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An Airline Merger and its Remedies: JAL-JAS of 2002*

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Abstract

This paper investigates the economic impacts of the merger between Japan Airlines (JAL) and Japan Air System (JAS) in October 2002 and its remedial measures. This paper performs simulation analyses using an estimated structural model in which airlines set both fares and flight frequencies on each route in the domestic market. By comparing supply models, the hypothesis that the merger caused a collusion among airlines is rejected. The marginal-cost estimates for the merging airlines significantly declined primarily through the expansion of its domestic network. The simulation estimates suggest that, although the merger increased the total social surplus for all domestic routes by 6.8%, it increased fares and decreased consumer surplus on the JAL–JAS duopoly routes. This paper also evaluates remedial measures associated with the merger.

Keywords: Horizontal merger, Remedial measures, Airline industry, Structural estimation

JEL classification: L11; L13; L93; L41; C51

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1 Introduction

Japan Airlines (hereinafter referred to as JAL) and Japan Air System (hereinafter referred to as JAS) merged in October 2002. During the year preceding the merger, domestic passenger market share was 25.3 percent for JAL and 23.8 percent for JAS, and they competed directly on 33 routes. On March 15, 2002, the Japan Fair Trade Commission (hereinafter referred to as JFTC) issued a concern (hereinto referred to as Decision 1) that the JAL–JAS merger plan, if implemented, would likely constitute a substantial restraint of competition within the domestic air passenger transport business (JFTC, 2002a). The merging airlines responded on April 23, 2002, stating that they would take remedial measures. On April 26, 2002, the JFTC officially announced its conclusion (hereinto referred to as Decision 2) that the proposed consolidation is unlikely to constitute a breach of Article 10 of the Antimonopoly Law as long as those remedial measures and the measures to promote competition envisaged by the Ministry of Land, Infrastructure, Transport and Tourism (hereinafter referred to as MLIT) are enacted (JFTC, 2002b).

The remedial measures primarily consist of measures to promote new entry and those concerning airfares. [1] Measures to promote new entry include returning nine takeoff-and-landing slots at Haneda Airport and offering airport facilities for new airlines. The measures concerning airfares include reducing normal fares (10 percent on all routes) and expanding discount fares. Although the measure regarding normal fares was initially scheduled to continue for at least three years from October 2002, it only ran until June 2003.

This paper estimates the economic impacts of the merger and the remedial measures using simulation analysis based on a structural model at the route level. This paper employs a structural model in which not only airfare but also flight frequency is endogenized. Mergers in the airline industry may influence flight frequency within a few years after a merger because airlines can revise flight frequency at short intervals. For example, from 2000 to 2005 in Japan, flight frequency was updated on average once every 1.5 years. Flight frequency affects airlines' operating costs of airlines and relates to consumer welfare. A higher flight frequency results in a higher possibility that passengers can travel on flights close to their desired departure and arrival times (Douglas and Miller, 1974). Furthermore, changing flight reservations becomes easier as flight frequency increases.

To investigate whether airlines began to collude after the merger and how the merger reduced

[1] In this paper, the term "measures to promote new entry" includes measures by both the merged company and the MLIT.

costs, we use data preceding and following the merger from 2000 to 2005. We compare oligopoly models using a test proposed by Rivers and Vuong (2002). The test rejects the hypothesis that the merger caused collusion between airlines. Estimates from marginal cost models suggest that the merger significantly reduced the marginal costs for the merging airline, and that this efficiency improvement was achieved primarily through an increase in the number of routes at each airport by integrating the JAL and JAS airline networks.

This paper then conducts a simulation analysis to compare the actual data and the counterfactual scenarios in which the merger had not occurred. The estimates reveal that, on domestic routes overall, the merger increased social surplus by 6.8 percent. On routes on which JAL and JAS directly competed before the merger and non-merging airlines also operated, fares decreased by an average of 1.0 percent and consumer surplus increased by 2.1 percent. However, on the JAL-JAS duopoly routes, fares increased by 1.6 percent on average and consumer surplus decreased by 1.7 percent.

These estimates of the merger effects include the effects of the measures used to promote new entry. New entries are estimated to significantly enhance consumer and social surplus on the routes entered. However, because new entries were observed on a limited number of routes, their impacts are not economically significant in the domestic airline market in Japan as a whole. The measures used to promote new entry increased social surplus as a whole by an estimated maximum of 1.5 percent.

This paper also evaluates the measures concerning airfares and their unplanned end in June 2003. If the measures had continued, the social surplus would have increased by an estimated 1.8 percent for the entire Japanese air transport market. Even on the JAL–JAS duopoly routes, the merger would have reduced airfares and increased consumer surplus if the remedial measures had continued. These results suggest that for the authority to allow the merging company to accelerate the end of the remedial measures was inappropriate from the viewpoint of social surplus. Additionally, a compulsory reduction in airfares was revealed to possibly reduce consumer surplus and social surplus when airlines are able to adjust their flight frequency.

The results suggest the following three points regarding the JFTC decision to approve the proposed merger under remedial measures. First, because the hypothesis that collusion occurred after the merger is rejected, no problem exists regarding the restrictions on competition through coordinated action. Second, as for the restraint of competition through unilateral conduct on a route on which JAL and JAS competed before the merger, no substantial restriction exists as long as non-merging airlines also operate on the route. Third, however, the remedial measures appear to be insufficient in addressing the restriction on competition resulting from the merger of the JAL–JAS duopoly routes. On the routes, relative to the case in which the merger did not occur, the merger increased fares and decreased consumer surplus after the fare measures ceased. The same results are confirmed from the analysis using only the data preceding Decision 1.

In merger analyses in markets with product differentiated goods, product characteristics are usually treated as exogenous (e.g., Nevo, 2000; Peters, 2006; Weinberg, 2011). Several studies have been conducted that analyzed the effects on product characteristics for hypothetical mergers, and those effects were noted as possibly being important in merger evaluations (e.g., Richard, 2003; Fan, 2013). [2] This paper analyzes a consummated merger using a structural model with an endogenous product characteristic. The results show that the merger had significant effects on the product characteristic.

A number of studies estimated the effects of airline mergers on airfare (e.g., Borenstein, 1990; Kim and Singal, 1993; Kwoka and Shumilkina, 2010). However, little is known of the effects of mergers on flight frequency. Using a structural model, this paper estimates the effects of a consummated merger on flight frequency. Although Richard (2003) studied the merger effects on flight frequency in a similar manner to that of this paper, that study estimated the effect of a hypothetical merger. Bilotkach (2011) analyzed the effects on flight frequency of the merger between US Airways and American West Airlines using a reduced form model of the difference-in-differences method. This paper's analysis clearly indicates that the merger increased flight frequency as a result of improvements in efficiency.

Regarding the JAL–JAS merger, Arai (2004) and Ito (2007) presented the details of the JFTC's decisions. Several papers empirically analyzed the merger's economic effects. For example, Ishioka, et al. (2007) estimated the effects on airfare with a reduced form model using post-merger data. This paper estimates the economic effects based on a structural model. Using structural estimation and pre- and post-merger data allows for an investigation of whether airlines began to collude after the merger and how the efficiency improvements were achieved. Quantitatively analyzing the effects on welfare as a result of the merger and remedies is also possible.

The remainder of this paper is organized as follows. Section 2 explains the sequence of events leading to the JAL–JAS merger and conducts preliminary analysis using airfare and flight frequency

[2]Regarding the effects on product positioning as a result of a merger there are studies related to both hypothetical mergers (Gandhi et al., 2008) and actual mergers (Sweeting, 2010).

data. Section 3 formulates the structural model. Section 4 explains the estimation results of the structural model and confirms the reproducibility of the model. Section 5 performs a simulation using the estimated model and quantitatively analyzes the effects of the merger. Section 6 estimates the effects of the remedies. Section 7 concludes this paper and is followed by the Data Appendix.

2 Background and Data

This section explains the background of the JAL–JAS merger. After discussing the circumstances surrounding the merger in Section 2.1, we examine the data on airfare and flight frequency in Section 2.2.

2.1 Background

In November 2001, JAL and JAS announced that they had agreed to a merger (JAL, 2001). The aim of the merger for JAL was said to be to expand domestic routes, whereas JAS's objective was management reconstruction (Sugiura, 2003). JAS's operating profits were in the black (approximately JPY 10 billion on average from 1998 to 2001), but its interest expense had reached the same level (close to JPY 9 billion on average).

In 2001, the share of the domestic passengers was 25.3 percent for JAL and 23.8 percent for JAS. Together with All Nippon Airways (hereinafter referred to as ANA), the three major companies accounted for 97.8 percent. In July 2001, of the 274 routes with scheduled flights in the Japanese domestic market, 166 routes were serviced by at least one of JAL and JAS. The 33 routes on which JAL and JAS directly competed are displayed in Figure 1. [3] Panel (A) shows the 27 routes operating under an oligopoly of three or more airlines, including JAL, JAS, and ANA. The monthly number of passengers exceeded 10,000 on all 27 routes, and exceeded 100,000 on 18 routes. Panel (B) shows the six routes under a JAL–JAS duopoly. No routes exceeded 100,000 passengers and four routes had less than 10,000 passengers. Of the 133 routes serviced by either JAL or JAS, 102 operated under a monopoly and the remaining 31 routes were duopolies with ANA.

The upper part of Table 1 shows the average number of passengers by route type. The average for the routes with JAL, JAS, and ANA is 158,100 and much larger than those for the other routes (16,900 for the JAL–JAS duopoly routes and 12,300 for the other routes). Therefore, the three

[3] In the JFTC's response to the prior consultation of the JAL–JAS merger, 32 routes were in direct competition between JAL and JAS (JFTC, 2002a) because JAS had halted service on the Fukuoka-Naha route at the time of the preliminary consultations. In this paper, we classify routes on the basis of their status as of July 2001, before agreement on the merger.

major airlines directly competed on routes commanding comparatively large demand, while the routes under JAL–JAS duopolies were those of relatively low demand.

On March 15, 2002, in response to a request for prior consultation, the JFTC expressed its concern that the planned consolidation, if implemented, would likely constitute a substantial restraint of competition within the domestic air passenger transport business (Decision 1). Specifically, the "domestic air passenger transport business" referred to realms covering (1) the entire domestic air transport market and air transport landing at Haneda Airport and Itami Airport, and (2) each domestic route (JFTC, 2002a). [4] Regarding the former, which includes the routes that were not in direct competition between JAL and JAS, concern over facilitating the fare-setting actions by major airlines was noted. In other words, a concern existed over a substantial restraint of competition through coordinated conduct. As for the latter, a substantial restraint of competition through unilateral conduct on the JAL–JAS routes was a concern.

In response to Decision 1, the concerned companies offered their intention to take remedial measures on April 23, 2002 (JAL, 2002a). The remedial measures consisted of those regarding airfares, those used to promote entry by new airlines, and others. The measures regarding airfares included a reduction in normal fares (a 10 percent reduction on all routes) and expanding discount fares. The measures to promote entry by new airlines included returning nine takeoff and landing slots at Haneda Airport, offering airport facilities for new airlines, and cooperating with new airlines by undertaking various services such as aircraft maintenance. The other remedial measures are related to expanding the route network and enhancing compliance with the Antimonopoly Law.

On April 26, 2006, the JFTC announced its conclusion that, on condition of these remedial measures and the competition promotion measures envisaged by the MLIT, the proposed consolidation is unlikely to constitute a breach of Article 10 of the Antimonopoly Law (Decision 2). Regarding the competition promotion measures, the MLIT envisaged creating "competition promotion slots" to be used by new airlines at Haneda Airport, including the nine slots returned by the merging airlines; undergoing an overall review of takeoff-and-landing slot allocation at Haneda Airport scheduled in February 2005; asking major airlines to cede to new airlines such airport facilities; and actively supporting new airlines by assisting in or undertaking various services (JFTC, 2002b). In particular, the review of slot allocation was evaluated to increase competitive pressure

[4] Because several other influential competitors existed in the international air passenger market and the international air cargo market, these markets were noted as not being the target of intense consideration. Additionally, because air cargo is transported with air passenger transport flights, the domestic air cargo market was not the target of intense consideration (JFTC, 2002a).

(Itoda, 2002).

JAL and JAS merged in October 2002. The JAL brand name remained and the JAS name ended after the merger. The merger integrated JAS's routes into JAL's network and increased the number of JAL's routes at each airport. We define the variable $nroute_{jrt}$ as the number of routes of airline j at the two endpoint airports of route r at time t. Figure 2 shows the trend in $nroute_{jrt}$ by airline and by route type. As shown in Figure 2, the average of $nroute_{jrt}$ of JAL-JAS rapidly increased by 20–65 percent after the merger. The increase in the number of routes at endpoint airports might enable JAL-JAS to have the opportunity to exploit the facilities and ground crews and to achieve lower costs. As for non-merging firms, the trend in $nroute_{jrt}$ did not change after the merger.

Figure 2 also shows the trends in characteristics of aircrafts used on each route: the number of seats ($seat_{jrt}$), operating weight (ow_{jrt}), and engine compression ratio (cr_{jrt}) of the aircraft used by airline j on route r at time t. As shown in Figure 2, their trends did not change after the merger.

In the remaining sections, the economic impacts of the merger and the remedies are investigated. From the perspective of assessing the commission's decisions, we note the following three points in particular. The first point is the restriction on competition on all domestic routes through coordinated conduct. The second point is the restriction on competition on the JAL–JAS routes through unilateral conduct. The third point is the efficacy of the remedies.

2.2 Data

Before the structural model analysis, this section conducts a preliminary analysis on airfare and flight frequency using monthly data by route and by airline from 2000 to 2005. The data period spans the date of the completion of the price deregulation on the domestic market (February 2000) to the scheduled expiration of a remedial measure related to normal fares (October 2005). The JFTC's "Guidelines to Application of the Antimonopoly Act Concerning Review of Business Combination" states that whether new market entry occurs within approximately two years in the case of price increases is a determinant for substantial restraint of competition caused by business combinations. In keeping with this notion of the guidelines, this paper examines the effect on competition by the merger up to a few years after the merger rather than analyzing long-term data. The appendix elaborates on the data.

