Assessing the Economic Impact of Domestic Airline Codesharing: A Case study of the ATA and Southwest Airlines Agreement

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Abstract: This paper examines the effect of code-sharing on domestic market air fares, passenger volumes and consumer welfare using data from the complementary code-share agreement between Southwest and ATA Airlines for Denver airline markets. Empirical results find that code-sharing decreased incumbents' air fares and increased their passenger volumes on code shared routes. Both consumer and producer surplus was found to increase, a result that supports findings by Park (1997) and Park and Zhang (2000). Furthermore, we find that the domestic market structure is Bertrand competitive, as opposed to previous findings of Cournot competition in international markets.

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1.0 Introduction

In October 2004, ATA Holdings and its subsidiaries filed for Chapter 11 bankruptcy protection.[1] Subsequently, Southwest Airlines injected capital into ATA Airlines that resulted in Southwest having a 27.5% ownership stake in ATA upon their exit from Chapter 11 bankruptcy proceedings. As part of the deal, Southwest entered into a code-sharing arrangement with ATA. This was Southwest's first domestic code-sharing arrangement. ATA chose 11 cities that had not been served by Southwest as the code-sharing cities with Chicago Midway Airport as the connecting airport for both airlines.

Southwest Airlines is based in Dallas, Texas. It is the third largest airline in the world, measured in terms of the number of passengers carried, and the largest with destinations exclusively in the United States. Despite the restrictions on its home base, Dallas Love Field, since 1978, Southwest has built a successful business by flying multiple short quick trips into the secondary airports of major cities using primarily Boeing 737 aircraft.[2] ATA Airlines is an American low cost and charter airline based in

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[1] "Chapter 11 is a chapter of the United States Bankruptcy Code which governs the process of reorganization under the bankruptcy laws of the United States. The Bankruptcy Code itself is Title 11 of the United States Code; therefore reorganization under bankruptcy is covered by Chapter 11 of Title 11 of the United States Code. In contrast Chapter 7 governs the process of a liquidation bankruptcy." Please see "Chapter 11" in Wikipedia at http://en.wikipedia.org/wiki/Chapter_11_bankruptcy for details.

[2] "When airline deregulation came in 1978, Southwest began planning to offer interstate service from Dallas Love Field, but a number of interest groups affiliated with Dallas - Fort Worth Airport, including American Airlines and the city of Fort Worth, pushed the Wright Amendment through Congress to restrict such flights. Southwest was barred from operating, or even ticketing passengers on flights from Love Field beyond the states immediately surrounding Texas. In 1997, the Shelby Amendment added the states of Alabama, Mississippi, and Kansas to the list of permissible destination states. Since late 2004, Southwest has been actively seeking the full repeal of the Wright Amendment restrictions. In late 2005, Missouri was added to the list of permissible destination states via a transportation appropriations bill. New service from Dallas Love Field to St. Louis and Kansas City quickly started in December of 2005. Southwest's efforts to

Indianapolis, Indiana. ATA operates scheduled passenger flights from a hub at Midway Airport in Chicago, Illinois, and charter flights across the globe.

As a low-cost air carrier, Southwest is well known as a "discount airline" compared to its domestic rivals and it is the only U.S. airline which has been profitable every year since 1973.[3] Past studies of Southwest deal with various aspects of Southwest's entry or potential entry on pre-existing market behavior such as Bennet and Craun (1993), Morrison (2001), Boguslaski, Ito and Lee (2004) and Fu, Dresner and Oum (2006). Most find that entry or potential entry by Southwest into a market significantly lowers market fares, which is the well known "Southwest Effect".

The purpose of this paper is to examine the impact of the 2005 code-sharing agreement between Southwest and ATA on air fares and passenger volumes in the Denver markets. We are also interested in the nature of competition in those markets and the impact of the codeshare agreement on social welfare.

What is unique about this code share agreement is that it is the first time that Southwest has entered a market in this way. While it is clearly a complementary code-sharing agreement, there is the question of whether this agreement will have the same impact on fares and competition that Southwest's direct entry has had in other markets.

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fully repeal the Wright Amendment are slated to continue in 2006." Please see Wikipedia at http://en.wikipedia.org/wiki/Southwest_Airlines for details.

[3] "A discount or no frills carrier or airline (also known as low cost carrier (LCC) or low cost airline) is an airline that offers generally low fares and few traditional passenger services. The concept originated in the United States before spreading to Europe in the early 1990s and subsequently to much of the rest of the world." Please see "discount airlines" in Wikipedia at http://en.wikipedia.org/wiki/Discount_airline for details.

From a policymaker's point of view, code-sharing alliances should be implemented if they have a net positive impact on social welfare. The purpose of this paper is to provide policymakers additional information on which to assess the effects of this code share agreement.

The next section provides a review of the literature on code share agreements, followed by presentation of the theoretical model. Section III explains the empirical model and Section IV details the data sources. The empirical results are then presented and discussed, followed by future research plans.

2.0 Background on Code Sharing Alliances

Code-sharing alliances began on international airline routes in 1986 and by the end of the 1990s had become one of the most popular alliance forms in the airline industry. Generally speaking, code-sharing arrangements have two basic forms: complementary and parallel alliances. Complementary alliances occur when contracting air carriers link existing flight networks, resulting in a new complementary network to provide services for connecting passengers (Park, 1997). On the other hand, parallel (or overlapping) alliances refer to collaboration between contracting air carriers competing on the same flight routes.

In the case of the ATA/Southwest code share agreement, we are mostly dealing with complementary alliances. Thus, there should be no concern that the agreement is eliminating an existing competitor as would be the situation with a parallel agreement.

Code-shared flights have several advantages for both alliance firms and passengers. First, the connecting flight is listed as a single-carrier flight under either the ticketing or operating airline's designation code and thus appears before listings of interline connections on Computer Reservation System (CRS) screens.[4] This listing priority can give alliance airlines an advantage over their competitors. Second, code-shared flights can provide as much convenience as a single-carrier flight. Customers only need to buy a single ticket for the entire route and their baggage will be transferred at the connecting airport by airline employees. Third, code-sharing combines alliance airlines' current route networks and consequently results in a substantial increase in the number of flight options that partner airlines can offer without adding additional aircraft departures.

Thus, alliance firms can benefit by generating additional passengers who might otherwise have chosen direct flights or flown through other hubs served by competitors in the absence of code-sharing. These expanded service options may attract new passengers and result in alliance firms coordinating and offering more frequent flights, thus attracting even more passengers. In the presence of economies of density, domestic traffic gains from code-sharing alliances may help lower the marginal operating cost of carrying an additional passenger.[5] In addition, joint use of airport facilities and development of

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[4] "Airline designation codes are two-letter codes assigned by the IATA (International Air Transport Association), which form the first two letters of a flight code. They are listed for use in reservations, timetables, tickets, tariffs, air waybills and in airline interline telecommunications, as well as in the airline industry applications." Please see Wikipedia, http://en.wikipedia.org/wiki/IATA_airline_designator for details.

