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An Empirical Analysis of Inter-Firm Rivalry  
between Japanese Legacy and Low-Cost Carriers

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# **An Empirical Analysis of Inter-firm Rivalry between Japanese Full-Service and Low-Cost Carriers**

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## **Abstract**

This paper empirically analyzes dynamic change in inter-firm rivalry between Japanese low-cost carriers (hereafter, LCCs) and full-service carriers<sup>1</sup> (hereafter, FSCs), by estimating each carrier's conduct parameters, and it deduces the dynamic change in consumer surplus after an LCC enters a market by estimating structural demand and airfare equations using unbalanced carrier-specific panel data of two to four carriers on nine routes for four to eight years (130 samples). Our findings are that (1) the conduct parameters of LCCs and reacting FSCs were extraordinarily low during that period, such that the Federal Trade Commission of Japan (FTCJ) was about to intervene; (2) the conduct parameters were restored to, or even exceeded, the pre-entry level in the third

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<sup>1</sup> Japan Airlines (JAL) and All Nippon Airways (ANA).

year of LCC entry; (3) gains in total welfare were recognized for five of the nine markets, whereas in three markets only the airline industry benefited, and in one market, total welfare decreased. On the basis of result (3), we conclude that Japanese regulatory sectors, which have allowed FSCs to engage in behavior that drives LCCs out of competitive markets while also allowing collusive code-shares between ANA and LCCs, seem to stand by the airline industry instead of consumers.

*Key words: low-cost carrier, conduct parameter, economic welfare*

## **I Introduction**

In 1996, responding to the worldwide tide of deregulation, Japan's Ministry of Transport (MoT) allowed for the foundation of two air carriers and let them enter domestic markets. One was Hokkaido International Airlines (called Air Do, with the code ADO), founded by bankers and farm entrepreneurs in Hokkaido who had argued that expensive airfares were damaging the economy in Hokkaido. The other is Skymark Airlines (SKY), founded by a travel agency, H.I.S. H.I.S. wanted to create new demand for package tours by issuing much cheaper tickets than FSCs did. In 1998, ADO and SKY entered Tokyo-Sapporo and Tokyo-Fukuoka, respectively, the largest and second largest city-pair routes in the world in terms of demand. SKY also

entered Osaka-Sapporo and Osaka-Fukuoka.

In 2000, MoT deregulated airfares and domestic market entry/exit, and two other airlines were founded: Skynet Asia (SNA) and Star Flyer (SFJ). In 2002, SNA entered Tokyo-Miyazaki, followed by Tokyo-Kumamoto and Tokyo-Nagasaki, all of which are long-distance city-pair routes with few surface transportation modes to compete with airlines. SFJ started operating in Tokyo-Kitakyushu in 2006, and then entered Tokyo-Kansai (Osaka) in 2007.

This paper analyzes the dynamic change in inter-firm rivalry between new and legacy Japanese carriers by modeling oligopolistic competition and estimating the conduct parameter derived from the oligopoly model. Our study focuses on the pre-entry strategy of FSCs, the strategies of new entrants and FSCs during the fare war, and FSCs' "price-recovery" behaviors after the new carriers exited. Furthermore, we investigate how the fares dynamically change from pre-entry to post-exit situations throughout the fare-war periods and compute the welfare effects by estimating a simultaneous demand and fare equation system. The next section overviews the characteristics of new Japanese carriers. Section III reviews previous studies, models the oligopolistic competition, and derives the conduct parameter and demand and fare equation system. Section IV explains our dataset and econometric method,

demonstrates our empirical results, and discusses the welfare effects based on the empirical results. Finally, we provide concluding remarks in Section V.

## **II An overview of new Japanese carriers: Are they really low-cost carriers?**

Although the Japanese Ministry of Land, Infrastructure, and Transport (MLITT<sup>2</sup>), some Japanese academics, and mass media call ADO, SKY, SNA, and SFJ low-cost carriers, it seems doubtful that they belong in the same category as Southwest, Ryan, or Jet Blue. We first summarize their service characteristics in Table 1 and compare them with those of US and European LCCs.

One characteristic is that none of the new carriers can choose to make secondary airports their base. Only SKY appears to be closest to the LCCs of the United States, such as Southwest Airlines in the 1990s, in terms of no-frills service, high discount ratios, very limited mileage service, and independence from FSCs. In addition, all of these new carriers except for SKY offer more-frilled service like the new-generation LCCs such as Jet Blue, even though the need for frills is lower than Jet Blue's, since most

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<sup>2</sup> The Ministry of Transport merged with the Ministry of Construction in 2001 and was later reorganized as the Ministry of Land, Infrastructure, Transport, and Tourism (MLITT).

Japanese routes are less than two in-flight hours.