Since the revision of the Civil Aeronautics Act in 2000, airfare and flight frequency for domestic routes are on a system of notification, thereby allowing airlines to essentially make their modifications freely. [5] According to this paper's data set, the average cycle for changes is once every 1.4 years for airfare and once every 1.5 years for flight frequency. [6]

Because flight frequency and airfare change every few years, the merger may affect not only airfare but also flight frequency even several years after its occurrence. Therefore, for the case in which passengers' welfare and airlines' profits depend on flight frequency, evaluating the merger by considering the effects on flight frequency is desirable. In the remainder of this subsection, we first review the changes in airfare and flight frequency in the data period. Next, we use the hedonic approach to verify whether or not passengers feel worthy of flight frequency.

Changes in Airfare and Flight Frequency First, we review the airfare data. The airfare variable used throughout this paper is the normal fare adjusted depending on the number of airlines operating each route. Published data on actual fares for the Japanese domestic routes before 2002 cannot be found. Therefore, we adjust the normal fare using the discount rate according to the number of operating airlines, which is calculated using the Travel Survey for Domestic Air Passengers (Koku Ryokyaku Dotai Chosa; in Japanese) for 2003 and 2005. Details regarding airfare data are explained in the appendix.

When comparing airfares between routes, controlling route distance is necessary. Table 2 indicates the changes in the "relative fares." Following Borenstein (1990), this term is defined as the rate of deviation from the industrial average fares for routes with the same distance. For industrial average fares, the predicted value from the model regressing fare on route distance is used. The regression is carried out separately for each period.

Table 2 shows the change in relative fares by route type. Route type is defined on the basis of operating airlines before the merger. Routes are then classified on the basis of whether or not the route saw entry by new airlines (e.g., Skymark Airlines) after the merger. The upper part of Table 2 reports relative fares for routes on which the merging airlines competed with ANA: routes with JAL, JAS, and ANA (LSA type), with JAL and ANA (LA type), and with JAS and ANA (SA type). The relative fare did not increase significantly on the LSA type routes. The changes (1.7 percent for routes without new entry and –9.2 percent for ones with it) are not significantly different from the corresponding values for LA or SA type routes (1.9 percent and –8.5 percent,

[5] However, changes to flight frequency for congested airports, such as Haneda Airport, remain on a permission system.

[6] Incidents of change are counted for changes greater than JPY 100 from the preceding period for airfare, and greater than 0.5 flights per day for flight frequency. To eliminate the effects of the merger, calculations are made by omitting the data for the year preceding and following the merger.

respectively). This finding suggests that, on competitive routes among the merging airlines and ANA, the effect of the reduction in the number of companies as a result of the merger was offset by improvements in efficiency.

The lower part of Table 2 reports relative fares for routes not serviced by ANA. On the JAL–JAS duopoly routes (LS type), fare levels increased significantly. The difference between that increase (5.6 percent) and the value for monopoly routes operated by either JAL or JAS (2.6 percent) is statistically significant. This finding suggests that as JAL–JAS duopoly routes became monopolies as a result of the merger, the effects of the reduction in the number of companies was significant and exceeded the effects of efficiency improvements.

Additionally, Table 2 suggests that fares decreased as a result of entry, although lacking statistical significance given the small number of applicable routes. Entries occurred on five routes of LSA type and on seven other routes. No entries on JAL–JAS duopoly routes occurred during the data period. The new entries occurred on routes with higher demand. As shown in the lower part of Table 1, the average number of passengers on the routes with new entries after the merger is 97,600 and much larger than the average across all domestic routes (about 30,000).

Next, Table 3 indicates changes in flight frequency. The passenger-weighted average of flight frequency (round trips per day) for each route was calculated, and the average of these weighted averages across routes is shown. On routes on which JAL and JAS competed before the merger, flight frequency increased after the merger by 1.7 to 1.9 for LSA type and by 1.1 for LS type. A decrease in competition as a result of the merger can be expected to lower service quality, namely, reduce flight frequency. One possible reason for the increase in flight frequency is improvements in efficiency resulting from the merger. In addition, the fact that no significant increase in flight frequency occurred on routes operated by either JAL or JAS (LA, SA, L, and S types) suggests the possibility that efficiency improved, particularly on JAL–JAS competitive routes.

We examined the changes in fares and flight frequency before and after the merger. However, shocks on demand and cost other than the merger are also reflected in these changes. Accordingly, in the following sections, we conduct simulations based on structural estimations that attempt to determine the effects of the merger and remedial measures under the form of controlling those shocks. Before we formulate the passenger demand model in the next section, at the end of this section we verify whether or not passengers feel worthy of flight frequency using the hedonic approach.

Hedonic Approach Flight frequency may affect passengers' welfare. The higher the flight frequency, the greater the possibility that passengers can travel on flights with departure and arrival times that suit their schedule (Douglas and Miller, 1974); furthermore, changes to flight reservations are easier. A number of existing studies (e.g., Richard, 2003) confirmed the positive effect of flight frequency on passenger demand.

For a preliminary analysis on the demand model estimation in subsequent sections, we estimate the following hedonic price function:

$$p_{jrt} = a_1 f_{jrt} + a_2 ftotal_{rt} + \boldsymbol{X'_{jrt}} \boldsymbol{a_3} + e_{jrt},$$

where subscript j represents the airline company, r represents the route, and t represents the period. p_{jrt} represents airfare, f_{jrt} represents flight frequency, $ftotal_{rt}$ represents the total flight frequency operated on route r during period t by all airline companies, $\boldsymbol{X_{jrt}}$ is a vector of other explanatory variables, and e_{jrt} is the error term. If passengers derive benefits from f_{jrt} and/or $ftotal_{rt}$, their coefficients are estimated as being positive.

Table 4 provides the estimated results based on the ordinary least-squares (OLS) method. In (4-1) $\boldsymbol{X_{jrt}}$ includes route distance ($dist_r$), dummy variables for each airline, and dummy variables for each month. In (4-2) and (4-4), a dummy variable ($dnew_{rt}$) is included that takes the value of 1 if new airlines operate on route r during period t and 0 otherwise. [7] To mitigate the problems associated with omitted-variable bias, dummy variables representing each route are added in the estimations shown in (4-3) and (4-4). [8]

In all of the estimations, although the coefficient for f_{jrt} is significantly positive, the coefficient for $ftotal_{rt}$ is not positive. This result suggests that, in terms of passenger benefits, the flight frequency for each airline is of higher importance than the flight frequency for all companies combined. A conceivable explanation of this result is the tendency for competing airlines to set their departure and arrival times close to each other (Borenstein and Netz, 1999; Salvanes et al., 2005) and the fact that changes to flight reservations are only possible primarily within the same airline. The coefficient for $ftotal_{rt}$ was estimated to be negative because it represents the degree of competition on the route given the value of f_{jrt}. If a variable representing the degree of competition, $dnew_{rt}$, is added, the coefficient for $ftotal_{rt}$ approaches zero and its statistical significance decreases. The

[7] In the estimation of a hedonic function of an oligopolistic market, variables related to market power are added to the explanatory variables (e.g., Feenstra, 1995; Anstine, 2004).

[8] Triplett (2006) thoroughly explained the issue of omitted variables in the hedonic approach.

coefficient for $dnew_{rt}$ is estimated to be significantly negative, suggesting that the entrance of new airline companies into the market lowers airfares.

From these results, flight frequency is suggested as having a positive impact on passengers' welfare. In subsequent sections, we formulate a demand model and more formally estimate the relationship between passenger demand and flight frequency. We then estimate the effects of the merger and remedies by considering the effects not only on airfare but also on flight frequency.

3 Model

This section describes the structural model used to explain the Japanese air travel market. Subsection 3.1 introduces a supply model in which airlines choose both airfare and flight frequency on each route. Subsection 3.2 introduces a nested logit model of the demand for air transport services on each route. Subsection 3.3 describes the procedures used to estimate the structural model. The estimation results are discussed in the subsequent section.

3.1 Supply Model

Airlines decide airfare and flight frequency. We consider four oligopoly models with different airlines' objectives. In the first model ("Nash"), an airline maximizes its own profits. Typically, this model is used in the structural estimation analysis on the airline industry (e.g., Berry and Jia, 2010). The second model ("Collusion") assumes collusion across airlines throughout the data period from April 2000 to October 2005. In this model, airlines maximize their joint profits. In the third and fourth models, airlines are assumed to collude during a limited period. In the third model ("Mix 1"), airlines collude throughout the post-merger period, after October 2002. The fourth model ("Mix 2") assumes collusion during the period from October 2002 to February 2005, before the MLIT reallocated landing slots at Haneda Airport. Among these four models, we choose a model to use for simulation analyses by comparing each model's fit with the data. The details on the model comparison are explained in Subsection 3.3.

On route r ($r = 1, 2, \cdots, R$) in time t ($t = 1, 2, \cdots, T$), the profit of airline j ($j = 1, 2, \cdots, J_{rt}$) [9] is given by:

$$\pi_{jrt} = \left(p_{jrt} - MC^{Q}_{jrt} - AFC^{Q}_{jrt}\right) q_{jrt}(\boldsymbol{p}_{rt}, \boldsymbol{f_{rt}}) - \left(MC^{F}_{jrt} + AFC^{F}_{jrt}\right) f_{jrt} \tag{1}$$

[9] In this paper we assume that airlines set airfare and flight frequency independently across routes, as in previous studies (e.g., Richard, 2003; Peters, 2006; Berry and Jia, 2010).

where p_{jrt} represents airfare; f_{jrt} represents flight frequency; $q_{jrt}(\cdot)$ represents the passenger demand function; $\boldsymbol{p_{rt}}$ and $\boldsymbol{f_{rt}}$ are vectors for airfares and flight frequencies, respectively, of all airlines that operate on route r at time t; MC^{Q}_{jrt} and MC^{F}_{jrt} represent marginal costs with respect to the number of passengers and flight frequency, respectively. Airport charges are represented by AFC^{Q}_{jrt} and AFC^{F}_{jrt}. The sum of the per-passenger charges, including security charges and passenger service facility charges, is denoted by AFC^{Q}_{jrt}. The sum of the per-flight charges, including landing fees and facility usage fees for aids to navigation, is denoted by AFC^{F}_{jrt}.

Suppose first that an airline on route r in time t chooses its fare and flight frequency to maximize its own profit. The first-order conditions are as follows:

$$q_{jrt}(\cdot) + \left(p_{jrt} - MC^{Q}_{jrt} - AFC^{Q}_{jrt}\right)\frac{\partial q_{jrt}(\cdot)}{\partial p_{jrt}} = 0, \tag{2}$$

$$\left(p_{jrt} - MC^{Q}_{jrt} - AFC^{Q}_{jrt}\right)\frac{\partial q_{jrt}(\cdot)}{\partial f_{jrt}} - MC^{F}_{jrt} - AFC^{F}_{jrt} = 0. \tag{3}$$

Suppose next that airlines on route r in time t collude and choose their fares and flight frequencies to maximize their joint profits. The first-order conditions are as follows:

$$q_{jrt}(\cdot) + \left(p_{jrt} - MC^{Q}_{jrt} - AFC^{Q}_{jrt}\right)\frac{\partial q_{jrt}(\cdot)}{\partial p_{jrt}} + \sum_{k\neq j}\left(p_{krt} - MC^{Q}_{krt} - AFC^{Q}_{krt}\right)\frac{\partial q_{krt}(\cdot)}{\partial p_{jrt}} = 0, \tag{4}$$

$$\left(p_{jrt} - MC^{Q}_{jrt} - AFC^{Q}_{jrt}\right)\frac{\partial q_{jrt}(\cdot)}{\partial f_{jrt}} - MC^{F}_{jrt} - AFC^{F}_{jrt} + \sum_{k\neq j}\left(p_{krt} - MC^{Q}_{krt} - AFC^{Q}_{krt}\right)\frac{\partial q_{krt}(\cdot)}{\partial f_{jrt}} = 0. \tag{5}$$

In this case, each airline takes into account the effects of a change in fare and flight frequency on the profits of other airlines.

The first-order conditions, (2)–(5), are summarized in vector notation as (6) and (7):

$$\boldsymbol{q} + \Delta^{p}(\boldsymbol{p}, \boldsymbol{f})(\boldsymbol{p} - \boldsymbol{MC^{Q}} - \boldsymbol{AFC^{Q}}) = \boldsymbol{0} \tag{6}$$

$$\Delta^{f}(\boldsymbol{p}, \boldsymbol{f})(\boldsymbol{p} - \boldsymbol{MC^{Q}} - \boldsymbol{AFC^{Q}}) - \boldsymbol{MC^{F}} - \boldsymbol{AFC^{F}} = \boldsymbol{0}. \tag{7}$$

Note that $\boldsymbol{A} \equiv (\boldsymbol{A}_{11}, \boldsymbol{A}_{21}, \cdots, \boldsymbol{A}_{RT})'$, where $\boldsymbol{A}_{rt}$ is a row vector of $(A_{1rt}, A_{2rt}, \cdots, A_{J_{rt}rt})$ and A is either p, f, q, MC^{Q}, MC^{F}, AFC^{Q}, or AFC^{F}. $\Delta^{B}(\cdot)$, where B is either p or f, is defined as $diag\left(\Delta^{B}_{11}(\boldsymbol{p}_{11}, \boldsymbol{f_{11}}), \Delta^{B}_{21}(\boldsymbol{p}_{21}, \boldsymbol{f_{21}}), \cdots, \Delta^{B}_{RT}(\boldsymbol{p}_{RT}, \boldsymbol{f_{RT}})\right)$, where $\Delta^{B}_{rt}(\cdot)$ is a J_{rt} by J_{rt} matrix with

(j, k) element

$$\begin{cases} \frac{\partial q_{jrt}(\cdot)}{\partial B_{jrt}}, & \text{if } j = k \text{ or airlines maximize joint profits on route } r \text{ in time } t; \\ 0, & \text{otherwise.} \end{cases} \tag{8}$$

We consider the following marginal cost model:

$$\ln(MC^Q_{jrt}) = b^Q_1 \ln(seat_{jrt}) + b^Q_2 \ln(cr_{jrt}) + b^Q_3 \ln(nroute_{jrt}) + \psi^Q_r + \omega^Q_j + \eta^Q_t + e^Q_{jrt}, \tag{9}$$

$$\ln(MC^F_{jrt}) = b^F_1 \ln(ow_{jrt}) + b^F_2 \ln(cr_{jrt}) + b^F_3 \ln(nroute_{jrt}) + \psi^F_r + \omega^F_j + \eta^F_t + e^F_{jrt}, \tag{10}$$

where ψ^X_r, ω^X_j, and η^X_t denote route-, airline-, and time-specific components of marginal costs, and e^X_{jrt} is the error term (X represents either Q or F). In estimating the model, route-, airline-, and time-specific dummy variables are used to control the specific components.