[5] Economies of density mean that within a network of given size, increases in the size of aircraft will lead to a decrease in unit cost. Please See Caves, Christensen, Tretheway (1984) and Oum and Tretheway (1982) for details.

new routes that may restructure the current network may also reduce costs. Therefore, partner airlines may be able to lower air fares to passengers as a result of the code sharing alliance.

However, it has also been argued that code-sharing may harm market competition and decrease consumer welfare. According to the U.S. General Accounting Office (1998), the listing priority given code-shared flights on the CRS screen may decrease market competition with competitors operating on the same routes. Second, although code-sharing is not regarded as a merger, it may reduce the incentive for alliance partners to compete with each other on hundreds of nonstop, one-stop or multiple-stop long-haul markets. Currently these routes are the most competitive markets because they offer the greatest number of airlines from which consumers can choose. If the alliance airlines successfully gain market share, market incumbents could be driven out and entry could become more difficult. Limited competition and increased market concentration on these routes could result in an increased possibility of collusion, leading to airfare increases and decreases in service quality. Thus, it is possible that code-sharing agreements could have a negative impact on customers and incumbent carriers.

Most studies of code-sharing alliances have involved international code-sharing practices. Oum, Park and Zhang (1996), Park (1997), Park and Zhang (2000), Park, Zhang and Zhang (2001), Park, Park and Zhang (2003), Brueckner and Whalen (2000), Shy (2001), Brueckner (2001, 2003), Hassin and Shy (2004) examine the impact of international code-sharing alliances on firm output, air fares and economic welfare, either empirically or theoretically. Almost all of these found that complementary international code-sharing alliances are likely to increase passenger volumes, decrease air fares and improve consumer welfare.

To date, studies of domestic code-sharing and its competitive effects include Bamberger, Carlton and Neumann (2004), Armantier and Richard (2005a, 2005b), Chua, Kew and Yong (2005) and Gayle (2006). Bamberger, Carlton and Neumann (2004) find that complementary code-sharing between Continental and America West decreased average air fares and increased total traffic the code-shared markets while Gayle (2006) predicted that alliance firms' air fares would fall after a *parallel* code-sharing agreement between Continental, Delta and Northwest was proposed in 2002. Armantier and Richard (2005a) find that air fares increased significantly in markets where partner firms (Continental (CO) and Northwest Airlines (NW)) offered code shared flights and had nonstop direct flights as well, whereas air fares were lower in markets where firms code-shared flights but did not operate any nonstop flight. Armantier and Richard (2005b) further find that consumer surplus per passenger falls after code-sharing between CO and NW. Chua, Kew and Yong (2005) use firm-specific panel data to assess the impact of code-sharing on operating cost and find that large alliance partners have a negative effect while small alliance partners have a positive effect on firm operating costs.

This paper makes several contributions to the existing literature. It is the first analysis of domestic codesharing between two low cost carriers; previous researchers have examined code sharing alliances between U.S. legacy air carriers but low cost carriers are known to have different business model practices than legacy carriers.[6] Further, this is Southwest's first domestic codesharing agreement and our results will shed light on whether this sort of entry generates the same "Southwest" effect observed when Southwest directly enters a market. Our results are obtained using a model that estimates demand and supply sides of the market simultaneously. We use route level data and develop an indexing methodology for calculating route level factor prices. Our results are then used to determine the type of competition observed in domestic code shared markets (Cournot or Bertrand) and the result is compared to those obtained in international markets where code sharing has taken place. The impact of the agreement on incumbent firm fares (prices) and quantity, and the overall change in social welfare are the other key results presented here.

3.0 Theoretical Model

We follow previous researchers (Brander and Zhang (1990, 1993), Oum, Park and Zhang (1996), Captain and Sickles (1997) and Fischer and Kamerschen (2003)) and use a general conjectural variation reduced form approach. The basic model was originally suggested by Iwata (1974) and later extended and generalized by Bresnahan (1989). This methodology allows us to find the average degree of market power and estimate the price-cost margin while imposing less demanding data requirements than a structural conjectural variation model. Further, instead of regarding the conjectural variation as a

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[6] In contrast to legacy carriers who are usually engaged in complicated yield management, operating practices of low cost air carriers include: "a) a single passenger class, b) a single type of aero plane, reducing training, servicing and maintenance costs, c) a simple fare scheme, d) flying to cheaper, less congested secondary airports and flying early in the morning or late in the evening to avoid air traffic delays and take advantage of lower landing fees, e) short flights and fast turnaround times" and etc. Please refer to the website at http://en.wikipedia.org/wiki/Low_cost_carrier for details.

firm's expectation, it can be interpreted as "a market parameter to capture the whole range of market performance and dynamic patterns can be approximated by repeated, one-shot static equilibrium game" in the airline industry (Fischer and Kamerschen, 2003).

In this paper, we regard a city-pair flight route as a market and assume that *n* airlines (firm *i*=1,…*n*) offer flight services. Further, we assume that the passenger volume demanded from each air carrier is a function of its own air fare, its competitors' air fares and other exogenous variables that affect its demand. Then firm 1's inverse market demand function can be written as:

$$P_1 = P_1(Q_1, Q_{-1}, \Gamma, \alpha) \tag{1}$$

where Q_1 is the passenger volumes for firm 1; P_1 is its price; Q_{-1} is the aggregate of rivals' output; Γ denotes the exogenous variables that affect market demand and α is the unknown parameter vector. Similarly, for other firms, their demand function can be written using column vector notations as follows:

$$P_j = P_j(Q_j, Q_{-j}, \Gamma_j, \alpha_j) \qquad j=2,..n \tag{2}$$

where P_j is firm *j*'s price ($j \neq 1$) in the market, Q_j is firm *j*'s output and Q_{-j} is firm *j* rival's aggregate output. Γ_j denotes the exogenous variables that affect firm *j*'s market demand and α_j is the unknown parameter vector. Then, firm 1's profit function can be written as:

$$\pi_1 = P_1(Q_1, Q_{-1}, \Gamma, \alpha)Q_1 - C_1(Q_1, W_1, Z_1, \beta_1) \tag{3}$$

where C_1 stands for firm 1's total cost which is a function of firm 1's output Q_1, input prices W_1 and other exogenous variables Z_1 (such as flight distance, traffic density etc.); β_1 is the unknown parameter vector.

If we assume firms are profit maximizers and compete on output, then the Cournot Nash equilibrium is represented by taking first order conditions:

$$\begin{aligned}\frac{\partial \pi_1}{\partial Q_1} &= P_1 + Q_1 P_1^{'}(Q_1, Q_{-1}, \Gamma, \alpha) - c_1 \\ &= P_1 + Q_1 (\frac{\partial P_1}{\partial Q_1} + \frac{\partial Q_{-1}}{\partial Q_1}) - c_1 \\ &= P_1 + Q_1 \frac{\partial P_1}{\partial Q_1} (\frac{\partial Q_1}{\partial Q_1} + \sum_{j=2}^{n} \frac{\partial Q_j}{\partial Q_1}) - c_1 \\ &= P_1 + Q_1 \frac{\partial P_1}{\partial Q_1} (1 + v_1) - c_1 \\ &= 0\end{aligned} \tag{4}$$

where $v_1 = \frac{\partial Q_{-1}}{\partial Q_1}$ and c_1 stands for the marginal cost of firm 1.

