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and consumers' welfare:
Japan's full-service vs. new air carriers

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Dynamic effect of inter-airline rivalry on airfares and consumers' welfare: Japan's full-service vs. new air carriers

Hideki MURAKAMI and Yoshihisa AMANO

Abstract. We analyzed the dynamic changes in carriers' airfares and outputs and computed the changes in the consumers' surplus year by year after new Japanese carriers entered thriving routes and started to compete with Japanese full-service airlines (FSAs). Using unbalanced panel data of 222 route-and-carrier-specific sample observations, we found that new carriers discounted airfares significantly as soon as they entered new markets, but two early-comers, Skymark Airlines and AIRDO that had entered with very low airfares raised their price year by year. The two FSAs All Nippon Airways and Japan Airlines responded to the new entrants and lowered their airfares to a much lesser extent than new entrants did, and kept their airfare levels almost unchanged for at least four years from the first entry, although a tiny fluctuation of airfares was recognized. The consumers' surplus increased significantly in the first year of new entries but gradually reduced as new entrants raised their airfares.

Key words: Japanese airlines, entry, dynamic change in airfare, consumers' surplus

1. Introduction

In 1996, the Ministry of Transport of Japan authorized Skymark Airlines (SKY) and AIRDO (ADO) to commence operations. These new entries were followed by Skynet Asia Airways (SNA, now renamed Solaseed Air) and Star Flyer Inc. (SFJ), founded in 2000 when the Japanese Ministry of Land, Infrastructure, and Transport deregulated airlines' entry and exit and airfares.

These new airlines were initially referred to as low-cost carriers (LCCs). However, although new Japanese carriers have some features of LCCs in common with those of other countries in terms of route-by-route service and low airfares, the services and cost structures of Japan's new entrants differ from those of foreign LCCs. The most salient difference between the foreign LCCs and new Japanese carriers is that, unlike the situation in the U.S., Japan's metropolitan areas do not have secondary commercial airports available for LCCs. In addition, the cost structures of the new Japanese carriers are almost the same as those of full-service airlines (FSAs) except for the new carriers' low labor cost. The airplane-maintenance cost of the new carriers could be more expensive than those of the FSAs, however. The reason is that new carriers do not have their own maintenance subsidiary company or division, and they had to arrange to have the maintenance performed by the FSAs. Since FSAs charge the new carriers high maintenance fees in order to weaken the new carriers' cost competitiveness, the new

carriers are compelled to lower their input prices such as labor, in-flight services, and maintenance costs. In addition, new Japanese airlines offer some frequent flyer programs (FFPs) without simplifying the service, and costs such as landing fees, fuel prices and taxes are uniform among Japanese airlines; thus, there is not much difference between the new airlines and the FSAs. However, the Japanese government imposes a tax for the fixed assets on each airplane, the costs of the new Japanese new airlines are higher than those of oversea LCCs.

Figure 1 depicts the average cost of seven Japanese airlines over a recent 10-year period. The average costs of the new carriers did not differ greatly from those of the FSAs (ANA, JAL, and JAS). In fact, ADO went bankrupt in 2002, and in 2004 SNA/Solaseed Airlines received financial support from the Industrial Revitalizing Corporation.

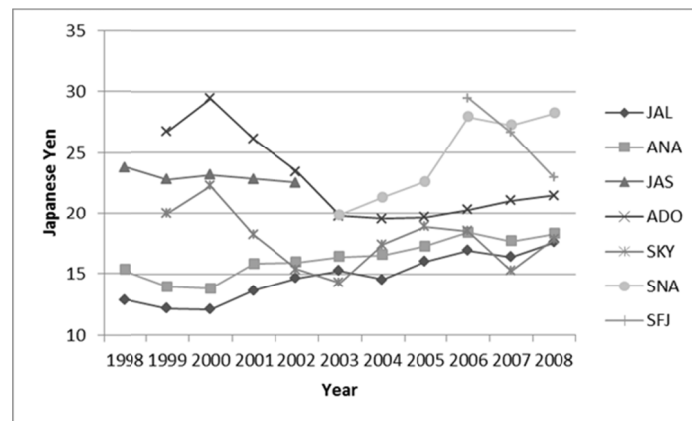


Fig. 1. Changes in Japanese airlines' average costs from 1998 to 2008.

Source: JAA Civil Aviation Databook and financial statements of each airline, 1998–2008.

JAL: Japan Airlines; ANA: All Nippon Airways; JAS: Japan Air System; ADO: AIRDO; SKY, Skymark Airlines; SNA: Solaseed Air; SFJ, Star Flyer Inc.

We analyzed the dynamic price competition between Japan's FSAs and the new Japanese airlines (i.e., SKY, ADO, SNA, and SFJ). The carriers have different scales and characteristics. The analysis included not only the duopoly market (i.e., served by JAL and ANA), but also the market in which several new airlines have entered.

Having observed the airline regulatory reforms and the founding of new carriers, we were motivated to analyze the market performance for the routes in which new carriers have entered, and how the market performance has changed over time. To measure the performance, we estimated the structural demand and quasi-supply equations, and we introduced entry-year dummy variables for the new entrants and for the FSAs to investigate the dynamic changes in airfares and passenger volume after the new carriers entered the market.

In Section 2, we review the literature on the competition between FSAs and carriers

providing heterogeneous service such as LCCs, mainly concerning the U.S. In Section 3 we model the entry-effect of a firm on the market price and output in a “one-shot game” case, assuming that two firms produce heterogeneous products. We discuss the results in relation to the dynamic competition issue, and we describe the econometric model. In Section 4 we demonstrate our dataset, and in Section 5 we present and discuss the empirical results and the consumer surplus. Section 6 provides our concluding remarks.

