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**The Economic Impact of the ATA/Southwest Airlines Code Share
Alliance**

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I. 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 eleven cities that had not been previously served by Southwest as code-share cities and established Chicago Midway Airport as the connecting airport (See Table 1 for a listing of the code share cities).

Southwest Airlines, based in Dallas, Texas, is the third largest airline in the world 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

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 (DFW), but a number of interest groups affiliated with DFW 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

Table I Southwest/ATA Code-sharing Cities

SOUTHWEST CITY (Code Sharing)	ATA CITY	SOUTHWEST CITY (Non Code Sharing)
ALBUQUERQUE	BOSTON	ALBANY
BALTIMORE WASHINGTON	DENVER	AMARILLO
BIRMINGHAM	FT MYERS NAPLES	AUSTIN
CLEVELAND	HONOLULU	BOISE
COLUMBUS	MINNEAPOLIS ST PAUL	BUFFALO
DETROIT METRO	NEWARK	BURBANK
FT LAUDERDALE HOLLYWOOD	NEW YORK LAGUARDIA	CORPUS
HARTFORD SPRINGFIELD	SAN FRANCISCO	DALLAS
HOUSTON	SARASOTA BRADENTON	DULLES
INDIANAPOLIS	ST FETERSBURG	EL PASO
JACKSON	WASHINGTON NATIONAL DC	HARLINGEN/SOUTH
JACKSONVILLE		PADRE ISLAND
KANSAS CITY		LUBBOCK
LAS VEGAS		MIDLAND/ODESSA
LITTLE ROCK		NORFOLK
LONG ISLAND MACARTHUR		ORANGE COUNTY
LOS ANGELES		PITTSBURGH
LOUISVILLE		RENO
MANCHESTER		SALT LAKE CITY
NASHVILLE		SAN ANTONIO
NEW ORLEANS		SAN JOSE
OAKLAND		SPOKANE
OKLAHOMA CITY		
OMAHA		
ONTARIO		
ORLANDO		
PHILADELPHIA		
PHOENIX		
PROVIDENCE		
RALEIGH DURHAM		
SACRAMENTO		
SAN DIEGO		
SEATTLE		
ST LOUIS		
TAMPA BAY		
TUCSON		
TULSA		
WEST PALM BEACH		

Indianapolis, Indiana. ATA operates scheduled passenger flights from a hub at Midway

Airport in Chicago, Illinois, and charter flights across the globe.

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

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 (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.

The purpose of this paper is to examine the impact of the 2005 code-sharing agreement between Southwest and ATA on market power, air fares and passenger volumes in the affected markets. What is unique about this code share agreement is that it is the first time that Southwest has entered a market in this manner. This raises the question of whether Southwest' participation in a code share agreement will have the same impact on fares and competition that Southwest's direct entry has had in other markets. 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

³ "A discount or no frills carrier or airline (also known as low cost carrier (LLC) 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.

model and Section IV details the data sources. The empirical results are then presented and discussed, followed by future research plans.

II. Background on Code Sharing Alliance

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 two air carriers link existing flight networks, resulting in a new complementary network to provide services for connecting passengers (Park, 1997). This means that an airline combines the local segment of one city pair flight on its own planes with the other segment flown by its alliance partner. With code-sharing, alliance airlines can sell air tickets and offer services on some city pairs where they do not directly serve the entire route. On the other hand, parallel (or overlapping) alliances refer to collaboration between two air carriers competing on the same flight routes.

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

Code-sharing 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 appears before listings of interline

connections on Computer Reservation Systems (CRS).⁴ This listing priority may help alliance airlines gain market advantage over their competitors. Second, code-sharing 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 in addition to existing destinations without adding additional aircraft.

Alliance firms may benefit from an increase in the number of additional travelers who might otherwise choose direct flights or fly through other hubs served by competitors in the absence of code-sharing. These expanded service options may attract new passengers and thus result in alliance firms coordinating and offering more frequent flights, 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 new routes that may restructure the current network may also reduce costs. Thus, partner airlines may be able to lower air fares to passengers as a result of the code sharing alliance.