So $$P_1 + Q_1 \frac{\partial P_1}{\partial Q_1} (1 + v_1) - c_1 = 0 \tag{5}$$

In the symmetric oligopoly model, v_1 equals 0 for Cournot competition; v_1 equals -1 for Bertrand competition and v_1 equals 1 for the cartel solution. Because we do not know whether the firms are competing on output or price, or whether they are colluding, we have to adopt more general supply relations to describe the quantity or price setting conduct and other oligopoly behaviors generalized by Bresnahan (1989) as follows:

$$P_1 = c_1 - \frac{\partial P_1}{\partial Q_1} \lambda_1 Q_1 \tag{6}$$

where $\lambda_1 = 1 + v_1$ ($\lambda_1 \geq 0$) is defined as the market power parameter. As λ_1 moves farther from 0, the conduct of firm 1 moves farther from perfect competition. Accordingly, firm *j*'s supply relation can be written as:

$$P_j = c_j - \frac{\partial P_j}{\partial Q_j} \lambda_j Q_j \tag{7}$$

One way to measure the effect of code-sharing on the market incumbents' prices and passenger volumes is to estimate the *n* structural demand equations (1)-(2) and supply relations (6)-(7) simultaneously as a system of equations, with code-sharing as an explanatory variable.

4.0 Empirical Model Specifications

4.1 Demand Equation

The market demand functions are specified as follows:

$$\begin{aligned} Q_{ijt} = {} & \alpha_0 + \beta_1 CS_{it} + \beta_2 P_{ijt} + \beta_3 CS_{it} P_{ijt} + \beta_4 ORIPOP_{it} + \beta_5 ORIINCO_{it} + \beta_6 DESTPOP_{it} \\ & + \beta_7 DESTINCO_{it} + \beta_8 FREQ_{ijt} + \beta_9 CS_{it} FREQ_{ijt} + \sum_{j=1}^{N-1} \gamma_j FIRM_j + \sum_{i=1}^{M-1} \psi_i ROUTE_i \\ & + \sum_{t=1}^{2} \varphi_t YEAR_t + \varpi_{ijt} \end{aligned} \tag{8}$$

where Q_{ijt} is the incumbent firm *j*'s specific demand on route *i* at time *t*; CS_{it} is the code-sharing dummy variable which equals 1 if the route was in a code-sharing arrangement in 2005, and equals 0 if not. We expect the coefficient of CS_{it} to be negative because code sharing offers passengers more flight options and thus may decrease market demand for incumbent airlines' services. However, incumbents may also make full use of their frequent flyer program or increase their departure frequency to attract more passengers and thus possibly increases their demand. Compared with code-sharing services, incumbents' nonstop flights are of higher service quality. In this case, code sharing may indirectly increase incumbents' demand so the coefficient sign may also be positive. P_{ijt} is firm *j*'s air fare on route *i* at time *t* and we expect this coefficient to be negative. $CS_{it}P_{ijt}$ captures the interaction between code-sharing and firm *j*'s air fare. We expect this coefficient sign to be negative because code sharing service can work as a substitute, thus making incumbent firm *j*'s passengers more responsive to firm *j*'s price changes. $ORIPOP_{it}$, $DESTPOP_{it}$ are exogenous variables defined as the population of the origin and destination metropolitan statistical areas and their coefficients are expected to be positively related to the market demand. Similarly, $ORIINCO_{it}$, $DESTINCO_{it}$ are defined as the per capital incomes of the origin and destination cities, respectively with coefficients expected to be positive for normal goods and negative for interior goods.

Flight frequency is one of the most important elements that affect airline demand and service quality.[7] Passengers usually prefer airlines that offer more frequent flights and thus reduce schedule delay time. So we include $FREQ_{ijt}$ (the number of firm *j*'s

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[7] There is also a possibility that flight frequency is endogenous because as the air travel demand increases, airlines may offer more frequent flight departures. However, Wald test (Green, 2003) shows the null hypothesis that flight frequency is exogenous can not be rejected: Wald statistics=1.3859945, which is less than 5.02 critical value at 5% confidence interval. We use the predicted value of flight frequency as the instrument in the test and least square estimates for the predicted value are good with high adjusted R square =99.96%. Possible reasons for the exogeneity of flight frequency can be that as the air travel demand increases, airlines tend to adopt larger aircrafts with more seats to avoid more landing and take off fees associated with the increasing number of departures given that the airport capacity is limited as well.

performed departures on route i at time t) and expect its coefficient to be positively related to the demand. $CS_{it}FREQ_{ijt}$ captures the interaction between code-sharing and firm j's departure frequency on route i at time t and we expect the coefficient sign to be positive if code-sharing between code sharing helps increase incumbent firm j's departure frequency and negative if decrease incumbent' firm j's departure frequency. $FIRM_j$, $ROUTE_i$ and $YEAR_t$ are dummy variables that account for unobserved firm, route and time specific fixed effects, respectively. ϖ_{ijt} is the normally distributed error term that might be contemporaneously correlated across equations.

4.2 Supply Relation

To estimate the supply relation equation (4), we need to consider the marginal cost function. However, precise definition and estimation of marginal cost is problematic for the airline industry. Researchers have addressed airline costs in a variety of ways. Brander and Zhang (1990, 1993), use average cost as a proxy for marginal costs, a method later adopted by Oum, Zhang and Zhang (1993) and Morrison and Winston (1995). However, most of these papers estimate the firm-specific total and marginal cost on a domestic system-wide level rather than on the specific route level.

For the purposes of this study, we need to specify marginal costs at the route level. It is generally accepted that the airline industry is characterized by constant returns to scale technology (CRS). This conclusion is supported by previous researchers (Caves (1962), Eads, Nerlove and Raduchel (1969), Douglas and Miller (1974), Keeler (1978), Caves, Christensen and Tretheway (CCT, 1984), Gillen, Oum and Tretheway (1990), Oum and Zhang (1991), Brueckner and Spiller (1994) and Creel and Farell (2001)).

However, CRS assumption is not appropriate on the route level. On a specific route, the more passengers an airline's aircraft carries, the lower the marginal cost given that the number of flight departure does not change. We refer this as the economies of aircraft size, which is the reason for the existence of economies of traffic density (Morrison, 2006).