2. Literature Review

Although Japanese new carriers cannot be classified in the LCC category, but it is useful to review literatures on LCCs for our research¹. There have been many studies on the economic impact of the entry of the U.S. LCCs into the air transportation market. Morrison and Winston (1996) empirically showed that Southwest Airlines forces its competitors to reduce their fares.² Dresner et al. (1996) and Morrison (2001) measured the airfare-reduction effect of LCC entry in the primary and adjacent markets by incorporating LCC dummy variables in their econometric work. In an empirical analysis of the U.S. domestic air markets that included a number of LCCs, Vowles (2000) found that Southwest Airlines, other LCCs, and the market share of LCCs had statistically significant effects on the decrease in carriers’ airfares. Alderighi et al. (2004) estimated the price equations derived from oligopoly theories and found that competition between European LCCs and FSAs reduced all classes of the FSAs’ airfares. The airfare changes after LCC entry were investigated by Pitfield (2005, 2008) in time series analyses. Goolsbee and Syverson (2005) and Oliveira and Huse (2009) studied the effects of LCC entries on the incumbents’ responses.

Fu et al. (2006) explicitly incorporated a duopolistic inter-firm rivalry into their LCCs versus FSA competition study, and they incorporated the effect of the pricing behavior of an unregulated-monopoly airport on the downstream competition between LCCs and FSAs. Murakami (2011a) empirically analyzed the effect of LCC entry on airfares and market welfare in the Japanese domestic airline industry. According to Fu et al. (2011), service differentiation between FSAs and LCCs leads to the cartelized behavior of FSAs. Murakami and Asahi (2011) studied the effect of multimarket contact on LCCs and FSAs and LCCs keep their airfares low despite the fact that they frequently contact with each other.

Despite the number of studies on the effect of LCC entry on airfares, few researchers have analyzed the dynamic effect of LCC entry on both airfares and market welfare using data that have a time-series dimension. Here we explain our econometric analysis of these untried issues, using panel data from 1998 to 2008 and focusing on the markets where new carriers entered.

¹ Why we reviewed U.S. LCCs is that originally, Japan’s new carriers were called “LCC” and their pricing behavior, the quality of services (no or little frilled services) were similar to the U.S. LCCs’.

²Morrison and Winston, *The Evolution of the Airline Industry*, Brookings Institution (1996), pp.132-156.

For the time-series dimension of our dataset, we chose to discard the samples beyond 2008 since Japan Airlines' data were inconsistent before and after the year 2008 and we found it impossible to adjust the data to be consistent; Japan Airlines changed their manner of financial disclosure from an unconsolidated to consolidated statement of accounting and then went bankrupt in 2010.

3. The Model

In this section we explain the model and derive the demand and quasi-supply functions, demonstrate the method of approximating marginal cost, and show what happens to market output if FSAs increase the degree of service homogeneity.

3.1. Quasi-Supply and Demand Equations

In a perfect competition, a firm's supply function can be derived by taking the first-order condition of profit function with regard to price, according to Hotelling's lemma. However, since we focus on the oligopolistic airline industry of Japan, we must assume the carrier-specific "quasi-supply" instead of an ordinary supply function. Assume the following general profit functions of Carrier 1 (a new carrier) and Carrier 2 (an incumbent FSA) that engage in Cournot competition with each other.

$$\max_{q_1} \pi^1(P(q_1, q_2), TC_1(q_1), q_1; \omega_1) \quad (1)$$

$$\max_{q_2} \pi^2(P(q_1, q_2), TC_2(q_2), q_2; \omega_2) \quad (2)$$

where ω_1 and ω_2 are the coefficients of rival's output in the inverse demand function usually assumed in a Cournot model.

For convenience, let ω_1 be the numeraire, and ω_2 be $\omega^* \in (0,1)$. We can rewrite Eqs. (1) and (2) as follows:

$\max_{q_1} \pi^1(P(q_1, q_2), TC_1(q_1), q_1)$	(3)
$\max_{q_2} \pi^2(P(q_1, q_2), TC_2(q_2), q_2; \omega^*)$	(4)

Taking the first-order condition of Eqs. (3) and (4) with regard to each output, we obtain the best reply functions; these are also the inverse quasi-supply functions of Carrier 1 [Eq. (5)] and Carrier 2 [Eq. (6)] with the theoretically expected sign ahead of each variable:

$P = f_1((+)q_1, (+)MC_1, (+)m_1)$	(5)
$P = f_2((+)q_2, (+)MC_2, (+)m_2; (-)\omega^*)$	(6)

where m_1 and m_2 are the price mark-up factors.

As for the carrier-specific demand functions, ours is ordinary Marshallian demand,

where demand is explained by own price, cross-price, income, population, and other control variables. The demand function of Carrier 1 is written as follows:

$$q_1 = g_1((-)q_1, (+)\sum q_{-1}, (+)INC, (+)POP, Control) \quad (7)$$

These models explain the one-shot equilibria. As we see later, we will analyze the dynamic effect of new carriers' entries, so we need to explain how to relate these one-shot equilibria to the dynamic issue. One possible method is that we assume the finite game with a long time dimension or an infinite game. In this case, our solution is to derive the series of the subgame-perfect equilibrium at each stage with the discount factor. Although this method does not explain the true dynamic competition such as in Stackelberg fashion, our assumption of a "series of one-shot games" is supported by a carrier.³

3.2. Approximating Marginal Costs

To approximate route- and carrier-specific marginal costs, the most commonly used method is to estimate the translog total cost function together with the shared equations derived from Shephard's lemma, such as that reported by Caves et al. (1984), Gillen et al.(1990), and Johnston and Ozment (2013).and Fischer and Kamerschen (2003). However, since we cannot obtain a sufficient number of observations to use the translog functional form that requires many numbers of variables, we use the following formula of approximation that was proposed by Brander and Zhang (1990, 1993) and Oum et al. (1993)⁴ and used by Murakami (2011a, 2011b):

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

where AC_t^k is the aggregate average cost of carrier k in year t , $Dist_i$ is the distance of route i , and AFL_{it}^k is the average distance flown by airline k in year t .