Table 1 Characteristics of new Japanese carriers

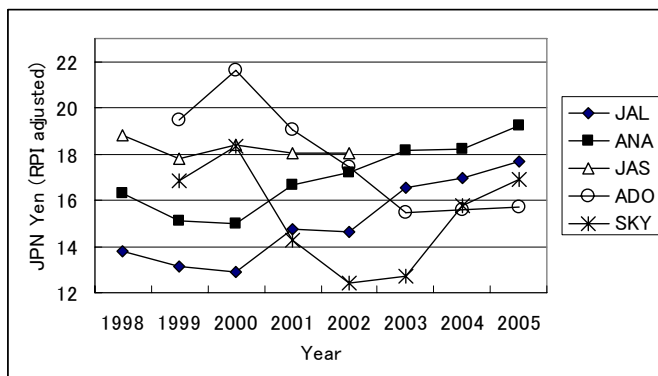
	ADO	SKY	SNA	SFJ
Seating class	Economy*1	Economy and Cygnus class*2	Economy*6	Economy*6
Discount ratio at its entry against FSC's airfare	36%	50%	32.3%	17%
Fleet configuration	B767 and B737	B767 and B737	B737	A320
Frequent Flyer Program	Yes	Limited*3	Limited*6	Yes
Method for booking tickets	Internet, Toll-free tel, Mobile,, Ticket desk	Internet, Tel, Mobile Ticket desk,, Travel Agent*4,	Internet, Toll-free tel, Mobile	Internet, Tel, Mobile Ticket desk,, Travel Agent*4,
Free in-flight service and/or amenity	Nothing for B737; radio & music for B767	Nothing (even for Cygnus class)	Beverages (coffee, soft drinks)	Sweets, Beverages (coffee, drinks)
Code-share/Partnership	ANA, SNA	None*5	ANA, ADO	ANA
Base airport	Sapporo	Tokyo	Miyazaki	Kita-Kyushu
Profit/loss (in total of 2000-06), million USD (1 USD=120 yen)	-14.23	-69.51	-70.18 (2002-06)	-20.31 (2005-06)

Note:\*1: Discount tickets are available for pre-purchasing, students, the handicapped, and for inhabitants of Hokkaido and businesspeople working for companies in Hokkaido.  
\*2: Discount tickets are available for pre-purchasing, students, and the handicapped. Cygnus class offers more wide-pitched, comfortable seats than economy class for 1,000 yen more than economy fare.  
\*3: Available for buyers who pay with Skymark Visa/Master Card.  
\*4: Designated travel agents.  
\*5: SKY once allied with JAL in 2005 in Tokyo-Osaka (Kansai) and Tokyo-Kobe, but terminated this alliance quickly.  
\*6: Discount tickets are available for pre-purchasing, round-trip, students, and the handicapped.  
\*7: One free ticket for every 10 flights.

As for costs, Figure 1 shows the difference in RPI-adjusted unit costs between

FSCs and LCCs as well as the change in those costs over time.

Figure 1 Changes in carriers' unit costs from 1998 to 2005



Source: JAA Civil Aviation Databook (Koku Tokei Yoran), Japan Aeronautic Association, 1998-2005.

The reasons why these new carriers cannot achieve low cost are twofold: one is that the government tax, fuel prices, maintenance costs, and airport charges are the same among all Japanese airlines; the other is that Japan does not have secondary airports in its metropolitan areas, such as Chicago Midway, which would charge cheaper landing fees. New carriers can choose to relegate maintenance to low-cost foreign companies, but due to the problems with the quality of those foreign services, they currently have their aircraft maintained by their rivals, FSCs. Only in labor costs can new carriers spend less than FSCs, and indeed this labor cost difference equals the total cost difference.

As we see in Table 1, all the LCCs were deficit-ridden during the study period. In addition to the high cost structure of new airlines, what makes them worse off is the pricing strategy of FSCs, which seem to have tried to drive their new competitors out of the market by matching their fares. For example, when ADO entered the Tokyo-Sapporo market, FSCs matched its fares almost exactly. As a result, ADO's cumulative deficit reached 61 million USD for its first four years, and it filed for protection under Japan's Corporate Reorganization Law (Minji Saisei Hou) in 2002. It was later reorganized by code-sharing with ANA and paid off its debt in 2005, a year earlier than scheduled. SNA's fortunes were very similar to ADO's, and it is now

code-shares with ANA. Only SKY was able to reduce its costs to 20% lower than the highest-cost carrier, JAS, between 2001 and 2002, but it made a profit only in 2004.

### **III The model**

As stated above, Japanese FSCs have responded to low-cost entrants by cutting fares, and seem to have tried to expel them. This section models oligopolistic competition between FSCs and their new rivals, and derives the conjectural variation (conduct parameter) to investigate rigidly what types of competition FSCs and LCCs have engaged in. We also investigate how much of an impact such competition has on social welfare by constructing and estimating carrier-specific simultaneous equations of demand and price.

#### **1. Conduct parameter**

Many previous studies have used the conduct parameter to analyze inter-firm rivalry: Iwata (1979), Appelbaum (1982), Brander and Zhang (1990)(1993), Oum, Zhang, and Zhang (1993), and Fischer and Kamerschen (2003). In particular, the last three sets of authors have focused on the US airline industry. Those studies use cross-sectional data and focus on duopoly, in which two “symmetric” carriers, such as



United Airlines and American Airlines, compete. This paper has two distinguishing features: (1) it focuses on asymmetric carriers (FSCs vs an LCC), and (2) it derives the conduct parameters of the Japanese airline industry on route-by-route and year-by-year bases, using the panel data.

The reason why we use panel data instead of cross-sectional data is that we do not have a sufficient number of samples for each year. Therefore, the variables to be used in our model have superscripts,  $L$  and  $k$ , which denote a carrier, and subscripts  $i$ , which denotes a market, and  $t$ , which denotes a fiscal year. Our model assumes that each market has one LCC and three FSCs. This scenario was found more often before 2002, when JAL and JAS merged, than after. We denote the three FSCs as carrier  $k$  ( $k=1, 2, 3$ ) and the LCC as carrier 4. The market demand of route  $i$  in year  $t$  is denoted as follows:

$$Q_{it} = \sum_{k=1}^3 q_{it}^k + q_{it}^4 \equiv \sum_{L=1}^4 q_{it}^L \quad (k = 1,2,3, L = 1,2,3,4) \quad (1)$$

where superscripts  $k$  and  $L$  each denote a carrier;  $L$  includes an LCC ( $L \equiv 1,2,3,4$ ) while  $k$  denotes FSCs only. The profit function of each carrier at route  $i$  in year  $t$  is denoted as follows:

$$\pi_{it}^L = q_{it}^L p_{it}(Q_{it}) - TC_{it}^L(q_{it}^L) \quad (2) \quad \text{where } TC_{it}^k(\bullet) > TC_{it}^4(\bullet)$$

