AIR TRANSPORT IN JAPAN:
POLICY CHANGES AND ITS EVALUATION

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1 Introduction

There are presently eight scheduled airline companies in Japan. With respect to passenger transport, the big three — Japan Airlines (JAL), All Nippon Airways (ANA) and Japan Air System (JAS) — account for nearly all of the major markets: together they serve roughly 91% of the passengers on both domestic and international routes. ANA claims about 45% of the domestic market, while JAL about 76% of the international market. The other airlines are for the most part subsidiaries of the big three. The domestic air transport market, with about 70 million passengers annually (55 billion revenue-passenger kilometers), is one-sixth (one-tenth) the size of the United States' markets. Japan's airlines carry about 11 million international passengers a year, about one-quarter of that of the United States' carriers.

Japanese airlines experienced a boom during the second half of the 1980s. From 1985 to 1991, revenue passenger kilometers in the domestic market grew at the rate of 9.3% annually, and in international markets 8.0%. As a result, their operating profits also soared, and they recorded the highest profits in their company histories. These trends reversed from the beginning of 1990. The average growth rate from 1991 to 1993 fell to 3.4% and 4.8% respectively. The declining growth rate influenced the companies' operating performance. JAL, especially, operations in international markets constitute more than half of their business, has suffered huge losses since 1991. It is true that the losses of JAL were caused mainly by changing market conditions, but it should be noticed that the rapid appreciation of yen also made the situation worse.

Air transport markets in Japan have developed in a strictly regulated environment. The Civil Aeronautics Law, which governs the industry, requires that airline companies obtain government licenses to enter the market. Airlines also need government approval for setting and charging their fares, and even for their annual business plans. Naturally, international routes also require government-negotiated bilateral agreements with other countries. In this respect, Japan has been a traditionalist. Its agreements are generally modeled after the old Bermuda Agreement, concluded between the United States and the United Kingdom in 1946.

However, the world-wide policy trend to deregulate the industry reached Japan in the mid-1980s. In 1985, the United States and Japan concluded a provisional agreement on international air transport. This agreement allowed new entry into the market, but required the Japanese government to change their air transport policy, because the government had restricted its carrier in the international market to just one. The government then changed its policy not only in the international market but also in the domestic, intending to promote competition in both markets. But this policy change was not as complete as that of the U.S. government. Since the institutional framework (such
as entry licensing and fare approval system) remained unchanged, whether the competition would work effectively depends on how the regulators control markets.

The purpose of this paper is to evaluate the policy changes the in Japanese air transport industry. In sections 2 and 3, we describe the evolution of the policies, and in section 4 we sketch the domestic market structure and performance of the industry. Then, from section 5 to 7, we examine the effects of the policy change by econometric analysis, focusing on the airlines’ behavior and cost structure.

2 Evolution of Domestic Air Transport Policy

In 1952, Japan Airlines was established as a major private company and started service in domestic markets. The following year, Japan was allowed to operate an international air transport service, and the government decided to reform JAL to a “half public” corporation. The purpose of this reform was to foster the company as a national flag carrier.1 Around that time, several private airline companies were founded. These companies were small and their business conditions were unstable, so some bankruptcies and consolidations occurred. In 1957, the two biggest of these carriers merged to form All Nippon Airways, which is the second major and purely private carrier. After that, the remaining companies had also undergone integration and consolidation, and in the mid-1960s, four airline companies in Japan existed: JAL, ANA, Japan Domestic Airlines (JDA) and Toa Airways (TA). In the second half of the 1960s, TA developed a cooperative arrangement with ANA, as did JDA with JAL. As a result, it was assumed that they would be consolidated into the big two, JAL and ANA.

However, the government policy changed its course due to the Cabinet Meeting Resolution “Concerning Airline Operations” of November 1970 and the Notice from the Minister of Transport in July 1972. The Cabinet Meeting Resolution of 1970 specified not a two-company system, but rather a three-company system resulting from the consolidation of JDA and TA. This sudden policy change was said to be brought about by strong political pressure from particular corporate groups, and this is clear evidence that Japanese government policy could be moved by influential private bodies at that time. Furthermore, the ministerial notification of 1972 laid out specific rules, etc., pertaining to the business fields of the three firms and increasing transport capabilities. According to this decision and notification, generally referred to as the “Aviation Constitution,” Japan Airlines would be responsible for international routes and domestic trunk routes; ANA would be responsible

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1 The government invested in JAL the same amount as the capital stock that the company obtained in starting their business. A new bill was passed to make JAL a special organization.
for domestic trunk routes, local routes and short-distance international charter flights; and Toa Domestic Airlines, the new company resulting from the consolidation of JDA and TA, would be responsible for local routes and a portion of domestic trunk routes. Thus, the so-called 1970-1972 airline regulation system (the old regime, hereafter) was established.²

The old regime was intended to secure and nurture transport capacities of all members of the airline industry by establishing a segmented business base for each firm.³ In actuality, trunk route (Sapporo — Tokyo — Osaka — Fukuoka) markets grew much faster than other “local” markets and became a source of internal cross-subsidization. Under this internal cross-subsidization system, each carrier expanded their route network, and at the same time, succeeded in stabilizing their business. In 1970s, the average growth rate of revenue passenger kilometers in the domestic market was 12.2% and that of international market was 42.4% (!!).

However, during the period from the end of the 1970s to the mid-1980s, new trends were witnessed in the field of air transportation. For example, the United States deregulated its domestic air transport market, and the results of this policy change sounded all over the world. In Europe, the Thatcher government started its privatization policy, in which British Airways was the most important objective. Influenced by these policy trends of foreign countries, it was in this period that general opinions in Japan started to change toward a more liberal environment in industrial policy.⁴

In technological respects, the introduction and spread of wide-body aircraft changed the market structure and competitive strategies. Especially, international air cargo transport grew very fast, and this growth spilled over to the regulation of Japanese domestic air transport. The establishment of Nippon Cargo Airways (NCA), along with its entry into the market was a case in point. The firm was jointly founded in 1978 by ANA and several shipping companies in order to accommodate the rapidly growing field of international air cargo transport. The Ministry of Transport promptly granted NCA a license in 1983 following its application. This decision essentially resulted in the collapse of the single-company system in which JAL handled international routes in the field of air cargo transport.

In 1985, the government of Japan and the United States started negotiations on the entry of

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² In Japan, this is known as the 45-47 regime, standing for Showa 45th year (1970) and 47th year (1972).
³ The segmentation of the market is a common feature of Japanese industrial policy in the 1950s, 60s and bigging of the 70s. The airline industry was a typical case.
⁴ As for transport and aviation fields, the opinions of the Fair Trade Commission calling for relaxation of regulations in all areas of transport administration, including aviation (1982) and administrative inspections of the Administrative Management Agency with respect to aviation administration (1984) were announced.
NCA and concluded a provisional agreement. The provisional agreement proved to be a decisive factor which voided the significance of the old regime. The contents of the US-Japan provisional agreement allowed both countries to commence operation of three new airline companies each on trans-Pacific routes based on “balanced expansion” of the air transport of both countries. On the basis of the conditions which led to the exchange of this type of agreement, the Minister of Transport consulted the Council for Transport Policy, an official advisory committee of the Minister, about the state of the future operating status of airline corporations in September 1985. The council submitted an interim report in December 1985 followed by a final report in June 1986. Both reports indicated that the old regime needed a change, and that efforts should be made to enhance competition both in domestic and international markets. In particular, the framework of this new aviation policy was outlined as follows:

1. international routes will be served by multiple carriers;
2. competition on domestic routes will be promoted by new entry to a particular city-pair market;
3. Japan Airlines will be 100% privatized.

After receiving the interim report, the government immediately decided to abolish the old regime in a Cabinet Meeting Resolution.

3 New Policy Since 1986

The core of the new policy adopted in 1986 can be summarized as follows. Although we do not necessarily agree with its logic, we will describe its basic features.

With respect to a competitive policy itself, the report states that “an American-style deregulation does not suit the actual circumstances of Japan” based on the limitations of Tokyo International (Haneda) Airport and Osaka International (Itami) Airport and on the problem of differences in competitive strength between airline companies. As such, the report also states that, “For the time being, it is appropriate to proceed with policies which promote competition through the implementation of flexible administrative management as much as possible.” In this report, promotion of competition specifically refers to “the promotion of double tracking and even triple tracking not in accordance with the previous demarcation of trunk routes and local routes, but rather corresponding to the size of the demand of individual routes and status of progress at airport facilities and so on.” On the other hand, the report also points out the difficulty in increasing the number of flights due to restrictions on the capacities of major airports, indicating a manner of thinking which states that, “it is necessary to attempt to further expand air traffic capacity through improvement of air transport facilities and the air traffic control system.”
With respect to domestic aviation, the Ministry of Transport changed over to a policy which promotes competition (such as in the form of double tracking and so on) based on quantitative standards, in 1986. According to these standards, new entries were judged on the number of passengers carried in the previous year. Since that policy change, double and triple trucking routes have increased gradually. In 1993, about 65% of total air transport passenger flied in either double or triple trucking routes, although the number of these routes counts for only 19% of the total.

In addition, a related bill was passed in September 1987 pertaining to the complete privatization of JAL, which led to the realization of its transformation to a private corporation in November of the same year.5

However, it should be noted that the new policy did not give enough freedom for airlines to change themselves. This new policy seeks “promotion of competition” within the range of administrative operation without altering the previous systematic framework stipulated by the Civil Aeronautics Law. In other words, the licensing system for new entry and the approval system for setting fares remained unchanged. On the contrary, some have criticized that the new policy enhanced administrative discretion, and that in some respects the regulation was strengthened, because they have to decide which route would become a double track or a triple track, and which carrier would enter. As is pointed out by the report itself, these conditions greatly differ from the United States, where deregulation was implemented through legal reforms without the discretion of the bureaucracy.

From the consumers’ view point, the new policy did not bring about substantial benefits. This is far from the case of deregulation in the United States. Many researchers showed that the deregulation of domestic air transport markets in the United States increased consumers’ surplus dramatically, and that the main factors of this benefit are price and flight frequency change.6 Concerning fares, the most important effect of the deregulation was that it made air fares much more diversified and lowered them on average in real terms (“diversify” refers to the availability of many fares with different conditions). Airlines introduced many discount fares for the purpose of their yield management, while the discount fares benefit consumers who otherwise would not use air transport or pay more for the same service. It is reported that now more than 90% of passengers are making use of discount tickets.