The model includes aircraft characteristics: the number of seats ($seat_{jrt}$), operating weight (ow_{jrt}), and engine compression ratio (cr_{jrt}) of the aircraft used by airline j on route r at time t. A higher number of seats per flight results in an expected lower marginal cost for passengers (MC^Q_{jrt}) including costs for ticketing, luggage handling, and cabin services. A heavier airplane is expected to result in a higher marginal cost with respect to flight (MC^F_{jrt}) because a flight consumes more fuel to fly. Because the compression ratio of an engine is positively related to fuel efficiency, it is expected to have a negative correlation with both MC^Q_{jrt} and MC^F_{jrt}.

As a variable representing hub effects, the model includes the number of routes of airline j at the two endpoint airports of route r ($nroute_{jrt}$). Existing studies showed that a higher number of routes of an airline at an airport results in lower marginal costs at that airport (e.g., Berry, 1990). The large number of routes at an airport might enable an airline to have the opportunity to exploit the facilities and ground crews at the shared airport and to achieve lower costs.

This paper's supply model is noted as omitting slot constraints at Haneda Airport because adding the constraint to the model makes identifying its Lagrange multiplier from the route fixed effects on the routes to/from Haneda Airport (e.g., the reduction in costs attributable to a hub premium) difficult. When we estimate the value of MC^F_{jrt} in the manner explained in Subsection 3.3, omitting the constraints might cause an overestimation of MC^F_{jrt} for routes to/from Haneda Airport. However, this overestimation problem is likely to have little influence on the conclusions of this paper because the marginal cost model (10) include route-specific components and can control the overestimation on routes to/from Haneda Airport. [10]

3.2 Demand Model

This subsection describes a nested logit model of the demand for air travel services on Japanese domestic routes. Each individual decides whether or not to travel by air on a route and, if travelling by air, the airline to use. The set of alternatives consists of operating airlines on the route and the outside option, i.e., not travelling by air. Individual i is assumed to maximize the following indirect utility on route r in time t by choosing airline j or the outside option ($j = 0$):

$$u_{ijrt} = \alpha p_{jrt} + \beta f_{jrt}^{\rho} + \boldsymbol{x}'_{jrt}\boldsymbol{\gamma} + \xi_{jrt} + \nu_{irt} + (1-\sigma)\epsilon_{ijrt}, \tag{11}$$

where p_{jrt} represents airfare, f_{jrt} represents flight frequency, and $\boldsymbol{x}_{jrt}$ is the vector of other control variables, including route distance, its squared and cubed terms, airline-specific dummy variables, and month-specific dummy variables. The utility function contains ξ_{jrt}, an unobserved (by an econometrician) quality of airline j (e.g., passengers' evaluation of the safety level) with $E(\xi_{jrt}) = 0$. The last two terms of (11) represent the nest structure. We place airlines in one nest and the outside option in another nest. We assume that ϵ_{ijrt} independently follows the Type I Extreme Value distribution and that ν_{irt} is distributed such that $\nu_{irt} + (1-\sigma)\epsilon_{ijrt}$ also follows the Type I Extreme Value distribution. Cardell (1997) showed that such a distribution of ν_{irt} exists and is unique for each value of $\sigma \in [0, 1)$. The parameter σ is estimated and measures the correlation in the unobserved individual-specific utility between airlines. When σ is zero, the model is a standard logit model. As σ approaches 1, the substitutability among airlines becomes high. We normalize the mean utility from the outside option to 0, as is typical in the literature.

The higher the flight frequency, the higher the possibility that passengers can travel on flights with departure and arrival times that suit their schedules (Douglas and Miller, 1974); furthermore, changes to flight reservations are easier. Hence, as flight frequency increases, a passenger's utility is likely to increase. Therefore, it is expected that $\beta\rho > 0$. However, the utility increase from an increase in flight frequency is expected to gradually diminish (cf. Brueckner, 2004), that is, $\rho < 1$ when $\beta\rho > 0$. Subsequently, we estimate both β and ρ.

[10] Indeed, when we conduct analyses using the data set excluding routes to/from Haneda Airport, the main results subsequently discussed do not change significantly.

The passenger demand function for airline j on route r in time t is as follows (cf. Berry, 1994):

$$q_{jrt}(\boldsymbol{p_{rt}}, \boldsymbol{f_{rt}}) = M_{rt} \frac{\exp\left(\frac{\alpha p_{jrt} + \beta f_{jrt}^{\rho} + \boldsymbol{x}_{jrt}' \boldsymbol{\gamma} + \xi_{jrt}}{1-\sigma}\right)}{V_{rt}^{\sigma}\left(1 + V_{rt}^{1-\sigma}\right)}, \tag{12}$$

where M_{rt} is potential market size. The fraction multiplied by M_{rt} represents the probability of a passenger selecting airline j, where $V_{rt} \equiv \sum_{k \in J_{rt}} \exp\left(\frac{\alpha p_{krt} + \beta f_{krt}^{\rho} + \boldsymbol{x}_{krt}' \boldsymbol{\gamma} + \xi_{krt}}{1-\sigma}\right)$.

3.3 Estimation Procedure

We estimate the parameters of the marginal cost models (9) and (10) and the demand model (11) using monthly data by route and by airline in the Japanese domestic market. The appendix provides a detailed explanation of the data.

Supply Estimation We estimate the marginal cost model for each supply model (Nash, Collusion, Mix 1, or Mix 2) and compare the data fit among the four supply models to select a model used in the simulation analyses to evaluate the merger and the remedies (cf. Villas-Boas, 2007; Bonnet and Dubois, 2010). To estimate the cost model, the marginal cost values with respect to passengers (MC_{jrt}^{Q}) and flight frequency (MC_{jrt}^{F}) are required. Although the data on marginal costs by route are not published, we estimate their values using the first-order conditions of airlines' maximization problem (cf. Peters, 2006; Berry and Jia, 2010). Specifically, we solve for MC_{jrt}^{Q} and MC_{jrt}^{F} using the system of equations (6) and (7) into which the demand estimates and the data on airfare and flight frequency are substituted. We then estimate the parameters of the marginal cost models using the OLS method. Note that we exclude from the sample the period from October 2002 to June 2003 in estimating the supply models. During this period, as normal airfares of the merging companies were fixed as part of the remedial measures, the first-order conditions of the maximization problem were unlikely to be satisfied. Therefore, estimating the marginal cost values in the previously described procedure is impossible.

We compare the fit of each supply model using the test proposed by Rivers and Vuong (2002) (hereinafter referred to as the Rivers-Vuong test). This pairwise test first calculates the value of a lack-of-fit criterion for each supply model and then tests the difference in the values between two models. The lack-of-fit criterion used below ($Q_n^h(\boldsymbol{b}^h)$) is as follows:

$$Q_n^h(\boldsymbol{b}^h) = \frac{1}{n} \sum_{jrt} \left\{ \left(\hat{e}_{jrt}^{Qh} \right)^2 + \left(\hat{e}_{jrt}^{Fh} \right)^2 \right\}, \tag{13}$$

where $\boldsymbol{b}^h$ is the set of parameters of model h, n represents the sample size, and $\hat{e}_{jrt}^{Qh}$ and $\hat{e}_{jrt}^{Fh}$ are the residuals of the marginal cost models (9) and (10) in supply model h. Under the null hypothesis that the difference between $Q_n^h(\boldsymbol{b}^h)$ and $Q_n^{h'}(\boldsymbol{b}^{h'})$ converges to zero, the test statistics T follows an asymptotically normal distribution (Rivers and Vuong, 2002):

$$T = \frac{\sqrt{n}}{\hat{\sigma}_n^{hh'}} \left\{ Q_n^h(\hat{\mathbf{b}}^h) - Q_n^{h'}(\hat{\mathbf{b}}^{h'}) \right\}, \tag{14}$$

where $\hat{\boldsymbol{b}}^h$ is the estimate of $\boldsymbol{b}^h$ and $\left(\hat{\sigma}_n^{hh'}\right)^2$ is the estimator of the asymptotic variance between the difference of $Q_n^h(\boldsymbol{b}^h)$ and $Q_n^{h'}(\boldsymbol{b}^{h'})$. We compare the value of T to the critical values of the standard normal distribution. If that value is significantly negative, model h' is rejected against model h. If it is significantly positive, model h is rejected against model h'.

Demand Estimation Following Berry (1994), we derive a linear regression model for the nested logit model previously described:

$$\ln(s_{jrt}) - \ln(s_{0rt}) = \alpha p_{jrt} + \beta f_{jrt}^{\rho} + \boldsymbol{x}'_{jrt}\gamma + \sigma \ln(\bar{s}_{jrt}) + \xi_{jrt},$$

where s_{jrt} denotes the market share of airline j, s_{0rt} represents the market share of the outside option, and $\bar{s}_{jrt}$ denotes the share of the passengers choosing airline j among all individuals who choose to travel by air. The market share of airline j on route r is defined as the ratio of the number of passengers of j to the potential market size, M_{rt}, which is assumed to be the geometric mean of the populations of the prefectures in which the endpoint airports of route r are located, as in previous studies (e.g., Peters, 2006). [11] We estimate the demand parameters using a generalized method of moments (GMM) with the population moment condition of a product of ξ_{jrt} and exogenous variables.

We employ cost-related variables and airport charges as instruments. The set of instruments includes aircraft characteristics: the number of seats ($seat_{jrt}$), operating weight (ow_{jrt}), and engine

[11] The demand estimation results are robust to the definition of potential market size. For example, when market size is multiplied by 0.6, 2, or 5, we obtain very similar results.

compression ratio (cr_{jrt}) of the aircraft used by airline j on route r in time t. The set also contains fuel price ($fuel_t$). The interaction terms between fuel price and aircraft characteristics are added into the set of instrumental variables because the impact of fuel price changes is likely to depend on the aircraft used.

We also include airport charge variables in the set of instruments. The rate of per-passenger charges, AFC^Q_{jrt}, is expected to be correlated positively to airfare and negatively to flight frequency. As the rate of per-flight charges, AFC^F_{jrt}, appears in (7), the first-order condition with respect to flight frequency, AFC^F_{jrt} is expected to be negatively correlated to flight frequency.

4 Estimation Results

This section describes the estimation results of the structural model. Subsections 4.1 and 4.2 explain the results for the demand and supply models, respectively. Subsection 4.2 indicates that the null hypothesis that airlines colluded during the data period is rejected and that the JAL–JAS merger generated a significant improvement in the efficiency of the merging airlines. Subsection 4.3 confirms the fit of the estimated structural model.

4.1 Demand Estimates

Table 5 indicates the estimation results of the demand model. In (5-1) p_{jrt}, f_{jrt}, and $\bar{s}_{jrt}$ are treated as exogenous variables. [12] In (5-2), these variables are treated as endogenous variables, and the parameters are estimated using the GMM with the instrumental variables introduced in subsection 3.3. The first-stage F-statistic for the explanatory power of the instruments conditional on the included exogenous variables is 129.2 on average, indicating that the instruments are not weak. The chi-squared statistic tests the validity of the instruments conditional on the existence of a set of valid instruments that just identify the model. The value of the chi-squared statistic is not large enough to reject the orthogonality condition at the 1 percent level. The finite-sample size of the test in small samples is known to far exceed the normal size, i.e., the test too frequently rejects (Hayashi, 2000). Subsequently, we use the estimates in (5-2).

The price coefficient, α, is negative and significantly different from zero. The price coefficient moves from -0.007 in (5-1) to -0.082 in (5-2). This result is consistent with the expected upward bias owing to the positive correlation between the price measure and the error term, which is well

[12] To estimate the exponent of flight frequency, ρ, the squared term of f_{jrt} is added to the set of exogenous variables in the GMM estimation in (5-1).

documented in the literature. The average of own-price elasticities, calculated using the estimates in (5-2), is -1.85. This result is similar to those reported by previous studies that estimated air travel demand using a discrete choice model. For example, the average of own-price elasticities are reported in the range from -1.5 to -2.8 by Armantier and Richard (2008), approximately -2.0 by Berry and Jia (2010), and in the range from -3.2 to -4.0 by Peters (2006).

Both the coefficient and the exponent of flight frequency are significantly negative, suggesting a positive marginal utility from flight frequency. Because the exponent is less than 1, the marginal utility is decreasing. The average flight frequency elasticity is 0.88. Adding one daily departure to all airlines on all routes increases aggregate demand by 16 percent. From a similar analysis, Berry and Jia (2010) reported that the aggregate demand in the domestic market of the United States is driven by 6–16 percent.

The nest parameter, σ, is estimated to be 0.08. As σ approaches 1, the substitutability among airlines becomes high. The nest parameter is significantly less than 1 at the 1 percent level, suggesting that other transport modes are relevant substitutes for air transport in Japan, which is a small country and has a developed network of highways and high-speed rails. The transportation mode share for air passengers in Japan was 5.9 percent (based on passenger-kilo) in 2005, suggesting that airlines compete with other transport modes on many routes. For example, the nest parameter for the domestic market in the United States was estimated to be 0.405 in Peters (2006) and 0.416 in Wei and Hansen (2005).

4.2 Supply Estimates

The marginal cost values are obtained by substituting demand estimates into the first-order conditions of the maximization problem of airlines. Because the first-order conditions are different across supply models, the obtained marginal cost values also differ. This subsection first confirms the validity of the marginal cost values, and then estimates the cost model parameters and compares the data fit across supply models.