Taking the first-order condition of (2), we have:

$$\frac{\partial \pi_{it}^L}{\partial q_{it}^L} = p_{it}(Q_{it}) + q_{it}^L \frac{\partial p_{it}(Q_{it})}{\partial Q_{it}} \frac{\partial Q_{it}}{\partial q_{it}^L} - MC_{it}^L(q_{it}^L) = 0 \quad (3)$$

We then define the conduct parameters as (4) and (5):

$$v_{it}^k \equiv \frac{d}{dq_{it}^k} \left( \sum q_{it}^j + q_{it}^4 \right) \quad j \neq k \quad (4) \quad v_{it}^4 \equiv \frac{d}{dq_{it}^4} \left( \sum q_{it}^k \right) \quad (5)$$

Substituting (4) and (5) into (3), respectively, we obtain:

$$\frac{\partial \pi_{it}^L}{\partial q_{it}^L} = p_{it}(Q_{it}) + q_{it}^L \frac{\partial p_{it}(Q_{it})}{\partial Q_{it}} (1 + v_{it}^L) - MC_{it}^L(q_{it}^L) = 0 \quad (6)$$

where  $MC_{it}^k(\bullet) > MC_{it}^4(\bullet)$ .

For example, the conduct parameter (4) means the marginal change in the output of other carriers (two FSCs except for  $k$  plus carrier 4) against the marginal change in the output of carrier  $k$ . If both of them move in the same direction and have the same volume, the result is 1 and this means collusion. If the conduct parameter is 0, (6) equals the first-order conditions for Cournot competition. If it is  $-1$ , the price equals the marginal cost, and this is considered Bertrand competition.

In our model, if the price equals the marginal cost of an LCC, FSCs would have to exit the market, since  $MC_{it}^k(\bullet) > MC_{it}^4(\bullet)$  as long as carriers operate at the minimum efficient scale where average cost equals marginal cost. In Japan's case, we may have observed this scenario once with Tokyo-Asahikawa (the second-largest city in Hokkaido), from which ANA and JAS (just before it merged with JAL) exited and only one LCC (ADO) stayed. But in most cases, FSCs stay, so we expect that the market

price rarely falls close to an LCC's marginal cost level.

As in the previous studies, equation (6) can be inverted to (7) by using the price elasticity of demand ( $\eta_{it}$ ) and the market share of each carrier ( $s_{it}^L$ ).

$$v_{it}^L = \frac{\{p_{it}(Q_{it}) - MC_{it}^L(q_{it}^L)\} \eta_{it}}{p_{it}(Q_{it}) s_{it}^L} - 1 \quad (7)$$

As for the variables and parameters in (7), we already have information on  $p_{it}$  and  $s_{it}^L$ , but the route-specific marginal cost for each carrier and the route-specific price elasticity of demand are unknown. Therefore, we need to estimate these two unknown variables and parameters in advance to compute the conduct parameters.

To estimate the route-specific marginal cost for each carrier, Fischer and Kamerschen (2003) jointly estimate a translog total cost function and then approximate the route-specific marginal cost for each carrier<sup>3</sup>. The estimation of translog total cost function requires a sufficient number of samples. However, since Japan had only three major airlines until 2002 and now has only two, the number of samples of our unbalanced panel dataset, which take 20 years for the time-series dimension, would be less than 60. In addition, since no Japanese LCCs have officially disclosed their costs for labor, capital materials, and so on, we cannot incorporate these LCCs into the dataset for our cost analysis. Therefore, it is hardly possible to arrive at marginal cost by estimating translog cost function. Alternatively, we use the following proxy to approximate route-specific marginal cost for each carrier, as proposed by Brander and Zhang (1990), (1993) and Oum et al. (1993).

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<sup>3</sup> See Fischer and Kamerschen (2003), pp.235-237.

$$MC_{it}^L = AC_t^L \left( \frac{Dist_i}{AFL_t^L} \right)^{-\lambda} Dist_i \quad (8)$$

where  $AC_t^L$  is the aggregate average cost of carrier  $L$  at year  $t$ ,  $Dist_i$  is the distance of route  $i$  regardless of time,  $AFL_t^L$  is the average distance flown by airline  $L$  at year  $t$ <sup>4</sup>. Studies on airline costs, such as Caves, Christensen, and Tretheway (1984), and Gillen, Oum, Tretheway (1990), show that economies of density exist in the airline industry, and this means that the total cost function is strictly concave. Therefore,  $\lambda$  in (8) ranges between 0 and 1. It is apparent that if  $\lambda$  is 0, the carrier's marginal cost is proportional to distance, while if  $\lambda$  is 1, the marginal cost is indifferent to distance. Oum, Zhang, and Zhang (1993) statistically estimated that  $\lambda = 0.43$ . Armantier and Richard (2003) predict that the route-specific marginal cost of an airline is just equal to the product of "cost per mile" and distance (this means  $\lambda = 0$ )<sup>5</sup>. Among these studies, the most comprehensive way to approximate the marginal cost with small samples seems to be that proposed by Oum, Zhang, and Zhang (1993). They construct the following nonlinear price equation to obtain  $\lambda$  and the system-wide conduct parameter  $\nu$ .

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<sup>4</sup> See Brander and Zhang (1990), pp. 572-575, Brander and Zhang (1993), pp.417-420, and Oum, Zhang, and Zhang (1993), pp. 175-178.