5 At the time of privatization of Japan Airlines, the share of Japanese government was 34.7%.
6 For example, see Morrison and Winston [1986]. They estimated that annual improvement in the welfare of travelers by deregulation was at least $6 billion (in 1977 dollars), of which the greatest net benefits had gone to business travelers from increased flights frequency.
Ito [1992] compares fares in Japan and the United States (Table 1). In the table unit fares are passenger's expenditure per kilometer. The table shows that normal (fare basis Y) fares of the United States are higher than Japan, but that discount fares in the States are much lower than Japan. As noted above, most passengers fly with discount fares. It should be noticed that deregulation brings price diversification and not simple downward pressure on prices. From the beginning of the 1990s, discount fares have been moving toward simplification. However, since discounts rates in the States are much larger than Japan, we can say that the fare level in Japan are still higher than that of the States.

As we saw, the new air transport policy since 1986 has not brought effective competition to the market. As a result, consumers have not obtained any benefit from the policy change. Thus what Japanese government should do urgently is to make competition effective in the air transport markets. At the end of last year, the government revised the Civil Aeronautics Law to relax the conditions for introducing and setting discount fare in domestic markets, but in order to bear fruit for consumers, more drastic relaxation is needed.

4 The Market Structure and Performance of the Japanese Airline Industry : Descriptive Statistics

In this section we will refer briefly to the domestic market structure and performance of the Japanese airline industry, using the annual data filed in Koku Tokei Yoran (issued annually by Nihon Koku Kyokai) and Koku Yuso Tokei Nempo (by Ministry of Transport), in order to better understand the character of the Japanese airline industry.

4.1 The Market Structure of the Japanese Airline Industry

To begin with, we will survey the cost structure. The three major airlines' total annual cost, labor, and fuel costs (included in total cost) are shown in Figure 1 (Figure 1-1 is nominal base, and Figure 1-2 real, i.e., deflated by RPI index).

The total cost had been almost unchanged before the regulatory change, but suddenly began to increase after 1986. It is apparent that fuel costs, the share of which was around 30% at the end of 1970s, has been decreasing, and that the labor costs remained constant in real base. And Figure 2 shows that the airport charges, which are said to have been a burden for Japanese airlines, have also been decreasing. So, what have raised the total cost recently are such non-operational costs as sales and administrative costs, and commissions for travel agencies. The reason why the shares of these

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7 For details, see the footnotes of the table.
costs increased is thought to be that airlines’ entry into new routes after the regulatory change caused airlines to spend more to attract demand. According to the context mentioned above, we may say that the ratio of fixed cost has also decreased.

Figure 3 shows changes of the big three’s real average costs (operating cost per available seat kilometer). The cost trend experienced two turning points. One is 1986, the other 1990. All three companies succeeded in cost reduction in the early 1980s. Especially, JAS, the highest-cost carrier, reduced its cost greatly. The average costs remained constant or slightly increased between 1986 to 1990, and they decreased again in 1991 and 1992. As we noted earlier, the second half of 1980s boomed and the air transport policy change occurred in 1986. These are the reasons for the cost trend in that period.

In Figures 4-1, 4-2 and 4-3, the airplane size, the passengers carried by the three airline, and the share of passengers carried are shown respectively. As noted above, Japanese domestic markets can be divided into three groups. One is what is called “triple truck routes,” of which the demand in previous year is above 700,000, where JAL, ANA, and JAS operate. Another is “double truck routes,” the demand of which is above 400,000 in principle, where JAL and ANA or ANA and JAS operate, and the other is a monopoly.

Among the 179 domestic routes in 1991, the number of triple truck ones are 10 (5.6%), double truck 24 (13.4%), and monopoly 145 (81.0%). However, the number of passengers carried in triple truck was 29,484,000 (42.9%), double truck 15,530,000 (22.6%), and monopoly 23,673,000 (34.4%). So the average market size of triple (double) truck routes are eighteen times (four times) larger than that of monopoly. In addition, these Japanese routes are also classified into trunk routes and local routes. The definition of the former city-pair routes is that they connect Sapporo (Shin’Chitose), Tokyo (Haneda, Narita), Osaka (Itami10), Fukuoka, and Naha, and the number of the passenger carried in 1991 in the trunk routes was 25,840,000 (38.2%), which happen to include many triple and double truck routes.

Before the regulatory change, with regard to the domestic markets, JAL has been in operation only in trunk routes. Under the new policy, JAL was authorized to operate in domestically denser local routes; that is some double and triple truck routes. Generally speaking, the denser the market, the wider airplanes employed tend to be. It is clear that JAL always employs the largest type

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8 Initially, the MoT put the standard for triple and double truck at one million and 700,000 or more a year respectively. Then they relaxed the standard, but some exceptions exist.
9 Commuter routes are included.
10 Since 1994, Kansai International Airport has been included in trunk routes.
of airplane. However, after the regulatory change JAL’s aircraft size shrunk slightly, whereas ANA and JAS have come to employ the larger aircraft. The reason is that the markets JAL was newly authorized to enter were smaller than those which he had been in operation before the regulatory change, while, roughly speaking, in the case of ANA and JAS, it was vice versa.

On the other hand, ANA has already been in operation both in the trunk routes and in denser local routes (see the passenger share in Figure 4-2), so there has been no room left for ANA to enter the domestic market. The routes ANA has newly entered are both international (for U.S. and Europe) and domestic long haul monopoly routes newly authorized (e.g., Shin’Chitose/Okayama, etc). So the average aircraft size became larger, especially since the regulatory change.

With regard to JAS, it was authorized to enter some domestic trunk and shorter haul international routes, but the extent of entry was less than that of ANA. Figure 4-1 shows that the average aircraft size of JAS became larger in almost the same way as ANA.

Finally, let us investigate the share of departure from each airport by Figure 5. Figure 5-1 shows the situation in 1979, while Figure 5-2 shows that of 1992. As Tokyo and Osaka areas have by far the largest population, so it has been said that departures are concentrated at both Handeda and Itami, and this is as true as ever. However, as the capacity constraint at Itami Airport has been substantial, and has prevented airlines from increasing departures responding to the demand increase, the departure share of Itami has gradually decreased. The construction of Kansai International Airport was expected to relieve traffic, but due to the high landing fees and the lack of the runway, it is said that the new Kansai Airport has not yet played a great role toward solving the problem.

4.2 The Performance

Here we will survey the market performance of the Japanese domestic airline industry after the regulatory change from the viewpoints of load factor (i.e., the substitution of productivity), yield, and profit rate of each firm.

Figure 6-1 shows that there seems to be little difference of average load factor between 1979-1985 and 1986-1990, so we may say that the regulatory change hardly contributed to airlines’ productivity. The average operating indices of all industries (including the airline industry) are down in that figure. It should be noted that the average load factor has something to do with the average operating rate of all the industries, which means that the load factor cyclically reflects both boom and recession.11 In fact, the average load factor of the three airlines during 1986-1992 (67.1%),

11 The correlation between domestic average load factor and average operation rate of all the industries is shown in the table below.

The correlation between average load factor and average operation rate of all industries
which includes the boom, is a little higher than during 1979-1985 (64.4%). However, from a statistical viewpoints, significant difference between them was not recognized as a result of a one-way layout analysis of variance (F = 3.15 < F(1,40;0.05) = 4.08). So neither the regulatory change nor the boom could raise the load factor. On the other hand, from Figure 6-1, we can see that the crash of JAL's B747SR in 1985 had a substantial effect on its load factor that year.

Figures 7-1 and 7-2 show the yields of Japanese airlines (the international data are also included, because they are not separately published). Note that the real yields of JAL and JAS (shown in Figure 7-2) have been slightly decreasing, except for the boom whereas ANA's has been slightly increasing, and that even the nominal yield of those two firms (in Figure 7-1) have not necessarily increased. As JAL has been in operation mainly in international markets, so JAL may be suffering from the lack of revenue caused by discount fares in international markets. However, JAL has also been successful in being authorized to enter some domestic routes where discount tickets are less available than in international markets, which is expected to prevent the yield from decreasing. On the contrary, ANA is facing the opposite situation. ANA's yield may go down as the company goes on entering international markets. So ANA will aim at being authorized to enter domestic longer haul markets, where it can constantly keep more sufficient revenue.

With regard to JAS, after the regulatory change JAS came to operate in domestic major markets where coupon tickets are more available than in minor local routes in which the company used to operate. In addition, JAS was allowed to enter shorter-haul international markets, which may deprive it of its revenue. So JAS may suffer from the situation it faces after the regulatory change.

Finally, according to Figure 8, it seems that the profit rate became higher after the regulatory change, but as mentioned in the case of the load factor, we can say that not so much the regulatory change as the boom caused the higher profit rate, because the recession from 1991 apparently lowered the profit. According to the surveys above, where we found that total cost has been increasing while yields decreased, it is said that the profit rate after the regulatory change is quite

<table>
<thead>
<tr>
<th></th>
<th>JAL</th>
<th>ANA</th>
<th>JAS</th>
<th>JAL(85 was excluded)</th>
<th>ANA(85 was excluded)</th>
<th>JAS(85 was excluded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>all industries</td>
<td>0.556 (2.32**)</td>
<td>0.565 (2.37*)</td>
<td>0.611 (2.67*)</td>
<td>0.669 (2.99**)</td>
<td>0.626 (2.66*)</td>
<td>0.662 (2.93**)</td>
</tr>
<tr>
<td>service industries</td>
<td>0.744 (3.86***)</td>
<td>0.280 (1.01)</td>
<td>0.110 (0.38)</td>
<td>0.704 (3.29***)</td>
<td>0.296 (1.03)</td>
<td>0.132 (0.44)</td>
</tr>
</tbody>
</table>

Note: N-14(79-92). Level of significance: *5%, **2.5%, ***1%.

As a result of one-way layout analysis of variance, the average profit rate of three firms after '86 (i.e., after the regulatory change) is significantly higher than during '79-'85 (i.e., 45-47 system). F = 7.06 > F(1,400.025) = 5.43
unstable, and is ruled by cyclical business conditions.