To confirm the validity of the marginal cost values, we calculate the per passenger cost as follows:

$$ac_{jrt} = MC^{Q}_{jrt} + \frac{\left(MC^{F}_{jrt} + AFC^{F}_{jrt}\right) f_{jrt}}{q_{jrt}}.$$

We then compare this cost with the per passenger cost calculated as in Brander and Zhang (1990):

$$ac_{jrt}^{BZ} = cpkm_{jt} \left(\frac{dist_r}{avedist_{jt}} \right)^{-\theta} dist_r,$$

where $cpkm_{jt}$ represents the unit cost, that is, the operating cost per passenger-kilometer of airline j at time t, $dist_r$ represents the route distance, $avedist_{jt}$ represents the average of the route distance of airline j at time t, and θ is the (positive) elasticity of $cpkm_{jt}$ with respect to distance. Brander and Zhang (1990) take $\theta = 0.5$ as their base case value for θ and conduct sensitivity analyses using other elasticity values (0.25 and 0.75).

Table 6 indicates the summary statistics of ac_{jrt} and ac_{jrt}^{BZ}. The values of ac_{jrt}^{BZ} depend on the value of θ. The means of ac_{jrt} are similar to that of ac_{jrt}^{BZ} with $\theta = 0.75$. Whereas the per passenger cost is positive for all observations for the model in which airlines maximize their own profit (Nash), it is estimated to be negative for a part of the sample for the supply models with collusion periods (Collusion, Mix1, and Mix2).

The dispersion of values is larger for ac_{jrt} than for ac_{jrt}^{BZ}. For ac_{jrt}^{BZ}, route distance is the only source of the difference in values across routes. However, existing studies showed that costs depend on aircraft type (e.g., Wei and Hansen, 2003) and are affected by hub effects (e.g., Berry, 1990). If these cost differences influence fares, ac_{jrt} is likely to reflect them. Indeed, Table 6 indicates that ac_{jrt} has negative correlation coefficients with the size of an aircraft and with the number of routes of an airline at endpoint airports, although ac_{jrt}^{BZ} has positive or near zero correlation coefficients with them. Figure 3 displays the distributions of ac_{jrt} of Nash and ac_{jrt}^{BZ}, suggesting that ac_{jrt} is distributed more widely than ac_{jrt}^{BZ}. The Kolmogorov-Smirnov test rejects the equality of distributions.

Using the marginal costs estimated from the first-order conditions, we estimate the marginal cost models for each supply model. Table 7 provides the results of the Rivers-Vuong test that compared the data fit of the marginal cost models across the four supply models. To take into account the fact that marginal costs have been estimated after the estimation of the demand model, Table 7 indicates in parentheses the standard errors of the test statistics calculated from the bootstrap using 100 replications. Even if the tests need not be transitive, we see that Nash is the best one because its row statistic estimates are always negative and lower than the 1 percent negative critical value of a normal test for which T is different from 0. Therefore, the hypothesis that airlines began to collude after the merger is rejected. In subsequent sections, the Nash model is employed for simulations that evaluate the merger and remedies.

Table 8 indicates the estimation results of the marginal cost models for Nash. Models (8-1) and (8-3) are for marginal costs with respect to passengers and for marginal costs with respect to flights, respectively. In both models, the coefficient of the number of routes at endpoint airports is significantly negative, as in existing studies (e.g., Berry, 1990; Berry and Jia, 2010; Aguirregabiria and Ho, 2012). The models have the expected signs for the coefficients of the number of seats and the operating weight of aircrafts.

The coefficient of the $nroute_{jrt}$ variable can be interpreted as capturing integration of networks of JAL-JAS, a source of efficiency improvement. As shown in Figure 2, the merger integrated JAS's routes into JAL's network and increased the number of JAL's routes at each airports. We assume that in the absence of the merger the value of JAL's $nroue_{jrt}$ on a route would have been the same as its value on the given route in the pre-merger period. Under this assumption, the merger increased JAL's $nroute_{jrt}$ by an average 50.1 percent on the JAL-JAS routes, by 64.5 percent on the JAL routes, and by 21.3 percent on the JAS routes. Because the number of domestic routes is 81 for JAL and 118 for JAS before the merger, the increase in $nroute_{jrt}$ is larger on JAL's routes than on JAS's routes. The trend in $nroute_{jrt}$ of non-merging firms did not change after the merger as shown in Figure 2.

The lower part of Table 8 reports the estimates of the productivity improvements from the merger, averaged over routes. We estimate the effect of the merger on marginal costs through network integration by taking the difference in values for $nroute_{jrt}$ between the actual and counterfactual scenarios. In model (8-1), the merger reduced marginal costs with respect to passengers by 3.6 percent on routes on which JAL and JAS competed directly, by 4.1 percent on the routes on which JAL operated but JAS did not, and by 1.7 percent on routes on which JAS operated but JAL did not. In model (8-3), the marginal cost with respect to flight frequency is estimated to decrease by 6.1 percent on JAL–JAS competitive routes, 6.9 percent on JAL routes, and 2.8 percent on JAS routes.

The productivity improvements from the merger are equivalent to JPY 28 billion per year. JAL stated that before the merger, the integration would reduce its cost by JPY 73 billion per year (JAL, 2002b). This cost reduction effect was supposed to be achieved gradually. After the integration, JAL stated that the cost reduction effects in 2003 amounted to JPY 17.5 billion and predicted that those in 2004 and 2005 would be JPY 47 billion and JPY 62 billion, respectively (JAL, 2004).

As cost-reduction effects generated by the integration, JAL expected the following five points (JAL, 2001). The first point is the effective usage of aircraft, airport facilities, and information systems. The second point is a reduction in aircraft and maintenance costs. The third point is job reduction. The fourth point is strengthening the negotiation power regarding outsourcing. The fifth point is a reduction in capital costs. The first four points appear to relate to the number of routes at each airport.

The estimated coefficient on $nroute_{jrt}$, however, might understate the overall efficiency gained from the merger: while network integration represented a significant gain, it was probably not the only aspect of efficiency that improved through the merger. We thus re-estimate equations (9) and (10) while replacing $nroute_{jrt}$ with a dummy variable that indicates the JAL-JAS merger. We consider the following marginal cost model:

$$\ln(MC^X_{jrt}) = b^X postJAL_{jt} + \omega^X_j + \eta^X_t + JJcomp_r(\tilde{b}^X postJAL_{jt} + \tilde{\omega}^X_j + \tilde{\eta}^X_t) + \psi^X_r + e^X_{jrt}, \quad (15)$$

where X represents either Q or F, $postJAL_{jt}$ is a dummy variable that takes the value of 1 for JAL in the post-merger period and 0 otherwise, [13] $JJcomp_r$ is a dummy variable that takes the value of 1 on the routes on which JAL and JAS directly competed before the merger and 0 otherwise, ω^X_j and η^X_t denote airline- and time-specific components of marginal costs, $\tilde{\omega}^X_j$ and $\tilde{\eta}^X_j$ denote the specific components added onto the routes on which JAL and JAS competed, ψ^X_r denotes the route-specific components, and e^X_{jrt} is the error term. In estimating the model, route-, airline- and time-specific dummy variables are used to control the airline- and time-specific components.

This model represents the impacts of the merger on marginal costs in the spirit of the difference-in-differences approach. The fixed effects of cost differences across airlines are controlled by ω^X_j. The macro shocks that affect all airlines' costs are controlled by η^X_t. Therefore, the coefficient of $postJAL_{jt}$ represents the cost shock specific to JAL after the merger and can be interpreted as the impact of the merger on the merging airlines. If the merger improved efficiency, the coefficient is negative.

The impacts of the merger on costs, if any, might differ across routes. In the previously described marginal cost model, the part of the parenthesis multiplied by $JJcomp_r$ allows for a possible difference in merger effects across routes. In the parenthesis, the terms $\tilde{\omega}^X_j$and $\tilde{\eta}^X_t$ control the differences in fixed effects and macro shocks, respectively, between the routes on which JAL and

[13] The JAS brand disappeared after the merger.

JAS directly competed before the merger and the other routes. Therefore, the difference in the merger effects across routes is represented by $\tilde{b}^X$. If efficiency improved particularly on the JAL-JAS competitive routes, then $\tilde{b}^X$ is negative.

In summary, the merger effects on marginal costs in model (15) are represented as follows: $b^X + \tilde{b}^X$ for the routes on which JAL and JAS competed before the merger, b^X for the routes on which JAL operated but JAS did not, and b^X plus the difference between the coefficients of the JAS-specific dummy variable and the JAL-specific dummy variable for routes on which JAS operated but JAL did not.

Columns (8-2) and (8-4) in Table 8 show the estimation results of (15). In model (8-2), the estimated coefficients indicate that the merger decreased the marginal cost with respect to passengers by 2.3–6.3 percent. In model (8-4), the marginal cost with respect to flights is estimated to decrease by 0.2–4.9 percent. These figures are similar to those in (8-1) and (8-3).

4.3 Model Fit

This subsection confirms the fit of the structural model. First, we examine whether the second-order conditions of the maximization problem are satisfied. For the estimated structural model, the second-order conditions are satisfied for 99 percent of the observations. Additionally, they are satisfied for most observations in the simulations in subsequent sections.

Second, to examine how the model can reproduce the data, we calculate the values predicted by the model and compare them to the actual data. The predicted values are obtained as follows. We substitute the demand estimates and the marginal cost estimates into the first-order conditions (6) and (7) and solve the system of equations for airfare and flight frequency. Then, we substitute them into the demand function (12) and predict the number of passengers.We use as the marginal cost values the fitted values of the marginal cost models (9) and (10).

Figure 4 compares the predicted values and the data on airfare, flight frequency, and number of passengers by route type: the routes on which JAL and JAS competed directly before the merger (JAL & JAS), the routes on which one of either JAL or JAS operated (JAL or JAS), and the other routes (Other). Figure 4-3 suggests that the structural model predicts the data well because the differences in means across route types are reproduced and the correlation coefficients of the predicted and actual values are high within each route type. In Sections 5 and 6, we use this structural model for simulation analysis.

5 Effects of the Merger

This section simulates counterfactual scenarios in which the JAL–JAS merger did not occur and estimates the economic impacts of the merger by comparing the results of the simulation with the actual data. Subsection 5.1 describes the simulation setting, and subsection 5.2 explains the results. The data from the period after the merger are used in this simulation analysis. However, the competition authorities must judge the benefits and challenges of the merger in advance, under the condition that the post-merger data are not available. In subsection 5.3, the data set is limited to the period before the time of Decision 1 and is reanalyzed to investigate the extent to which the effects of the merger could be anticipated in advance. The effects of the remedial measures are discussed in the next section.

5.1 Simulation Setting

In reality, JAL and JAS merged in October 2002. To estimate the economic consequences of the merger, we compare the reality and the counterfactual scenarios in which this merger did not occur. The merger effects are estimated for the period after July 2003, when a remedial measure of the reduction in normal fares was terminated. The effects of the remedy are investigated in the next section. The counterfactual scenarios are simulated using the estimated structural model. The fares and flight frequency in the virtual situation are calculated by numerically solving the simultaneous equations consisting of the first-order conditions of (6) and (7).

The main differences between reality and the virtual scenarios are the marginal costs of the merged company and the set of operating airlines. The marginal costs in the virtual scenarios are assumed to be the values in reality plus the effects of improved efficiency. Specifically, these costs are obtained by replacing $nroute_{jrt}$ with its pre-merger value in the marginal cost models (9) and (10).

Regarding the set of operating airlines in the virtual scenarios, two types of scenarios are considered on the basis of the fact that JAS aimed to rebuild its business through the merger: the "JAS survival" scenario and the "JAS bankruptcy" scenario. In the JAS survival scenario, even if the merger with JAL had not occurred, JAS was assumed to have survived and continued in business. In the JAS bankruptcy scenario, JAS was assumed to have exited from the market if no merger had occurred.

Although both scenarios—the JAS survival and the JAS bankruptcy—are simulated, particular attention is paid to the results of the JAS survival scenario. The following two facts indicate that for JAS to have survived even if the merger had not taken place is highly possible. The first fact is that, although JAS was suffering between 1998 and 2001 from the size of its interest-bearing debt, its operating profits were in the black. The second fact is that JAL was bailed out by an injection of public funds after its bankruptcy in 2010, suggesting that even if JAS had gone bankrupt, it would be able to continue to operate.

The ANA routes in the virtual scenarios are assumed the same as in reality. In other words, the JAL–JAS merger was assumed to not affect the entry or exit of ANA in the short term. This assumption seems reasonable because ANA's entry or exit was not observed even for routes for which the market structure significantly changed through the merger. For example, even one year after the merger, ANA was not seen entering the six JAL–JAS duopoly routes or exiting from the 27 JAL–JAS–ANA oligopoly routes.

The merger was likely to affect the decision of new airlines, such as Skymark Airlines, about the routes that they would enter because remedial measures to promote new entry accompanied the merger. In the sample up to October 2005, new airlines entered 12 routes after the merger, as shown in Table 1. Whether or not these entries would have occurred if the merger had not taken place is difficult to know. In the counterfactual scenario without the merger, these entries are assumed to not have arisen. However, the results discussed in this section are shown not to change when we make the alternative assumption that the entries would have occurred even when JAL and JAS had not merged.

5.2 Simulation Results

This subsection reports the merger effects estimated by comparing the actual data and the simulation results of the counterfactual scenarios discussed in subsection 5.1. In particular, we focus on the JAL survival scenario without new entries. This subsection first provides the effects on airfare and flight frequency on each route, and then investigates the effects on welfare. This subsection concludes by reporting the merger effects estimated on the basis of other counterfactual scenarios.

Effects on Airfare Table 9 provides the merger effects on airfare and indicates the average and the standard deviation across routes by route type as defined by the airlines operating before the merger.

On routes on which JAL and JAS competed before the merger, the merger might cause both the efficiency effect and the market power effect—the effect that competition relaxes as the number of rivals decreases. On routes with ANA and JAL–JAS (LSA type), the airfare decreased by 1.0 percent on average as a result of the merger. On such routes, because at least two airlines continued to compete after the merger, the market power effect was not as significant and was largely cancelled out by the efficiency effect. In contrast, on the JAL–JAS duopoly routes (LS type), the airfare increased 1.6 percent because the market power effect outweighed the efficiency effect.