<sup>5</sup> Armantier and Richard (2003), pp. 468-469.

$$p_{it}^L = \frac{\{AC_t^L (Dist_i / AFL_t^L)^{-\lambda} Dist_i\} \eta}{\eta - (1 + \nu) s_{it}^L} + \varepsilon_{it}^L \quad (9)$$

Before we can estimate the price equation (9), we need the route-specific price elasticity of demand  $\eta$ . We estimate the following Marshallian demand function by using route-specific unbalanced panel data to obtain the information on  $\eta$ .

$$\ln(Q_{it}) = A - \eta \ln p_{it} + \beta \ln INC_{it} + \gamma \ln Dist_i + \delta \ln POP_{it} + \rho \ln HI_{it} + \mu_{it} \quad (10)$$

where  $p_{it}$  is the lowest price of each airline at route  $i$  in year  $t$ , and  $INC_i$  is the arithmetic average of per-capita income of route  $i$  in year  $t$ . Both  $p_{it}$  and  $INC_i$  are adjusted by the RPI index.  $POP_i$  is the arithmetic average of the population of route  $i$  in year  $t$ , and  $HI_{it}$  is the Herfindahl index of route  $i$  at year  $t$ . The Herfindahl index is expected to have a negative effect on the number of passengers when price elasticity of demand is relatively small, since carriers with monopolistic power will reduce output to maximize profit.

## 2. Structural equations of demand and price

Our second interest is in how much the route-specific social welfare gain has been since the new entry of LCCs and, for a couple of routes where competition ended, how much the welfare loss might be after the LCC exited. To know this, we need to know (a) how the price and demand have dynamically changed from the pre-entry situation to

the years of the fare-war; (b) in the route from which the LCC exited, whether or not (or by how much) the price recovered after the competition ended; and (c) the yearly profit/loss of each carrier.

The effect of the entry of low-cost carriers on carrier's airfare at primary and secondary airports has been analyzed empirically by Dresner et al. (1996) and Morrison (2001). We build upon the method proposed by Dresner et al. (1996) who estimated the simultaneous demand and airfare equations using three stage least squares. To ascertain the consumer welfare effect, we also need to know the demand for low-cost carriers as well as the airfare, both of which are simultaneously related to each other in the demand and supply system. To incorporate the simultaneous relations of airfare and demand, we construct the following structural equation system for FSCs.

$$\ln q_{it}^k = \alpha_0 + \alpha_1 \ln p_{it}^k + \alpha_2 \ln p_{it}^4 + \alpha_3 \ln POP_{it} + \alpha_4 \ln INC_{it} + \alpha_5 \ln Dist_i + \alpha_6 FRQ_{it}^k + \alpha_7 MSHE_{it}^k + \alpha_8 MJJ + \sum_{n=1}^4 \alpha_{9n} ADO_n + \sum_{n=1}^4 \alpha_{10n} SKY_n + \sum_{m=1}^3 \alpha_{11m} SNA_m + e_{it}^k \quad (11)$$

( $k = 1,2,3, n = 1,2,3,4, m = 1,2,3$ )

$$\ln p_{it}^k = \beta_0 + \beta_1 \ln q_{it}^k + \beta_2 \ln MC_{it}^k + \beta_3 FRQ_{it}^k + \beta_4 MSHE_{it}^k + \sum_{n=1}^4 \beta_{5n} JAL_n + \sum_{n=1}^4 \beta_{6n} ANA_n + \sum_{n=1}^4 \beta_{7n} JAS_n + \beta_8 EXJ + \beta_9 EXA + \beta_{10} EXD + \beta_{11} EXH + u_{it}^k \quad (n = 1,2,3,4) \quad (12)$$

where  $FRQ_{it}^k$  is the number of departures of carrier  $k$  at route  $i$  in year  $t$ ,  $MJJ$  is the JAL-JAS merger's dummy variable. For  $MJJ$ , the three elements of JAL's years 2003, '04, and '05 take 1, and all the other elements take 0.  $JAL_n, ANA_n, JAS_n, ADO_n,$

$SKY_n$ , and  $SNA_n$  are the dummy variables showing the dynamic effect of an LCC's entry. For example, the elements of  $ADO_1$  are 1 for ADO's first year of entry and 0 for the other year of ADO and the other carriers, and the observation of  $JAL_1$  is 1 for the first year of any LCC's entry. Therefore,  $JAL_n$ ,  $ANA_n$ , and  $JAS_n$  reflect the strategy FSCs took against LCCs.  $MSHE_{it}^k$  shows the market share of carrier  $k$  at route  $i$  in year  $t$ . This structural equation has five endogenous variables. Considering the demand and supply system, it would make sense to assume that demand, own price, cross price, and marginal cost are endogenous. In addition, a carrier's market share is determined by the market structure and is also assumed to be endogenous. Similarly, the structural equation system for carrier 4 is obtained by replacing  $\alpha_2 \ln p_{it}^4$  with  $\alpha_2 \ln p_{it}^j$  in the demand equation where  $j$  is the FSC having the lowest airfare among JAL, ANA, and JAS, and replacing all the other superscript  $k$  with superscript 4.

Since we assume a case of four-carrier oligopoly, we have to have three cross-price terms in the demand equation. However, FSCs set almost the same airfares as each other. Therefore, we introduce one cross term, and by doing this we mean that three FSCs pay attention to the LCC's fare<sup>6</sup> while the LCC sets its fare below the

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<sup>6</sup> According to G. Nishimura who experienced the director of yield management of

lowest fare or the collusion fare of the FSC(s).

As for the dummy variables related to exit, we have created the dummy variables  $EXJ$ ,  $EXA$ , and  $EXD$  to see the effect of the FSCs' fare-restoring behavior. These variables are each 1 for the legacies' elements in the year after an LCC's exit.  $EXH$  is the dummy variable to show ADO's fare-restoring behavior after the FSCs have exited. The element of  $EXH$  is 1 for the year after an FSC's exit.