5 Service Competition and Demand Character in Double/Triple Truck Routes

In this section we will clarify the effect of authorization of entry on airlines’ competition by econometric analysis. It is generally thought that almost all kinds of competition, e.g., through price, frequency, and service quality, have been forbidden since the introduction of the old regulatory regime. On the other hand, it is pointed out that Japanese airlines have engaged in such competition as employing newer type of airplanes. In addition it is true that the MoT in Japan intended to promote competition among airlines since the abolishment of the old regulatory regime. In effect, with respect to domestic aviation policy, the MoT authorized JAL and JAS to enter the routes where ANA already operated as incumbent, so that 34 double or triple truck routes were formed by 1992 (See Table 2).

Table 2. The domestic double and triple truck route in 1992, and the number of the firms in operation during the period 1989-92.

<table>
<thead>
<tr>
<th>City Pair Route</th>
<th>92</th>
<th>91</th>
<th>90</th>
<th>89</th>
<th>Firms</th>
<th>City Pair Route</th>
<th>92</th>
<th>91</th>
<th>90</th>
<th>89</th>
<th>Firms</th>
</tr>
</thead>
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<tr>
<td>1. Tokyo/Sapporo</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>JAL, ANA</td>
<td>17. Tokyo/Nagasaki</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>ANA, JAS</td>
</tr>
<tr>
<td>2. Tokyo/Osaka</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>JAL, ANA</td>
<td>18. Tokyo/Kumamoto</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>ANA, JAS</td>
</tr>
<tr>
<td>3. Tokyo/Fukuoka</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>JAL, ANA</td>
<td>19. Tokyo/Oita</td>
<td>2</td>
<td>2</td>
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<td>2</td>
<td>ANA, JAS</td>
</tr>
<tr>
<td>4. Tokyo/Naha</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>JAL, ANA</td>
<td>20. Tokyo/Miyazaki</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>ANA, JAS</td>
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<tr>
<td>5. Osaka/Sapporo</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>JAL, ANA</td>
<td>21. Tokyo/Kagoshima</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<td></td>
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<td>6. Osaka/Fukuoka</td>
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<td>2</td>
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<td>2</td>
<td>JAL, ANA</td>
<td>22. Osaka/Sendai</td>
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<td>1</td>
<td>JAL, ANA</td>
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<td>7. Osaka/Naha</td>
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<td>JAL, ANA</td>
<td>23. Osaka/Matsuyama</td>
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<td>8. Fukuoka/Sapporo</td>
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<td>2</td>
<td>1</td>
<td>1</td>
<td>JAL, ANA</td>
<td>24. Osaka/Kochi</td>
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<td>ANA, ANK, JAS</td>
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<td>9. Fukuoka/Naha</td>
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<td>2</td>
<td>JAL, ANA</td>
<td>25. Osaka/Kagoshima</td>
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<td>10. Tokyo/Kushiro</td>
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<td>JAL, ANA</td>
<td>26. Nagoya/Sapporo</td>
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<td>11. Tokyo/Hokkaido</td>
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<td>JAL, ANA</td>
<td>27. Nagoya/Sendai</td>
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<td>ANA, JAS</td>
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<tr>
<td>12. Tokyo/Akita</td>
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<td>JAL, ANA</td>
<td>28. Nagoya/Fukuoka</td>
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<td>13. Tokyo/Kanazawa</td>
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<td>JAL, ANA</td>
<td>29. Nagoya/Nagasaki</td>
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<td>2</td>
<td>2</td>
<td>ANA, JAS</td>
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<tr>
<td>14. Tokyo/Hiroshima</td>
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<td>3</td>
<td>3</td>
<td>2</td>
<td>JAL, ANA</td>
<td>30. Nagoya/Kagoshima</td>
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<td>15. Tokyo/Takamatsu</td>
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<td>31. Nagoya/Naha</td>
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<td>ANA, JAL &amp; JTA</td>
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<td>16. Tokyo/Matsuyama</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>JAL, ANA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: (1) The route where ANA and ANK or JAL and JTA operates is not regarded as double truck, because they are horizontally integrated.
(2) Firms which operate for less than 6 months in a year are not included.
(3) JAL, ANA, and JAS operate in all the triple truck routes.
(4) The following local routes are excluded, because of their apparently smaller market size. Fukuoka / Kagoshima, Kagoshima/Amami, and Naha/Ishigaki

A famous example is the competition between JAL and ANA to employ B727s in the 1960s.
However, it is quite obscure what kind of competition MoT intends to introduce. In the following parts, the regression model referred in Douglas and Miller [1974b] will be constructed in order to verify the null hypothesis that a kind of service competition (like frequency competition) did not exist in double or triple truck routes as a result of regulatory change. And through the analysis, we will clarify the demand character in the area.

5.1 Service Competition Model

According to Douglas & Miller [1974b], if the additional demand increase of an individual firm $i$ due to the additional increase of frequency $\frac{\partial PAX_i}{\partial FRQ_i}$ is greater than that of the market, i.e., $\frac{\partial PAX_i}{\partial FRQ_i} > \frac{\partial PAX}{\partial FRQ}$, then airlines are supposed to choose the frequency competition as their strategy to increase their passenger share. Indeed one may say it is inappropriate to apply Douglas & Miller’s theory to the Japanese airline industry, where the airport capacity is limited, but it is possible to think that the knowledge of demand character mentioned above induces Japanese airlines to apply to the Japanese MoT for entry into double or triple truck routes in order to increase their traffic share. This will be further accelerated when the capacity limitation in airports is loosened in the future.

In addition, let us suppose the other hypothesis inherent in the case of the Japanese airlines; that is, if $\frac{\partial PAX_i}{\partial EQ_i} > \frac{\partial PAX}{\partial EQ}$, then the airline are supposed to choose the equipment competition. The reason for supposing this hypothesis is that Japanese airlines, especially JAL and ANA, are said to have been in competition to employ the newer type of airplanes than the other since the 1970s.

Here let us construct the log linear regression models (1) and (2) in order to test these two hypotheses.

\[
\ln \left( \frac{\sum_{j=1}^{n} PAX_i}{\sum_{j=1}^{n} PAX} \right) = \alpha_1 + \sum_{k=89}^{91} \beta_{1k} AD_k + \left( \gamma_1 + \sum_{k=89}^{91} \delta_{1k} AD_k \right) \ln \left( \frac{\sum_{j=1}^{n} FRQ_i}{\sum_{j=1}^{n} FRQ} \right) + \mu
\]

where $n$ is the number of firms in operation in a route, $PAX_i$ is the total annual traffic carried by the $i$ th firm in a city pair route, $FRQ_i$ is the total annual departures of the $i$ th firm in a city pair route, and $\mu$ is the error term.
where \( EQ_i \) is the number of seats per flight of the \( i \) th firm in a city pair route.

In addition to the models above, we suppose that each firm is to increase its demand share by increasing its total seat supply (i.e., \( S = FRQ_i \times EQ_i \) share). In this case the carrier is supposed to choose the mixed strategy of increasing departure and widening bodies optimally in order to increase its own demand share under the circumstances or constraints (e.g., slot constraint) the carrier faces.

\[
\frac{\text{PAX}_i}{\text{PAX}} = \alpha_3 \left( \frac{S_i}{S} \right)^r = \alpha_3 \left( \frac{FRQ_i}{FRQ} \right)^{\gamma_3} \left( \frac{EQ_i}{EQ} \right)^{\phi_3}
\]

\( r = \gamma_3 + \phi_3 \), if profit exists for firm \( i \), \( r > 1 \). Here we construct a multiple regression demand share model where the share of departure and that of seats are dependent variables (See equation (3)).

\[
\ln \left( \frac{\text{PAX}_i}{\sum_{j=1}^{91} \text{PAX}_j} \right) = \alpha_3 + \sum_{k=1}^{91} \beta_{3k} AD_k + \left( \gamma_3 + \sum_{k=1}^{91} \delta_{3k} AD_k \right) \ln \left( \frac{FRQ_i}{\sum_{j=1}^{91} FRQ_j} \right) + \left( \phi_3 + \sum_{k=1}^{91} \lambda_{3k} AD_k \right) \ln \left( \frac{\sum_{j=1}^{91} EQ_j}{EQ_i} \right) + \mu
\]

In equation (3) if the sum of \( \gamma_3 \) and \( \phi_3 \) are larger than unity, we suppose that airlines intend to increase its demand share by increasing its total seat supply share. And in case \( \gamma_3 \) are larger than \( \phi_3 \) with both of them statistically significant, we judge that the airline sheds more light on the strategy of increasing the number of departures.

The data in this section is obtained from Koku Yuso Tokkei Nempo (this is an annual statistical report published by the MoT), issued between 1989-1992.

### 5.2 The Regression Results

The results are shown in Tables 3, 4 and 5.

In all cases, we say that the increase of flight share brings about that of passenger share, but each equation shows different results, judging from the result of the Chow test. Each firm might behave in a different manner in this period. In addition, in the case of JAL and JAS, a percent increase of frequency share leads to 1.3-1.4% increase of demand share, whereas with regard to ANA, which had already been in operation in the market of denser traffic and did not enter double or triple truck routes during the period of 1989-1992, this phenomenon was no longer seen. From these results, JAL and JAS have the good reason to apply for the entry into the denser routes. And from the viewpoint of demand side, passengers tend to choose the flights of dominant airlines in the market.
Table 3. Regression results of demand share function (1) and the 95% confidence limit of parameter $\gamma_1$ with regard to each firm.

| Firm | $\alpha_i+\beta_{ik}$ | $\gamma_1+\delta_{ik}$ | adj R$^2$ | SE | $Pr(|\gamma_1| \leq x)=0.95$ |
|------|------------------------|------------------------|----------|----|----------------------------|
| JAL  | $-1.845+1.099\tilde{AD}_{89}+0.793\tilde{AD}_{90}$ (12.30a)(2.96a) | 1.420-0.253$\tilde{AD}_{89}+0.190\tilde{AD}_{90}$ (39.55a)(3.00a) | 0.970 | 0.114 | $1.353 \leq \gamma_1 \leq 1.498$ |
| ANA  | 0.019 (0.15) | 0.995 (36.71a) | 0.918 | 0.096 | $0.942 \leq \gamma_1 \leq 1.048$ |
| JAS  | $-1.291 (7.65a)$ | 1.266 (33.66a) | 0.944 | 0.186 | $1.191 \leq \gamma_1 \leq 1.341$ |

Note: (1) $t$-statistics are in parentheses; Level of Significance: $a=1\%$  
(2) estimated by OLS.  
(3) The confidence limit of JAL(2) is the value of '92.  
(4) The equations in the upper row of each firm’s empirical results were estimated without any annual dummy variables.  
(5) The results of the Chow test between firms are:  
JAL/ANA : $F=13.92 > F(2,194:0.01)=4.71$  
JAL/JAS : $F=14.01 > F(2,140:0.01)=4.76$  
ANA/JAS : $F=28.00 > F(2,186:0.01)=4.71$

Next, we can compare the estimated results of equation (2) with those of (1), in Table 4.