Thus, we specify the marginal cost function for an individual firm *j* on a specific route *i* at time *t* as:

$$MC_{ijt} = \chi_2 W_{ijt}^F + \chi_3 W_{ijt}^L + \chi_4 W_{jt}^K + \chi_5 W_{jt}^M + \chi_6 CRAFTSIZE_{ijt} + \chi_7 DIST_i + \chi_8 Q_{ijt} + \sum_{j=1}^{N-1} \gamma_j' FIRM_j + \sum_{i=1}^{M-1} \psi_i' ROUTE_i + \sum_{t=1}^{2} \varphi_t' YEAR_t \qquad (9)$$

where W_{ijt}^F is the average fuel price measured as dollars per gallon for firm *j* on route *i* at time *t*;[8] W_{ijt}^L is the average labor price measured by employees' average hourly wage rate---dollars per worker for firm *j* on route *i* at time *t*;[9] W_{jt}^K is the capital input price defined

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[8] Since some air carriers, especially large air carriers use contractual or storage fuels to decrease their fuel cost, average fuel prices are actually different across airlines especially between large airlines and small ones. Moreover, according to *Petroleum Marketing Annual* published by *Energy Information Administration, Office of Oil and Gas, US Department of Energy*, fuel prices are also different across regions and states. Thus, after regional and firm adjustments, average fuel prices change with routes, firms and time. Please refer to Section 5 for detailed descriptions of adjustment calculation.

[9] According to *Bureau of Transportation Statistics, US Department of Transportation*, individual firm's financial report shows that labor cost is different across airlines as well. Following the same logic, we make some regional adjustment of firm level labor cost based on the *Occupational Employment Statistics (OES) Annual Survey* provided by *Bureau of Labor Statistics, US Department of Labor* at the website http:/stat.bls.gov/oes/home.htm. Please see Section 5 for details.

as firm specific capital cost per unit of airline capacity (available seat miles) at time t;[10] W_{jt}^{M} is the material input price measured by firm specific material cost per available seat mile which, except fuel, labor and capital costs, includes all the other expenditures such as maintenance, passenger food, advertising, insurance, communication, traffic commissions and etc;[11] We expect the coefficient signs of these four input prices to be positively related to the marginal cost. $CRAFTSIZE_{ijt}$ is the average number of available seats per aircraft operated by firm j on route i at time t and we expect the sign of its coefficient to be negative because the larger the number of seats, the larger the aircraft body size, the lower the cost per passenger due to the economies of traffic density in the airline industry and the lower the air fare is.[12] $DIST_i$ is the distance of route i and its coefficient sign is uncertain because air fares are usually higher for longer haul markets. However, since the large fixed cost is associated with take-off and landing fees, marginal cost could be lower for longer haul markets as distance increases. Q_{ijt} is the number of

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[10] Capital cost are the total cost of operating property and equipments which include flight equipment, ground property and equipment, and leased property under capital leases. We assume capital input prices do not change with flight routes. There is an alternative way to measure the capital input prices and will be adopted when the data are available in the future research. Please see Section 5 for details.

[11] We assume as well that airline firms buy those materials based on their whole system operation. Therefore, material input prices only change with firms and time but not with routes. Please see Section 5 for details.

[12] Because firms operate different types of aircrafts on different routes at different time, and different types of aircrafts have a different number of available seats, $CRAFTSIZE_{ijt}$ may also change with route, firm and time. Please see Section 5 for details.

passengers carried by incumbent firm *j* on route *i* at time *t*. We expect the coefficient on Q_{ijt} to be negative because of the economies of aircraft size (or economies of traffic density); however, higher travel demand may also lead to higher flight frequency. Marginal cost will drop only when the increase in cost associated with more take-offs and landings is less than the cost of carrying one more additional passenger. Therefore, the overall effect is uncertain.

4.3 Market Power Parameter Specification

We specify the market power parameter as follows:

$$\lambda = \rho_1 + \rho_2 RHHI_{it} + \rho_3 ORIHHI_{it} + \rho_4 DESTHHI_{it} \tag{10}$$

where $RHHI_i$ is the route Herfindahl-Hirschman index calculated by the number of passengers carried by individual firms on route *i*.[13] We expect that the higher the route HHI, the higher the firms' average market power on route *i*. On the other hand, firms may face the threat of potential entry, which discourages them from charging higher prices above marginal cost, so the overall effect of route HHI on market power is uncertain. $ORIHHI_i$ and $DESTHHI_i$ are the Herfindahl-Hirschman indices for the origin and destination airports respectively. High airport HHI means some carriers have hub dominance, which provides them with exclusive advantages---high flight frequency from a hub may indicate better service quality, raise the value of airlines' frequent flyer programs and create brand loyalty. Further, long-term leasing of airport space to

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[13] Herfindahl-Hirschman index is calculated by squaring the market share of each firm in the market and then summing the resulting numbers.

individual carriers gives them the power to decide when, to whom and at what price to sublease space to their rivals.

Substituting the MC_{ijt} expressed in (9) and λ expressed in (10) into supply relation, we have

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\begin{aligned}
P_{ijt} = {} & \chi_2 W_{ijt}^{F} + \chi_3 W_{ijt}^{L} + \chi_4 W_{jt}^{K} + \chi_5 W_{jt}^{M} + \chi_6 CRAFTSIZE_{ijt} + \chi_7 DIST_i + \chi_8 Q_{ijt} + \sum_{j=1}^{N-1} \gamma_j^{'} FIRM_j \\
& + \sum_{i=1}^{M-1} \psi_i^{'} ROUTE_i + \sum_{t=1}^{2} \varphi_t^{'} YEAR_t - \frac{\rho_1 + \rho_2 RHHI_{it} + \rho_3 ORIHHI_{it} + \rho_4 DESTHHI_{it}}{\beta_2 + \beta_3 CS_{it}} Q_{ijt} + \delta_{ijt}
\end{aligned}
\tag{11}
$$

where δ_{ijt} represents the error term that might be contemporaneously correlated across equations. Let $Q_{ijt}^{*} = -\dfrac{Q_{ijt}}{\beta_2 + \beta_3 CS_{it}}$ and we can rewrite (11) as follows:

$$
\begin{aligned}
P_{ijt} = {} & \chi_2 W_{ijt}^{F} + \chi_3 W_{ijt}^{L} + \chi_4 W_{jt}^{K} + \chi_5 W_{jt}^{M} + \chi_6 CRAFTSIZE_{ijt} + \chi_7 DIST_i + \chi_8 Q_{ijt} + \sum_{j=1}^{N-1} \gamma_j^{'} FIRM_j \\
& + \sum_{i=1}^{M-1} \psi_i^{'} ROUTE_i + \sum_{t=1}^{2} \varphi_t^{'} YEAR_t + \rho_1 Q_{ijt}^{*} + \rho_2 RHHI_i Q_{ijt}^{*} + \rho_3 ORIHHI_i Q_{ijt}^{*} + \rho_4 DESTHHI_i Q_{ijt}^{*} \\
& + \delta_{ijt}
\end{aligned}
\tag{12}
$$

If we estimate the demand function (8) and supply relation (11) simultaneously, we will find the effect of code-sharing on firm's air fares and passenger volumes on specified routes. Specifically, both β_2 and β_3 are shared by two equations to be estimated.

