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Empirical analysis of the airline industry on the U.S.-China route

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Dissertation

**EMPIRICAL ANALYSIS OF THE AIRLINE INDUSTRY ON THE
U.S.-CHINA ROUTE**

by

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of complementary routes to set lower prices, and we can check for this in the data. This paper uses a five-year panel data to examine the effects of airline alliances on airfares and traffic volume in the U.S.-China market.

The third chapter considers the relationship between mergers and code-sharing. Policy-makers typically view the effect of code-sharing on prices as similar to that of mergers. This paper tests to see if that holds true in this context. In particular, this paper studies the impact of Delta and Northwest merger on their international routes between the U.S. and China. I estimate the price effect on the routes where Delta and Northwest previously code-shared with each other before they merged. I find that merger did not have much impact on price in the markets where Delta and Northwest previously code-shared.

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List of Abbreviations

DB1B	The Airline Origin and Destination Survey
DOT	Department of Transportation
HHI	Herfindahl-Hirschman Index
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
OLS	Ordinary Least Squares

Chapter 1

Liberalization of the Airline Industry on the U.S.-China Route: Effects of the 2007 Amendment to the Aviation Agreement

1.1 Introduction

The airline industry is one of the industries that facilitate the globalization of trade. However, international air transport has been restricted by economic regulations and government controls. Under the framework of the 1944 Chicago Convention, when the International Civil Aviation Organization (ICAO) was established to coordinate and regulate international air travel, almost all international air travel is governed by a complex web of bilateral air service agreements between countries. For air passenger services, these bilateral agreements focus on traffic rights, market access, capacity, and pricing. A standard aviation agreement states the following: the points and routes where a foreign carrier can provide service, the number of designated airlines, traffic volume, flight frequency, airfare to be charged (which needs to be approved by both countries in advance), and cooperative arrangements between airlines. The liberalization of the international aviation market remains a challenge due to economic and political reasons.

This agreement plays an important role because it governs all of the aviation authorities in both of the countries. As the agreement has been amended gradually in recent years, the airline market has been liberalized with respect to route, carrier, and traffic volume. This paper aims to analyze the impact of such liberalization on price and quantity. Specifically, this paper examines the liberalization in the U.S. and China airline market based on micro-level data which contains ticket-level information. In particular, I provide a detailed analysis

of the changes resulting from the amendments to the aviation agreement. While most other airline-related literature has studied the airline alliances and mergers which are indirectly affected by the agreement, this paper focuses on the direct impact of the agreement through a market-by-market study that precisely addresses the impacts of liberalization on each market.

The central question for this paper is: What is the impact of liberalization on price and quantity in markets that are both directly and indirectly affected?¹ A secondary question is: How does liberalization affect price and quantity through its impact on demand and supply? The amendment liberalized the U.S.-China airline market by introducing additional routes and allowing additional carriers to enter this market. By matching and comparing routes, I examine the link between the amendment and changes in price and quantities. The main findings suggest that the amendment in general has led to lower airfares and higher traffic volume. The opened markets (where direct flights were permitted after the amendment) have experienced on average a 9 percent reduction in airfare and a huge growth (about 100 percent) in traffic volume. The potential explanations are related to changes in both air travel demand and supply. The beyond markets also see a reduction in airfare of 43 percent, depending on the connection with the opened markets.² Such results come from the spillover effect based on the route structure. Intuitively, if an airport is more closely connected to an airport that is opened up for direct flights, it is more likely to take advantage of receiving a spillover effect and become more competitive.³

I also estimate a structural econometric model of demand and supply for air travel. The estimates allow me to conduct a counterfactual analysis, and to measure the consumer welfare change based on simulations by comparing the simulated equilibrium to the observed actual equilibrium in a market. I find a consumer welfare improvement from the liberalization of the U.S.-China airline industry. These findings justify the expansion of routes created by the amendment.

¹In the regression, a market is defined as a directional pair of origin and destination.

