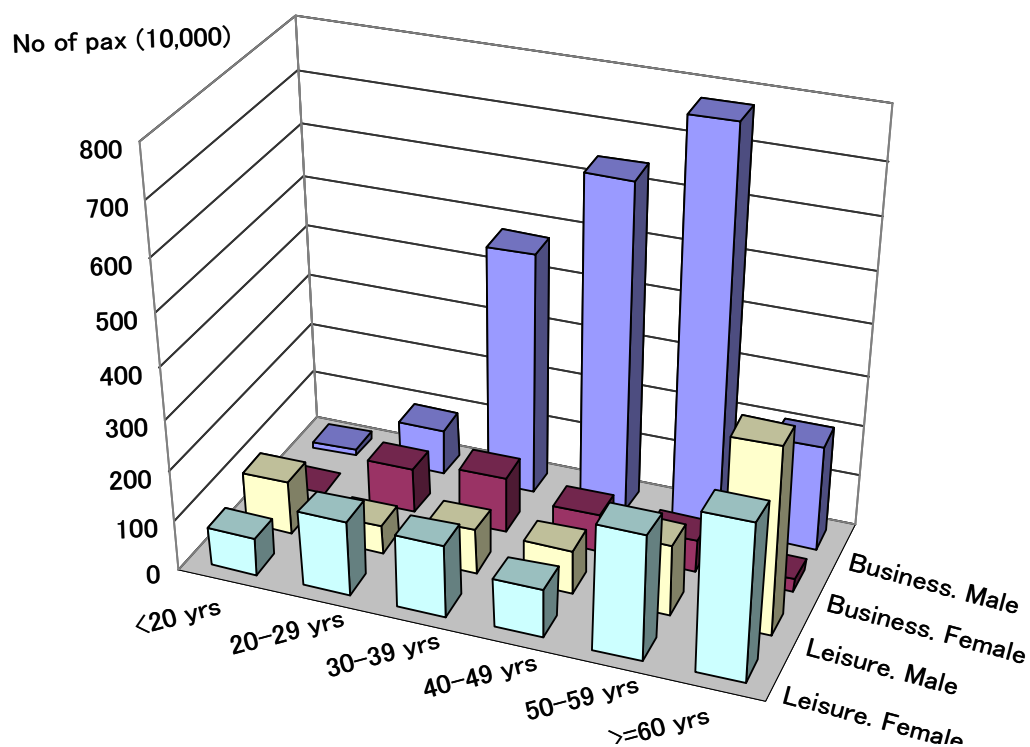


Figure 10 Cross tabulation

The plot of cross-tabulation in Figure 10 shows there is a large increase of male business travelers of aged 30's, 60's and 50's. Similarly, there is a significant increase in female travelers of 50's and 60's years old for sight seeing purposes

4. Concluding Remarks

The environment that airports and airlines are operating to provide services for domestic travelers in Japan has been changed frequently under different aviation policy measures over the last two decades. For example, airline networks and services have been changed, new airports have been opened, and multiple carriers are serving for a specific route making the market more competitive and attractive. In this study, we performed general aggregate time series analysis using pooled-cross sectional data so as to depict the actual characteristic features of aviation passenger transport. In this paper, we focused on the changes in the aviation policies and airline services, influences of such changes in passenger demand and, some featured case studies. Specifically, we analyzed both the changes in networks and services in different cities/regions, and the changes in national and regional travel demand and its characteristics such as, gender, age, purpose of trip etc. The results show that there is a significant change in both network services and the characteristics of the passenger demand such as increase in female travelers, increase in sightseeing trips over the years. These results are very useful for formulating future policy measures and for evaluating service qualities.

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