On routes on which one of either JAL or JAS operated before the merger (LA, L, SA, and S types), the merger did not decrease competitors and generated only the efficiency effect. As a result, airfare decreased by 0.7–2.3 percent. The average change in price for all domestic routes was –0.8 percent.

Airfares of non-merging firms also changed because of the merger, and decreased by 0.02–0.2 percent. This is because airfares are strategic complements. On some LSA type routes, airfares of non-merging firms increased because the effect of decreasing the number of rivals outweighed the effect of airfares being strategic complements.

Effects on Flight Frequency Table 10 indicates the effects on flight frequency. The flight frequency of the merging airline increased on average by 36.2 percent, attributable to the decrease in marginal costs with respect to both passengers and flight frequency. If the cost pass-through rate is less than 100 percent, a decrease in the marginal cost with respect to passengers expands the difference between the airfare and the marginal cost and enhances the marginal revenue of flight frequency represented by the first term in (7).

Flight frequency increases more on routes on which JAL and JAS competed directly than on other routes. This increase occurred because the deceases in marginal costs with respect to both passengers and flight frequency are larger on such routes than on the other routes.

The effects of the merger on the flight frequency of non-merging firms have the opposite signs of those of JAL–JAS because of the strategic substitute for flight frequency. Note, however, that on JAL–JAS competitive routes, the flight frequency of non-merging firms increased by 0.4 percent, which was of the same sign as the effects on JAL–JAS. This similarity occurred because, on some routes, the increase in airfare resulting from a decrease in the number of firms enhances the marginal revenue of flight frequency.

Effects on Surplus We turn to the merger effects on surplus. The social surplus is defined as the sum of consumer surplus and producer surplus.[14] The consumer surplus on route r in period t, represented by the compensating variation, is written as follows:

$$CS_{rt} = M_{rt} \frac{\ln\left(1 + V_{rt}^{1-\sigma}\right)}{-\alpha},$$

where the definitions of the variables are same as those in Subsection 3.2. The producer surplus, PS_{rt}, is defined as the sum of the profits π_{jrt} in (1) of all of the airlines on route r in period t.

Table 11 indicates the merger effects on a surplus. On LSA type routes, the merger increased the consumer surplus by 2.1 percent by decreasing airfares and increasing flight frequency. However, the merger decreased the consumer surplus on the LS type routes by 1.7 percent, primarily because of an increase in airfare.

The merger increased the producer surplus. The sum of the profits of JAL–JAS increased by 43.9 percent, which is equivalent to an increase of approximately JPY 49 billion per year. Before the merger, JAL expected a cost reduction of JPY 73 billion and a revenue increase of JPY 20–25 billion as merger effects (JAL, 2002b). The sum of the profits of non-merging firms increased by 1.0 percent, which is attributable to a decrease in the number of competitive firms on routes on which both JAL and JAS operated before the merger and to new airline entries.

The merger increased the social surplus of all routes by 6.8 percent. Even on the LS type routes on which the merger increased airfares by an average of 1.6 percent, the social surplus increased by 9.5 percent. This increase occurred because the efficiency improvement from the merger works on the marginal costs with respect to both flight (MC^F_{jrt}) and passengers (MC^Q_{jrt}). The reduction in MC^F_{jrt} does not appear as the first-order condition with respect to airfare (6) and does not directly influence airfare. Therefore, offsetting the effects of the decrease in the number of firms is insufficient. However, the reduction of MC^F_{jrt} contributes to an increase in the profits of the merging airline and increases the social surplus.

Estimates Based on Other Scenarios This subsection concludes by reporting the merger effects estimated on the basis of the simulation results of other counterfactual scenarios. Table 12 replicates the results previously discussed in column (13-1) and compares it with the results of other scenarios in the other columns.

[14] In this paper, to simplify the argument, airport revenue is omitted from the definition of the social surplus. The conclusions of this paper do not change when we alternatively define social surplus as the sum of consumer surplus, producer surplus, and airport revenue.

Column (13-2) reports the merger effects estimated by comparing reality with the simulation results of the JAS survival scenario with new entries, that is, with the assumption that new airlines entered even when the merger did not occur. The results are almost the same as in (12-1) because the entries occurred on only 12 routes.

Columns (13-3) and (13-4) correspond to the JAS bankruptcy scenario. This scenario assumes that JAS would have exited from the market even if no merger had occurred, implying that the merger itself did not decrease the number of airlines. Accordingly, airfares decreased more in this scenario than in the JAS survival scenario. In a similar manner, flight frequency increased more on the LS type routes. However, on the LSA type routes, flight frequency increased more in the JAS survival scenario than in the JAS bankruptcy scenario because the larger increase in markups raises the marginal revenue of flight frequency. The differences between columns (13-3) and (13-4) are small, implying again that the simulation results are robust to the assumption about new entries.

5.3 Analysis Based on Pre-merger Data

In the preceding sections, the effects of the merger are estimated using data before and after the merger. However, the competition authority should decide in advance whether or not a proposed merger is legal. This subsection analyzes the effects of the merger using pre-merger data, that is, a subsample restricting the data period to before Decision 1 in March 2002. This subsection then investigates how we could anticipate the effects of the merger in advance. First, the demand model is estimated on the subsample. Then, the merger simulation is conducted using the estimated model.

Column (5-3) of Table 5 shows the results of the demand estimation using the subsample. The estimates are similar to the estimates in column (5-2) for the base model. The average price elasticity is estimated to be –2.13 and the flight frequency is 1.19.

The merger simulation is conducted using the model in (5-3). In forecasting the effects of a merger, we need an assumption for the magnitude of the efficiency improvement. Three scenarios are assumed. Assumption 1 supposes that the JAL–JAS merger has no effect on the marginal cost with respect to passengers (MC^{Q}_{jrt}) and flights (MC^{F}_{jrt}). Assumption 2 postulates that the merger decreases both marginal costs by 4.5 percent. This figure corresponds to the cost reduction anticipated by JAL before the merger. The press release of JAL reported that the merger with JAS would reduce costs by JPY 73 billion (JAL, 2002b), equivalent to approximately 4.5 percent of the aviation business' operating costs of JPY 1.6 trillion in 2001. However, operating costs include costs for both international and domestic businesses. Assumption 3 supposes that the merger decreases marginal costs by 6.5 percent for MC^{Q}_{jrt} and by 5.0 percent for MC^{F}_{jrt}. These estimates are from the post-merger analysis previously presented.

Table 13 indicates the results of the merger simulation using only the pre-merger data. For Assumption 1, because the merger follows only the effects of a decrease in the number of firms, airfares increase on all JAL–JAS competition routes. For Assumption 3, the results are qualitatively similar to those of the previous subsection, suggesting that the effects of the merger could be forecasted in advance if the authority has adequate information on cost reductions.

6 Effects of the Remedial Measures

In the previous section, the effects of the JAL—JAS merger itself were estimated. This section verifies the effectiveness of the remedial measures that were a prerequisite for the merger to be allowed by the JFTC. Subsections 6.1 and 6.2 discuss measures to promote new entry and fare-related measures, respectively. [15]

6.1 Measures to Promote New Entry

Measures to promote new entry consist of ones by the merged company and by the MLIT. To enhance competition, the companies involved in the merger returned nine turnaround slots at Haneda Airport for new entrants at the time of the integration, provided facilities (such as boarding bridges, gate slots, and check-in counters) for new entrants, and offered to cooperate with their operations by undertaking various services such as aircraft maintenance, for example (JAL, 2002a). In addition, the MLIT expressed its policy to promote competition (such as the far-reaching review of the allocation of arrival-departure slots at Haneda in February 2005), which was a prerequisite of Decision 2 of the JFTC. In this section, the effects of the measures are estimated.

New airline companies entered 12 routes from October 2002 to October 2005. On five routes, JAL and JAS directly competed before the merger. The solid lines in Figure 1 indicate these five routes. On all of these routes, ANA also offered flights. No new airlines entered the JAL–JAS duopoly routes.

To evaluate the measures used to promote new entries, we need to estimate the effects of the

[15] As the other remedial measures, the merging airline offered to expand its route network and establish compliance against the Antimonopoly Law. However, specific measures to accomplish them are not published. Consequently, this paper does not investigate their effects.

entries that the measures caused, in other words, the entries that would not have occurred if this measure had not existed. However, distinguishing these types of entries from entries that would have occurred even if the measures to promote new entry had not existed is difficult. We estimate the effects of new entries on all 12 routes. The total of these effects can be considered the upper limit of the effects of the measures to promote new entry. As suggested by Table 12, which indicates the merger effects with and without these entries, new entries after the merger had little effect as a whole on the domestic airline market in Japan because of their small number. However, the entries could significantly affect fares, flight frequency, and surplus for individual routes on which they occurred.

The effects of the new entries are estimated by comparing the actual data of the situation with the merger and the entries and the simulation results of a counterfactual scenario with the merger but no new entries. Simulations are carried out using the estimated structural model for the period after July 2003, when a remedial measure of the reduction in normal fares was terminated.

Table 14, which shows the effects of the new entries on the 12 routes that the new airlines entered after the merger, indicates that new entries reduced airfares. Flight frequency also declined because of the decline in the marginal revenue of flights that resulted from fare decreases. The fare reductions and expanded choice set by new entries contribute to increasing the consumer surplus. Whereas the profits of JAL–JAS declined, the non-merging firms including new entrants expanded their profits. The social surplus is estimated to increase by the entries.

This discussion indicates that the measures to promote new entries can be economically evaluated as having worked in the direction of increasing both the consumer and the social surpluses. However, from the perspective of evaluating a remedial measure in the context of the Antitrust Law, being aware of the point that new entrants existed only on five of the 33 JAL–JAS competition routes and, in particular, no new entrants existed on the six JAL–JAS duopoly routes is necessary. On these JAL–JAS duopoly routes, the analysis in the previous section estimated that fares increased and the consumer surplus decreased because of the merger. Therefore, the measures to promote new entry are considered to have not eliminated the disadvantage imposed on consumers on these routes from the merger.

At the time of Decision 2, was the JFTC able to predict whether or not new airlines would enter on the JAL–JAS duopoly routes? Assuming that other conditions are constant, the possibility of new entrants is likely to increase on routes with higher demand. In actuality, as shown in the lower part of Table 1, the average number of passengers on routes that a new airline entered after the merger was high compared with other routes. Table 1 also shows that the new entries by the time of Decision 2 occurred on 6 routes with higher demand. However, the average number of passengers on the JAL–JAS duopoly routes was not large. These facts implies that the possibility was low that new entrants would occur on the JAL–JAS duopoly routes, although more accurate analyses are required, such as using a model endogenizing entry and exit. [16]

6.2 Measures Concerning Airfares

For measures concerning airfares, the merged company reduced normal fares and expanded discount fares. Normal fares became fixed on all routes at a 10 percent reduction compared with the fare amount as of April 2002. This measure was initially scheduled to continue for at least three years from October 2002. However, it only ran until June 2003 because of deterioration of the market environment following the Iraq War and the outbreak of Severe Acute Respiratory Syndrome (SARS). Discount rates on pre-merger duopoly routes, that is, JAL–ANA, JAS–ANA, or JAL–JAS competitive routes, were applied at the same level as on the pre-merger JAL–JAS–ANA competitive routes.

The reduction in airfares that brought them closer to the marginal cost (MC^Q_{jrt}) has the effect of diminishing the dead-weight loss and increasing the social surplus. However, when considering a model that makes flight frequency endogenous, compulsory fare reductions may not necessarily result in an increase in the social surplus because the fare reductions decrease the flight frequency by reducing the marginal revenue of flights and, thereby, decreasing passenger benefits. For example, as an extreme situation, in the event that fares are reduced to a level equal to MC^Q_{jrt}, the airline companies are expected to stop operating services, thus significantly decreasing the social surplus. From this discussion, with regard to the social surplus, compulsory fare reductions are considered to have a positive effect of bringing fares closer to the marginal cost and a negative effect of reducing flight frequency.

This subsection evaluates the unplanned stop of the measure relating to normal fares in June 2003. We simulate a counterfactual scenario in which the measure continued until October 2005. In the simulation, the airfare values p_{jrt} of the merged company are fixed. Specifically, these values are calculated in a manner that fixes the normal fares at a level that is 90 percent of the fares in April 2002, and the discount rates are assumed to be the values calculated from the Travel

[16]For example, Berry (1992), Ciliberto and Tamer (2009), and Sugawara and Omori (2012) estimated models for which airlines decide entry onto a route.

Survey for Domestic Air Passengers for 2003. Then, non-merger companies' fares and the flight frequencies of all companies are obtained by solving a simultaneous equation consisting of the first-order conditions (6) and (7). The set of operating airlines and the values of the exogenous variables are assumed to be the same as in reality.

Table 15 shows the effects of measures concerning airfares. Fare-related measures decrease fares by an average of 4.6. As the fare reductions decrease the marginal profit of the flights, flight frequency declines at an average of 3.4 percent. Although the decline in flight frequency has a negative effect on passenger utility, it is exceeded by the positive effect of the fare reductions, and the number of passengers and the consumer surplus increase. Profits declined because of measures to reduce fares. The profits of JAL–JAS decreased by 6.4 percent, equivalent to approximately JPY 11 billion a year. JAL predicted a decreased revenue effect from the fare-related measure of JPY 15 billion (JAL, 2002b). Because the decline in profits is exceeded by the increase in the consumer surplus, the social surplus on all domestic routes increases by 1.8 percent. These results suggest that the social surplus decreased by the unplanned stop of the measure regarding normal fares.

Paying special attention to the LS type routes—the JAL–JAS duopoly routes—is worthwhile. The merger increased airfares by 1.6 percent and decreased consumer surpluses by 1.7 percent, as indicated in the previous section. Table 15 reports that if the measures concerning airfares continued, airfares and consumer surplus would have been 11.4 percent less and 20.7 percent more, respectively, than in reality. That is, if the remedial measures were implemented as planned before the event, even on the JAL–JAS duopoly routes, the merger would have decreased airfares and increased consumer surplus. This result indicates that if implemented, the fare-related measure sufficiently addressed the disadvantage imposed on consumers on the JAL–JAS competition routes because of the merger. Similar results are obtained when the simulations are carried out using a structural model estimated with the subsample limited to the previous data, as in Subsection 5.3, depending on the assumption of efficiency improvement generated by the merger.