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 flight frequency and the size of aircraft will lead to a decrease in unit cost. It is widely used in the airline industry in contrast to the economy of scale, which means that increases in the network size will lead to a decrease in unit cost. Please See Caves, Christensen, Tretheway (1984) and Oum and Tretheway (1982) for details.

However, it has also been argued that code-sharing may harm market competition and decrease consumers' welfare. According to the US General Accounting Office (1998), the listing priority given code-shared flights on the CRS screen may decrease market competition on a route. 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 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 (1996), Park (1997, 2001, 2003), Park and Zhang (2000), 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.

However, international code shared airline markets are may not accurately portray what happens in domestic markets. In particular, international code sharing routes are

usually limited to a few large cities whereas domestic code sharing may involve hundreds of city pairs.

To date, studies of domestic code-sharing and its competitive effects include Bamberger and Carleton (2004), Armantier and Richard (2005a, 2005b), Chua, Kew and Yong (2005) and Gayle (2006). Armantier and Richard (2005a) and Bamberger and Carleton (2004) find that complementary code-sharing decreases average air fares and increases total traffic code-share markets. Further, Chua et al (2005) use firm-specific panel data to assess the impact of code-sharing on operating cost and find that large alliance partners tend to experience a reduction in operating cost small alliance partners tend to increase operating costs.

While we are interested in the impact of code-sharing on passenger volumes and fares, we are also concerned with the possible impact a code share agreement may have on market power. Previous studies of market power in the airline industry (Brander and Zhang (1990, 1993), Oum, Zhang and Zhang (1993), Park and Zhang (2000), Fischer and Kamerschen (2003)) assume product homogeneity which is generally not the case for airlines. Important service quality differences may take the forms of flight frequency, on-time performance such as arrival and departure delay, air time, ground transportation availability, advertising, departure schedule, day of the week and safety and accident reputation. Oum (1996) and Borenstein and Netz (1999) find that flight frequency or departure time is significantly different across firms. Thus, we assume product differentiation in this study of how incumbents responded to the Southwest and ATA code-sharing strategy.

III. Theoretical Model

We follow previous researchers (Brander and Zhang (1990, 1993), Oum (1996), Captain and Sickles (1997) and Fischer and Kamerschen (2003)) and use a general conjectural variation (CV) reduced form approach as our basic model as originally suggested by Iwata (1974) and later extended and generalized by Bresnahan (1989). The reduced form CV approach is able to find the average degree of market power and estimate the price-cost margin while imposing less demanding data requirement than a structural CV approach. Further, instead of regarding the CV as a 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 $i=1, \dots, n$) 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:

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

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:

$$P_j = P_j(Q_j, Q_{-j}, \Gamma_j, \alpha_j) \quad j=2, \dots, n \quad (2)$$

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:

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

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:

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

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

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

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:

$$P_1 = c_1 + \lambda_1 Q_1 \quad (6)$$

where $\lambda_1 = -(\partial P_1 / \partial Q_1) \cdot (1 + v_1)$ is defined as the market power parameter. The lower the level of λ_1 is, the less the price-cost margin and thus the more competitive the firm's conduct in the market. Accordingly, firm j 's supply relation can be written as:

$$P_j = c_j + \lambda_j Q_j \quad (7)$$

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.

IV. Empirical Model Specifications

(1) Demand Equation

The market demand functions are specified as follows:

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

where Q_{ijt} is 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 if code-sharing decreases market demand and positive if it increases market demand; P_{ijt} is firm j 's air fare on route i at time t and is expected 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 if code-sharing makes incumbent firm j 's passengers more sensitive with respect to changes in firm j 's price. $ORIPOP_{it}$ and $DESTPOP_{it}$ are exogenous variables defined as the population of the origin and destination cities and coefficients are expected to be positive. Similarly, $ORIINCO_{it}$ and $DESTINCO_{it}$ 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 affects airline demand and service quality. Passengers usually prefer airlines that offer more frequent flights. Thus, we include $FREQ_{ijt}$ (the number of firm j 's performed departures on route i at time t) and expect its coefficient to be positive. $CS_{it} FREQ_{ijt}$ 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 helps increase firm j 's departure frequency

and negative if it decreases 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.