5.0 Data Sources and Variable Definition

The data set used in this paper is panel data from 2003 to 2005. Since Southwest and ATA airlines entered into a code-sharing agreement in December 2004 and implemented it in February 2005, the sample data period was chosen to include observations from before and after the code-sharing agreement.[14] Routes with incomplete operating carrier information from 2003 to 2005 are excluded from the study.

Our current sample data deals only with Denver International Airport, an airport served by ATA airlines in the code-sharing agreement. As of 2006, "Denver International Airport was the fifth busiest airport in the United States in terms of traffic, and the tenth in the world with 47,324,844 passengers passing through the airport, a 9.1% change from 2005."[15] Note that during the 2003-2005 time period, Southwest did not serve Denver or nearby airports directly. Interestingly, Southwest Airlines directly entered the Denver International Airport in January 2006. Eventually, we hope to compare our results for this market with those for other Southwest/ATA code-shared markets where Southwest did not subsequently enter directly. This may help us predict in which markets Southwest will enter directly and where code sharing is preferred.

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[14] At the beginning of the code sharing agreement, ATA mainly chose Boston (Logan International Airport---BOS), Denver (Denver International Airport---DEN), Fort Myers Naples (Southwest Florida International Airport---RSW), Honolulu (Honolulu International Airport---HNL), Minneapolis St Paul (Minneapolis St Paul International Airport---MSP), New York City (New York LaGuardia Airport---LGA), Newark Liberty International Airport (EWR), San Francisco City (San Francisco International Airport---SFO) and Arlington County, Virginia (Ronald Reagan Washington National Airport---DCA), 9 airports to be code shared with Southwest destinations with very limited code sharing service in Sarasota Bradenton (Sarasota Bradenton International Airport---SRQ) and St Petersburg (Saint Petersburg-Clearwater International Airport--- PIE). Later on, due to ATA bankruptcy and reorganization, ATA ended flights in BOS, MSP and EWR in Oct 2005, thus ending code share with Southwest in these cities. To have a code shared period as long as possible, we do not include these three cities in the data sample. In addition, we do not include RSW route observations to separate any possible parallel code sharing effect because Southwest entered RSW directly in Oct 2005. Besides, Southwest has large operations in Oakland Airport, a popular alternative to SFO airport in San Francisco Bay area, so we do not include SFO route observations either for pure complementary code sharing effect. Therefore, good sample observations for the study can be chosen from four airports operated by ATA Airlines--- Denver (DEN), Honolulu (HNL), New York LaGuardia (LGA) and Arlington (DCA) to be code shared with Southwest destinations.

[15] Data source is from the website at http://en.wikipedia.org/wiki/Denver_International_Airport.

Given data limitations on multiple stop flight services, we focus on the routes where passenger volumes from direct flights account for more than 90% of the total passenger volume. Therefore, our data sample includes 486 observations for both code shared and non code shared routes to or from Denver International Airport.

5.1 Demand Function Variables

Firm specific average air fares, P_{ijt} and passenger volumes, Q_{ijt} are from *Bureau of Transportation Statistics (BTS) US Department of Transportation (DOT) Origin and Destination Survey DB1B Market*, a 10% ticket random sample data. The number of passenger volumes used in the regression is ten times that of passenger volumes in the DB1B Market data. Code sharing routes (CS_{it}) are identified from *Southwest Airlines News Releases "Southwest Airlines Announces Cities for Code-share Flights with ATA Airlines"* at http://www.southwest.com. $FREQ_{ijt}$ is defined as the total number of departures performed by firm *j* on route *i* at time *t* and the data are from *BTS DOT Air Carrier Traffic Statistics T-100 Domestic Segment*. To make the characteristics of non code shared routes comparable to those of code shared routes, we identify non code shared routes as those with one end from Denver, one of the ATA's cities chosen for code sharing, and the other end is from one of Southwest's destination cities that were not included in the code share agreement. The data for the population of origin and destination cities are from *Population Division US Census Bureau Annual Population Estimates of the Metropolitan Statistical Areas.*[16] The data for the per capita personal

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[16] The reason that we prefer to use population estimate by Metropolitan Statistical Areas (MSA) where either origin or destination city is located instead of population estimate by either origin or destination city

income (in dollars) of origin and destination cities are based on Metropolitan Statistical Areas level (MSA) provided by *Bureau of Economic Analysis*, *US Department of Commerce.*

5.2 Supply Relation Variables

Fuel price, W_{ijt}^{F} is regionally adjusted based on the average fuel price of firm *j* at time *t*, calculated by dividing the total domestic fuel cost of firm *j* by total domestic gallons used by firm *j* in year *t*. Data for total domestic fuel cost and gallons are from *BTS DOT Form 41 Air Carrier Financial Statistics Schedule P-12A.* Since some air carriers (especially large air carriers), may have contractual and storage fuel advantages over small ones, firm level average fuel prices are not completely the same as the concurrent market fuel prices and differences in average fuel prices may exist between large and small air carriers. To control for regional (state level) differences in average fuel prices, we normalize regional average fuel prices to provide route and firm specific average fuel price. To illustrate how we do this, suppose American Airlines' (AA) average fuel price in all domestic operations was $1.67 per gallon in 2005 and the average fuel price at the national level in 2005 was $1.74 per gallon. We take the national average fuel price as our base value and calculate the regional average fuel price on the flight route, for example, from Boston, MA (BOS) to Los Angles, CA (LAX) by taking the arithmetic means of fuel prices from both the state of the origin city---MA and that of

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only is due to the fact that the number of passengers may not be limited to the number of population in the departure city itself. Take Portland, Oregon for example: Besides the population of the Portland city itself, people around Portland such as those living in Beaverton Oregon may also choose Portland International Airport as the departure airport.

the destination city---CA.[17] Suppose the regional average fuel prices on the route BOSLAX we get here is \$1.70. Then, AA's final average fuel price on the route BOSLAX is obtained as $1.67 \times \frac{1.70}{1.74} = 1.632$ dollars per gallon in 2005. In this way, differences in average fuel prices at route level are captured in addition to differences across firms. Data for the fuel prices at both national and regional level (based on states) are available in the *Petroleum Marketing Annual (2003, 2004 and 2005)* published by *Energy Information Administration, Office of Oil and Gas, US Department of Energy*.

We derive route level labor input prices W_{ijt}^{L} for firm j on route i at time t using a similar normalization technique. We calculate firm level hourly average wage per worker by dividing firm j's total expenditure on salaries and related fringe benefits by the product of total employees and working hours per year.[18] The data are from *BTS DOT Form 41 Air Carrier Financial Statistics Schedule P-6* and *Schedule P-10* respectively. In order to take into consideration the regional (Metropolitan Statistics Area level---MSA level) differences in the hourly average wage per worker, we choose the hourly average wage per worker in transportation occupations at the national level as our base value and take the arithmetic means of hourly average wages from the origin and destination MSA cities to obtain regional hourly average wage per worker. Then following the same logic as the calculation of route level and firm specific average fuel price, we will have route

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[17] One assumption we make here is that air carriers add fuel at both origin and destination cities.