Although the fare reduction measures are estimated to increase the total consumer and social surpluses as a whole of the domestic airline market, they decrease the consumer and social surpluses on some routes. The routes on which consumer surplus is reduced by the measures account for 3.1 percent of the sample routes on which JAL operates. The routes on which the social surplus is decreased account for 9.1 percent of them. On these routes, JAL offered low flight frequency, at an average of 0.98 (round trips per day), whereas the sample average is 3.20. On routes with low flight frequency, the negative effect of the fare reductions, that is, the decline in passenger utility from the decrease in flight frequency, acts strongly given the diminishing marginal utility of flight frequency. This result suggests that, if flight frequency can be freely determined by airlines, a compulsory reduction in fares does not always benefit consumers.

7 Conclusion

This paper qualitatively analyzed the economic effects of the JAL–JAS merger in 2002 using a structural model endogenizing flight frequency, which is one of the main product characteristics of air-passenger services. A test comparing oligopoly models rejected the hypothesis that the merger caused collusion between airlines. Estimates of marginal cost models suggested that the merger significantly reduced the marginal costs for the merging airline, and that this efficiency improvement was achieved primarily through an increase in the number of routes at each airport by integrating the airline networks of JAL and JAS.

This paper then conducted a simulation analysis to compare the actual data and the counterfactual scenarios in which the merger had not occurred. The estimates revealed that, on domestic routes overall, the merger increased consumer surplus, producer surplus, and social surplus.

The simulations of this paper estimated that the merger increased JAL-JAS profits by 43.9 percent. Even when adding the profit-reduction effects resulting from the remedial measures, the merger was still estimated to increase profits of the merged company compared with a hypothetical scenario in which no merger occurred. Therefore, this result implies that the merger with JAS was not the cause of JAL's bankruptcy in 2010. However, the definition of profit in this paper does not include fixed costs that are not connected to number of passengers and flight frequency. Fixed costs include labor-related costs, costs related to procuring aircraft, and interest payments on interest-bearing debt. The merger may have increased these fixed costs and worsened the profitability of the merged company. Analyzing the effects of the merger on fixed costs is a task that needs to be performed in the future. [17]

On routes on which JAL and JAS directly competed before the merger and non-merging airlines also operated, fares decreased by an average of 1.0 percent and consumer surplus increased by 2.1 percent. However, on the JAL–JAS duopoly routes, fares increased by 1.6 percent on average and consumer surplus decreased by 1.7 percent.

The analysis in this paper provided the following implications on the JFTC decision that ap-

[17]For example, Jeziorski (2013) analyzed the effects of a merger on fixed costs for the radio industry in the United States.

proved the proposed merger under the remedial measures. First, under the remedial measures, no substantial restraint of competition occurred through coordinated action. Second, on the routes on which JAL, JAS, and non-merging airlines competed before the merger, no substantial restraint of competition existed through unilateral conduct. Third, however, on the JAL-JAS duopoly routes, the remedial measures appear to have been insufficient to address the restrictions on competition through unilateral conduct. Regardless of the measures to promote new entry, in the three years after the merger, new airlines did not enter the JAL–JAS duopoly routes. The measure concerning normal airfare was not implemented as scheduled, and ended in nine months.

If the measure concerning normal fare had continued, airfare was estimated to decrease and consumer surplus to increase compared with the case in which the merger had not occurred, even on the JAL–JAS duopoly routes. Moreover, the unplanned end of the measure decreased the social surplus summed across all domestic routes. However, note that measures concerning airfares decreased the consumer surplus and the social welfare on some routes because the positive effect on consumer surplus resulting from the fare reductions was exceeded by the negative effect of the reduction in flight frequency that occurred in conjunction with the airfare decrease. Therefore, a compulsory lowering of airfares will not necessarily result in an increase in consumer surplus and social surplus. This paper confirmed that the same results regarding the consequences of the merger and remedial measures could be obtained when we limited the data to before the time of JFTC judgements.

Additionally, the merger increased the social surplus even on the JAL–JAS competition routes because the improvements in efficiency that reduced the marginal cost of each flight (not of each passenger) had little influence on airfares and contributed to improving the profits of the merged company. These results reveal a problem with the consumer surplus standard in judging whether or not to allow a proposed merger. The analysis in this research showed that when efficiency improvements exist related to the costs of a product's characteristics, this reduction in costs is hardly reflected in prices. In such a case, even if prices increase and consumer surplus decreases because of a merger, the merged company's profits may significantly increase and, therefore, the social surplus may also increase.

Data Appendix

The data set used for the analysis in this paper is monthly panel data by route and airline. Routes are defined as a pair of endpoint airports. The data period is from April 2000 to October 2005, and data from January, April, July, and October in each year are used.

Data on flight frequency f_{jrt}, the number of passengers q_{jrt}, the number of available seats per flight $seat_{jrt}$, and route distance $dist_r$ are obtained from the Annual Report on Air Transport Statistics (*Koku Yuso Tokei Nempo*; in Japanese). The subscript characters j, r, and t, express the airline company, the route, and the period, respectively. Flight frequency is defined as the number of return trips within a day. Throughout this paper a route is defined as a pair of airports and is not distinguished by the direction of transport corresponding to the definition in the annual report.

The airfare variable p_{jrt} is defined as the value of the normal fare described in the timetable adjusted according to the number of airlines on that route. This adjustment is done because no published data on actual fares is found for domestic routes in Japan before the merger, whereas the Travel Survey for Domestic Air Passengers (*Koku Ryokyaku Dotai Chosa*; in Japanese) has offered data on actual fares for a couple of days basically once every two years since 2003.

The normal fares are adjusted as follows. First, the actual fares for each route were obtained from the Survey for 2003 and 2005. By comparing these actual fares with the normal fares obtained from the timetables, "discount rates" on each route are calculated. Next, the average discount rates are calculated by route groups according to the number of airlines operating on the route. The average is 10.01 percent on monopoly routes, 15.43 percent on duopoly routes, and 12.68 percent on routes with three or more airlines. Finally, these average values are used to adjust the normal fares. During the period after the merger, these average values are simply applied according to the number of airlines with flights on the route. During the period before the merger, they are adjusted as follows. For the monpoly routes, the average value for the post-merger monopoly routes (10.01 percent) is simply applied. For routes with three or more airlines , the discount rate is assumed to be at the same levels as the post-merger duopoly routes (15.43 percent). This assumption is made because, as one part of the series of remedial measures, the discount fare on the routes on which the merged company competed with ANA (in other words, the post-merger duopoly routes) is set as the same level as the routes on which three airlines competed before the merger (JFTC, 2002b). For the duopoly routes in the pre-merger period, the discount rate of 12.72 percent, which is the average of the discount rate of the monopoly routes (10.01 percent) and one of the routes with three or more airlines (15.43 percent), is applied. This rate is used because the level of discount rates on duopoly routes was reported to be in range of the level of monopoly routes and of routes with three airlines during the period before the merger (JFTC, 2002a).

Market size M_{rt} is defined as the geometric average of the urban area population in which the endpoint airports of route locate, and is calculated using the data of Kanemoto and Tokuoka (2002). Routes for which population data are not obtainable, such as to isolated islands, are excluded from the sample.

For fuel price $fuel_t$, a three-month lag in the three-month moving average of the kerosene jet fuel spot price is used. This standard was used by ANA and JAL to determine surcharges for international flights at that time. Each month's fuel price is obtained from the United States' Department of Energy website and converted into JPY using that month's exchange rate.

Aviation fuel tax tax_{rt} is the tax imposed on the fuel loaded onto the aircraft. The tax during the data period was JPY 26,000 per kiloliter of fuel, which declined to JPY 13,000 on routes to/from Naha Airport or airports on isolated islands.

The airport fee AFC^F_{jrt} is defined as the sum of landing fees and facility usage fees for navigation aids. These fees constitute the majority of the total airport fee. Both the landing fee and the air navigation service fee are charged once per flight. The method to calculate the landing fee is different for each airport management body, but is effectively the sum of the weight-proportion part that depends on the maximum takeoff weight (hereafter referred to as MTOW) of the aircraft used and the noise-proportion part that depends on the noise level of the aircraft used. The facility usage fees for navigation aids cover the costs of installing facilities to aid air navigation and their maintenance and management. These fees are calculated by multiplying the unit price determined using the distance of the route by the MTOW of the aircraft used.

To calculate the landing fee and the air navigation service fee, having information on MTOW and the noise level of the aircraft used is necessary. The data on aircraft characteristics are obtained from "*Suuji de Miru Koku*" (in Japanese) and "*Nihon Kokuki Zenshu*" (in Japanese). The timetable reports the type of aircraft for each flight.

Table A1 provides summary statistics. To correspond with the definition of f_{jrt}, AFC^F_{jrt} is defined as the airport fee for one return flight multiplied by the number of days in period t. In other words, if period t is 31 days, the value of AFC^F_{jrt} expresses the amount of airport charges for 31 return flights (62 flights). The airfares, the fuel price, the aviation fuel tax, and the airport charge are deflated by the overall consumer price index to constant 2005 JPY.

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Table 1
Number of Passengers

	Routes	Mean	Sta. Dev.
Route type			
LSA	27	158.1	166.7
LS	6	16.9	19.5
Other	207	12.3	17.6
Routes with entry			
Entry in the pre-merger period	6	263.9	325.1
Entry in the post-merger period	12	97.6	75.8

Notes: This table shows the number of passengers (1,000 per month) in January 2002. The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route.

Table 2
Relative Fare

Route type	New entry after the merger	Routes	2000	2001	2002	2003	2004	2005	Change: 2000-2005
LSA	No	22	-9.6	-10.3	-9.8	-10.2	-8.8	-8.2	1.7
			(11.8)	(10.7)	(10.8)	(13.9)	(9.8)	(9.8)	(9.1)
	Yes	5	-10.4	-10.0	-9.4	-8.6	-15.8	-19.6	-9.2
			(11.5)	(11.5)	(11.6)	(12.4)	(11.0)	(12.1)	(14.0)
LA / SA	No	25	0.4	0.8	1.2	-0.3	0.5	2.1	1.9 *
			(9.4)	(9.1)	(9.5)	(9.8)	(10.3)	(9.9)	(4.6)
	Yes	6	-0.8	-1.1	-0.5	-13.9	-5.5	-9.3	-8.5 *
			(12.9)	(12.9)	(13.0)	(19.3)	(13.3)	(12.2)	(12.2)
LS	No	6	11.5	11.4	11.5	15.9	15.8	18.2	5.6 ***
			(7.5)	(5.0)	(4.8)	(4.1)	(4.3)	(4.9)	(3.0)
	Yes	0							
L / S	No	101	3.1	4.1	3.9	4.2	3.9	3.1	2.6 ***
			(18.4)	(18.0)	(18.4)	(18.5)	(18.7)	(19.3)	(3.2)
	Yes	1	14.8	14.9	15.5	15.6	15.3	10.4	-4.4

Notes: Relative fare (expressed in percent) is defined as the rate of deviation from the industrial average fares for routes of the same distance. The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. The numbers are means for July of each year with standard deviations in parenthesis. The change from 2000 to 2005 is calculated for the routes existing over the entire period. ***, **, and * denote 1-, 5-, and 10-percent significance, respectively.

Table 3
Flight Frequency

Route type	New entry after the merger	Routes	2000	2001	2002	2003	2004	2005	Change: 2000-2005
LSA	No	22	4.6	4.6	4.8	6.5	6.5	6.2	1.7 ***
			(2.8)	(2.8)	(3.2)	(4.5)	(4.6)	(4.5)	(2.1)
	Yes	5	4.7	5.0	5.1	6.8	6.6	6.5	1.9 ***
			(1.4)	(1.7)	(1.7)	(2.1)	(2.1)	(2.0)	(1.3)
LA / SA	No	25	3.3	3.4	3.3	3.7	3.6	3.7	0.2
			(2.1)	(2.2)	(2.0)	(2.4)	(2.4)	(2.3)	(0.6)
	Yes	6	3.9	3.7	4.0	3.9	3.9	4.0	0.1
			(0.8)	(0.6)	(0.9)	(1.2)	(1.2)	(1.6)	(1.4)
LS	No	6	2.0	2.2	2.3	3.5	3.3	3.1	1.1 ***
			(0.6)	(0.5)	(0.6)	(0.7)	(0.7)	(0.9)	(0.6)
	Yes	0							
L / S	No	101	1.6	1.7	1.7	1.8	1.7	1.7	-0.03
			(1.2)	(1.3)	(1.4)	(1.5)	(1.3)	(1.3)	(0.7)
	Yes	1	1.9	2.0	2.7	2.9	3.0	1.3	-0.5

Notes: Flight frequency is defined as the number of return trips within a day. The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. The numbers are means for July of each year with standard deviations in parenthesis. The change from 2000 to 2005 is calculated for the routes existing over the entire period. *** denotes 1-percent significance.

Table 4
Results of the Hedonic Regression

	(4-1)	(4-2)	(4-3)	(4-4)
f	0.175	0.164	0.124	0.118
	[0.032]***	[0.032]***	[0.026]***	[0.025]***
ftotal	-0.228	-0.211	-0.175	-0.064
	[0.013]***	[0.014]***	[0.032]***	[0.030]**
dist	0.016	0.016		
	[0.0001]***	[0.0001]***		
dnew		-0.836		-2.767
		[0.269]***		[0.284]***
Route-specific dummies	N	N	Y	Y
R^2	0.85	0.85	0.97	0.98

Notes: The sample size is 5,250. All estimations include airline- and month-specific dummy variables, which are not reported in the table. The numbers in brackets are the heteroskedasticity robust standard errors. *** and ** denote 1- and 5-percent significance, respectively.