(2) Supply Relation

To estimate the supply relation equation (4), we need the marginal cost function. However, precise definition and estimation of marginal cost is problematic in this industry. Researchers have addressed airline costs in a variety of ways. Brander and Zhang (1990, 1993), use average cost as a proxy for the route specific marginal cost, 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 route level.

For the purposes of this study, we need to specify marginal costs at the route level. To do this, we first make the simplifying assumption of constant returns to scale (CRS), a result supported by many previous researchers (Caves (1962), Eads et al (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 Farrell (2001)). We then follow Brander and Zhang (1990, 1993) and Oum, Zhang and Zhang (1993) and use average cost as a proxy for marginal cost and specify a linear marginal cost function.

Thus, the marginal cost for a firm j on a specific route i at time t is defined as:

$$MC_{ijt} = \alpha_1 + \chi_2 W_{ijt}^F + \chi_3 W_{ijt}^L + \chi_4 W_{jt}^K + \chi_5 W_{jt}^M + \chi_6 CRAFTSIZE_{ijt} + \chi_7 LOADFACTOR_{ijt} + \chi_8 DIST_i + \chi_9 LLC_j \quad (9)$$

where W_{ijt}^F is the average fuel price, measured as dollars per gallon for firm j on route i at time t ;⁶ W_{ijt}^L is the average price of labor defined as the average hourly wage rate for firm j on route i at time t ;⁷ W_{jt}^K is the capital input price defined as firm specific capital cost per unit of airline capacity (available seat miles) at time t ;⁸ W_{jt}^M is the material input price measured by firm specific material costs per available seat mile which includes all other expenditures such as maintenance, passenger food, advertising, insurance, communication, traffic commissions and etc.⁹ We expect the coefficient signs of these four input prices to be positive. $CRAFTSIZE_{ijt}$ is the average number of available seats per aircraft operated by firm j on route i at time t and the sign of this coefficient is

⁶ 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.

⁷ 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.

⁸Capital 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.

⁹ 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.

expected to be negative (because the more seats, the lower the cost per passenger and thus air fare can be lower).¹⁰ $LOADFACTOR_{ijt}$ is the load factor for firm j on route i at time t , measured by the ratio of the total number of passengers enplaned to the total number of available seats. The impact of $LOADFACTOR_{ijt}$ on fares is uncertain because on one hand, the cost per passenger decreases as load factor increases but a high load factor may indicate high demand that might allow airlines to increase air fares. So the overall effect will depend on which one is more strikingly significant. $DIST_i$ stands for distance on route i and this coefficient is expected to be positive since air fares are higher for longer flights reflecting the fact that costs increase with distance (although costs increase at a decreasing rate). We include a dummy, LLC to see whether or not low-cost air carriers have a cost-advantage in the airline operations where LLC equals 1 if the airline belongs to low cost carriers group. We expect the coefficient of LLC to be negative.

3) Market Power Parameter Specification

We specify the market power parameter as follows:

$$\lambda = \rho_1 + CS_{it}\rho_2 \quad (10)$$

where CS_{it} is the code-sharing dummy and is included to see whether code-sharing changes market power on code-shared routes. If ρ_2 is positive significant, then code-

¹⁰ 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.

sharing increases market power; If ρ_2 is negative, then code-sharing decreases market power.