[18] We assume 2,080 working hours for a full-time worker per year.

and firm level hourly average wage per worker for a specific year. The data for the hourly average wages at the national and MSA level are available in the *Occupational Employment Statistics (OES) Survey (Nov 2003, Nov 2004 and May 2005 Estimates) Transportation and Material Moving Occupation* reported by *Bureau of Labor Statistics US Department of Labor.*[19]

Airline capital assets mainly include flight equipment, ground property and equipment (GPE) such as maintenance and engineering equipment, ramp equipment and other miscellaneous ground equipment, land, construction work in progress, leased property under capital leases such as aircraft leases and etc. Compared to aircraft expenditures, GPE costs are relatively small. Although we would prefer to follow Oum and Yu (1998) and use aircraft lease rates as a proxy for capital cost, this information was not available to us.

Alternatively, we follow Chua, Kew and Yong (2005) and use total cost of operating property and equipment per unit of airline capacity (measured by available seat miles) that includes all the mentioned expenses above (GPE, land, construction work and leased property under capital leases) less allowance for depreciation as our firm level capital input prices. The data for the firm specific capital cost and total number of available seat miles are available in *BTS DOT Form 41 Air Carriers Financial Statistics Schedule B-1* and *BTS DOT Air Carrier Traffic Statistics T-100 Air Carrier Summary T-2*.

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[19] Nov 2005 OES Estimates are not available at this time.

Material input prices W_{jt}^{M} are calculated as a firm level materials and services cost per available seat mile. Materials and services cost includes all the expenditures except fuel, labor and aircraft leasing cost, such as maintenance materials, passenger food, advertising and promotions, communication and insurance and etc. The data for the firm level total materials and services cost are available in *BTS DOT Form 41 Air Carrier Financial Statistics Schedule P-6*. We assume that airlines buy these materials and services based on their entire system operations so the material input prices do not change with flight routes but only change across airlines and time.

$CRAFTSIZE_{ijt}$ is measured as the average number of available seats per aircraft operated by firm j on route i at time t. The larger the aircraft body size is, the more available seats in the fleet. We use firm and route specific total number of available seats divided by the total number of departures performed to get the average number of available seats per aircraft. $DIST_i$ is the market distance between the origin and destination cities and data for all of these variables are available from the *BTS DOT Air Carrier Traffic Statistics T-100 Domestic Segment*. $RHHI_{it}$ is the route Herfindahl-Hirschman index on route i. It is calculated by the sum of the squares of the individual firms' market share where market share is calculated as the number of individual firm's passengers divided by the total number of passengers carried by all firms on route i. $ORIHHI_{it}$ and $DESTHHI_{it}$ are the origin and destination airport Herfindahl-Hirschman index respectively. Following the same logic, they are calculated using the market share of passengers originating (or arriving) at an airport for each carrier serving the airport. All the data for the number of passengers carried by individual airlines are available from

Bureau of Transportation Statistics (BTS) US Department of Transportation (DOT) Origin and Destination Survey DB1B Market.

All dollar values in the demand equation are deflated by the Consumer Price Index (All Urban Consumers, All items, 1982-84=100) and those in the supply equation are deflated by the Producer Price Index (All commodities, 1982-84=100), obtained from the *Bureau of Labor Statistics US Department of Labor*. Descriptive statistics for all variables are listed in Table I.

6.0 Empirical Results

Empirical results are presented in Table II for both code shared and non code shared routes to or from Denver airport. We estimate both demand and supply functions simultaneously using Nonlinear Three State Least Squares (NL3SLS). Instrument variables are all the remaining exogenous variables in the equations.

6.1 Demand Function

First, the estimate of air fares is negative as expected and statistically significant at p=0.01 level. Second, compared to non code shared routes, code sharing between Southwest and ATA significantly increases incumbent market demand by 162809 passengers. Thus, code sharing between entrants does not decrease passenger demand for incumbents' flight services, a result consistent with findings by Oum, Park and Zhang (1996). Flight frequency is found to be a significant and positive determinant of airline demand. The interaction between code sharing and incumbents' flight frequency is positive and significant as well, suggesting that code sharing results in incumbent firms increasing flight frequency, thus resulting in higher service quality.

The estimated interaction between code sharing and air fares is negative and statistically significant. If we evaluate the price elasticity of demand on both code and non code shared routes at the mean value of price and quantity demanded, we find that the price elasticity of demand on the non code shared routes is 1.25 while on the code shared routes, it is 5.50. This suggests that code sharing makes passengers more responsive to the incumbent firms' price changes.

The population and per capita income in the origin airport MSAs has a significant impact on demand, but population and per capita income in the destination airport MSAs has no significant impact. Estimates of most route and airline dummies are strongly significant, suggesting that unobserved route specific fixed effects are important as are unobserved airline fixed effects.

6.2 Supply Relation

The coefficient of Q_{ijt} is positive χ_8=0.000398 and statistically significant, which means that the increase in marginal cost associated with more landing and take-offs due to more frequent departures is greater than the cost of carrying one more additional passenger. Airport dominance, measured by HHI, is a significant and important source of market power. This result is consistent with previous studies by Bailey and Williams (1988), Borenstein (1989, 1990, 1991), Berry (1990, 1992), Evans and Kessides (1993), Brueckner and Spiller (1994) and Oum, Zhang and Zhang (1995).

However, high route concentration level tends to decrease market power, which shows that the threat from potential entry is strong enough to discourage incumbent airlines to charge monopoly price.

According to our theoretical model, the market power parameter is $\lambda = 1 + \nu$ =0.14906 (We get this by substituting the mean values of all the explanatory variables back into the equation (10)). Therefore, ν = -0.85094, showing that in the domestic airline market, firms are closer to Bertrand price-setting than the Cournot quantity-setting competition. This suggests that the nature of competition in domestic markets tends to be more competitive than in international markets (Oum, Park and Zhang (1996) and Park and Zhang (2000)) and also more competitive than in domestic airline markets in the 1980s (Brander and Zhang (1990, 1993)). This result also supports the Bertrand assumption made by Gayle (2006) in his research on domestic code-sharing alliances.

The signs of three input prices, fuel, labor, capital in the supply relation are positively related to the price as expected, with the estimates of fuel prices strongly significant at 1% level of confidence. Estimates of labor, material and capital input prices are not significant.

Distance tends to increase air fares and aircraft body size is strongly significant with the expected negative sign, indicating lower marginal costs, a result consistent with previous studies such as Gillen, Oum and Tretheway (1990), Capital and Sickles (1997), Fischer and Kamerschen (2003) and Morrison (2006).