²Beyond market refers to the markets where direct flights do not exist. In other words, in a beyond market, either the origin airport or the destination airport is not a gateway airport (beyond gateway).

³The measure of connection is not limited to geographic location, but is more reflected by the flight frequency between two airports.

The rest of this paper is organized as follows. Section 2 presents an overview of the aviation agreement between the U.S. and China, and reviews the related literature. Section 3 provides a description of the data sources used in this paper. In Section 4, a reduced form estimation regarding the price and quantity effects in several aspects is discussed. In Section 5, a structural model of demand and supply is presented, where the estimation strategy and results are discussed. An elasticity analysis is presented in Section 6. The counterfactual and welfare analysis are presented in Section 7. A conclusion is made in Section 8.

1.2 The Aviation Agreement and Liberalization

Although the U.S. has advocated deregulation of international aviation for years, the U.S.-China airline market has moved towards liberalization very slowly, and remains restricted when compared with the airline markets governed by the Open Skies Agreements.

A potential reason for this could be the unbalanced incentives that have existed for both countries at the start of liberalization. During the liberalization process, the U.S. airlines were enthusiastic about flying to China, while Chinese carriers resisted liberalization. In the early stage of liberalization, the U.S. carriers did enjoy a competitive advantage in China due to their customer amenities, carrier alliances, frequent flyer programs, and well-established domestic hubs. One concern for the Chinese carrier was that liberalizing the airline markets between the U.S. and China would result in difficulty competing against U.S. carriers, thereby simply perpetuating the lead that U.S. carriers enjoyed in passenger traffic at that time. For carriers, more flights result in losses if they cannot attract enough passengers. However, rapid economic growth in China has increased demand for air travel between China and the U.S., which has in many ways accelerated the liberalization process. The expectation is that competitive advantages in the aviation market are not a permanent phenomenon, and as such, competition created through the liberalization should ultimately benefit passengers.

The U.S.-China bilateral aviation agreement, established in the 1980s as a result of diplomatic efforts, governs aviation rights between mainland China and the U.S., covering both cargo and passenger services. This U.S.-China Aviation Agreement of 1980 (“the Agree-

ment”) restricts market access to only two designated airlines from each country, with each being allowed to operate a maximum of two round-trip flights per week on routes between four U.S. points and two Chinese points in both directions: New York, San Francisco, Los Angeles, Honolulu (U.S.), via Tokyo or another point in Japan, to Beijing, Shanghai (China). In other words, the routes between specified cities in the U.S. and China must have a stop in Japan. Within the U.S., there is further regulation since the Department of Transportation (DOT) determines who gets to fly which routes.

Several amendments to the 1980 Agreement were negotiated in 1992, 1999, 2004, and 2007, leading to expansions in routes, carriers and capacity. It also resulted in increased cooperation between airlines. The amendments in 1992 and 1999 increased the frequency of authorized flights per origin country from 27 per week to 54 per week. The 2004 Amendment expanded authorized flights per origin country to 249 per week by 2010, designated 4 new airlines (passenger or cargo), allowed carriers from each country to serve any city in the other country, and permitted unlimited code-sharing between U.S. and Chinese airlines, which was previously restricted to certain cities. In practice, however, service between the two countries occurred in three Chinese cities and a few cities in the U.S. The expansion in routes included nonstop Chicago-Shanghai flights operated by United Airlines and American Airlines, as well as nonstop Newark-Beijing flights operated by Continental Airlines.