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

$$\begin{aligned}
P_{ijt} = & \alpha_1 + \chi_2 W_{ijt}^F + \chi_3 W_{ijt}^L + \chi_4 W_{jt}^K + \chi_5 W_{jt}^M + \chi_6 CRAFTSIZE_{ijt} + \chi_7 LOADFACTOR_{ijt} \\
& + \chi_9 DIST_i + \chi_{10} LLC_j + \rho_1 Q_{ijt} + \rho_2 CS_{it} Q_{ijt} + \sum_{j=1}^{N-1} \gamma_j' FIRM_j + \sum_{i=1}^{M-1} \lambda_i' ROUTE_i \\
& + \sum_{t=1}^2 \phi_t' YEAR_t + \delta_{ijt}
\end{aligned} \tag{11}$$

where δ_{ijt} represents the normally distributed error term that might be contemporaneously correlated across equations. When we estimate the demand function (8) and supply relation (11) simultaneously, we will find the effect of code-sharing on market power, air fares and passenger volumes on specified routes.

V. Data Sources

The data set used in this paper is annual 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 include observations from before and after the code-sharing agreement. 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.

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> and a limited number of other code sharing routes are identified directly from the *DB1B Market* data set. To make the characteristics of non code shared routes comparable to those of code shared routes, we identify non code sharing routes as ATA Airlines from the ten cities that were chosen for code-sharing connecting, and Southwest 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*.¹¹ The data for the per capita personal income (in dollars) of origin and destination cities are also based on Metropolitan Statistical Areas level (MSA) provided by *Bureau of Economic Analysis, US Department of Commerce (BEA US DOC)*.

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

¹¹The 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 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.

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 Angeles, CA (LAX) by taking the arithmetic means of fuel prices from both the state of the origin city---MA and that of the destination city---CA.¹² 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 the 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*.

¹² One assumption we make here is that air carriers add fuels at both origin and destination cities.

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.¹³ 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 obtain route and firm level hourly average wages per worker. 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*.¹⁴

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

¹³ We assume 2,080 working hours for a full-time worker per year.

¹⁴ Nov 2005 OES Estimates are not available at this time.

and Yu (1998) and use aircraft lease rates as a proxy for capital cost, this information was not available to us at this time.

Accordingly, we follow Chua et al (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*.

Material input prices W_{jt}^M are calculated as 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 . 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. $LOADFACTOR_{ijt}$ is defined as the ratio of firm specific enplaned passengers to the number of its available seats on route i at time t .

$DIST_i$ 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*.

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 II.

VI. Empirical Results

Empirical results are presented in Table II for the code-shared routes operated by ATA and Southwest out of Denver. We estimate both demand and supply functions simultaneously using Full Information Maximum Likelihood (FIML). According to Green (2004), with normally distributed disturbances, maximum likelihood has the same asymptotic distribution as Three Stage Least Squares (3SLS) and is efficient among estimators of the simultaneous equations model but does not require identification of instrument variables to substitute for the endogenous variables.

Table II Descriptive Statistics

Variables (Descriptions and Units)	Mean	Std
Q (The number of passengers)	43042.61	37305.43
P (The air fare in dollars)	170.7834	38.83831
CS (Equals 1 if the route was in code sharing in 2005)	0.149349	0.356375
$ORIPOP$ (The number of population in the origin MSAs)	2563005	2004067
$ORIINCO$ (The per capita personal income (dollars) in the origin MSAs)	36495.37	4949.198
$DESTPOP$ (The number of population in the destination MSAs)	2479798	1937857
$DESTINCO$ (The per capita personal income (dollars) in the destination MSAs)	35958.84	4953.98
$FREQ$ (The number of departure performed)	1139.635	792.892
W^F (Fuel input prices, dollars per gallon)	1.220401	0.28702

W^L (Labor input prices, dollars per hour per worker)	33.61486	9.533209
W^K (Capital input prices, dollars per available seat mile)	0.143664	0.064132
W^M (Material input prices, dollars per available seat mile)	0.013742	0.002
<i>LOADFACTOR</i> (The ratio of the number of passengers to the number of available seats)	0.747882	0.121841
<i>CRAFTSIZE</i> (The average number of available seats per aircraft)	119.9003	33.18534
<i>DIST</i> (The market distance of a flight route in miles)	876.6101	356.1342
<i>LLC</i> (Equals 1 if the firm belongs to low cost air carriers)	0.313668	0.464365
<i>HHI</i> (Hirschman-Herfindahl Index per route in 2004)	3488.387	831.6164

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

Our empirical results show that the coefficient of Q_{ijt} obtained in the Table II is $\rho_1=0.000601$ and statistically significant while the estimate of code-sharing dummy variable ρ_2 is not statistically different from zero. Thus, the adoption of the ATA/Southwest code share agreement did not have any effect on market power.