The aggregate average cost is calculated by dividing operating costs by the available ton-kilometer. And AFL_{it}^k was derived by dividing total distance flown by the number of flights of the year.

λ is a parameter that denotes the degree of taper. Caves et al. (1984) and Fischer and Kamerschen (2003) showed that the total cost function was strictly concave. Therefore, λ in Eq. (8) ranges between 0 and 1. If λ is 0, the carrier's marginal cost is proportional to the distance

³Source: The authors' interview of Mr. Go Nishimura and Katsuhiko Okamura, who worked in the pricing division in All Nippon Airways and Solaseed Air, respectively. According to them, carriers do not react to the previous day's airfares of their rivals, but they refer to last year's airfares from the same season. The interviews were conducted on May 24 and July 26, 2013, respectively.

⁴See Brander and Zhang (1990, pp.572-575), Brander and Zhang (1993, pp.417-420), Oum et al. (1993, pp.175-178).

flown by the carrier, whereas in the case of $\lambda = 1$, the marginal cost of each airline is indifferent to distance.

Studies such as those by Brander and Zhang (1990, 1993) and Murakami (2011a, 2011b) demonstrated that λ ranges between 0.15 and 0.67.⁵ We also estimate the unknown parameter λ with the following equation:

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

To obtain λ , we estimate the price Eq. (9) above by the nonlinear least-squares method. The system-wide conduct parameter $I?$ is also obtained from Eq. (9).⁶

Before we estimate the price Eq. (9), we need the information about the price elasticity of demand η . Therefore, we will estimate the following Marshallian demand function by using route-specific unbalanced panel data.

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

where p_{it} is the lowest airfare at route i in year t . INC_{it} is the arithmetic average of per-capita income of the cities/counties around route i in year t . Both p_{it} and INC_{it} are adjusted by the retail price index. POP_{it} 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 calculated from the share of each airline. “Time” is the time trend variable. As we multiply POP_{it} and INC_{it} , parameter $I2$ stands for the “gross regional income elasticity of demand.” The reason why we did this multiplication is that if we separate these two variables, the estimate coefficient becomes negative (but not statistically significant) against the assumption of microeconomics. Okinawa’s per-capita income is much lower than Japan’s average, but the demand for air transportation is large since Okinawa is an island isolated from the mainland (Honshu). This seems to affect the estimation, and when we substitute per-capita income with gross regional income, this problem is eliminated as will be shown in Table 1.

3.3. Entry effect of a new carrier when firms produce heterogeneous services

⁵Oum et al. (1993) obtained $\lambda=0.43$, and Murakami (2011a,2011b) obtained $\lambda=0.374, 0.271$.

⁶The conduct parameter “ v ”(= $dq_{-k} // dq_k$) means the prediction of changes in the supply amount of the third airline when Airline k increases its supply. If all of the airlines move in the same direction at the same rate, the result is $N-1$ (N = number of carriers), indicating collusion. If the conduct parameter is 0, it implies the Cournot competition. If it is -1 , the price equals the marginal cost, and we interpret it as homogeneous Bertrand competition. See Brander and Zhang (1990), Oum et al. (1993), and Fischer and Kamerchen (2003).

This subsection investigates the following question: if an FSA successfully separates its markets from its rivals' markets, what happens to the FSA's output and that of new carriers. When airlines provide homogeneous services, the model is rather simpler than what we have presented, but it is natural that Japan's FSAs provide higher-quality service than new carriers. Considering this fact, we assume the following general profit functions of firm 1 (a new carrier) and firm 2 (an incumbent FSA) that engage in Cournot competition with each other. There are alternative versions of Eqs. (1) and (2) in subsection 3.1; functions (1) and (2) are written as composite

functional forms, and if we write (1) and (2) as function of outputs only, they will be:

$\max_{q_1} \pi^1(q_1, q_2; \omega_1)$	(11)
$\max_{q_2} \pi^2(q_1, q_2; \omega_2)$	(12)

where ω_1 and ω_2 are the coefficients of own output in the inverse demand function usually assumed in a Cournot model.

For convenience, let ω_1 be the numeraire, and ω_2 be $\omega^* \in (0,1)$. We can rewrite (11) and (12) as follows:

$\max_{q_1} \pi^1(q_1, q_2)$	(13)
$\max_{q_2} \pi^2(q_1, q_2; \omega^*)$	(14)

By our assumption, the smaller ω^* is, the more independent an FSA's markets, and the FSA becomes a monopolist.

Taking the first-order condition of Eqs. (13) and (14) with regard to each output, we obtain the best reply function described as the form of implicit function:

$\pi_1^1(q_1, q_2) = 0$	(15)
$\pi_2^2(q_1, q_2; \omega^*) = 0$	(16)

where $\pi_i^i \equiv \frac{\partial \pi^i}{\partial q_i}$.