A 2007 Amendment to the 1980 Agreement allowed for full liberalization of the air transport markets. The Amendment allowed for: unlimited designations of carriers, unrestricted route and traffic rights, and unrestricted capacity and frequencies on all agreed routes.⁴ It also means that at some point, both countries may designate an unlimited number of carriers to operate the agreed services on the specified routes, with unlimited selection of routes and unlimited frequencies for the airlines designated by each country. In particular, by the year 2011, authorized flights from airlines on each side were expected to expand toward unlimited frequencies; both the U.S. and China may designate an unlimited number of airlines (either passenger or cargo service) to operate on the agreed routes. However, this Amendment does

⁴The routes are unlimited within a group of cities specified in the Agreement.

not create free entry, because the government still picks carriers and routes based on the applications. In practice, the DOT decides which U.S. carriers can operate on which routes, and the number of routes is still restricted. Up until 2007, only five U.S. cities (New York, Newark, San Francisco, Chicago, and Los Angeles) offered nonstop access to three cities in China (Beijing, Shanghai, and Guangzhou). After several new nonstop routes were awarded by the DOT between 2007 and 2009, additional gateway cities (including Washington, D.C., Seattle, and Detroit) came into use as links to China.⁵

Adding direct routes was considered necessary and beneficial for both countries. As the demand for nonstop flights increased, restrictions led to an imbalance that began to benefit countries other than the U.S. and China.⁶ Since aviation is a global industry, the unique nature of bilateral liberalization is that travel restrictions imposed on one partner invariably benefit many other countries that are not part of the agreement. By some estimates, at least 16 percent of U.S.-China air traffic has moved to third countries.

Introducing nonstop flights along a certain route means providing improved options for passengers in travel time and convenience, since passengers usually prefer itineraries with shorter flying times and fewer connections. Although nonstop flights are generally more expensive, they still garner most of the market share (more than 60%) compared to connecting flights. Any beyond gateway market can make use of the new nonstop routes as connections. Furthermore, more options are always better for passengers. As a result, all of the participating markets enjoy the benefit of expanded nonstop flight service.

In the U.S., the DOT has the responsibility of selecting and awarding routes based on applications it receives from U.S. airlines. Since the DOT's decision processes are inherently opaque, for the purposes of my analysis, I consider carrier route selections as an exogenous factor. My focus, instead, is on the detailed passenger transaction data between 2005 and 2010, which is used to estimate the effects of the sequential route openings in the airline markets that took place between the U.S. and China. This analysis will be helpful for policymakers as

⁵In international air travel, a gateway refers to the port where customs clearance takes place.

⁶Student visa issuance increased 64 percent between 2004 and 2006. Travel from China to the United States is expanding rapidly and visa issuance growth in China is among the fastest in the world. Such growth is expected to continue.

they consider further amendments focusing on liberalization.

I focus on the impact of the newly opened nonstop routes in 2007 and 2009. As shown in Table 1.1, during the sample period of 2005 to 2010, additional nonstop routes between the U.S. and China were introduced during the years 2007 to 2009.⁷ While only three cities—Beijing, Shanghai and Guangzhou—remain as gateway cities for China, new cities also came into use as gateway cities for nonstop flights for the U.S., including Washington, D.C., Seattle, and Detroit. In March 2007, the route between Washington, D.C. (IAD) and Beijing (PEK) started nonstop flights operated by United Airlines. The linking of the two capital cities served as a new connection between the two countries. In 2009, nonstop flights on routes between Seattle (SEA)-Beijing (PEK) and Detroit (DTW)-Shanghai (PVG) were awarded to Delta Airlines, while Newark (EWR)-Shanghai (PVG) route was awarded to United Airlines.

The amendments also facilitated the formation of airline alliances between the two countries. Table 1.2 shows all the airline alliances. The code-sharing agreements among members of each airline alliance allow for better cooperation in international markets.