Table 4. Regression results of demand share function (2) and the 95% confidence limit of parameter $\gamma_2$

| Firm | $\alpha_i+\beta_{ik}$ | $\gamma_2+\delta_{ik}$ | adj R$^2$ | SE | $Pr(|\gamma_2| \leq x)=0.95$ |
|------|------------------------|------------------------|----------|----|----------------------------|
| JAL  | $-1.200+0.684\tilde{AD}_{89}+0.340\tilde{AD}_{90}$ (11.77a)(2.56b) | 1.266-0.152$\tilde{AD}_{89}+0.077\tilde{AD}_{90}$ (51.92a)(2.52b) (1.58d) | 0.983 | 0.087 | $1.217 \leq \gamma_2 \leq 1.315$ |
| ANA  | $-0.420 (5.68a)$ | 1.090 (67.27a) | 0.974 | 0.054 | $1.058 \leq \gamma_2 \leq 1.122$ |
| JAS  | $-0.404 (4.29a)$ | 1.082 (50.85a) | 0.975 | 0.125 | $1.039 \leq \gamma_2 \leq 1.125$ |

Note: (1) $t$-statistics are in parentheses; the level of significance: $a=1\%$, $b=5\%$, $c=10\%$, $d=20\%$  
(2) estimated by OLS.  
(3) The confidence limit of JAL(2) & ANA(2) are the value of '92.  
(4) The equations in the upper row of each firm’s empirical results were estimated without any annual dummy variables.  
(5) The results of the Chow test between firms are:  
JAL/ANA : $F=23.62 > F(2,194:0.01)=4.71$  
JAL/JAS : $F=23.68 > F(2,140:0.01)=4.76$  
ANA/JAS : $F=4.57 > F(2,186:0.05)=3.04$

What is apparently different from the results in Table 3 is that all the regression coefficients are larger than unity in this case, whereas the results of the Chow test are almost the same as those in Table 3. So it can be said from this viewpoint that all the Japanese airlines have room for choosing the strategy of expanding the equipment size, but their behavior may be different from one another. Especially in the case of ANA, there may be no choice but competing through the expansion of
equipment, because it already operates as an incumbent in almost all the domestic denser markets.

Let’s then look into the regression results of equation (3). Judging by the results shown in Table 5, we can recognize three notable findings:

(1) In all the cases \( r = \gamma_3 + \phi_3 > 1 \) is recognized. This means that the more each airline increase the total seat supply share, the more it can increase demand share.

(2) The Japanese airlines except for ANA may have the incentive of choosing these two strategies:

(1) increasing frequency in double or triple truck routes, (2) expanding equipment size in these routes.

(3) However, JAL and JAS seem to choose not so much frequency competition as equipment competition.

The reasons for these results may be that the lack of airport capacity makes it difficult for the airlines to depend heavily on frequency competition. The values of ANA — which has the biggest fleet in the domestic air network — gives us the evidence.

**Table 5. Regression results of demand share function 3**

<table>
<thead>
<tr>
<th>Firm</th>
<th>( \alpha + \beta m_k )</th>
<th>( \gamma + \delta m_k )</th>
<th>( \phi + \lambda m_k )</th>
<th>adj R²</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JAL</strong> (1)</td>
<td>-1.252 (12.21a)</td>
<td>0.319 (2.63b)</td>
<td>0.947 (8.58a)</td>
<td>0.983</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>-1.481+0.880AD89+0.563AD90 (12.63a)(3.49a) (2.74a)</td>
<td>0.282+0.427AD91 (2.16b)(2.04b)</td>
<td>1.053+0.200AD89 (8.61a)(3.51a) (2.05b)</td>
<td>0.987</td>
<td>0.080</td>
</tr>
<tr>
<td><strong>ANA</strong> (2)</td>
<td>-0.435 (5.85a)</td>
<td>-0.018 (0.28)</td>
<td>1.112 (16.31a)</td>
<td>0.974</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td>-0.608+0.271AD89 (5.16a)(1.43d)</td>
<td>-0.063+0.247AD90 (0.89)(1.56d)</td>
<td>1.189+0.306AD89 (15.47a)(1.84c) (1.32a)</td>
<td>0.987</td>
<td>0.080</td>
</tr>
<tr>
<td><strong>JAS</strong> (1)</td>
<td>-0.778 (7.60a)</td>
<td>0.410 (5.62a)</td>
<td>0.751 (12.24a)</td>
<td>0.983</td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td>-0.739 (7.55a)</td>
<td>0.513+0.277AD90 (6.50a)(2.73a)</td>
<td>0.646+0.284AD89 (9.19a)(2.66a)</td>
<td>0.984</td>
<td>0.098</td>
</tr>
</tbody>
</table>

Note: (1) t-statistics are in parentheses; the level of significance: a=1%, b=5%, c=10%.

(2) Estimated by OLS

(3) The equations in the upper row of each firm’s empirical results were estimated without any annual dummy variables.

(4) The results of the Chow test between firms are:

\[ JAL/ANA : F = 20.15 > F(3,192:0.01)=3.88 \]
\[ JAL/JAS : F = 6.66 > F(3,138:0.01)=3.93 \]
\[ ANA/JAS : F = 8.29 > F(3,184:0.01)=3.89 \]

### 5.3 Summary of Findings

Here we will sum up the findings in this section and briefly comment on them. According to the empirical results, passengers seemed to choose the airlines that had high frequency and seat-per-
flight share (equipment). On the other hand, from the viewpoint of airlines, JAL and JAS were able to increase their demand share by increasing the frequency and seat-per-flight share. In addition, the strategy of increasing equipment share was probably of comparative importance for these carriers because of the airport capacity constraints. However, in the case of ANA, the strategy of increasing equipment share — that is, employing wider bodied airplanes — was important.

If we take into account these results, the regulatory change that authorized the entry into double or triple truck routes was favorable not to ANA but to JAL and JAS. However, as in the case that once the frequency competition led to the waste of profit in the U.S. airline industry under regulation, it is necessary for the regulator (MoT) to pay attention to whether or not the service competition including frequency and/or equipment competition in double or triple truck routes causes the waste of scarce resources.

In the following section, it will be clarified whether this competition has brought about excess capacity or not.

6 Does the Demand Meet Supply in Double/Triple Truck Routes? :The Models and Regression Results

6.1 The Models and Data

According to the empirical results in section 5.2, something like service competition in double and/or triple truck routes may bring about excess capacity. On the other hand the capacity constraints in Haneda (Tokyo) and Itami (Osaka) Airports may be a crucial factor to prevent airlines from increasing their supply. In this section we will focus on the load factor of the routes where entry was newly authorized after the regulatory change in 1986 and investigate whether or not supply meets demand in these routes. To begin with, we will construct two kinds of load factor functions. The definitions of the variables used in the models are shown in Table 6.

The data in this section is the same as in section 5, i.e., the panel data of 31 routes between 1989-1992; the sample number is 124.

In treating the load factor we have to take into consideration that the average load factor changes according to boom and slump. So we restored to the analysis of variance (one-way layout) in order to make sure the existence of load factor’s difference between 1989-92. The result goes as follows.

\[ F = 10.84 > F_{(4,120:0.01)} = 3.48 \]

From the result, the null hypothesis that the average load factor in each year is equal is
rejected at 1 % level. So we introduced the annual dummy variable ADx (see Table 6).

Both demand and supply factors are to influence the load factor directly: demand factors, e.g., the number of passengers (PAX), and supply factors, e.g., the number of departures (FRQ), the number of seats per flight (EQ), and the stage length (DIST), and the factor of the market structure, e.g., the concentration (HERF). On the other hand, among these variables, PAX and EQ are endogenous variables in demand and supply function, so the load factor function may compose the simultaneous equations together with demand and supply functions.

In addition, we have to pay attention to the multicollinearity between variables. The partial correlation coefficients between variables are shown in Table 7.

Table 6. Variables and their definitions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition and data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF</td>
<td>the average annual load factor of each market, reported in “A”</td>
</tr>
<tr>
<td>PAX</td>
<td>the number of O&amp;D passengers in each market that traveled in a year, reported in “A”</td>
</tr>
<tr>
<td>DIST</td>
<td>each route’s nonstop distance between O&amp;D, reported in “A”</td>
</tr>
<tr>
<td>HERF</td>
<td>the Herfindahl index, the sum of the squares of the shares of each firm in the market, calculated by us. The data source is “A”</td>
</tr>
<tr>
<td>EQ</td>
<td>the average annual number of seats per flight in the market, which was calculated by the authors. The data source is “A”</td>
</tr>
<tr>
<td>FARE</td>
<td>the round trip ticket price of the market, filed in “B”</td>
</tr>
<tr>
<td>INC</td>
<td>the product of the per capita incomes of the two main cities served by each market, i.e., ( \sqrt{(Income \ of \ Origin) \times (Income \ of \ Destination)} ). The data source is “C”</td>
</tr>
<tr>
<td>POP</td>
<td>the product of the population of the two areas served by each market, i.e., ( \sqrt{(Population \ of \ Origin \ Area) \times Population \ of \ Destination \ Area} ), where “area” is both main city and its commuting zone. The data source is “C”</td>
</tr>
<tr>
<td>ADx</td>
<td>annual dummy variable (x=89,90,91)</td>
</tr>
<tr>
<td>DS</td>
<td>single truck dummy variable(1 for single truck route and 0 otherwise)</td>
</tr>
<tr>
<td>DT</td>
<td>triple truck dummy variable(1 for triple truck route and 0 otherwise)</td>
</tr>
<tr>
<td>DTR</td>
<td>trunk route dummy variable (1 for trunk route and 0 otherwise)</td>
</tr>
</tbody>
</table>

Note: Data Source “A” is Koku Yuso Tokei Nempo (issued between ‘89-‘92), “B” is Jikokuhyou (the time table, published by JTB), and “C” is Chiiki-keizai-souran, issued between 1991-94 (which reports regional annual data of population, income, etc, annually published by Toyo Keizai Shimposha)