Solving for each output, we obtain $q_1^*(\omega^*)$ and $q_2^*(\omega^*)$, and substituting $q_1^*(\omega^*)$ and $q_2^*(\omega^*)$ into Eqs. (3) and (4), we obtain:

$\pi_1^1(q_1^*(\omega^*), q_2^*(\omega^*)) = 0$	(17)
$\pi_2^2(q_1^*(\omega^*), q_2^*(\omega^*), \omega^*) = 0$	(18)

In order to see the effect of the increase in heterogeneity, we totally differentiate Eqs. (17) and (18).

$\pi_{11}^1 \frac{\partial q_1}{\partial \omega^*} + \pi_{12}^1 \frac{\partial q_2}{\partial \omega^*} = 0$	(19)
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$\pi_{21}^2 \frac{\partial q_1}{\partial \omega^*} + \pi_{22}^2 \frac{\partial q_2}{\partial \omega^*} + \pi_{2\omega^*}^2 = 0$	(20)
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Rewriting Eqs. (19) and (20) into a matrix form, we obtain:

$\begin{pmatrix} \pi_{11}^1 & \pi_{12}^1 \\ \pi_{21}^2 & \pi_{22}^2 \end{pmatrix} \begin{pmatrix} \frac{\partial q_1}{\partial \omega^*} \\ \frac{\partial q_2}{\partial \omega^*} \end{pmatrix} = \begin{pmatrix} 0 \\ -\pi_{2\omega^*}^2 \end{pmatrix}$	(21)
---	------

Let $H \equiv \begin{pmatrix} \pi_{11}^1 & \pi_{12}^1 \\ \pi_{21}^2 & \pi_{22}^2 \end{pmatrix}$, and since this is the symmetric nonsingular matrix, H can be inverted.

Then we obtain:

$$\begin{pmatrix} \frac{\partial q_1}{\partial \omega^*} \\ \frac{\partial q_2}{\partial \omega^*} \end{pmatrix} = \frac{1}{\pi_{11}^1 \pi_{22}^2 - \pi_{12}^1 \pi_{21}^2} \begin{pmatrix} \pi_{22}^2 & -\pi_{12}^1 \\ -\pi_{21}^2 & \pi_{11}^1 \end{pmatrix} \begin{pmatrix} 0 \\ -\pi_{2\omega^*}^2 \end{pmatrix} \quad (22)$$

From (22) we obtain:

$\frac{\partial q_1}{\partial \omega^*} = \frac{\pi_{12}^1 \pi_{2\omega^*}^2}{\pi_{11}^1 \pi_{22}^2 - \pi_{12}^1 \pi_{21}^2}$	(23)
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$\frac{\partial q_2}{\partial \omega^*} = -\frac{\pi_{11}^1 \pi_{2\omega^*}^2}{\pi_{11}^1 \pi_{22}^2 - \pi_{12}^1 \pi_{21}^2}$	(24)
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Matrix H must be a negative definite matrix due to the second-order condition for profit maximization. Therefore, $\pi_{11}^1 < 0$ and $\pi_{11}^1 \pi_{22}^2 - \pi_{12}^1 \pi_{21}^2 > 0$. In addition, since we assume Cournot competition, $\pi_{12}^1 < 0$, and $\pi_{21}^2 < 0$ due to the “strategic substitute” effect. ω^* is the index of the degree of heterogeneity and comes to the right-hand side of the inverse demand with a negative effect on price. As for the sign of $\pi_{2\omega^*}^2$, we take the derivative of Eq. (18) with regard to ω^* . Since it is obvious that ω^* has a negative effect on price and therefore profit [see Eq. (6)], $\pi_{2\omega^*}^2 < 0$. Substituting this result into Eqs. (23) and (24), we obtain:

$\frac{\partial q_1}{\partial \omega^*} = \frac{(-)\pi_{12}^1(-)\pi_{2\omega^*}^2}{(+)(\pi_{11}^1\pi_{22}^2 - \pi_{12}^1\pi_{21}^2)} > 0$	(25)
$\frac{\partial q_2}{\partial \omega^*} = -\frac{(-)\pi_{11}^1(-)\pi_{2\omega^*}^2}{(+)(\pi_{11}^1\pi_{22}^2 - \pi_{12}^1\pi_{21}^2)} < 0$	(26)

And we can suggest the following proposition.

Proposition: If an FSA distinguishes its service and creates a new market against new carriers (that is, smaller ω^*), its output increases and a new carrier's output decreases.

This proposition implicitly states that the fixed effect dummy variable for FSAs in the demand equation would be significantly positive as long as the FSAs provide differentiated service against new carriers. In addition, the effect of ω^* on airfares might not be specified; theoretically, the effect of ω^* on airfare is $(\partial P/\partial q_1)/(\partial q_1/\omega^*) < 0$ and $(\partial P/\partial q_2)/(\partial q_2/\omega^*) > 0$, but the creation of new market by FSAs could lead to the “shift-up” of the quasi-supply and the demand curves, that is, pushing the equilibrium point to the up-and-right direction. We will discuss this issue in the next subsection.