The airline industry has been the focus of many studies and research. A few empirical studies have looked at airline alliances and studied the risk of price collusion when the alliance was formed or when the airlines merged. For example, Whalen (2000) and Brueckner and Whalen (2003) examined international airline alliances, while Armantier and Richard (2006, 2008), Ito and Lee (2007), and Gayle and Brown (2010) studied domestic U.S. airline alliances. Peters (2006) and Berry and Jia (2008) studied mergers among certain U.S. airlines. Liberalization of airline regulations is another topic of interest, with a few studies focusing on the Open Skies Agreements between the U.S. and other countries. Micco and Serebrisky (2006), for example, studied the effect of the Open Skies Agreements related to air cargo service; Piermartini and Rousova (2009), and Cristea and Hummels (2012) have estimated the price and quantity effects associated with the Open Skies Agreements. All these previous studies have found that airline alliances and liberalization are associated with a drop in airfare and expansion in

⁷The nonstop flights on the route Atlanta (ATL)-Shanghai (PVG) operated by Delta Airlines started in 2008, but were suspended in 2009 due to poor performance coming from weak consumer demand and high fuel prices.

traffic volume, which are also consistent with the price and quantity results presented in this paper. This is because the introduction of nonstop flights reflects the liberalization of routes and carriers, thus promoting the formation of airline alliances between two or more countries. However, not much focus has been placed on the U.S.-China market, which is a huge market but remains regulated under a bilateral aviation agreement. I contribute to the literature by studying liberalization and analyzing its impacts on the U.S.-China airline market.

1.3 Data Source

The three main data sources used for empirical analysis are provided by the U.S. Department of Transportation (DOT). The Airline Origin and Destination Survey (known as DB1B) represents a 10 percent random sample of airline tickets from the U.S. reporting carriers. The international portion of the DB1B, unlike the domestic part, has restricted access which requires special permission to as well as substantial security precautions. The data set used in this paper covers international air travel to and from the U.S. over the period 2005-2010, and it contains detailed itinerary information for each ticket, including airfare paid by each passenger, origin and destination airports, connecting airports, travel distance, ticketing and operating carrier for each segment, and the number of passengers on each itinerary with the same fare.⁸

A second data set used is T-100 International Market data, which contains information on air traffic between the U.S. and China reported by the U.S. carriers, covering different service classes (passenger, mail, cargo) at monthly frequency. I focus on the passenger service data in order to estimate the change in traffic associated with the Amendment.

Another data set used for this paper is the T-100 Domestic Segment data. This firm-level data set contains information on the capacity and traffic reported by U.S. carrier on domestic nonstop flights, providing details on carrier, origin, destination, aircraft type and service class for transported passengers, scheduled departures, and departures performed. I focus on the passenger service entries in this data set. Since the data is collected monthly, I aggregated

⁸Distance associated with itinerary for the same origin and destination may differ since different connecting airports might be used for transferring passenger.

the number of departures performed for each origin-destination pair (in both directions) over carriers within a year, then constructed a measure of connection between cities based on the number of departures for nonstop flights for the empirical analysis.

1.4 Empirical Analysis

Two main questions are addressed in this section: (1) How does the Amendment affect markets that are directly affected by the Amendment, in terms of price and quantity respectively? (2) How does the Agreement affect markets that are indirectly affected (that is, they have no new direct flights, but they can fly on the new routes)? I estimate how much of the change in price and air traffic volume in the opened markets can be attributed to the introduction of direct flights by comparing with other markets which did not have much change.

Before conducting an empirical analysis of price and quantity changes caused by the Agreement, it is worthwhile to understand price and quantity fluctuations that occur with direct flights within the framework of competition and passenger preference. The introduction of direct flights increases the variety of routes offered and the change in ticket prices could be positive or negative. Prices could decrease because of the increased competition as the added nonstop flights generate more options. In addition, nonstop flights could also lower the unit cost for carriers, especially when firms start enjoying improved cooperation with alliance partners. Moreover, if new nonstop routes were granted to a new carrier to the market, there could be a reduction in markups as competition reduces the market power of incumbent carriers. On the other hand, prices could also increase. Since passengers usually prefer direct flights, increased demand may push up prices in the market. Firms could also increase prices because they offer choices that match the passenger's desired option. The traffic volume is expected to expand. The increase in quantity of passengers driven by the opening of nonstop routes partly comes from the growth of traffic on these new nonstop routes, and partly from the growth in the pre-existing routes through the spillover effects when they use those new routes for connections. Therefore, it requires an empirical analysis to understand the ambiguous effects on prices because there is a trade-off between the greater competition due to the new flights

and the fact that the new direct flights command a higher premium. The empirical analysis also provides an estimate of the effects on traffic volume in the related routes.