Coefficients for airline dummies including AS (Alaska Airlines), F9 (Frontier Airlines), OO (Trans State Airlines), QX (Horizon Air) and ZW (Air Wisconsin) are significant with the expected negative signs. We expect marginal cost and thus air fares for these air carriers to be lower because all of these firms are well-known low cost carriers. Coefficients for two year dummies are significant as well, which captures the cost changes from 2003 to 2005 due to the dramatic increase in the world oil prices.

6.3 Incumbent Air Fares and Passenger Volumes

Code sharing tends to increase market demand for incumbents' nonstop service but also has an effect on the slope of supply relation curve through $(-\frac{\partial P}{\partial Q})$. Specifically, since the slope of the supply curve is equal to 0.000575 in the presence of code sharing and increases to 0.000876 in the absence of code sharing, we expect an increase in equilibrium passenger volumes but are uncertain of the change in equilibrium air fares. In order to measure the exact changes before and after Southwest/ATA code sharing on both code-shared and non code-shared routes, we follow Oum, Park and Zhang (1996) and Park and Zhang (2000) and derive reduced-form equations for the incumbents' price and passenger volumes from equation (8) and (11):

$$Q = AP + B \text{ and } P = CQ + D$$

where $A = \beta_2 + \beta_3 CS_{it}$;

$$B = \alpha_0 + \beta_1 CS_{it} + \beta_4 ORIPOP_{it} + \beta_5 ORIINCO_{it} + \beta_6 DESTPOP_{it} + \beta_7 DESTINCO_{it} + \beta_8 FREQ_{ijt} + \beta_9 CS_{it} FREQ_{ijt} + \sum_{j=1}^{N-1} \gamma_j FIRM_j + \sum_{i=1}^{M-1} \lambda_i ROUTE_i + \sum_{t=1}^{2} \varphi_t YEAR_t + \varpi_{ijt};$$

(If $CS = 0,$ then $B' = B$.)

$$C = \chi_8 - \frac{\lambda}{\beta_2 + \beta_3 CS_{it}} = \chi_8 - \frac{\lambda}{A} ;$$

and

$$D = \chi_2 W_{ijt}^F + \chi_3 W_{ijt}^L + \chi_4 W_{jt}^K + \chi_5 W_{jt}^M + \chi_6 CRAFTSIZE_{ijt} + \chi_9 DIST_i + \sum_{j=1}^{N-1} \gamma_j^{'} FIRM_j$$
$$+ \sum_{i=1}^{M-1} \lambda_i^{'} ROUTE_i + \sum_{t=1}^{2} \varphi_t^{'} YEAR_t + \delta_{ijt}$$

Therefore, on code-shared routes, where $CS = 1$, equilibrium air fares and passenger volumes are $P_{cs} = \frac{(\chi_8(\beta_2 + \beta_3) - \lambda)B + (\beta_2 + \beta_3)D}{(1 + \lambda - \chi_8(\beta_2 + \beta_3))(\beta_2 + \beta_3)}$ and $Q_{cs} = (\beta_2 + \beta_3)P_{cs} + B$. On non code shared routes, where $CS = 0$, equilibrium passenger volumes and air fares are $P_{ncs} = \frac{(\beta_2 \chi_8 - \lambda)B^{'} + \beta_2 D^{'}}{(1 + \lambda - \chi_8 \beta_2)\beta_2}$ and $Q_{ncs} = \beta_2 P_{ncs} + B^{'}$. If we substitute the coefficient estimates back into the expressions above and calculate the air fare and passenger volume for each route and each year and take the average of these numbers,

we find that code sharing between Southwest and ATA decreases incumbents' equilibrium air fares by \$60 and increases passenger volumes by 93938 persons. The decrease in the incumbents' air fares is consistent with previous studies documenting the well-known "Southwest Effect", which occurs when Southwest directly enters a market. This result suggests that the "Southwest Effect" is also seen when the carrier enters through code sharing rather than direct entry. Lower air fares and higher passenger volumes due to code sharing are also consistent with all previous studies for both international and domestic code sharing (Oum, Park and Zhang (1996), Park (1997), Park and Zhang (2000), Park, Zhang and Zhang (2001), Park, Park and Zhang (2003), Brueckner and Whalen (2000), Brueckner (2001, 2003), Bamberger, Carlton and Neumann (2004) and Armantier and Richard (2005a)).

6.4 Welfare Analysis of Code sharing

To measure social welfare under code sharing, we need to calculate the area *OFH* in Figure 1 while social welfare without code sharing is equal to the area *OEG*. We calculate social welfare by setting all exogenous variables at mean values. We find that total social welfare gain due to code sharing in this market is equal to 8969492 dollars, which means that code sharing between Southwest and ATA helps increase social welfare. We find that both consumer and producer surplus gains ($\Delta CG = 4897211$ and $\Delta PG = 4072281$), a result supported by Park (1997), Park and Zhang (2000) but contrary to Armantier and Richard (2005b) who found that consumer welfare decreased after complementary code sharing between Continental and Northwest Airlines in the US markets. Possible reasons for this difference could be due to the nature of two code sharing alliances: Continental and Northwest Airlines are two major legacy air carriers but Southwest and ATA Airlines are two well-known low cost air carriers. Different business practice models between low cost and legacy carriers may bring about different effects of code-sharing alliances.

7.0 Conclusions and Future Research

Our empirical results show that the code sharing agreement between Southwest and ATA in the Denver market increases both producer and consumer surplus, a finding consistent with studies of international code sharing (Park (1997), Park and Zhang

(2000)) but contrary to Armantier and Richard (2005b) in domestic markets. We find that this complementary code sharing arrangement decreases incumbent carriers' air fares and increases their passenger volumes. Furthermore, we also find that the domestic airline market structure is more competitive with competition on price, as opposed to quantity competition in international markets (Oum, Park and Zhang (1996) and Park and Zhang (2000)) and in domestic markets in the 1980s (Brander and Zhang (1990, 1993)). This difference may be due to the fact that our study focuses on domestic code-shared routes where 90% of the passenger volume comes from direct flight services whereas international code-shared markets are mainly interline markets prior to code sharing. Also, international markets tend to have fewer carriers and often have regulatory restrictions that prevent the degree of competition observed in the domestic markets. Our results provide preliminary evidence that the "Southwest Effect" prevails even when Southwest entry occurs through code sharing rather than direct entry.

A major limitation of this study is that we have only included flight routes to or from Denver, Colorado. Results may be different in the future when we extend our sample to include the other three ATA connecting cities in the code share agreement that are preferable in the analysis of complementary code sharing effect.