### 3. Implications for market welfare

This section demonstrates how to compute the change in market welfare, referring to each carrier's price and output after an LCC enters. Our method is simply to compute the triangle surrounded by the intercept of the demand function, output, and price before and after an LCC's entry, and compare. The "benchmark" for computing consumer welfare is the triangle surrounded by the horizontal intercept of the demand curve,  $Int_0^{K,i}$ , the pre-entry price,  $p_0^{K,i}$ , and the corresponding market output  $q_0^{K,i}$ . Both  $p_0^{K,i}$  and  $q_0^{K,i}$  are estimated values computed from the simultaneous equations. The superscript  $i$  denotes the market, that is,  $i =$  Tokyo-Sapporo, Tokyo-Fukuoka, Tokyo-Asahikawa, Tokyo-Aomori, Tokyo-Tokushima, Tokyo-Miyazaki,

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ANA, this practice actually occurs.



Tokyo-Kagoshima, Osaka-Sapporo, and Osaka-Fukuoka; and  $K$  is the carrier in the market including the LCC. Letting this benchmark consumer surplus be  $\hat{CS}_0^K$ , we can describe the  $\hat{CS}_0$  of a market as:

$$\hat{CS}_0 = \sum_K \hat{CS}_0^K, \quad \text{where} \quad \hat{CS}_0^K = \int_{p_0^{K,i}}^{Int_0^{K,i}} f(p_0^{K,i}) dp_0^{K,i} \quad (13)$$

where  $f(\bullet)$  is the carrier-specific demand function defined as (11) in the last section.

Then we compute the size of the triangle surrounded by  $p_t^{K,i}$ ,  $q_t^{K,i}$  and the horizontal intercept of the demand curve adjusted by a carrier-entry dummy variable,  $Int_t^{K,i}$ . The subscript  $t$  denotes the years after the LCC entry, and the subscript 0 denotes the years before LCC entry. Letting the post-entry consumer surplus be  $\hat{CS}_t$ , we can describe  $\hat{CS}_t$  as:

$$\hat{CS}_t = \sum_K \hat{CS}_t^K, \quad \text{where} \quad \hat{CS}_t^K = \int_{p_t^{K,i}}^{Int_t^{K,i}} f(p_t^{K,i}) dp_t^{K,i} \quad (14)$$

Then we take the ratio  $\hat{W}_t \equiv \hat{CS}_t / \hat{CS}_0$  and show the change in consumer surplus graphically. After we compute the consumer surplus, we deduce the total welfare by summing consumer surplus and the route-specific profits of carriers. We use carrier profit as a proxy of producer surplus because we may not be able to find the true producer surplus, since the Japanese airline market is not perfectly competitive.

#### IV Empirical Results

## 1. Conduct parameter

The former half of this section derives each carrier's conduct parameter per route per year. The data sources for carrier costs, passengers, and flight frequency are *Koku Tokei Yoran (JAA Civil Aviation Handbook)* published by the Japan Aeronautic Association, and *Koku Yuso Tokei Nempo (Yearly Statistical Survey of Japanese Aviation)* published by MLITT. The fare information is obtained from *Jikoku Hyo* (a monthly published timetable of railways and airlines). The demographic data sources are *Kakei Chosa Hokoku (Family Income and Expenditure Survey)*, which is published by the Japan Statistics Bureau, and web pages of related prefectures and cities. For each year studied, the statistics on fares, population, flight frequency, and income are data from April, when airline demand is lowest. The reason why we use April data is that we can recognize a carrier's fare strategies best in that month, since carriers issue many varieties of discount tickets to convert potential demand to actual.

We estimated the demand equation (10), using the route-specific unbalanced panel data of nine routes for four to eight years. Values in parentheses are t-values computed using heteroskedasticity-robust standard errors, and "a" means that the parameters are significant at the 1% level.

$$\ln(Q_{it}) = -41.479_{(-1.441)} - 1.252 \ln p_{it} \text{ }_{(-4.269a)} + 2.254 \ln INC_{it} \text{ }_{(1.197)} + 0.604 \ln DIST_i \text{ }_{(1.272)} + 1.894 \ln POP_{it} \text{ }_{(3.692a)} - 1.299 \ln HI_{it} \text{ }_{(3.291a)}$$

$$\bar{R}^2 = 0.503 \quad \hat{\sigma}^2 = 0.536 \quad n = 43$$

The price elasticity of demand ( $\eta$ ) is  $-1.252$ , and we will use this information to estimate  $\lambda$  and  $\nu$  in equation (9). The dataset for estimating (9) is different from the one used for estimating the demand equation (10). It is the carrier-specific unbalanced panel data of two to four carriers on nine routes for four to eight years ( $n=130$ ). Using the nonlinear least-squares method, we obtain the estimated results shown in Table 2.

Table 2 The estimated parameters of price equation (9)

Parameter	Parameter value	Asymptotic t-stat	Test result
$\lambda$	0.374	7.274	a
$\nu$	-0.242	-6.119	a

Note: Log-likelihood =  $-1317.63$   $n = 130$  "a": significant at 1% level

According to Table 2, we recognize that economies of density also may exist in Japan's airline industry, though we do not treat all the domestic markets. The system-wide conduct parameter is  $-0.242$ , so the markets where an LCC enters are regarded as more competitive than the Cournot competition level.

First we discuss two major LCC markets: Tokyo-Sapporo and Tokyo-Fukuoka.

Figure 2 (a) shows the dynamic change in conduct parameters of the four airlines operating in Tokyo-Sapporo.