Table 7. The partial correlation coefficients between variables

<table>
<thead>
<tr>
<th></th>
<th>LF</th>
<th>PAX</th>
<th>DIST</th>
<th>FRQ</th>
<th>EQ</th>
<th>HERF</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAX</td>
<td>0.253</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRQ</td>
<td>0.240</td>
<td>0.880*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIST</td>
<td>-0.355*</td>
<td>0.014</td>
<td>-0.238</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQ</td>
<td>-0.048</td>
<td>0.667*</td>
<td>0.244</td>
<td>0.457*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>HERF</td>
<td>0.162</td>
<td>-0.581*</td>
<td>-0.514*</td>
<td>-0.251</td>
<td>-0.445*</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: *significant at 0.1% level
Among these coefficients the correlation between $\text{PAX}$ and $\text{FRQ}$ is strong (coefficient is 0.88). So in the construction of the load factor function, we chose not to include these two variables simultaneously but to build two type of load factor equations (Load factor function [1] and [2]) each of which includes $\text{PAX}$ or $\text{FRQ}$ as independent variable. Each equation in log-linear form and its expected sign of coefficients are as follows:

**(1) Load factor function** ($x=89, 90, 91$)

\[
\ln(\text{LF}) = a_1 + \sum_{x=89}^{91} b_{1x}AD_x + \left( c_1 + \sum_{x=89}^{91} d_{1x}AD_x \right) \ln(\text{PAX}) + \left( e_1 + \sum_{x=89}^{91} f_{1x}AD_x \right) \ln(DIST)
\]

\[
+ \left( g_1 + \sum_{x=89}^{91} h_{1x}AD_x \right) \ln(\text{HERF}) + \left( i_1 + \sum_{x=89}^{91} j_{1x}AD_x \right) \ln(\text{EQ}) + \mu_1
\]

The coefficient of $\ln(\text{PAX})$ is expected to be $c_1 > 0$, because, other things being equal, the more the traffic increases, the higher the load factor becomes. In addition, the value of the coefficient is thought to be $0 < c_1 < 114$. And if at once $c_1 > 0$ and the null hypothesis that $c_1 = 1$ cannot be rejected, airlines are thought to have enough capacity for demand.

According to Douglas & Miller [1974b], the longer the stage length is, the lower the actual load factor.\(^{15}\) We accept this hypothesis and expect $-1 < e_1 < 0$.

On the other hand, against our expectation, if $e_1 > 0$, then airlines are expected to make a profit in routes of longer distance. However, according to Murakami [1994], airlines do not necessarily make profits in longer routes other than monopoly ones, so in this paper we expect the coefficient of stage length to be $-1 < e_1 < 0$. The signs of the coefficient of $\ln(\text{HERF})$ are expected to be $0 < g_1 < 1$, because each airline will increase the number of departures until zero rent if it knows that the more the frequency share increases, the more does its traffic share. So the departures in oligopoly markets will be more numerous than those in monopoly ones, and the load factor in the former type of markets will be lower, with traffic being constant. The coefficient of $\ln(\text{EQ})$ is expected to be $0 < i_1 < 1$, if airlines can induce those passengers who would not take airplane if airlines did not offer attractive service through, e.g., equipment competition. However, in case airlines fail to attract passengers, $-1 < i_1 < 0$ will be expected and excess capacity may be brought

\[^{14}\] $\frac{\partial LF}{\partial \text{PAX}} > 0$, $\frac{\partial^2 LF}{\partial (\text{PAX})^2} < 0$

\[^{15}\] According to Douglas & Miller [1974a], pp.50-51, the change of productivity caused by technological development or the revision of fares makes the break-even load factor lower. This also causes a lower real load factor.
about.

Then we will examine the sign of coefficients of the demand function.

(2) Demand function \((x=89,90,91)\)

\[
\ln(PAX) = a_2 + \sum_{x=89}^{91} b_{2x} AD_x + \left( c_2 + \sum_{x=89}^{91} d_{2x} AD_x \right) \ln(LF) + \left( e_2 + \sum_{x=89}^{91} f_{2x} AD_x \right) \ln(EQ)
\]

\[
+ \left( g_2 + \sum_{x=89}^{91} h_{2x} AD_x \right) \ln(PP) + \left( i_2 + \sum_{x=89}^{91} j_{2x} AD_x \right) \ln(FARE) + \left( k_2 + \sum_{x=89}^{91} l_{2x} AD_x \right) \ln(INC) + \mu_2
\]

To begin with, the sign of the coefficient of \(\ln(LF)\) will be \(c_2 > 0\), because the higher load factor of the double or triple truck routes means that the OD cities of these routes are attractive for business passengers because of many business opportunities.\(^{16}\) With regard to the coefficients of \(\ln(EQ)\) and \(\ln(PP)\), \(e_2 > 0\) and \(g_2 > 0\) will be expected because both the variables reflect market structure. The coefficient of \(\ln(FARE)\) will be \(i_2 < 0\) according to the law of demand, and \(k_2\) of \(\ln(INC)\) will be \(k_2 > 0\), if we assume that the air transport service is normal goods.

(3) Equipment (Supply per flight) function \((x=89,90,91)\)

\[
\ln(EQ) = a_3 + \sum_{x=89}^{91} b_{3x} AD_x + \left( c_3 + \sum_{x=89}^{91} d_{3x} AD_x \right) \ln(PAX) + \left( e_3 + \sum_{x=89}^{91} f_{3x} AD_x \right) \ln(FARE)
\]

\[
+ \left( g_3 + \sum_{x=89}^{91} h_{3x} AD_x \right) \ln(DIST) + \mu_4
\]

Airlines are expected to employ wide-bodied airplanes to meet demand, so \(C_3 > 0\). And according to the condition of the sign of the price in a supply function, \(e_3 > 0\). In respect of the relation between the equipment and stage length, the longer the distance of a route is, the bigger the size of airplane employed, so \(g_3 > 0\), will be expected.

(4) Fare determination function \((x=89,90,91)\)

---

\(^{16}\) On the other hand, there have been some studies where the load factor is regarded as representative of service quality (e.g., Graham, Kaplan and Sibley [1983], p.126, or Borenstein [1989], pp.349-350). In these studies it was defined that the higher the load factor, the lower the service quality, so the sign of the load factor variables in the demand function is supposed to be negative. But this is true only in the case of the tourists on holiday who may avoid congested times. Business travelers are supposed to gather in the denser markets in the OD cities in which there are many business opportunities. So here we expect the sign to be positive.
\[ \ln(FARE) = a_4 + \sum_{x=89}^{91} b_{4x}AD_x + \left( c_4 + \sum_{x=89}^{91} d_{4x}AD_x \right) \ln(DIST) + \left( e_4 + \sum_{x=89}^{91} f_{4x}AD_x \right) \ln(LF) \\
+ \left( g_4 + \sum_{x=89}^{91} h_{4x}AD_x \right) \ln(HERF) + \left( i_4 + \sum_{x=89}^{91} j_{4x}AD_x \right) \ln(INC) + \mu_4 \]

In the fare determination function, we are to verify the hypothesis that the domestic air fares are determined according to the full-cost principle. The determinants of fares are supposed to be (1) stage length which reflects the operating cost, (2) the load factor, (3) concentration measured by Herfindal Index, and (4) income of the OD area of the market. The factors (2), (3), and (4) are supposed to determine the mark-up ratio. As regards the parameter \( c_4 \) \( 0 < c_4 < 1 \) will be expected, because the fares are set higher, but the extent to which they increase decreases as the distance grows.

The sign of coefficient of \( \ln(LF) \) is expected to be \( e_4 < 0 \), because in a route where the load factor is lower, airlines are expected to set higher fares in order to compensate for the loss of revenue. The higher the concentration, and the higher the income of the OD areas a market serves, the easier it may be for an airline to set more substantial margin on the operational cost, so \( g_4 > 0 \) and \( i_4 > 0 \) may be expected.

In addition, another Load factor function [2] will be shown, where we substituted \( \ln(FRQ) \) for \( \ln(PAX) \) in Load factor function [1].

**5. Load factor function [2] \((x=89,90,91)\)**

\[ \ln(LF) = a_5 + \sum_{x=89}^{91} b_{5x}AD_x + \left( c_5 + \sum_{x=89}^{91} d_{5x}AD_x \right) \ln(FRQ) + \left( e_5 + \sum_{x=89}^{91} f_{5x}AD_x \right) \ln(DIST) \\
+ \left( g_5 + \sum_{x=89}^{91} h_{5x}AD_x \right) \ln(HERF) + \left( i_5 + \sum_{x=89}^{91} j_{5x}AD_x \right) \ln(EQ) + \mu_5 \]

If a unit of increase of frequency causes one or more unit of increase of demand (e.g., the increase of frequency newly cultivates demand), \( c_5 < 0 \) will be expected (for the sign of the other coefficients, see Load factor function[1]).

### 6.2 Regression Results

In this subsection both the regression results of simultaneous equations (see Table 8) and the Load factor function[2] (See Table 9) will be shown. The former equations were estimated by 2SLS, the latter by OLS.

Prior to the appreciation of both the load factor functions by which we will judge whether supply meets demand, we are to appreciate the results of the other equations. With respect to the demand and the supply per flight function, all the signs of estimated values meet the required conditions. The price elasticity of demand is about -0.7. In addition, as to the method of estimation,
we substituted single truck dummy variable $DS$ and triple truck dummy $DT$ for $\ln(PP)$ in demand function, and the dummy variable $DT$ which can be regarded as the variable reflecting distance for $\ln(DIST)$ in supply per flight function. All of them were introduced in the intercept of each equation, so that the values of adj R$^2$ and standard error were improved with the sign of coefficients of the other variables meeting the conditions.