In the following analysis, a market is defined as a directional pair of an origin and a destination airport. For example, a round-trip ticket from Boston (BOS) to Beijing (PEK) is a distinct market from a round-trip ticket from Beijing (PEK) to Boston (BOS). This definition implicitly assumes that the market demand depends on the location characteristics of the origin airport.

1.4.1 Price Effect

The DB1B data is used here to analyze the impact of nonstop flights on price in the markets that opened for nonstop flights. Specifically, I compare the trends in airfare in the opened markets to those in the pre-existing gateway-to-gateway markets.⁹

Several filters were applied to the original data set before the empirical analysis. I focus on round-trip itineraries between the U.S. and China in the third quarter of each year. To limit heterogeneity, I exclude the business and first class tickets, as well as tickets with unreasonable fares to avoid coding errors in price.¹⁰ I retain tickets with at most six coupon segments, and exclude tickets with fares below \$100 or above \$9999.

Since all the tickets were reported by the U.S. carriers, and it is unlikely that a U.S. carrier flies any segment within China, most tickets reflect travels between a U.S. city and two major gateway cities in China-Beijing (PEK) and Shanghai (PVG).¹¹ However, tickets with a segment in domestic China segment are observed if the itinerary is cooperatively operated by a U.S. carrier and a Chinese carrier. These tickets accounted for over 90 percent of the markets and passengers in the original data. Therefore, I restrict the sample to exclude tickets on beyond-gateway cities in China, and remove tickets on the very thin markets to the U.S. cities (which

⁹The existing gateway-to-gateway markets include: Beijing (PEK) to Newark (EWR), Chicago (ORD) and San Francisco (SFO); Shanghai (PVG) to Chicago (ORD) and San Francisco (SFO).

¹⁰The selection was based on the ticket class code and fare credibility indicator set by the DOT.

¹¹According to the aviation agreement, a carrier is not allowed to fly between any two foreign points. A beyond-gateway itinerary usually takes place in terms of cooperation between a carrier with its foreign partners. Another gateway city is Guangzhou (CAN), and most nonstop flights to Guangzhou are operated by carriers from China.

account for less than 10 percent of the sample). Excluding small and thin markets eliminates the heterogeneity between large markets and small ones, which is difficult to capture in my econometric model. The remaining sample is the focus of the empirical analysis. Specifically, I compare the trends in airfare in the opened markets to those in the pre-existing gateway-to-gateway markets.

The final sample covers traffic in both directions in 885 markets in the year 2005 and 1,113 markets in the year 2010, and it contains 61,451 records of tickets with 72,889 passengers.¹² Table 1.3 reports the summary statistics of passenger air transport between the U.S. and China during 2005-2010. The average fare increased from \$1,401 to \$1,747, which is about a 25 percent growth in six years. The only exception is that a 7 percent reduction occurred in 2009.¹³ The number of passengers on nonstop flights showed a steady increase up until 2009; in 2010, there was a drop in flight frequency resulting from the suspension of nonstop service on some routes due to weak demand. Accordingly, the average number of connections had steadily decreased until 2009, with a small rebound occurring in 2010.