3.4. Structural Equations to Estimate

This subsection models the structural equations based on the prior subsections 3.1 to 3.3. Our quasi-inverse supply function in the econometric model goes as follows:

$$\begin{aligned} \ln p_{it}^k = & \alpha_0 + \alpha_1 \ln q_{it}^k + \alpha_2 \ln RMC_{it}^k + \alpha_3 \ln MSHE_{it}^k + \sum_{n=1}^4 \alpha_{4n} ADO_n + \sum_{n=1}^4 \alpha_{5n} SKY_n \\ & + \sum_{n=1}^4 \alpha_{6n} SNA_n + \sum_{n=1}^3 \alpha_{7n} SFJ_n + \alpha_8 EXJL + \alpha_9 EXNH + \alpha_{10} EXJD \\ & + \alpha_{11} EXAD + \alpha_{12} DJJM + u_{it}^k \end{aligned} \quad (27)$$

where, p_{it}^k is the airfare of each carrier k at route i in year t , q_{it}^k is the number of passengers at route i in year t , and RMC_{it}^k is the route-specific marginal cost of each carrier at route i in year t calculated from Eq. (8). $MSHE_{it}^k$ shows the market share of carrier k at route i in year t .

$ADO_n, SKY_n, SNA_n, SFJ_n$ are the carrier-fixed effect dummy variables for new carriers, and subscript “ n ” stands for the year after their entries. By these dummy variables we see the dynamic effect of entries. $EXJL, EXNH$, and $EXJD$ are also the dummy variables used to see the effect of the FSA's airfare-restoring behavior. These variables are each 1 for the FSA's elements in the year after a new Japanese airline's exit, and otherwise they are 0.

We will also estimate the following demand function together with the inverse quasi-supply function.

$$\begin{aligned}
\ln q_{it}^k = & \beta_0 + \beta_1 \ln p_{it}^k + \beta_2 \ln Dist_i + \beta_3 \ln FRQ_{it}^k + \beta_4 \ln MSHE_{it}^k + \beta_5 INC_{it} + \beta_6 INC_{it}^2 \\
& + \beta_7 POP_{it} + \beta_8 POP_{it}^2 + \sum_{n=1}^4 \beta_{9n} JAL_n + \sum_{n=1}^4 \beta_{10n} ANA_n + \sum_{n=1}^4 \beta_{11n} JAS_n \\
& + \sum_{n=1}^2 \beta_{12n} JTA_n + \varepsilon_{it}^k
\end{aligned} \tag{28}$$

where $Dist_i$ is the origin-destination distance that is not affected by carrier or time. FRQ_{it}^k is the flight frequency of each carrier k at route i in year t . INC_{it} is the population-weighted-average of per-capita income, and POP_{it} is the weighted average of populations of origin-destination cities or county areas around the main cities. The functional form of these two variables are quadratic, and these forms were selected by comparing log-likelihood functions of log-linear, log-linear of gross regional income ($=\ln(INC_{it} * POP_{it})$) and linear-quadratic. JAL_n , ANA_n , JAS_n , and JTA_n are the carrier-specific fixed-effect dummy variables to demonstrate the dynamic behavior of FSAs against new carriers' entries.

The benchmark markets of these carrier-specific dummy variables are those without new carriers' entries; that is, one-year before new carriers' entries and one-year after their exits. Therefore, we expect the parameter of FSAs' carrier-specific dummy variables will be positive. According to our proposition in section 3.3, the effect of increasing ω^* on new carriers' outputs is negative, as long as FSAs successfully create their markets. However, the effect of increasing ω^* on airfares are not necessarily negative due to the effect of "shift-up" of demand curve, that is, the positive sign of the parameters of carrier-specific dummy variables in the demand function.

4. The Data

We used the data of Japanese domestic routes from 1998 to 2008. The total number of routes is 14. The period of data for each route depends on the timing at which new carriers entered. We chose the period from one year before the new entry to one year after the exit years. For example, Tokyo-Miyazaki's data starts from the year 2002 to 2008 because SNA had entered in 2003 and it still continues to serve. The total number of samples is 222.

The data sources for available ton-kilometer, the operating costs of each carrier, the flight distances, and the number of flights are the *Koku Tokei Yoran (JAA Civil Aviation Handbook)* issued by the Japan Aeronautic Association and the website of each airline. The passenger data and the distance of each route were obtained from the *Koku Yuso Tokei Nempo (Yearly Statistical Survey of Japanese Aviation)* published by the Ministry of Land, Infrastructure and Transport and Tourism. The fare information was obtained from the *Jikoku Hyo* (a timetable of railways and airlines that is issued monthly by the Japan Tourist Bureau).

The demographic data sources such as population, income, and retail price index are from

the *Kakei Chosa Hokoku (Family Income and Expenditure Survey)*, which is published by the Japan Statistics Bureau, and the websites of the relevant prefectures and cities.

Passengers, numbers of flights, population and income are monthly data; we used April's data from each year, when the airline demand is the lowest in Japan. When evaluating the lowest-demand month, we observed that the carriers issue various types of discount airfares to generate demand. By choosing April, then, we can analyze the carriers that were most competitive each year. The lists of routes and descriptive statistics are shown in Appendix 1 and Appendix 2, respectively.

5. Empirical Results and discussin

The estimation results of Eq. (7) are shown in Table 1. We estimated them by OLS with heterocedasticity robust standard errors. The data are the route-specific unbalanced panel data of 14 routes for 2–11 years.

Table 1. The estimated parameters of Eq. (10)

Variable	Estimated Coefficient	T-Ratio
Price elasticity (η)	-0.839	-2.562*
Per-capita income*population (β)	1.381	4.124**
Distance (γ)	2.038	4.659**
Herfindahl index (δ)	-1.140	-3.409**
Time trend (ρ)	-0.041	-1.486
Constant (A)	-25.692	-1.936
Log likelihood function=-78.670, n = 76		

Note: ** and * = significant at the 1% and 5% levels, respectively.