Table 8. Regression results of simultaneous equations

<table>
<thead>
<tr>
<th>d.v</th>
<th>INTERCEPT</th>
<th>LnLF</th>
<th>LnPAX</th>
<th>LnEQ</th>
<th>LnFARE</th>
<th>LnDIST</th>
<th>LnHERF</th>
<th>LnINC</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnLF</td>
<td>4.215+0.073$AD_{36}$</td>
<td>(4.31a)</td>
<td>0.025</td>
<td>0.071</td>
<td>-0.097</td>
<td>0.075</td>
<td>0.401</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(20.63a)</td>
<td>(1.72a)</td>
<td></td>
<td>(3.91a)</td>
<td></td>
<td>(2.71a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LnPAX</td>
<td>-6.960-0.331$DS$</td>
<td>(2.25b)</td>
<td>1.283</td>
<td>1.018</td>
<td>-0.731</td>
<td>0.817</td>
<td>0.670</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.22b)</td>
<td>(3.78a)</td>
<td></td>
<td>(3.69a)</td>
<td></td>
<td>(3.35b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LnEQ</td>
<td>2.062+0.198$DT$</td>
<td>(2.26b)</td>
<td>0.105</td>
<td>0.420</td>
<td>0.105</td>
<td>0.420</td>
<td>0.691</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.27b)</td>
<td>(4.38a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LnFARE</td>
<td>2.960-0.084$DH$</td>
<td>(4.65a)</td>
<td>0.851</td>
<td>0.770</td>
<td>0.100</td>
<td>0.100</td>
<td>0.960</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.32b)</td>
<td>(5.5a)</td>
<td></td>
<td>(3.76a)</td>
<td></td>
<td>(5.74b)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: t-statistics are in parentheses; the level of significance is $a=1\%$, $b=5\%$, $c=10\%$. d.v means "dependent variable."

Judging from the results of the fare determination function, we may say that air fares are determined according to the full-cost principle, and that the ratio of the increase of fares decreases with distance. As regards the other variables, all the estimated signs meet the expected conditions.

According to the results of Load factor equation[1], the value of the estimated parameter of $\ln(PAX)$ and $\ln(EQ)$ is considerably small, to the extent that the hypothesis of $c_1=0$ and $d_1=0$ are barely rejected at 10% level, although both signs are expected ones. So in the markets which we chose as samples, it may be pointed out that not so much excess capacity as the equilibrium of demand/supply or excess demand is brought about. In addition, the sign of estimated parameter of $\ln(HERF)$ meets the expected condition at 1% level. From this result, e.g., especially in those single truck routes the trucking number of which was once increased, the excess demand might occur, or it can be said that in the routes where the number of trucking is large it is less easy for

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17 For example, we will refer to the regression results of Douglas & Miller [1974b], p.662 (the names of variables are standardized):

- Douglas&Miller1974b, adjR$^2$=0.144, degree of freedom : 347.

$\ln(LF)=0.257-0.019\ln(DIST)+0.073\ln(PAX)-1.46\ln(\text{the number of firms})$

(1.8c) (7.1a) (5.5a)
airlines to control the load factor.

Then let us check up whether the same results were obtained from the Load factor equation [2].

The difference between equation [1] and [2] is that in the latter equation we canceled the variable of \( \text{Ln(EQ)} \), which was relatively insignificant, and added the ‘Shinkansen Express’ dummy variable \( \text{DH} \) which may reflect the competition between airways and railways in the markets the stage length of which is about 500km. Then the values of statistics were improved.

The results shows that an additional flight brings about a bit increase of average load factor. In addition, it is true the estimated parameter of \( \text{Ln(FRQ)} \) is more stable than that of \( \text{Ln(PAX)} \) in the Load factor function[1]. But we can draw from this result the same appreciation as the Load factor function[1], i.e., in the sample markets the demand/supply equilibrium or the excess demand may exist. And judged by the result that the estimated coefficient of trunk dummy variable \( \text{DTR} \) completely cancels out that of \( \text{Ln(FRQ)} \), the inclination of the excess demand may be strong. On the other hand, both the estimated parameters of \( \text{Ln(HERF)} \) are less stable than in the load factor function[1]. In order to investigate why this result was brought about, we looked up the annual round-trip average load factors of all the markets chosen as samples, and then verified the null hypothesis that all the average load factors of single, double and triple truck routes were equal (See Table 10).

**Table 9. Regression results of the load factor function[2]**

<table>
<thead>
<tr>
<th></th>
<th>INTERCEPT</th>
<th>LnFRQ</th>
<th>LnDIST</th>
<th>LnEQ</th>
<th>LnHERF</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.201+0.346DTR+0.074AD90</td>
<td>0.074</td>
<td>-0.071</td>
<td>0.027</td>
<td>0.047</td>
<td>( \text{adjR}^2=0.437 )</td>
</tr>
<tr>
<td></td>
<td>(19.80a)(3.88a)(4.52a)</td>
<td>(4.47a)</td>
<td>(5.72a)</td>
<td>(1.45d)</td>
<td>(1.74c)</td>
<td>( \text{SE}=0.063 )</td>
</tr>
<tr>
<td></td>
<td>+0.105AD90+0.070AD91</td>
<td>0.074</td>
<td>-0.071</td>
<td>0.027</td>
<td>0.047</td>
<td>( F=11.62 )</td>
</tr>
<tr>
<td></td>
<td>(6.46a)</td>
<td>(4.38a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4.504+0.348DTR+0.073AD90</td>
<td>0.066</td>
<td>-0.090</td>
<td>0.032</td>
<td>0.047</td>
<td>( \text{adjR}^2=0.464 )</td>
</tr>
<tr>
<td></td>
<td>(20.87a)(4.02a)(4.56a)</td>
<td>(4.05a)</td>
<td>(4.46a)</td>
<td>(1.20)</td>
<td>( \text{SE}=0.061 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+0.105AD90+0.069AD91-0.080DH</td>
<td>0.066</td>
<td>-0.090</td>
<td>0.032</td>
<td>0.047</td>
<td>( F=12.83 )</td>
</tr>
<tr>
<td></td>
<td>(6.60a)</td>
<td>(4.45a)</td>
<td>(3.43a)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 10. The two-tailed test of the null hypothesis that all the average load factors of single, double and triple truck routes were equal**

<table>
<thead>
<tr>
<th>the kind of routes I dealt with</th>
<th>the difference of sample mean</th>
<th>( t )-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>double truck/triple truck</td>
<td>2.04</td>
<td>2.60 (significant at 5% level)</td>
</tr>
<tr>
<td>double truck/single truck</td>
<td>1.70</td>
<td>1.17</td>
</tr>
<tr>
<td>single truck/triple truck</td>
<td>0.34</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Note: The sample number of single truck routes is 14 (the sample mean is 72.05, standard deviation is 4.97), double truck 78 (70.35, 5.37), triple truck 32 (72.39, 2.84). The verification of the hypothesis was done after the adjustment of the difference of the average value between years.

The results show that the average load factor of the double truck routes are substantially
lower than that of the triple truck routes, and also lower than that of the single truck routes, although the t-value is insignificant. The reason why both the estimated parameter of $\ln(\text{HERF})$ in the load factor function[2] were not stable may be that we can recognize the phenomenon that the higher concentration leads to the higher load factor with regard to single and double truck routes, whereas the inverse situation exists with regard to double and triple truck routes. So in the triple and single truck routes we chose as samples demand may meet or exceed supply. Regarding this point, we did a further investigation: we tried to reveal whether the average load factor in triple truck routes mean the congestion level or not. In judging whether congestion occurs, we selected a criteria of 75% level of load factor above which it is difficult for passengers to reserve the seat. Then we verified the null hypothesis that the annual round-trip average load factor of triple truck routes is 75% (See Table 11). For the purpose of the comparison with the case of the triple truck routes, we also dealt with the double truck routes.

According to the results, as regards both triple and double truck routes, the null hypothesis cannot be rejected except in 1992, the slump year. So congestion may occur, or be on the verge of occurrence in both types of routes, but it is clear that the value of standard deviation of double truck routes is larger than that of triple truck routes. This may mean that a variety of routes are included in double truck routes and some of them cause the destruction of the causal chain that the higher concentration leads to the higher load factor. So we classified the double truck routes into two groups: (1) Haneda or Itami are at least included in the origin or destination, (2) Nagoya is included in either of the endpoint, and verified the null hypothesis that there is no significant difference between two groups (See Table 12).

Table 12. The two-tailed test of the null hypothesis that there is no significant difference between two groups

| Group (1) | 70.57 | 5.73 | 59 | 3.18 |
| Group (2) | 66.02 | 5.32 | 19 | (significant 1% level) |

The findings are that the average load factor of group (2), i.e., the routes either of which endpoint is at least Nagoya, is significantly lower than that of category (1), and that we can reject the null hypothesis that the average load factor of category (2) is 75% at 10% level (t-value is 1.70). So in the category (2) type double truck routes, excess capacity may exist. The reasons behind these results are that the market size is relatively smaller in these routes, and that routes such as Nagoya/Sendai and Nagoya/Nagasaki, (of which the number of passengers is less than 400,000, the
6.3 Summary of Findings

In this section we revealed that the traffic may be congested or be on the point of congestion in the triple truck routes, in the double truck routes the endpoint of which is Haneda or Itami Airport, (in which the trunk routes are also included), and in single truck routes where the entry was newly authorized between 1989-1992. With regard to these routes the authorization of new entry has been unable to solve the problem of excess demand. An expansion of airport capacities is required to relieve the traffic.

However, in some of the double truck routes excess capacity may exist. This is thought to be brought about by the re-allocation of the routes for the purpose of adjusting the vested rights among airlines or by some intention which has little to do with the viewpoint of economic regulation. In these routes the rationalization of supply is desired.

7 The Regulatory Change and Cost Structure

In this section we will investigate how the regulatory change affected the cost structure of three Japanese airlines, JAL, ANA, and JAS.

7.1 Models and Regression Results

As already mentioned, Japanese airlines were authorized to enter new domestic and international routes after the regulatory change in 1985. For example, the average stage length of ANA and JAS became longer because they were authorized to enter both international routes and domestic routes of longer distance, and to exit the shorter haul local routes and hand them to their subsidiaries. These regulatory changes caused them to employ wider-bodied airplanes, which lower the operating cost per passenger or output. On the other hand, JAL entered domestic local routes that were comparatively shorter but denser. This may have led to higher cost per output.

In order to measure the effect of these entries and exits on airlines' cost, we constructed two kind of cost functions of the Cobb & Douglas type. The variables will be shown in Table 13.