Since the Tokyo-Sapporo market has few alternative surface transportation

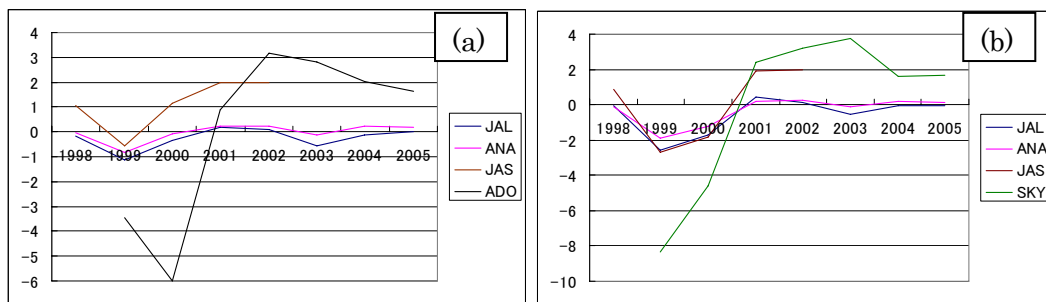
modes that can compete with airlines, three airlines could have colluded and shared a monopoly profit. But rather, it seems that before ADO entered, two big FSCs, JAL and ANA, engaged in Cournot competition to try to obviate intervention by the Japan Fair Trade Commission (FTCJ, Kosei Torihiki Iinkai). Since JAS's marginal cost was lower than those of the big two, while its fares were almost the same as theirs, its conduct parameter is closer to the collusion level. Then, in 1998, ADO entered with an incredibly low conduct parameter that can theoretically be impossible in the equilibrium. ADO, which had only less than 10% market share, adopted such behavior because it wanted to create new demand by reducing fares, and subsidized the loss in the low-demand month by the profit earned in high-demand months. At that time, FTCJ was about to intervene, as it considered this behavior as predatory pricing, but ultimately it did not act, since "predatory pricing is difficult to establish unless fares increase after new entrants exit the market."<sup>7</sup> Three FSCs quickly matched their fares to the marginal cost level, and the fierce fare war lasted till 2001, by which time ADO had accumulated serious deficits. The next year ADO filed for protection under Japan's Corporate Reorganization Law (Minji Saisei Hou) and reorganized under ANA's support. Since ADO code-shared with ANA, its conduct parameter substantially

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<sup>7</sup> Ito (2003), p. 27.

increased and now appears to be converging to the collusion level. In Figure 2 (b), we observe almost the same behavior in Tokyo-Fukuoka as was seen in Tokyo-Sapporo in Figure 2 (a). The logic of SKY's behavior seems to be almost the same as ADO's, and it had become deficit-ridden by the end of 2000.

Figure 2 Conduct parameter change in Tokyo-Sapporo (a) and Tokyo-Fukuoka (b)



Note: The vertical axis is the conduct parameter, and the horizontal is the fiscal year.

Figures 2 (a) and (b) also show that the conduct parameter of JAL moves in the same direction as that of ANA. The correlation coefficient between JAL's and ANA's conduct parameters is 0.955 for Tokyo-Sapporo and 0.984 for Tokyo-Fukuoka, and both are statistically significant at the 5% level. These results imply a higher probability that JAL and ANA are colluding. However, it appears that they have been exhibiting Bertrand competition between 1999 and 2000 and then Cournot competition after 2001, at least during the off-season, rather than colluding, probably due to the anti-trust consideration mentioned above.

A similar finding is that SNA entered Tokyo-Miyazaki in 2003 with a conduct

parameter equal to  $-0.118$ , and it always kept the parameter at low levels:  $-0.050$  and  $-0.186$  between 2003 and '05. JAL tried to match its fare in the first year of entry but restored it when the year was over, while ANA matched its fare for the first two years. During the competition period, SNA's deficit had grown to 61.6 million USD by 2005. Although SNA made efforts to keep its fares low a little longer than ADO and SKY it finally resorted to code-sharing with ANA, and market-averaged airfares increased. Tokyo-Kagoshima, where low-cost competition lasted more than four years, experienced SKY's entry in 2002. It is interesting that the conduct parameter movement is quite similar to the right-hand side of Figure 2 (b); that is, the high conduct parameter of SKY and the low conduct parameters of the FSCs. SKY was already suffering from deficits in Tokyo-Fukuoka, so it had to set airfares high to make profits, while it seems that FSCs were trying to expel SKY from the market. This scenario also holds for Tokyo-Tokushima, where low-cost competition lasted three years.

The only market where an LCC seems to have won a fare war against FSCs is Tokyo-Asahikawa, as mentioned in section III(1). Before ADO entered this route, the JAL-JAS group had an 85% market share while ANA had a 15% share, with their conduct parameters  $-0.422$  and  $1.868$ , respectively. Then in 2004 ADO entered with its conduct parameter  $0.810$ , after its code-share partner, ANA, exited. This value is

close to a monopoly level, but ADO's fare was 16.4% less than JAL-JAS's. By doing this, the ANA-ADO group increased its market share from 15% to 30%, and JAL exited due to the low profitability of the route, even though it still had a 70% market share.

Three other markets (Osaka-Sapporo, Osaka-Fukuoka, and Tokyo-Aomori) experienced only one- or two-year price wars initiated by SKY. The pre-entry conduct parameter of the FSCs was 0.148, and the FSCs kept that parameter just above the Cournot competition level even after the fare wars ended, while SKY entered with a very low conduct parameter and then exited the next year. The FSCs may have anticipated that SKY would exit soon without any price-matching strategy, since they knew that potential demand was too low for SKY to achieve profitability.