The price elasticity of demand (η) is -0.839, which was significant at the 5% level. Then, using the estimated η , we further estimate λ and the system-wide conduct parameter ν . The data used to estimate the Eq. (9) are different from those used for the estimation of Eq. (10). They are the carrier-specific unbalanced panel data of 2 to 5 carriers in 14 routes for 2–11 years. Using the nonlinear least-squares method, we obtain the estimated results shown in Table 2.

Table 2. The estimated parameters of Eq. (9)

Coefficient	Estimated Coefficient	T-Ratio
λ	0.216	13.671
ν	0.018	6.820
Log-likelihood function= -2548.48, n = 222		

Note: Both parameters are significant at the 1% level.

The parameter λ is 0.216, which rejects the null hypothesis that λ equals 0 at the 1% level. The system-wide conduct parameter ν is 0.018. This value is very close to the Cournot-competition

hypothesis, but is rejected at the 1% level of significance. Therefore, the system-wide fashion of competition in Japanese domestic air markets falls between the Cournot fashion and collusion. Comparing this result with Murakami (2011a), who found that ν was -0.242 , Japanese airlines are less competitive than before, since the “latecomer” carriers, SNA and SFJ, chose to soften their competition compared to the first comers, that is, ADO and SKY.

Next, we discuss the empirical results of the structural equation model in Table 3.

Table 3. Estimation results of the structural equations

Inverse quasi-supply (=airfare) function			Demand function		
Variable Name	Estimated Coefficient	T-Ratio	Variable Name	Estimated Coefficient	T-Ratio
Passenger	-0.038	-2.474*	Air fare	-0.762	-5.594**
Marginal cost	0.656	12.170**	Distance	0.605	4.033**
Share	0.111	4.359**	Frequency	1.133	30.94**
JAL-JAS merger	0.178	5.450**	Share	0.177	3.907**
JAL exit	0.017	0.209	Income	-97.077	-0.738
ANA exit	-0.055	-0.525	Income ²	3.725	0.734
JAS exit	-0.142	-1.098	Population	-21.976	-2.135*
ADO exit	0.524	2.079*	Population ²	0.735	2.137*
ADO 1 st year	-0.658	-3.644**	JAL 1 st year	0.170	2.041*
ADO 2 nd year	-0.404	-3.157**	JAL 2 nd year	0.165	1.866
ADO 3 rd year	-0.269	-2.113*	JAL 3 rd year	0.086	0.834
ADO 4 th year	-0.169	-2.647**	JAL 4 th year	0.122	1.557
SKY 1 st year	-0.532	-7.419**	ANA 1 st year	0.234	2.676**
SKY 2 nd year	-0.418	-5.801**	ANA 2 nd year	0.250	2.521*
SKY 3 rd year	-0.290	-3.557**	ANA 3 rd year	0.250	2.094*
SKY 4 th year	-0.249	-4.015**	ANA 4 th year	0.247	3.049**
SNA 1 st year	-0.215	-1.998*	JAS 1 st year	0.176	1.345
SNA 2 nd year	-0.243	-1.883	JAS 2 nd year	0.056	0.387
SNA 3 rd year	-0.141	-1.086	JAS 3 rd year	0.192	0.954
SNA 4 th year	-0.311	-2.843**	JAS 4 th year	0.257	1.247
SFJ 1 st year	-0.205	-1.604	JTA 1 st year	-0.076	-0.250
SFJ 2 nd year	-0.168	-0.927	JTA 2 nd year	-0.026	-0.086
SFJ 3 rd year	-0.004	-0.021			
Constant	3.877	7.054	Constant	803.990	0.950

Note: ** and * = significant at the 1% and 5% levels, respectively. System $R^2=0.973$, R^2 of quasi-supply=0.622, R^2 of demand=0.916, $n=222$, estimated by Iterated 3SLS.

The endogenous variables are specified as airfare and price, so the model is over-identified. As for the quasi-supply, the parameter ‘passengers’ is slightly negative. This implies that economies of density exist. The first two new carriers discounted their airfares significantly for the first four years of entries, unlike the two latecomers, but airfare levels have gradually risen, as shown in Figure 2.

Testing the hypothesis that the first year’s airfare levels equal the fourth year’s for ADO and SKY, the hypotheses were rejected at the 1% level of significance (the Wald chi-square values with a degree of freedom equal to one are 6.864 and 11.400, respectively). ADO’s price-adjusting behavior can be explained by the following fact; when it entered the

Tokyo-Sapporo market in 1998, it was a budget carrier fully independent of the FSAs, but after it went bankrupt and then revived under the codeshare agreement with ANA, ADO stopped offering aggressive discounts. SKY has been independent of FSAs since its founding in 1996 (the first entry was in 1998) as of now, but its price-adjusting behavior is quite similar to ADO's.

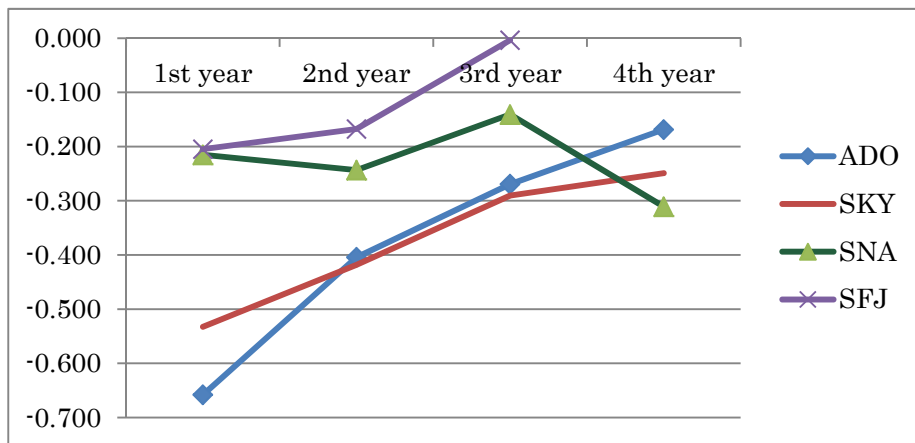


Fig. 2. Overtime changes in the airfares of new Japanese carriers.