Table 5
Demand Estimates

	(5-1)	(5-2)	(5-3)
Sample period	Entire		2000.4-2002.2
Instruments		Y	Y
α	-0.007	-0.082	-0.089
	(0.003) **	(0.007) ***	(0.011) ***
β	-10.76	-3.56	-2.32
	(1.78) ***	(0.64) ***	(0.37) ***
ρ	-0.10	-0.30	-0.68
	(0.02) ***	(0.09) ***	(0.17) ***
σ	0.37	0.08	0.23
	(0.02) ***	(0.12)	(0.20)
Sample size	5,680	5,680	2,184
R^2	0.63	0.52	0.32
Chi -square statistics (d.f.)		12.76 (6) **	2.27 (5)
First-stage *F* -statistics (d.f.)		129.2 (9, 5656) ***	47.6 (8, 2164) **

Notes: In (4-1), the squared term of f_{jrt} is added in the set of exogenous variables. The numbers in brackets are standard errors. All estimations include route distance, its squared and cubed terms, and airline- and month-specific dummy variables, which are not reported in the table. The *Chi* -square statistics are for a test of overidentifying restrictions. The First-stage *F* -statistics provide the average explanatory power of the instruments, conditional on exogenous variables. *** and ** denote 1- and 5-percent significance, respectively.

Table 6
Estimates of Cost per Passenger

		Estimates based on the F.O.C.s (*ac*)				ac^{BZ}	
		Nash	Collusion	Mix 1	Mix 2	θ= 0.5	θ= 0.75
Mean		21.4	20.9	21.2	21.2	19.0	22.0
Standard deviation		8.0	8.3	8.2	8.1	5.6	5.9
Min		3.8	-7.4	-7.4	-7.4	5.7	6.2
Max		59.4	59.4	59.4	59.4	45.4	42.5
Obs. with negative estimates		0	22	18	12	0	0
Correlation coefficients with							
dist		0.83	0.81	0.82	0.82	0.83	0.48
nroute		-0.11	-0.12	-0.12	-0.12	0.24	0.15
seat	-500 km	-0.38	-0.37	-0.36	-0.37	-0.02	-0.12
	500-1000 km	-0.39	-0.41	-0.40	-0.40	-0.01	0.01
	1000-1500 km	-0.49	-0.50	-0.49	-0.49	-0.10	-0.03
	1500 km-	-0.64	-0.65	-0.64	-0.64	-0.07	-0.04

Notes: The sample size is 5,207. The sample excludes the period from October 2002 to June 2003. The correlation coefficients with *seat* are calculated by class of route distance.

Table 7
Results of the Rivers-Vuong Test

Model h \ Model h'	Collusion	Mix 1	Mix 2
Nash	-2.67 ***	-3.16 ***	-3.13 ***
	(2.08)	(3.85)	(4.08)
Collusion		0.79	0.78
		(3.00)	(3.48)
Mix 1			-0.03
			(0.94)

Notes: The numbers in parentheses are standard errors of the test statistics. If the value of the test statistic is lower than the negative critical value of the standard normal distribution, model h' is rejected in favor of model h. *** and ** denote the test statistics is lower than the 1- and 5-percent negative critical value, respectively.

Table 8
Marginal Cost Model Estimates

Parameters / Variables	(8-1)	(8-2)	(8-3)	(8-4)
	Marginal cost w.r.t. passenger		Marginal cost w.r.t. flight	
ln(seat)	-0.064 [0.019]***			
ln(ow)			0.370 [0.020]***	
ln(cr)	0.069 [0.062]		-0.014 [0.035]	
ln(nroute)	-0.090 [0.025]***		-0.152 [0.022]***	
b^X		-0.050 [0.023]**		-0.023 [0.033]
$b^X + \tilde{b}^X$		-0.063 [0.032]**		-0.049 [0.030]*
JAL dummy	0.007 [0.017]	0.057 [0.029]**	-0.047 [0.012]***	-0.049 [0.031]
JAS dummy	0.024 [0.021]	0.030 [0.023]	-0.097 [0.017]***	-0.070 [0.024]***
Sample size	4,873	5,022	4,980	5,022
R^2	0.94	0.94	0.85	0.83
Merger effects on marginal costs				
Route type				
LSA / LS	-3.6% ***	-6.3% **	-6.1% ***	-4.9% *
LA / L	-4.1% ***	-5.0% **	-6.9% ***	-2.3%
SA / S	-1.7% ***	-2.3%	-2.8% ***	-0.2%

Notes: Observations during the period of the 10 percent reductions of standard fare (from October 2002 to June 2003) are excluded from the sample. Heteroskedasticity robust standard errors in brackets. The route type is defined according to the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively. ***, **, and * denote 1-, 5-, and 10-percent significance, respectively.

Table 9
Merger Effects on Fares

	All firms			JAL-JAS			Non-merging firms		
	Mean	Sta. Dev.		Mean	Sta. Dev.		Mean	Sta. Dev.	
All routes	-0.8%	(2.2)	***	-1.7%	(5.5)	***	-0.1%	(0.8)	**
By route type									
LSA	-1.0%	(5.0)	**	-1.8%	(11.0)	**	-0.02%	(1.7)	
LS	1.6%	(1.8)	***	1.6%	(1.8)	***			
LA	-0.7%	(0.6)	***	-1.7%	(0.6)	***	-0.2%	(0.2)	***
L	-2.3%	(0.4)	***	-2.3%	(0.4)	***			
SA	-1.5%	(1.3)	***	-2.2%	(1.1)	***	-0.2%	(0.1)	***
S	-1.9%	(0.8)	***	-1.9%	(0.8)	***			

Notes: The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. *** and ** denote 1- and 5-percent significance, respectively.

Table 10
Merger Effects on Flight Frequency

	All firms			JAL-JAS			Non-merging firms		
	Mean	Sta. Dev.		Mean	Sta. Dev.		Mean	Sta. Dev.	
All routes	13.4%	(20.3)	***	36.2%	(39.9)	***	-0.2%	(1.5)	***
By route type									
LSA	23.4%	(15.4)	***	74.7%	(56.1)	***	0.4%	(2.2)	**
LS	49.7%	(32.6)	***	49.7%	(32.6)	***			
LA	5.0%	(11.9)	***	17.5%	(18.0)	***	-1.3%	(2.7)	***
L	41.6%	(24.8)	***	41.6%	(24.8)	***			
SA	5.3%	(5.5)	***	11.3%	(7.9)	***	-1.1%	(0.9)	***
S	25.5%	(21.6)	***	25.5%	(21.6)	***			

Notes: The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. *** and ** denote 1- and 5-percent significance, respectively.

Table 11
Merger Effects on Surplus

	Consumer surplus	Profits		Social surplus
		JAL-JAS	Non-merging firms	
All routes	4.3% (2.9) ***	43.9% (13.6) ***	1.0% (1.4) **	6.8% (3.0) ***
By route type				
LSA	2.1% (4.1)	49.9% (19.1) ***	0.9% (1.5)	5.8% (4.2) ***
LS	-1.7% (13.5)	210.7% (191.3) ***		9.5% (16.4)
Other routes	9.0% (1.0) ***	25.4% (1.5) ***	1.5% (1.3) ***	9.3% (0.9) ***

Notes: This table shows the averages of merger effects calculated for each period with the standard deviations in parentheses. The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. *** and ** denote 1- and 5-percent significance, respectively.

Table 12
Merger Effects in Other Scenarios

		(13-1) Replicated			(13-2)			(13-3)			(13-4)		
		JAS survival scenario						JAS bankruptcy scenario					
New entry in the no-merger scenario					Y						Y		
Average across routes													
Fare	LSA	-1.0%	(5.0)	**	-0.8%	(4.6)	**	-1.7%	(4.0)	***	-1.4%	(3.5)	***
	LS	1.6%	(1.8)	***	1.6%	(1.8)	***	-2.5%	(2.4)	***	-2.5%	(2.4)	***
	Other	-0.9%	(1.0)	***	-0.8%	(1.0)	***	-0.5%	(0.9)	***	-0.5%	(0.9)	***
Flight frequency	LSA	23.4%	(15.4)	***	23.0%	(15.5)	***	14.3%	(16.0)	***	13.8%	(15.9)	***
	LS	49.7%	(32.6)	***	49.7%	(32.6)	***	109.9%	(113.9)	***	109.9%	(113.9)	***
	Other	10.5%	(18.9)	***	10.6%	(18.9)	***	5.4%	(15.9)	***	5.4%	(15.9)	***
Total													
Consumer surplus		4.3%	(2.9)	***	2.8%	(2.8)	**	19.2%	(3.1)	***	17.6%	(3.2)	***
Profit	JAL-JAS	43.9%	(13.6)	***	45.0%	(13.7)	***	109.2%	(26.7)	***	110.1%	(26.8)	***
	Non-merging firms	1.0%	(1.4)	**	-0.7%	(1.1)	*	-4.2%	(1.1)	***	-5.5%	(1.0)	***
Social surplus		6.8%	(3.0)	***	5.4%	(2.9)	***	21.1%	(3.2)	***	19.6%	(3.3)	***

Notes: The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. The numbers in parentheses are the standard deviations. ***, **, and * denote 1-, 5-, and 10-percent significance, respectively.

Table 13
Results of the Merger Simulation Using Only the Pre-merger Data

Assumption on efficiency improvement		Assumption 1		Assumption 2		Assumption 3		Base results from the	
Marginal cost w.r.t. passenger		0%		-4.5%		-6.3%		post-merger analysis	
Marginal cost w.r.t. flight		0%		-4.5%		-4.9%		(replicated)	
Average across routes									
Fare	LSA	1.5%	(0.6) ***	0.3%	(0.7) ***	-0.1%	(0.8) *	-1.0%	(5.0) **
	LS	4.5%	(4.0) ***	3.3%	(3.0) ***	2.9%	(2.6) ***	1.6%	(1.8) ***
	Other	0.0%		-0.1%	(0.5) ***	-0.2%	(0.7) ***	-0.9%	(1.0) ***
Flight frequency	LSA	15.1%	(7.1) ***	20.0%	(10.2) ***	21.4%	(11.2) ***	23.4%	(15.4) ***
	LS	1.4%	(15.2)	6.9%	(17.0)	8.0%	(17.5) *	49.7%	(32.6) ***
	Other	0.0%		1.2%	(5.5) ***	1.5%	(6.6) ***	10.5%	(18.9) ***
Total									
Consumer surplus		-3.6%	(1.0) ***	-0.8%	(1.1) *	0.2%	(1.1)	4.3%	(2.9) ***
Profit	JAL-JAS	22.6%	(7.4) ***	40.2%	(8.4) ***	45.8%	(8.6) ***	43.9%	(13.6) ***
	Non-merging firms	4.4%	(1.8) ***	8.5%	(1.8) ***	9.8%	(1.8) ***	1.0%	(1.4) **
Social surplus		-1.1%	(1.1) **	2.4%	(1.2) ***	3.5%	(1.2) ***	6.8%	(3.0) ***

Notes: The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. The numbers in parentheses are the standard deviations. ***, **, and * denote 1-, 5-, and 10-percent significance, respectively.

Table 14
Effects of New Entry

Average across routes				
Fare		-1.0%	(2.5)	**
Flight frequency		-4.3%	(6.0)	***
Total				
Consumer surplus		33.0%	(10.7)	***
Profit	JAL-JAS	-9.8%	(3.0)	***
	Non-merging firms	72.8%	(30.5)	***
Social surplus		30.0%	(9.9)	***

Notes: The numbers are calculated for the 12 routes with new entry. On 5 routes of them JAL, JAS, and ANA competed before the merger. For fare and flight frequency, the numbers show the average across routes. For the other variables, the numbers show the average across time periods. The numbers in parentheses are the standard deviations. ***, **, and * denote 1-, 5-, and 10-percent significance, respectively.

Table 15
Effects of Measures Concerning Airfares

		All routes	By route type: LSA	LS	Other
Average across routes					
Fare		-4.6% (5.2) ***	-4.1% (4.1) ***	-11.4% (1.5) ***	-4.4% (5.3) ***
Flight frequency		-3.4% (5.1) ***	-3.0% (2.1) ***	-4.4% (2.0) ***	-3.4% (5.5) ***
Total					
Consumer surplus		4.3% (1.3) ***	3.8% (2.0) ***	20.7% (1.1) ***	4.9% (0.9) ***
Profit	JAL-JAS	-6.4% (0.5) ***	-6.2% (0.7) ***	-11.2% (1.5) ***	-6.9% (0.7) ***
	Non-merging firms	-1.1% (0.7) ***	-1.0% (0.9) ***		-1.5% (0.3) ***
Social surplus		1.8% (0.7) ***	1.3% (1.1) ***	11.3% (0.5) ***	2.6% (0.5) ***

Notes: The route type is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route. For fare and flight frequency, the numbers show the average across routes. For the other variables, the numbers show the average across time periods. The numbers in parentheses are the standard deviations. ***, **, and * denote 1-, 5-, and 10-percent significance, respectively.