Next we focus on the relationship between conduct parameters and market share. Usually, firms with strong market power will increase their price-to-cost margins as their market share increases. However, firms with higher market share sometimes choose low price (and as a result, low conduct parameters) in order to expel rivals. Oum, Zhang, and Zhang (1993) empirically recognize this behavior through an analysis of duopolistic competition between American Airlines and United Airlines. Japanese FSCs appear to have chosen almost the same behaviors as AA and UA. The correlation coefficient between an FSC's conduct parameter and its market share is —

0.517, which is statistically significant at the 1% level by t-test, while that of an LCC is 0.072, which is not statistically significant. This implies that LCCs behave as the oligopolistic theory predicts.

Oum, Zhang, and Zhang (1993) also argue that an airline’s conduct parameter inversely correlates with market distance. Usually, US long-haul markets are so large and thriving that more entrants try to enter and compete in them than in short-haul markets. As a result, conduct parameters decrease. This situation also occurred in Japan. By carrying out a simple regression of the conduct parameter on distance, we observe a negative, though weak, relationship between conduct parameter and distance<sup>8</sup>. Furthermore, this result tends to be stronger for LCCs than FSCs. These results seem attributable to the “seemingly predatory” prices in the first and second years of ADO’s and SKY’s entry into Tokyo-Sapporo and Tokyo-Fukuoka.

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<sup>8</sup> Since we detect the heteroskedasticity for this regression (BPG test:  $\chi^2_{(3)} = 25.45$  with P-Value 0.000), we use the ML method. “a”, “b”: significant at 1% and 5%..

$CP_{iAv}^L = 1.314 - (0.00083 + 0.00447 DLCC) Dist_i + 4.301 DLCC$  *Log – likelihood* = -68.206  
(3.122a) (-2.159b) (-3.474a) (3.191a)

where *DLCC* is the dummy variable, each of which is 1 for LCCs’ elements. The subscript “Av” beside CP means that the conduct parameter used here is the average value of each firm at route *i* after an LCC enters. n=30.



## 2. Market welfare

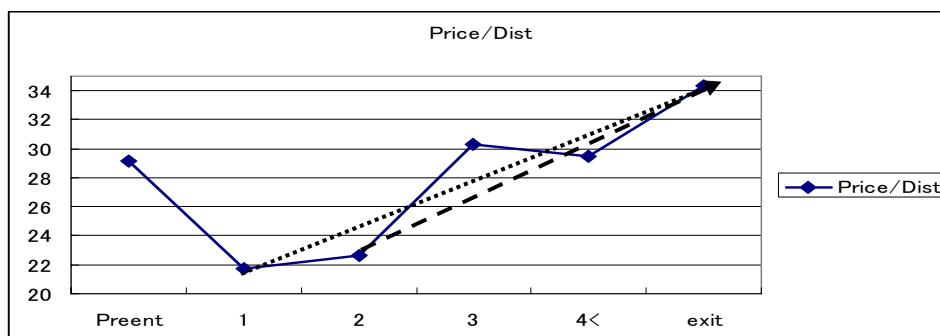
The latter half of this section discusses the effect of an LCC's entry on consumer surplus. Information for computing consumer surplus is obtained from the following simultaneous equations of carrier-specific demand and price. Table 3 shows the estimated results.

Table 3 Empirical results of demand and price equations

Demand Equation	Parameter	t-stat.	Price Equation	Parameter	t-stat.
Own Price Elasticity	-1.089	-3.709a	Output	-0.464	-4.696a
Cross Price Elasticity	0.383	2.043b	Route Marginal Cost	1.196	8.520a
Distance	0.775	3.958a	Frequency	0.537	4.486a
Population	0.249	1.921c	Market Share	0.212	4.325a
Frequency	1.186	25.540a	1st year of JAL	-0.150	-2.263b
Market Share	0.245	2.768a	2nd year of JAL	-0.058	-1.019
1st year of ADO	-0.057	-0.375	3rd year of JAL	0.093	1.451
2nd year of ADO	0.079	0.382	4th and further years of JAL	-0.129	-2.040b
3rd year of ADO	-0.184	-0.852	1st year of ANA	-0.080	-1.137
4th and further years of ADO	-0.345	-2.637a	2nd year of ANA	0.047	0.587
1st year of SKY	-0.212	-0.952	3rd year of ANA	-0.143	-1.964b
2nd year of SKY	-0.155	-1.021	4th and further years of ANA	-0.101	-1.449
3rd year of SKY	-0.342	-2.673a	1st year of JAS	0.008	0.077
4th and further years of SKY	-0.396	-2.699a	2nd year of JAS	-0.213	-2.843a
1st year of SNA	-0.568	-2.931a	3rd year of JAS	-0.060	-0.912
2nd year of SNA	-0.450	-2.433b	4th year of JAS	0.179	1.721
3rd year of SNA	-0.523	-2.508b	Post-exit Price of JAL	0.072	0.857
JAL-JAS Merger	-0.143	-2.515b	Post-exit Price of ANA	0.202	2.214b
Income	-247.130	-2.277b	Post-exit Price of JAS	0.408	3.769a
Income*Income	9.460	2.263b	Post-exit Price of ADO	0.208	0.992
CONSTANT	1614.400	2.292b	CONSTANT	-0.240	-0.186

Our estimation method is the three-stage least squares. The empirical statistic is that the system  $R^2$  is 0.9911. The letter "a" beside a t-statistic means the parameter is significant at the 1% level, and "b" indicates significance at the 5% level.

Figure 3 Dynamic change in market average price before, during, and after competition between LCCs and FSCs



Note: The vertical axis is airfare in Japanese yen per mile, and the horizontal axis is the n-th year of LCC entry (“Preent” is the pre-entry average fare per distance, “4<” denotes the average fare per distance in the fourth year and after, and “exit” denotes the average fare of FSCs after an LCC has exited).