Note: The airfares were adjusted by retail price index (chain of average).

During the period we analyzed, SKY seems to have faced the same situation as ADO, but unlike the case of ADO, SKY was saved by a large investment from an individual entrepreneur who managed an internet service provider.⁷

Regarding the carrier-exit dummy variables, the FSAs did not raise airfares after their rivals exited, but ADO did. This means that ADO is not a U.S.-type LCC like Southwest Airlines in the 1990s that kept airfares at low levels, but rather is similar to FSAs.

In the demand function, the signs of ANA's fixed-effect dummy variables are consistently positive, and JAL's first year is also positive and significant. Considering our *Proposition*, ANA successfully created different markets against the entry of new carriers, but other FSAs did not necessarily do so. When we derive the reduced form of demand function, new carriers' parameters are also positive, and this result is contrary to the assumption of FSAs' creation of new markets. Considering this result and the unstable parameters of FSAs, only ANA succeeded in distinguishing itself compared with other FSAs.

Our final analysis is how the consumers' surplus changed from the first year of entries by new carriers to the fourth year. Table 4 shows the increase or decrease in the consumers' surplus on year by year and carrier by carrier bases. The method of computation is to use the estimated demand function and calculate the change in the triangle surrounded by the intercept of inverse

⁷The Nikkei, September 24th, 2003.

demand, the average airfare of each carrier, and the corresponding quantities of each carrier. Therefore, what is derived was is the size of trapezoids (=increase or decrease in consumers' surplus).

Table 4. Change in consumers' surplus after new entries of carriers

	1st year	2nd year	3rd year	4th year	Total
JAL	362.51	351.77	182.72	259.61	1156.61
ANA	583.82	624.17	624.17	616.60	2448.75
JAS	229.73	72.71	250.79	336.64	889.88
JTA	-12.57	-4.31			-16.88
ADO	553.68	337.12	223.47	139.93	1254.20
SKY	359.11	281.10	194.20	166.52	1000.93
SNA	96.54	109.21	63.15	140.08	408.98
SFJ	156.21	127.86	3.03		287.09
TOTAL	2329.02	1899.63	1541.53	1659.38	7429.57

Note: 1,000USD (1 USD = 100 Yen).

Overall, the first-year impacts were the largest, and the impacts gradually got weaker. However, the consumers' surplus was apparently increased by the new entries. From the viewpoint of consumers' protection, the introduction of the policy allowing new carriers' entries was successful. However, it must be noted that this result may have come from the large increase in consumers' surplus in two large markets, Tokyo-Sapporo and Tokyo-Fukuoka. Looking at the results of JTA and SFJ (which are comparatively small carriers), our concern is that small communities might not have benefited or benefited only slightly from the policy.⁸ Another concern is that the merger of JAL and JAS generated a \$230,000 USD loss of consumers' surplus in the merger year. More attention should be paid to merging carriers, and forecasts of the welfare gain or loss will be needed.

6. Conclusions

The outstanding features of our analyses are that we modeled the effect of market separation on the outputs of carriers and empirically found that the border of market separation was ambiguous, that new entries improved the consumers' surplus of large markets, seemingly, and that the first-year impact on the improvement of the consumers' surplus was largest and then gradually declined. From the perspective of consumers' welfare, it would be better to leave ambiguous the border of market separation between FSAs and new carriers and to let

⁸JTA connects the mainland (Honshu) and Okinawa and flies between islands in Okinawa. SFJ was based at Kita-Kyushu Airport during this examination period and connected Kita-Kyushu City and Tokyo. Kita-Kyushu City is in Fukuoka Prefecture, but the Tokyo-Kitakyushu market is much smaller than the Tokyo-Fukuoka market.

passengers move between FSAs and new carriers, since the market separation enforces the increase in FSAs' output; this would lead to enhancement of the monopolistic power of FSAs. We also need to let new entrants maintain their airfare levels in the long run. To do this, we need to open the slots of large airports to new entrants and bring up the new entrants so that they can survive the airfare competition with FSAs.

The limitations of our paper are that (1) we could not cover the period during which JAL changed their disclosure method, and (2) we did not include Japanese LCCs such as Peach Aviation, Jetstar Japan and Air Asia Japan due to the unavailability of data. These drawbacks will be eliminated by our future research.