The first one is the average cost function where the input price variables were excluded. Before the estimation of the cost function, we investigated the partial correlation matrix to check

---

18 The numbers of passengers of these routes in '90, the boom year, are 218,005 (Nagoya/Sendai), and 161,525 (Nagoya / Nagasaki). And even in the boom, the average load factor of the former route is 72.6%, and the latter 69.2%.
whether multicolinearity existed (See Table 14). Taking into account the results in Table 14, we constructed the average cost function in the following manner: (1) as the permit of entry and exit is the most remarkable point in the regulatory change, we included the network variable \( \text{NET} \) in the average cost function. (2) we then chose to include those variables which had little correlation with the variable \( \text{NET} \). The reason for selecting average cost function of this type is to keep as numerous degree of freedom as possible, as well as to avoid multicolinearity. The regulatory change dummy \( \text{DRC} \) (1 for 1986-1992) and the firm dummy variables (ANA : 1 for ANA, and JAS : 1 for JAS) were introduced in each intercept and all the coefficients, but those which were not significant even at 20% level were excluded (See Table 15).

### Table 13 Variables of cost function

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>total operating cost deflated by RPI index</td>
</tr>
<tr>
<td>AC</td>
<td>average operating cost (=TC/ATK)</td>
</tr>
<tr>
<td>EQ</td>
<td>the average annual number of seats per flight</td>
</tr>
<tr>
<td>FRQ</td>
<td>the total departure in the year</td>
</tr>
<tr>
<td>DIST</td>
<td>the average annual distance per flight</td>
</tr>
<tr>
<td>NET</td>
<td>the total number of entrance and withdrawal to/from routes since '79</td>
</tr>
<tr>
<td>PAX</td>
<td>the total passenger in the year</td>
</tr>
<tr>
<td>ATK</td>
<td>the total available ton kilo in the year</td>
</tr>
<tr>
<td>LP</td>
<td>Labor price (labor cost/the number of employees) deflated by RPI index.</td>
</tr>
<tr>
<td>FP</td>
<td>Fuel price (fuel cost/ATK)</td>
</tr>
<tr>
<td>CP</td>
<td>Capital cost deflated by RPI index (the sum of depreciation cost, maintenance cost, cost of using airport facilities, insurance cost, divided by the number of airplane really owned)</td>
</tr>
</tbody>
</table>

Note: All the data were obtained from *Koku Toukei Yoran*, published annually by Nihon Koku Kyokai.

### Table 14 Partial correlation coefficients between independent variables of average cost Function(N=42)

<table>
<thead>
<tr>
<th></th>
<th>EQ</th>
<th>FRQ</th>
<th>DIST</th>
<th>NET</th>
<th>PAX</th>
<th>ATK</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRQ</td>
<td>0.202*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIST</td>
<td>0.615*</td>
<td>-0.722*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>0.299</td>
<td>-0.704*</td>
<td>-0.841*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAX</td>
<td>0.792*</td>
<td>0.277</td>
<td>-0.406</td>
<td>-0.117</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ATK</td>
<td>-0.343</td>
<td>0.578*</td>
<td>0.915*</td>
<td>0.874*</td>
<td>0.339</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: * : significant at 0.1% level

The findings are that (1) the economies of network rationalization were substantial in all the equations and especially so with regard to ANA and JAS, (2) the economies of traffic did not existed (see 1), (3) the economy of aircraft size is observed with regard to ANA and JAS, and especially

---

19 As the exception we introduced the variable \( \text{DIST} \) that correlated with \( \text{NET} \) at 0.1% level, because it is thought to have much effect on the average cost.
strengthened after regulatory change, but in the case of JAL, (4) the economy of distance had not
existed, but was improved after the regulatory change (See 4).

Table 15 Regression results of the Cobb-Douglas average cost function

<table>
<thead>
<tr>
<th></th>
<th>INTERCEPT</th>
<th>LnPA</th>
<th>LnNET</th>
<th>LnEQ</th>
<th>LnDIST</th>
<th>adjR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.796+0.136 ANA (9.70a) (2.54b) +1.248 JAS (8.88a)</td>
<td>0.242</td>
<td>-0.123-0.152 JAS (5.36a) (5.47a) -0.022 DRC (2.94a)</td>
<td>0.967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.859+2.208 ANA (3.36a) (2.54b) +1.720 JAS (5.62a)</td>
<td>-0.096-0.216 JAS (3.72a) (4.89a)</td>
<td>0.387-0.399 JAS (2.14b) (2.28b) -0.020 DRC (2.79a)</td>
<td>0.967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-1.720+7.246 ANA (0.89) (5.8a) +6.429 JAS +0.533 DRC (3.49a) (2.8a)</td>
<td>-0.091-0.181 JAS (3.19a) (2.88a)</td>
<td>0.922-1.373 ANA (3.39a) (3.60a) -0.972 JAS (2.43b)</td>
<td>0.973</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note (1) t-statistics are in parentheses : a=1%, b=5%, c=10%, d=20%
(2) estimated by OLS, using annually aggregated firm data of ’79-’92, N=42

The other cost function is the total cost function that included the input price variables AP, FP, and LP, in which multicollinearity was not taken into account. The empirical model of log linear form which includes the dummy variables is as follows:

\[
\ln(TC) = a_1 + \sum_{a=1}^{2} a_{2a}(DF_a) + a_3(DRC) + \left\{ a_4 + \sum_{a=1}^{2} a_{5a}(DF_a) + a_6(DRC) \right\} \ln(DIST) \\
+ \left\{ a_7 + \sum_{a=1}^{2} a_{8a}(DF_a) + a_9(DRC) \right\} \ln(NET) + \left\{ a_{10} + \sum_{a=1}^{2} a_{11a}(DF_a) + a_{12}(DRC) \right\} \ln(FRQ) \\
+ \left\{ a_{13} + \sum_{a=1}^{2} a_{14a}(DF_a) + a_{15}(DRC) \right\} \ln(EQ) + \left\{ a_{16} + \sum_{a=1}^{2} a_{17a}(DF_a) + a_{18}(DRC) \right\} \ln(LF) \\
+ \left\{ a_{19} + \sum_{a=1}^{2} a_{20a}(DF_a) + a_{21}(DRC) \right\} \ln(LP) + \left\{ a_{22} + \sum_{a=1}^{2} a_{23a}(DF_a) + a_{24}(DRC) \right\} \ln(FP) \\
+ \left\{ a_{25} + \sum_{a=1}^{2} a_{26a}(DF_a) + a_{27}(DRC) \right\} \ln(CP) + \mu
\]

where (1) the variable of output was divided into DIST, FRQ, and EQ, (2) \( \mu \) is the error term, and (3) DF \( a \) is the firm dummy (DF1 represents ANA, and DF2 : JAS).

The procedure of estimation is that (1) we estimated with the dummy variable DRC and DF
a included in the intercept and each coefficient, (2) then excluded both independent variables and the
dummy variables insignificant, even at the 20% level, in order to keep the degree of freedom and
improve the statistics.20 And the parameter constraint that “total cost is homogeneous to input price”
was added in the equation in the upper row, while no constraint was added in the other (See Table
16).

### Table 16 Total cost function of Cobb-Douglas form

<table>
<thead>
<tr>
<th>INTERCEPT</th>
<th>LnDIST</th>
<th>LnNET</th>
<th>LnFRQ</th>
<th>LnEQ</th>
<th>LnLF</th>
<th>LnLP</th>
<th>LnFP</th>
<th>LnCP</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.472(4.34a)</td>
<td>0.471(2.40b)</td>
<td>0.050(1.95d)</td>
<td>0.514(2.08b)</td>
<td>-0.162(2.27b)</td>
<td>0.705(3.89a)</td>
<td>0.388(2.82a)</td>
<td>0.206(3.67a)</td>
<td>0.406(3.39a)</td>
<td>adjR² =0.9991</td>
</tr>
<tr>
<td>-3.737ANA(3.01a)</td>
<td>-0.97ANA(2.11b)</td>
<td>-0.069JAS(1.47d)</td>
<td>+0.285DRC(3.72a)</td>
<td>0.050ANA(2.90a)</td>
<td>0.909JAS(5.94a)</td>
<td>0.032+0.083DRC(1.71d)</td>
<td>0.214(6.50a)</td>
<td>0.338(6.97a)</td>
<td>SE=0.017</td>
</tr>
<tr>
<td>-4.684JAS(7.64a)</td>
<td>0.032+0.083DRC(1.71d)</td>
<td>-0.119ANA(3.59a)</td>
<td>+0.190DRC(3.45a)</td>
<td>0.316(2.04c)</td>
<td>0.721ANA(3.98a)</td>
<td>+0.752DRC(3.87a)</td>
<td>0.214(6.50a)</td>
<td>0.338(6.97a)</td>
<td>SE=0.013</td>
</tr>
<tr>
<td>-0.359-4.184DRC(0.31)</td>
<td>+0.586ANA(4.04a)</td>
<td>0.032+0.083DRC(1.71d)</td>
<td>+0.190DRC(3.45a)</td>
<td>0.316(2.04c)</td>
<td>0.721ANA(3.98a)</td>
<td>+0.752DRC(3.87a)</td>
<td>0.214(6.50a)</td>
<td>0.338(6.97a)</td>
<td>SE=0.013</td>
</tr>
<tr>
<td>-9.702ANA(5.49a)</td>
<td>+0.842JAS(3.29a)</td>
<td>-0.051JAS(1.40d)</td>
<td>+0.797ANA(2.37b)</td>
<td>0.316(2.04c)</td>
<td>0.721ANA(3.98a)</td>
<td>+0.752DRC(3.87a)</td>
<td>0.214(6.50a)</td>
<td>0.338(6.97a)</td>
<td>SE=0.013</td>
</tr>
<tr>
<td>-5.945JAS(10.05a)</td>
<td>+0.586ANA(4.04a)</td>
<td>0.032+0.083DRC(1.71d)</td>
<td>+0.190DRC(3.45a)</td>
<td>0.316(2.04c)</td>
<td>0.721ANA(3.98a)</td>
<td>+0.752DRC(3.87a)</td>
<td>0.214(6.50a)</td>
<td>0.338(6.97a)</td>
<td>SE=0.013</td>
</tr>
</tbody>
</table>

Note: N=42, estimated by OLS, and t-statistics are in parentheses.

**Findings**: Looking at the coefficient of Ln(NET), we can recognize that the entry and exit
after the regulatory change deteriorated the cost efficiency. This is different from the result in Table
15. But in addition to this result, if we take it into consideration that the t-value of DRC is unstable,
we can conclude that the cost inefficiency of JAL that entered the shorter haul routes represents the
whole effect and made the sign of DRC positive. And one reason for the unsuitability of t-value of
DRC is that some domestic routes of ANA and JAS had already been rationalized before the
regulatory change. Especially with regard to ANA, which was more successful in entering longer
haul routes than JAS, it can be said that the rationalization of these routes had led to slightly
lowering the total cost before the regulatory change if we exclude the effect of unstable dummy
variable DRC. So at least with regard to ANA, it would be natural to think that the economies
caused by the entry into the international markets and exit from domestic local markets arose around
or after the regulatory change.