Then according to the theoretical model, $\lambda = -\frac{\partial P}{\partial Q}(1+\nu)=0.000601$. From the estimates of demand function, we have that in the code-shared market; that is, $CS=1$, $\frac{\partial P}{\partial Q} = \frac{1}{\beta_2 + \beta_3}$ and in the non code-shared market; that is, $CS=0$, $\frac{\partial P}{\partial Q} = \frac{1}{\beta_2}$. In our current sample, the coefficient of $CS * P$ is not statistically significant, so we take $\frac{\partial P}{\partial Q} = \frac{1}{\beta_2}$. Therefore, $\nu = -0.8715$, a market power parameter estimate is much closer to Bertrand competition than Cournot quantity-setting competition, suggesting that firms compete on price in this code share market. This differs international code share agreements where competition was found to be on the quantity dimension (Oum (1996) and Brander and Zhang (1993)). Meanwhile, our results support Bertrand assumption made by Gayle (2006) in his research of domestic *parallel* code-sharing alliances.

Preliminary empirical results show that code-sharing tends to decrease market incumbents' demand by 1925 passengers if we measure the air fare at its mean level, though currently the estimate is not significant. Flight frequency is found to be a significant and positive determinant of airline demand. Further, we find a positive relationship between flight frequency and code sharing --- the implication being that code sharing increases flight frequency and thus consumer welfare. This is consistent with findings from Oum's (1996) study of international code-sharing alliances.

Both the estimates of the number of population in the origin and destination Metropolitan Statistical Areas are strongly significant at $p=0.01$ level with the expected sign. Estimates of 28 routes dummies are strongly significant at $p=0.01$ or $p=0.05$ level, suggesting that unobserved route specific are important as are unobserved time fixed effects.

The signs of three input prices, fuel, labor, and capital, in the supply relation are as expected although most do not have a high level of significance. The sign of material input prices unexpectedly negative, but not significant.

The coefficient on load factor is positive and strongly significant. This suggests that although high load factors decrease marginal cost per passenger, the depressing impact of this on fare is outweighed by the strong route demand indicated by high load factors. The estimate of aircraft size is strongly significant with the expected sign at $p=0.05$ level. This shows that larger body size tends to decrease marginal cost and thus air fares, which is consistent with previous studies.

7. Conclusions and future research

Our current sample results show that code sharing does not significantly affect market power, contrary to findings from previous studies from international markets (Oum (1996)). One reason may be that market competition was already high on these routes prior to the code share agreement. Another reason may be due to differences between international and domestic market characteristics. Our study focuses on domestic code-shared routes where 90% of the passenger volume comes from direct flight services whereas international code-shared markets studied were mainly interline markets prior to code sharing. In addition, our preliminary results show that code sharing tends to decrease incumbents' passenger volume but increase flight frequencies significantly.

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 ten ATA connecting cities in the code share agreement.