Appendix 1. The route list used for estimation

<i>Route</i>	<i>Period</i>	<i>Distance (km)</i>	<i>Carrier (period)</i>	<i>Sample</i>
Tokyo-Sapporo	1998-2008	894	JAL(98-08) ANA (98-08) JAS(98-02) ADO(99-08) SKY(06-08)	40
Tokyo-Fukuoka	1998-2008	1041	JAL(98-08) ANA (98-08) JAS(98-02) SKY(99-08)	37
Osaka-Sapporo	1998-2001	1161	JAL(98-01) ANA (98-01) JAS(98-01) SKY(00)	13
Osaka-Fukuoka	1998-2001	578	JAL(98-01) ANA (98-01) JAS(99-01) SKY(99-00)	13
Tokyo-Asahikawa	2003-2008	1052	JAL(03-08) ANA (03) ADO(04-08) SKY(08)	13
Tokyo-Aomori	2002-2004	690	JAL(03-04) ANA (02-03) JAS(02) SKY(03)	6
Tokyo-Tokushima	2002-2007	703	JAL(03-07) ANA (02-03) JAS(02) SKY(03-06)	12
Tokyo-Miyazaki	2002-2008	1023	JAL(02-08) ANA (02-08) JAS(02) SNA(03-08)	21
Tokyo-Kagoshima	2001-2008	1111	JAL(01-08) ANA (01-08) JAS(01-02) SKY(02-06) SNA(08)	24
Tokyo-Kobe	2006-2008	695	JAL(06-08) ANA (06-08) SKY(06-08)	9
Tokyo-Kitakyushu	2005-2008	958	JAL(05-08) SFJ(06-08)	7
Tokyo-Osaka	2007-2008	678	JAL(07-08) ANA (07-08) SFJ(08)	5
Tokyo-Nagasaki	2005-2008	1143	JAL(05-08) ANA (05-08) SNA (06-08)	11
Tokyo-Okinawa	2006-2008	1687	JAL(06-08) ANA (06-08) JTA(06-08) SKY(07-08)	11

Number of Routes = 14, Number of Samples = 222

Appendix 2. Descriptive statistics

<i>Variable Name</i>	<i>Mean</i>	<i>Standard Error</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Median</i>
Distance	985.450	15.559	578.000	1109.000	1023.000
Passenger	88433.982	5731.941	1599.000	324299.000	53069.000
Price	26787.838	497.385	9600.000	40800.000	28000.000
Price (lowest)	23946.396	490.321	9600.000	40800.000	23000.000
Population	3944138.636	54251.184	1966125.798	4936713.245	4100038.640
Income	2010057.529	127487.364	369972.647	4578925.465	432980.034
Share	34.234	1.290	1.463	100.000	35.569

References

- Alderighi, M., A. Cento, P. Nijkamp, and P. Rietveld, 2004. The entry of low-cost airlines: price competition in the European airline market, Tinbergen Institute discussion paper, TI 04-074/3.
- Brander, J. A., and A. Zhang, 1990. Market conduct in the airline industry: An empirical investigation, RAND Journal of Economics 21, 567-583.
- Brander, J. A., and A. Zhang, 1993. Dynamic oligopoly behavior in the airline industry, International

- Journal of Industrial Organization 11, 407-435.
- Caves, D. W., L. R. Chistensen, and M. W. Tretheway, 1984. Economies of density versus economies of scale: Why trunk and local service airline costs differ, *RAND Journal of Economics*, 15, 471-489.
- Dresner, M., J. S. C. Lin, and R. Windle, 1996. The impact of low-cost carriers on airport and route competition, *Journal of Transport Economics and Policy*, 30(3), 309-328.
- Fischer T. and D. R. Kamerschen, 2003. Price-cost margins in the US airline industry using a conjectural variation approach, *Journal of Transport Economics and Policy*, 37(2), 227-259.
- Fu, X., M. Dresner, and T.H. Oum, 2011. Effects of transport service differentiation in the US domestic airline market, *Transportation Research Part E*, 47(3), 297-305.
- Gillen D. W., T. H. Oum and M. W. Tretheway, 1990. Airline cost structure and policy implications: A multi-product approach for Canadian airlines, *Journal of Transport Economics and Policy*, 24(1), 9-33.
- Goolsbee, A. and C. Syverson, 2005. How do incumbents respond to the threat of entry?: evidence from the major airlines, NBER Working Paper, 11072.
- Johnston, A. and J.Ozment, 2013. Economies of scale in the US airline industry. *Transportation Research Part E*, 51, 95-108.
- Morrison, S. A. and C. Winston, 1996. *Evolution of Airline Industry*, Brookings Institution, Chapter 4.
- Morrison, S. A., 2001, Actual, adjacent, and potential competition: Estimating the full effect of Southwest Airlines, *Journal of Transport Economics and Policy*, 35, 239-256.
- Murakami, H., 2011a, An empirical analysis of inter-firm rivalry between Japanese full-service and low-cost carriers, *Pacific Economic Review*, 16(1), 103-119.
- Murakami, H., 2011b, Time effect of low-cost carrier entry and social welfare in US large air markets, *Transportation Research Part E*, 47(3), 306-314
- Murakami, H. and R. Asahi, 2011. An empirical analysis of the effect of multimarket contacts on US air carriers' pricing behaviors, *Singapore Economic Review*, 56(4), 593-600.
- Oliveira, A.V.M., and C. Huse., 2009, Localized competitive advantage and price reactions to entry: Full-service vs. low-cost airlines in recently liberalized emerging markets, *Transportation Research Part E*, 45(2), 307-320.
- Oum, T. H., A. Zhang., and Y. Zhang, 1993. Inter-firm rivalry and firm-specific price elasticities in the deregulated airline markets, *Journal of Transport Economics and Policy*, 27, 171-192.
- Pitfield, D.E., 2005. Some speculations and empirical evidence on the oligopolistic behavior of competing low-cost airlines," *Journal of Transport Economics and Policy*, 39(3), 379-390.
- Pitfield, D.E., 2008. The Southwest effect: A time-series analysis on passengers carried by selected routes and a market share comparison, *Journal of Air Transport Management*, 14(3), 113-122.
- Vowles, T. W., 2000, "The effect of low fare air carriers on airfares in the US", *Journal of Transport Geography*, 8, 121-128.