20 In addition, in advance of the estimation of Cobb-Douglas total cost functions, we estimated the total
cost function of the translog form, using the same independent variables as in table.16. As a result, the t-
value of all the second order terms were not significant even at 20% level, so we decided on excluding all of
them and selecting the Cobb-Douglas form with the constraint that all the coefficients of the second order
term is zero. Consequently, the value of statistics was improved.
Looking at the coefficient of Ln(FRQ), the regulatory change accelerated the cost inefficiency. But if we look at this result from the opposite viewpoint, we may say the reason why this phenomenon arose is that, as regards ANA and JAS, cost efficiency was achieved by the rationalization of frequency caused by the exit from domestic short-haul routes and entry into international routes. With regard to ANA, this inclination can be clearly observed in the equation in the lower row.

Next we look at the coefficient of Ln(EQ). As the sign of the coefficient of DRC is negative, it is said that the regulatory change improved the economies of aircraft size. However, it is also observed that the coefficient of JAL is unstable (so not shown). JAL had already employed the jumbo (B747 series) by the time of the regulatory change, so the economy of aircraft size was comparatively obscure. As regards the coefficients of input price variables, the values of labor price and fuel price are a little greater than the results of Caves et al. [1984] (labor price: 0.356, fuel price: 0.166, material-capital: 0.478) and Gillen et al. [1985] (0.330, 0.177, 0.500). It may be inappropriate to compare our empirical results with theirs because we introduced a different form of the cost function, but our results probably reflect the higher labor cost structure inherent in the Japanese airline industry.

### 7.2 The Summary of Findings

Summing up the results of Table 15 and Table 16, we can see that not only the cost structure of Japanese airlines but the effects of regulatory change on them are different from one another. Regarding cost structure, ANA may have benefited most by the regulatory change that authorized the company to enter the long-haul international markets and exit from some domestic shorter-haul ones. This can be observed in the regression coefficients of either network or aircraft size. Similar results were obtained in the case of JAS, but JAS probably did not benefit as much as ANA.

On the other hand, it is not clear whether JAL benefited by the regulatory change. Authorization for JAL to enter the domestic denser routes may have brought more revenue to the company, but worsened the cost efficiency, because it made the average stage length shorter with average aircraft size constant or larger. So we have to say that these noncommittal policies to JAL caused to obscure its operational performance.

### 8 Summary and Conclusions

The air transport market in Japan was strictly regulated until 1986. In that year, the

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21 See Caves, Christensen and Tretheway [1984], p.485 and Gillen, Oum and Tretheway [1985], p.112.
government changed its air transport policy to promote competition in the market. This competition policy, however, was far from the deregulation policies adopted in other developed countries, especially in the United States. The characteristic feature of Japanese competition policy is that the competition is controlled through the administrative process. It is true that an airport capacity shortage exists and that this prevents free entry into the market, but the government does not want to revise the law and to clarify entry conditions. It is not clear how effectively the air transport markets work. Comparing fares in Japan with those in the States, we can conclude that the consumers in Japan hardly benefited from the new policy. We think that the government should urgently adopt a more effective competition policy.

In section 5 to 7, we investigated the effects of the policy change on the airlines’ behavior, supply and demand conditions in markets and airlines’ cost structure by econometric analysis. As noted above, the policy change brought about “controlled competition,” in which price competition is effectively ruled out. In this case, the possibility exists that airlines engage in service competition such as frequency and in seat-per-flight share competition. Our analysis shows that JAL and JAS, which expanded their rout network by the new policy, were able to obtain a large share by increasing the frequency and seat-per-flight share. From the experience in the States, especially during the era under the Civil Aeronautics Board’s regulation, it is said that service competition of this type lead to over-capacity. But in Japan, airport capacity constraints are so severe that such effects were not recognized, with the exception of some routs. Finally, we can conclude that by the relaxation of entry regulations, carriers that started long-haul operations benefited in improving their cost structure.

**APPENDIX**

In this appendix we will investigate in what kind of markets the fares are set higher or lower, and how these fares will change in case fares be set approximately at the average cost level, and clarify what kind of consumer will benefit or lose by the revision of the way of setting fares.

Regarding the fares of the U.S. domestic markets under CAB’s regulation, as was already mentioned, fares were set higher (lower) in longer-haul (shorter-haul) markets judged by the fact that the longer the stage length was, the lower the average load factor. However, the similar phenomena are not observed in the Japanese case, i.e., there is no correlation between distance and load factor (see Figure 9). Although the Japanese domestic air fares are regulated, the way of setting fares (or the demand character) is quite different from what was observed in USA. The following part is to
investigate the way of setting air fares in the Japanese domestic market.

To begin with, we will construct the fare determination function as follows:

\[ \text{FARE} = f(\text{DIST}, \text{PAX}, \text{LFsd}) \]

‘FARE’ is the normal round-trip fare filed in the time table. ‘DIST (=the stage length of a market)’ is the variable that represents the operational cost at a market, and both ‘PAX (the total number of passengers in a year)’ and ‘LFsd (the standard deviation of the monthly-average load factors in a year)’ are the variables that represent the mark-up ratio. It is expected that the larger the number of passenger is, and the larger the value of standard deviation of the monthly-average load factors is, the higher the mark up ratio.22

The estimated result of the fare determination function of log-linear form is shown in table 17. The sample number is 164, and they are obtained from the cross-section data of 1991.

Table 17. Estimated results of the fare determination function (by OLS)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>INTERCEPT</th>
<th>Ln(DIST)</th>
<th>Ln(LFsd)</th>
<th>Ln(PAX)</th>
<th>adjR²</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(FARE)</td>
<td>1.083</td>
<td>0.740</td>
<td>0.055</td>
<td>-0.028</td>
<td>0.926</td>
<td>0.137</td>
</tr>
<tr>
<td></td>
<td>(8.18a)</td>
<td>(38.82a)</td>
<td>(1.86c)</td>
<td>(3.16a)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: t-statistics are in parenthesis; level of significance: a=1%, c=10%.

Except for Ln(PAX), the signs of the coefficients meet the expected conditions. The negative sign of the coefficient of Ln(PAX) means that the regulator (MoT) refrains from setting “too high” fares at larger markets.

Then comparing the obtained estimated fares (i.e., close to average cost based fares) with the real ones filed in the time table (i.e., residual between estimated value and real one), we will specify the markets where the fares are set higher or lower. If the estimated fare of a market is lower than the real one, we judge that the passengers of the market lose the mutual consumer surplus. Those which are classified as “high fare markets” are, for example, short haul markets in Hokkaido (where the standard deviation of the monthly average load factor is large) or long haul markets without any substitutional (competitive) mode (e.g., Shin Kansen). Speaking of the former type of markets, the real fares are 20-30% higher than the estimated ones. On the other hand, those which can be classified as “lower fare markets” are the ones to/from isolated islands. With regard to these markets, the real fares are 40-50% lower than the estimated ones.

In order to classify the markets more strictly, we will introduce the hierarchical cluster

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22 The large value of standard deviation means that there is/are month(s) in which the average load factor is substantially low. So the airline has to set higher fares so as to cover the loss which arises in these months.
analysis. Using the same variables already introduced (i.e., DIST, PAX, LFsd, which can be regarded as market structure variables) and the same dataset, we will classify 160 markets into 5 clusters by Ward method that is most frequently used. Then multiplying the residual (converted into ¥) of each market by the total annual passengers of the market, we intend to obtain the total gain or loss of consumer surplus after the current method of pricing (i.e., price discrimination) is abolished and the method approximate to the average cost pricing is achieved.

The results of cluster analysis is shown in table 18.

### Table 18. Results of cluster analysis

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Description of Markets</th>
<th>Total Gain (+) or Loss (-) of Consumer Surplus (1991 Million ¥)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>long haul &amp; very large (double or triple track)</td>
<td>+6,579.74</td>
</tr>
<tr>
<td>2</td>
<td>long-medium haul &amp; large (single or double track)</td>
<td>+274.85</td>
</tr>
<tr>
<td>3</td>
<td>long haul &amp; medium (single track, including a few double track)</td>
<td>+78.97</td>
</tr>
<tr>
<td>4</td>
<td>short haul from/to/in Hokkaido and Kyusyu district</td>
<td>+186.58</td>
</tr>
<tr>
<td>5</td>
<td>short haul other than the markets in Cluster:4</td>
<td>-130.98</td>
</tr>
</tbody>
</table>

Note: It depends considerably on author's subjective judgment to determine how many clusters are introduced. In this case, "the error sum of square" is 0.0296, at which level 160 data are classified into 5 clusters.

Judging by the results, we can point out
(a) that the nominal total gain of consumer surplus is about 7,000 million yen,
(b) that in most of the markets the consumer surplus will increase,
(c) that from the viewpoint of the expected change of consumer surplus, shorter haul markets can be classified into 2 types.

With regard to Cluster 4, we can classify them into more detailed 3 clusters. One is (4-1) the markets to/from/in Hokkaido, another is (4-2) to/from/in Kyusyu, and the other is (4-3) to/from/between isolated islands. And after the re-calculation, we got the following results: as to (4-1) type markets, the gain of consumer surplus will amount to 155.01 million yen, and (4-2) type 62.90 million yen, whereas as to (4-3) the loss of consumer surplus will be about 31.33 million yen.

In addition, regardless of the size or type of the markets, the loss of consumer surplus is
recognized as to the markets to/from Naha, which will amount to 1,104.16 million yen, while the consumer surplus of Cluster.1 will increase to be 7,215.24, Cluster.2 to be 394.5, and Cluster.3 to be 387.98 million yen, excluding the effect of the markets to/from Naha. Taking into consideration this result and the result of (4:3) type cluster, the fares to/from/in Okinawa prefecture are set lower, partly because of the lower income level, or partly because of the higher ratio of tourists the price elasticity of whom is thought to be larger.

However, even though we take it into consideration that the discount air tickets have already been available in the Japanese domestic markets, we can expect the consumer surplus to increase in most of the markets after the abolishment of the price discrimination.