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Table II Descriptive Statistics

Variables (Descriptions and Units)	Mean	Std
Q (The number of passengers)	42784.51	36414.44
P (The air fare in dollars)	170.9938	37.90606
CS (Equals 1 if the route was in code sharing in 2005)	0.236626	0.425448
ORIPOP (The number of population in the origin MSAs)	2394473	1686644
ORIINCO (The per capita personal income (dollars) in the origin MSAs)	36252.59	4904.613
DESTPOP (The number of population in the destination MSAs)	2401816	1667021
DESTINCO (The per capita personal income (dollars) in the destination MSAs)	36450.89	4762.899
FREQ (The number of departure performed)	1213.426	888.2739
W^F (Fuel input prices, dollars per gallon)	1.219384	0.28094
W^L (Labor input prices, dollars per hour per worker)	33.82447	9.702598
W^K (Capital input prices, dollars per available seat mile)	0.144664	0.06385
W^M (Material input prices, dollars per available seat mile)	0.013791	0.00218
CRAFTSIZE (The average number of available seats per aircraft)	120.7976	34.09199
DIST (The market distance of a flight route in miles)	894.4691	370.3058
RHHI (The route Herfindahl-Hirschman index)	3623.638	1005.612
ORIHHI (The Herfindahl-Hirschman index at the origin airport)	1898.409	431.807
DESTHHI (The Herfindahl-Hirschman index at the destination airport)	1927.913	483.321
AA (Equals 1 if the carrier is American Airlines)	0.024691	0.15534
AS (Equals 1 if the carrier is Alaska Airlines)	0.024691	0.15534
CO (Equals 1 if the carrier is Continental Airlines)	0.012346	0.11054
DL (Equals 1 if the carrier is Delta Air Lines)	0.030864	0.17313
F9 (Equals 1 if the carrier is Frontier Airlines)	0.296296	0.45709
HP (Equals 1 if the carrier is America West Airlines)	0.024691	0.15534

NW (Equals 1 if the carrier is Northwest Airlines)	0.012346	0.11054
UA (Equals 1 if the carrier is United Airlines)	0.388889	0.488
US (Equals 1 if the carrier is US Airways)	0.012346	0.110537
OO (Equals 1 if the carrier is Trans State Airlines)	0.123457	0.3293
QX (Equals 1 if the carrier is Horizon Air)	0.018519	0.134956
ZW (Equals 1 if the carrier is Air Wisconsin)	0.018519	0.134956
YEAR2003 (Equals 1 if in the year 2003)	0.333333	0.47189
YEAR2003 (Equals 1 if in the year 2004)	0.333333	0.47189

All dollars are measured in real terms (1982-84 dollars).

Table II Regression Results NL3SLS Parameter Estimates

Demand Function	Estimate	Std Error	t Value	Supply Function	Estimate	Std Error	t Value
CONSTANT	11140.58	111355	0.1				
CS	162808.7	68622.9	2.37***				
P	-311.845	105.2	-2.96****				
*CS*P*	-1072.03	419.2	-2.56****				
ORIGINPOP	0.015969	0.0064	2.49****				
ORIINCOME	-1.14209	0.7813	-1.46*				
DESTPOP	0.012173	0.0461	0.26				
DESTINCOME	0.225103	0.7961	0.28				
FREQ	16.39144	1.9618	8.36****				
*CS*FREQ*	61.5065	16.1899	3.80****				
AA	3421.544	9795.8	0.35				
AS	28607.97	10170.5	2.81****				
CO	42027.32	13075.2	3.21****				
DL	-19309.8	10754.8	-1.80**				
F9	21734.86	8260.2	2.63****				
HP	9710.389	10032.1	0.97				
NW	57787.01	12781.5	4.52****				
OO	9844.093	8236.5	1.2				
QX	5901.17	10696.2	0.55				
UA	30814.72	7985.6	3.86****				
US	19883.35	12750.9	1.56*				
ZW	4568.732	10584	0.43				
YEAR2003	-3692.12	3458.9	-1.07				
YEAR2004	-296.271	2538.3	-0.12				
				FUEL	137.5877	33.3069	4.13****
				LABOR	0.401796	0.5092	0.79
				CAPITAL	155.3111	142.2	1.09
				MATERIAL	-3402.8	2205.7	-1.54
				CRAFTSIZE	-0.42518	0.1422	-2.99****
				DIST	0.030218	0.00971	3.11****
				Q	0.000398	0.00021	1.90***
				*Q**	-0.93416	0.3743	-2.50****
				*RHHIQ**	-0.000091	0.000039	-2.34****
				*ORIHHIQ**	0.00045	0.00017	2.67****
				*DESTHHIQ**	0.00029	0.000132	2.20****
				AA	-23.3451	26.4905	-0.88
				AS	-45.0234	23.5703	-1.91***
				CO	6.291873	27.5291	0.23
				DL	-32.4742	29.6187	-1.1
				F9	-41.4996	24.8404	-1.67**
				HP	-8.19999	28.1013	-0.29
				NW	5.25298	28.048	0.19
				OO	-56.7337	26.1254	-2.17***
				QX	-50.0688	20.5488	-2.44****
				UA	-29.3355	27.9378	-1.05
				US	-12.2162	24.2	-0.5
				ZW	-42.0761	23.721	-1.77**
				YEAR2003	70.05195	17.372	4.03****
				YEAR2004	41.87595	11.0529	3.79****
Adjusted	R square	77.17			64.30		

*p=0.20; **p=0.10; ***p=0.05; ****p=0.01.

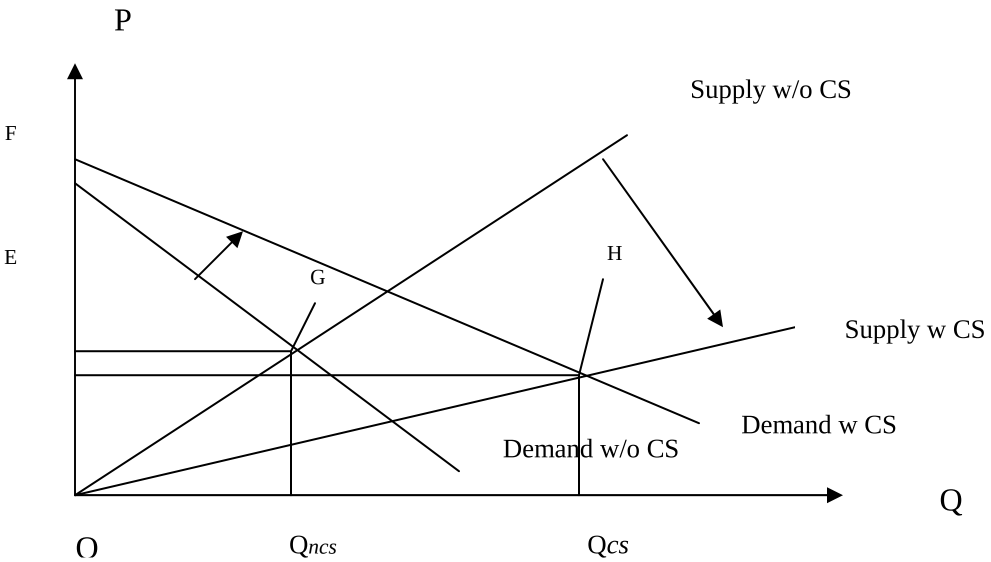

Figure 1 Effects of Code Sharing on Incumbents' P and Q