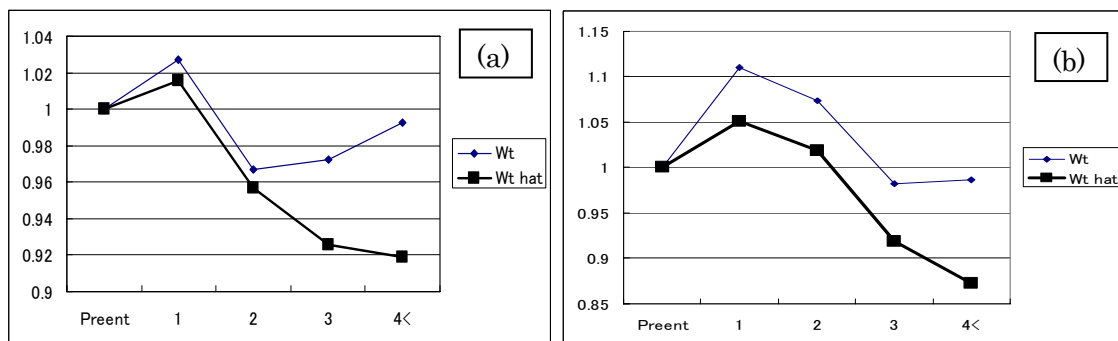
Before performing welfare analysis using the results of the econometric model, we do a preliminary analysis of how the price per distance has changed from the LCC pre-entry year to their post-exit year. Figure 3 describes the change in fares per distance. Each is the passenger-weighted average of six carriers. We have nine routes for the pre-entry year and for the first year of LCC entry. The low-cost competition ended within a year in Osaka-Sapporo and Tokyo-Aomori, and within two years in Osaka-Fukuoka and Tokyo-Asahikawa. For these four routes, we observe the FSC’s fares after an LCC has exited. For the other five routes, the cost competition continued for more than three years. Therefore, we don’t observe a post-exit price.

Figure 3 shows the fare drops by 25% after LCC entry. In the routes in which low-cost competition ended within one or two years, the initial significant price drop

reversed, eventually exceeding the pre-entry price, probably because the FSCs tried to compensate for the loss incurred during the fare war (see the dotted and dashed lines, which jump from 1 to exit and 2 to exit). In the routes in which the wars lasted more than four years, the fare was restored close to the pre-entry fare in the third year.

Figures 4 (a) and (b) describe the change in two kinds of consumer surplus using the real values of price and output ( $W_t$ ), as well as using estimated output and price in our simultaneous equation ( $\hat{W}_t$ ). Looking at the graphs in those figures, our estimated results ( $\hat{W}_t$ ), which predict that consumer-surplus curves will slope down in the long run, look “pessimistic” compared with the case using the real values.

Figure 4 Change in consumer surplus in Tokyo-Sapporo (a) and Tokyo-Fukuoka (b)



However, for Tokyo-Sapporo and Tokyo-Fukuoka, consumer surplus increased in the first year and first two years, respectively, of LCC entry, but decreased from the second and third years. The total consumer surpluses from the first years can be summarized as follows: the surplus decreased in Tokyo-Sapporo even from the optimistic viewpoint

(1% decrease) as well as the pessimistic viewpoint (6% decrease). As for Tokyo-Fukuoka, consumer surplus may have increased by 1.5% from the optimistic computation using real value, but decreased by 7.5% from the pessimistic computation by estimated output and price. Among the other seven markets, those where low-cost competition lasted more than three years saw relatively large gains in consumer welfare, while other markets did not. Table 4 summarizes the percent change in consumer welfare on a route-by route basis.

Table 4 Percent change in consumer welfare by low-cost competition

O/D	Sapporo	Fukuoka	Asahikawa	Aomori	Tokushima	Miyazaki	Kagoshima
Tokyo	-1.00	1.50	0.04	-2.60	3.52	6.98	4.23
Osaka	-2.17	-7.50					

Finally, we comment on issues of social welfare. The industry's profit in the pre-entry year (1998) was 42 million USD for Tokyo-Sapporo and 44 million for Tokyo-Fukuoka. Profit significantly dropped in the first year of new entry, but recovered and even surpassed the previous levels in the third year (61 and 72 million USD, respectively) and stabilized from the fourth year on.

Jointly considering consumer welfare as shown in Table 4, it is apparent that total welfare increased in five of the nine markets but decreased in Tokyo-Aomori, a thin demand route. Meanwhile, only the industry-side benefited in Tokyo-Sapporo,

Osaka-Sapporo, and Osaka-Fukuoka.

Table 5 Cumulative industry profit during low-cost competition (million USD)

O/D	Sapporo	Fukuoka	Asahikawa	Aomori	Tokushima	Miyazaki	Kagoshima
Tokyo	374.00	289.67	9.27	-28.03	61.25	26.56	71.57
Osaka	26.19	24.01					

Note: We assume 1 USD=120 yen.

## V Concluding Remarks

Summarizing the findings of empirical analyses, the first and second years of LCC entry saw very fierce fare wars in the two biggest markets, such that the antitrust sector was about to intervene. Despite the fare wars, consumer welfare did not increase very much in any of the markets, probably due to the limited size of the market pie in the off-peak season. To recover the losses incurred during that period, the industry quickly tried to collude to restore prices to the pre-entry level or higher. At the same time, the FSCs tried to expel the LCCs by financially battering them, and eventually succeeded in establishing code-share arrangements with them. The industry succeeded in making a profit even during the fare ware period, and now the profits continue through such collusive behaviors, while the gain in consumer welfare has been relatively small and may actually decrease from now, especially in the two biggest markets. Therefore, our conclusion is that Japanese regulatory sectors seem to stand

by the industry rather than protecting consumers. Because this analysis was performed using off-peak data, our next focus will be on the analysis of high-season data.

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