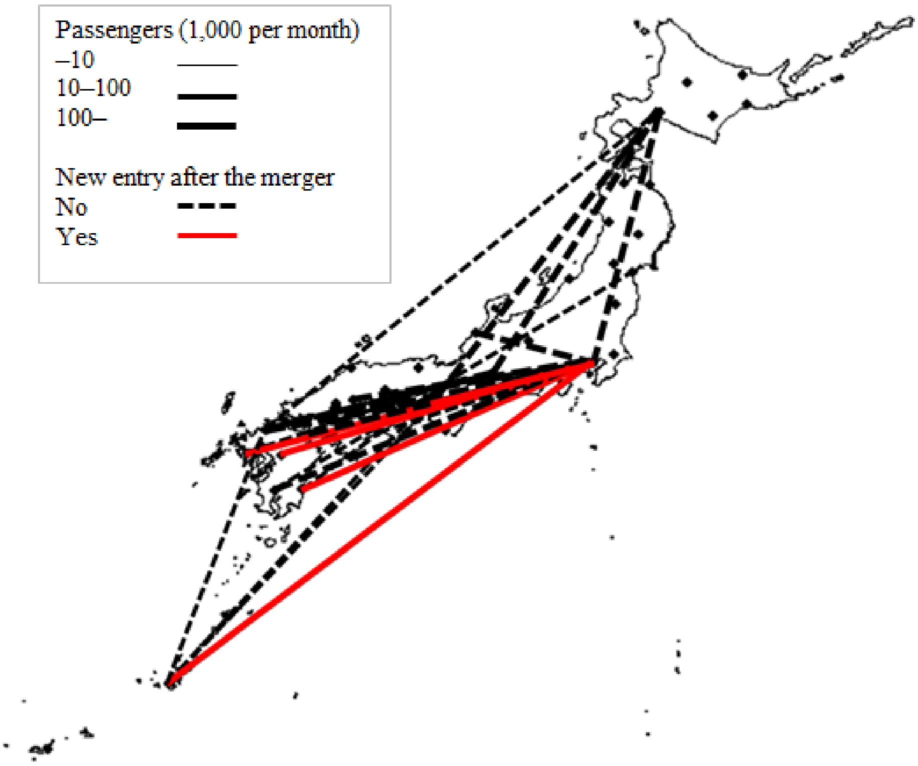
Table A1
Summary Statistics

Variable	Description (unit)	Mean	Sta. Dev.	Min	Median	Max
p	Airfare (1,000 JPY)	22.4	6.8	8.1	21.7	46.6
f	Flight frequency (round trips per day)	2.9	2.8	0.03	2.0	23.6
q	Passengers (1,000)	27.3	45.3	0.1	12.0	445.8
dist	Route distance (km)	834	397	153	790	2418
M	Market size (million)	3.1	3.5	0.2	2.2	19.6
fuel	Fuel price (1,000 JPY/kl)	26.6	7.0	18.0	24.6	46.5
tax	Aviation fuel tax (1,000 JPY/kl)	24.2	4.1	12.7	25.8	26.0
seat	Available seats per flight	201.6	115.0	21	166	568
ow	Operating weight (t)	55.7	38.4	4.8	40.0	164.0
cr	Engine compression ratio	27.6	6.5	6.4	30.4	40.0
nroute	Routes at endpoint airports	25.5	10.8	2.0	24.0	64.0
AFC^Q	Per-passenger airport charge (1,000 JPY)	0.02	0.06	0	0	0.5
AFC^F	Per-flight airport charge (million JPY)	14.3	10.6	0.6	12.4	55.2

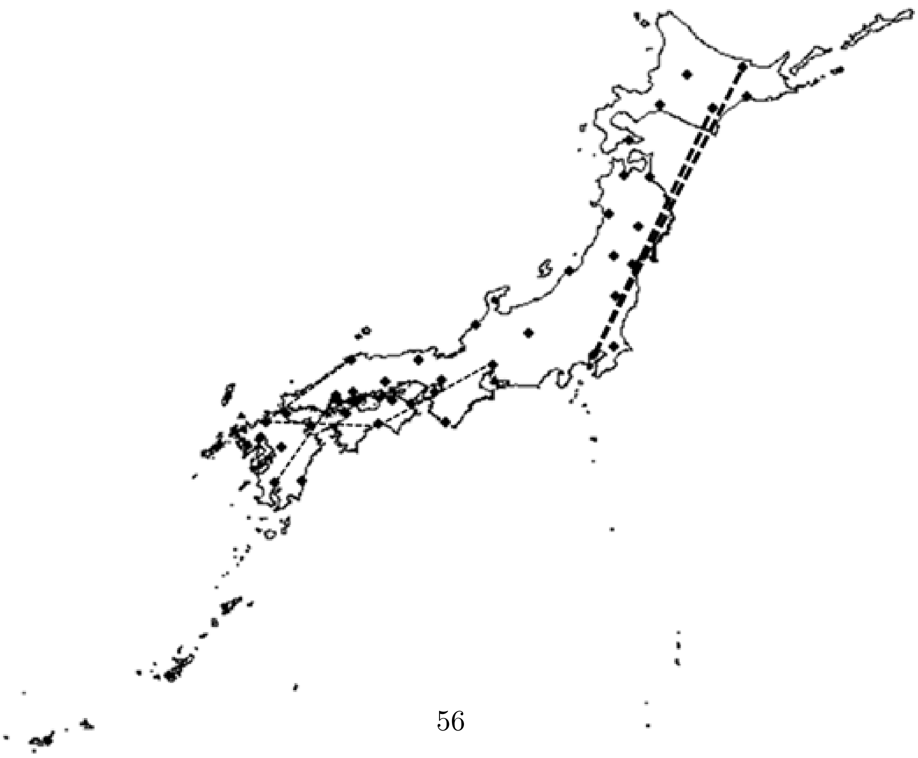
Note: The number of observations is 6,086.

Figure 1
Routes in Direct Competition by JAL and JAS

(A) With ANA



(B) JAL-JAS duopoly

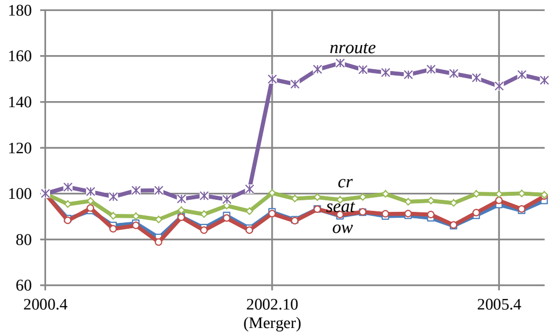


Notes: This figure shows the routes where both JAL and JAS operate on July 2001. The line width represents the number of passengers on a route. The dots in the figure denote airports at which JAL or JAS had some routes.

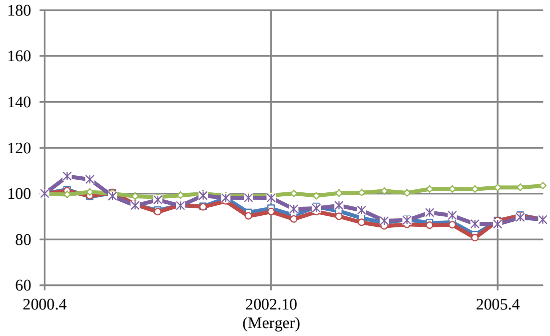
Figure 2
Cost Variables (normalized to 100 in 2000.4)

(i) LSA / LS

JAL-JAS

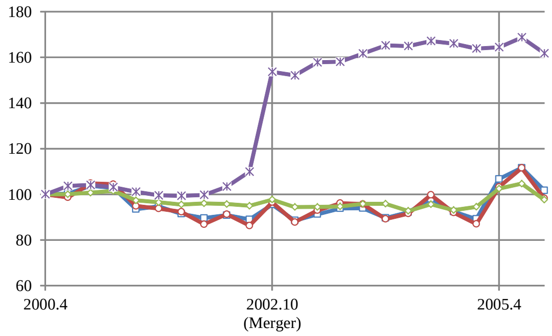


Non-merging firms

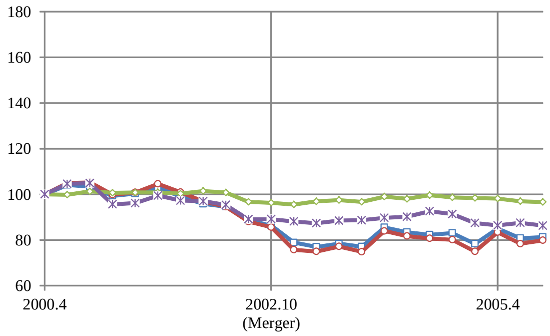


(ii) LA / L

JAL-JAS

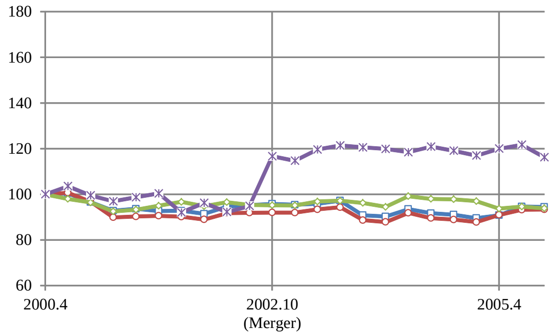


Non-merging firms

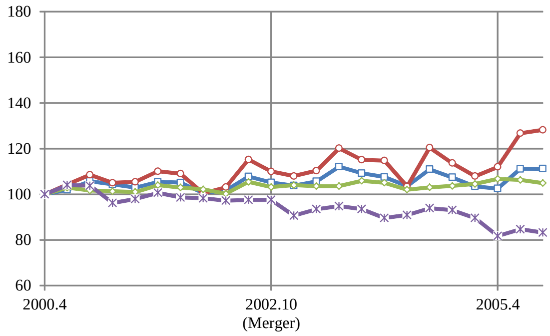


(iii) SA / S

JAL-JAS



Non-merging firms



Notes: The figure shows averages across routes for each route type, which is defined based on the operating airlines in July 2001; characters L, S, and A means JAL, JAS, and ANA, respectively, operated on the route.

Figure 3
Distribution of Cost per Passenger

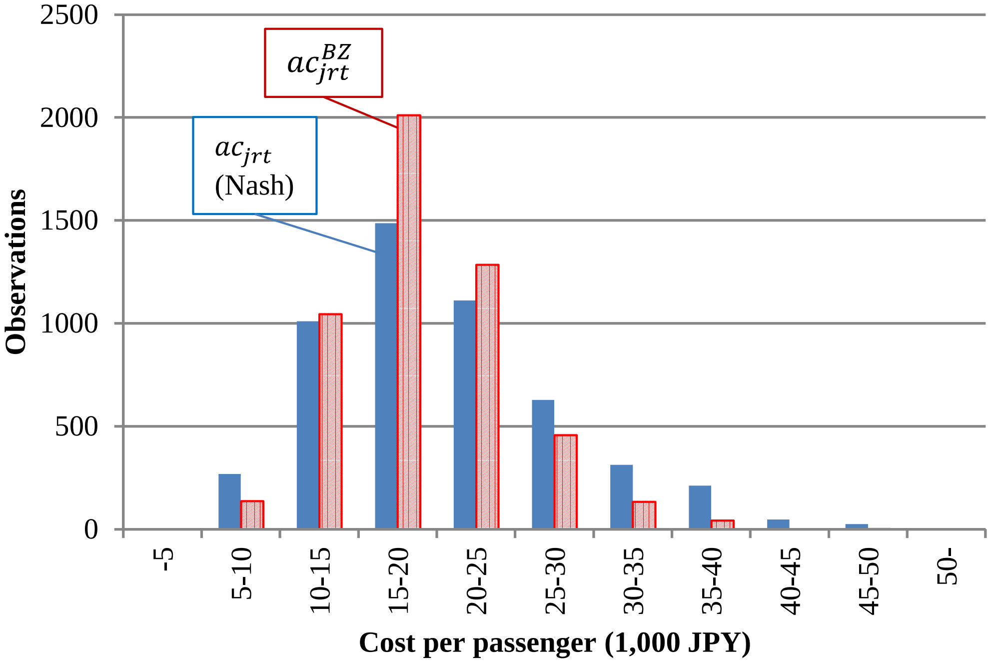
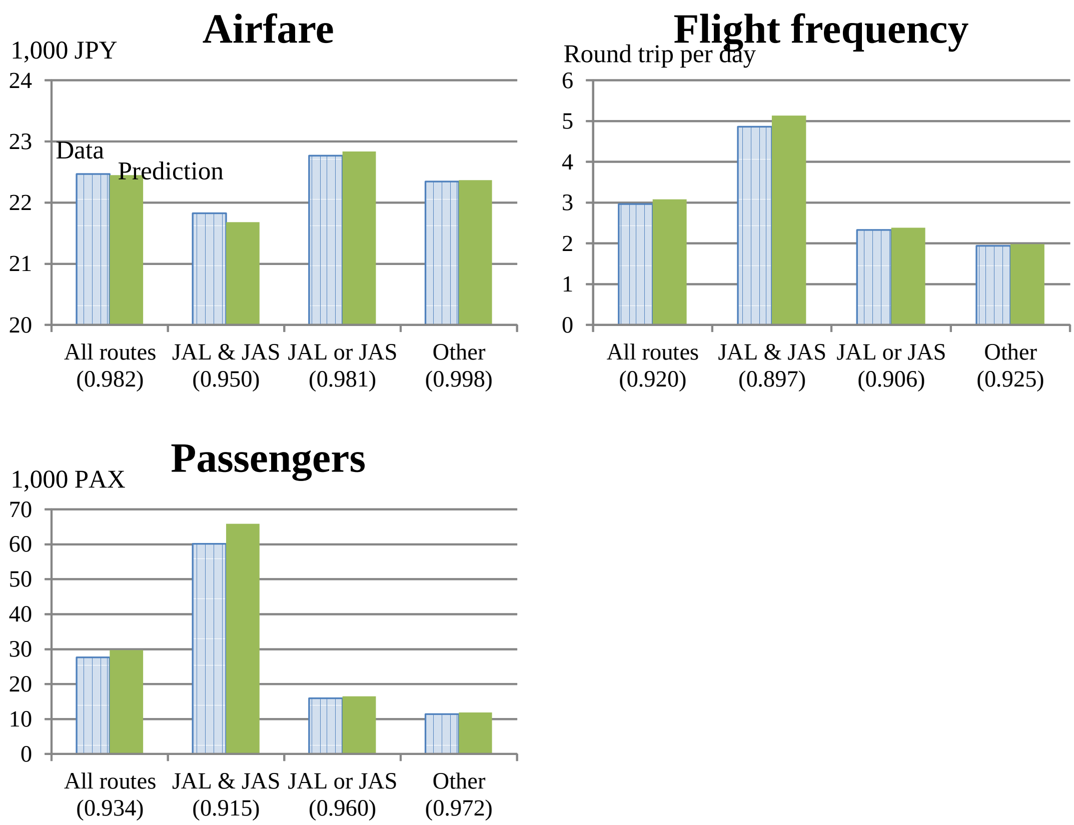


Figure 4
Model Fit



Notes: The figure shows averages across routes. The route type is defined based on the operating airlines in July 2001. The numbers in parentheses are correlation coefficients between the data and prediction. Observations during the period of the 10 percent reductions of standard fare (from October 2002 to June 2003) are excluded from the sample.