Table III Regression Results FIML Parameter Estimates

Demand Function				Supply Function			
Parameter	Estimate	Std Err	t Value	Parameter	Estimate	Std Err	t Value
<i>CONSTANT</i>	-182579	89756.9	-2.03***				
<i>CS</i>	-18960.3	16030.9	-1.18				
<i>P</i>	-213.859	94.8485	-2.22***				
<i>CS*P</i>	98.16297	101.4	0.97				
<i>ORIGINPOP</i>	0.08611	0.0301	2.86****				
<i>ORIINCOME</i>	-1.52589	0.9587	-1.59*				
<i>DESTPOP</i>	0.081224	0.0325	2.5****				
<i>DESTINCOME</i>	-0.59372	0.7896	-0.75				
<i>FREQ</i>	30.72615	2.4635	12.47****				
<i>CS*FREQ</i>	4.385132	3.0318	1.47*				
<i>AA</i>	1134.333	13144.5	0.09				
<i>AS</i>	24415.18	14011.7	1.74**				
<i>AX</i>	-15650.6	14214.3	-1.1				
<i>CO</i>	4286.744	26317.6	0.16				
<i>DL</i>	-9394.24	12984.7	-0.72				
<i>F9</i>	11393.67	12513.8	0.91				
<i>HP</i>	902.1756	13914.5	0.06				
<i>NW</i>	36967.86	15899.9	2.33****				

<i>OO</i>	-3205.32	12664.8	-0.25				
<i>QX</i>	4504.986	23963.2	0.19				
<i>UA</i>	7745.585	12841.4	0.6				
<i>US</i>	5240.316	31297.1	0.17				
<i>YEAR3</i>	9745.923	3908	2.49****				
<i>YEAR4</i>	4911.072	2412.9	2.04****				
				<i>FUEL</i>	89.09876	100.5	0.89
				<i>LABOR</i>	1.14886	0.8756	1.31 [†]
				<i>CAPITAL</i>	72.4689	246.7	0.29
				<i>MATERIAL</i>	-1184.76	4368.9	-0.27
				<i>LOADFACTOR</i>	78.67474	9.2993	8.46****
				<i>DIST</i>	-0.11379	0.5517	-0.21
				<i>CRAFTSIZE</i>	-0.30288	0.1419	-2.13***
				<i>LLC</i>	-2.11343	82.5505	-0.03
				<i>Q</i>	0.000601	0.000183	3.27****
				<i>CS*Q</i>	-0.00003	0.000103	-0.33
				<i>AA</i>	85.96377	112	0.77
				<i>AS</i>	46.21948	99.0983	0.47
				<i>AX</i>	32.05164	66.2485	0.48
				<i>CO</i>	72.84786	120.2	0.61
				<i>DL</i>	43.94542	90.539	0.49
				<i>F9</i>	-13.2454	114.2	-0.12
				<i>HP</i>	27.73072	113.5	0.24
				<i>NW</i>	47.69094	80.7531	0.59
				<i>OO</i>	-22.2778	35.2483	-0.63
				<i>QX</i>	12.11606	49.2776	0.25
				<i>UA</i>	64.51061	107.3	0.6
				<i>US</i>	46.74756	84.2226	0.56
				<i>YEAR3</i>	64.61189	64.6304	1
				<i>YEAR4</i>	33.97502	42.407	0.8
Adjusted R square		91.02				71.24	

[†] p=0.20 level; * p=0.15 level; **p=0.10 level; ***p=0.05 level; ****p=0.01level.

Once we include the additional code share cities, we plan to divide the sample into routes where pre-code share Herfindahl Indices (HHIs) were below 1800 (competitive) and above 1800 to see whether the impact of code share agreements on market power is different depending on the initial level of market power.¹⁵ For Denver, the majority of the routes from or to Denver had a HHI above 1800 in 2004. Code sharing might not change market power on monopoly routes but might do so on more competitive routes.

¹⁵ Based on the definition of “highly concentrated” market by US Department of Justice (1997), we pool routes with pre- alliance HHI above 1800 together as highly concentrated, routes with HHI between 1000 and 1800 as moderately concentrated and routes with HHI below 1000 as unconcentrated.

Future research should also take airline hubs into consideration as they are known to be an important factor affecting market power (Borenstein, 1989). As for product differentiation, future research will add more variables to differentiate firms' products. Besides flight frequency, firms' departure time such as the day of the week, whether the firms provide overnight or weekend flights, the average time of their arrival and departure delays, and ground transportation time could be added into the demand function to better capture individual firm characteristics.

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