The fraction of outbound traffic from the U.S. accounts for more than half of the sample each year, even though this number is declining over time. In the full sample, the U.S. outbound traffic share was as high as 75 percent in 2005, but gradually dropped to 60 percent in 2010. This is primarily due to a limitation of the DB1B data set, which is a collection of tickets reported by U.S. carriers, and not foreign carriers.¹⁴ As a result, the tickets marketed by foreign carriers, which mostly originate from China and end in a U.S. gateway airport, are likely to be under-represented in this sample. However, because of the formation of airline alliances, the cooperation between carriers from U.S. and China is increasing, and the shares of both directions tend to be close in the sample.¹⁵ As of 2010, the fraction of U.S. outbound traffic decreased by 20 percent compared to its share in 2005. I therefore include a direction

¹²The ticket record in a market in a given year has duplications due to different fares.

¹³The fares are adjusted by CPI in 2010 dollars. This reduction may reflect the relatively high demand in 2008 caused by the Beijing Olympics event, and a decline in demand in the year following this event.

¹⁴It is the marketing carrier's responsibility to report the complete itinerary when there is more than one operating carrier.

¹⁵In an international itinerary involving a beyond-gateway airport, the domestic partner of a foreign carrier is required to provide service on the domestic segment.

indicator in my estimation.

A gateway-to-gateway market refers to a market that has direct flights, and therefore is less likely to make use of any other gateway-to-gateway market as a connection. However, the newly opened gateway markets may have an impact on pre-existing ones by serving as substitute connections in any beyond markets between the two countries. The prices are expected to drop in these pre-existing gateway markets due to the introduction of competition and the reduction of demand.

I restrict the sample to round-trip itineraries in the gateway-to-gateway markets between the U.S. and China, which are routes between gateway airports where designated carriers were allowed to offer nonstop flights. Gateway airports, whether the pre-existing ones or new ones, usually serve as domestic hubs, so they should share similar characteristics. Therefore, the identifying assumption is that in the absence of introducing nonstop flights, the price and traffic volume would have evolved similarly in the opened markets as in the pre-existing gateway markets (comparison markets), and thus any deviation of trend from the comparison markets could be attributed to the emerging nonstop flights.

In order to evaluate the validity of this assumption, I plot the price trend as seen in Figure 1 for the comparison market with each of the opened markets. All the opened markets followed the similar trend prior to the year when the nonstop flights started, but they show a deviation in the year the change occurred. The trends suggest that the deviations were responses to the introduction of nonstop flights in each of the markets.

This analysis is formalized by the following estimation

$$Y_{imt} = \beta_0 + \delta AG \times postAG + X_{imt}\beta + \alpha_m^1 + \alpha_t^2 + \alpha_r^3 + \epsilon_{imt} \quad (1.1)$$

where Y_{imt} represents the airfare (log) for a ticket i in market m in year t ; AG is an indicator for the opened market; $postAG$ is an indicator variable that equals to 1 for the tickets observed after the market opened up. I control for itinerary characteristics in X_{imt} (distance, nonstop indicator, and direction indicator). I also include the year fixed effect α_t^2 , the market fixed

effect α_m^1 , and the carrier fixed effect α_r^3 . The parameter of interest is δ , which captures how the price changed in each of the opened markets relative to the comparison markets. The estimation results are reported in Table 1.4. I find that, over the four opened routes, the average effect of nonstop flights on airfare is significantly negative. As reported in Column (5): the introduction of nonstop flights in those opened markets, on average, leads to a 9 percent drop in airfare.

It is also interesting to look at this effect in each of the opened market, although we do not have a lot of statistical power in these cases. This is because of the contaminated comparison group as the pre-existing gateway markets were unavoidably affected by the introduction of nonstop routes. Interestingly, I get the same negative sign for each market, although it is significant in only one case. Columns (1) through (4) report the impact of nonstop flights on each of the opened markets. In particular, the Beijing-Seattle market had a significant 17 percent drop in average airfare conditional on other itinerary characteristics, while the other three opened markets experienced a decrease in average airfare ranging from 2 to 5 percent. These fare reductions might be explained by the increased competition among gateway markets, as well as the cost synergies from the carriers' re-structured route network.

All other control variables display the expected signs, indicating that nonstop flights are more costly than connecting flights; airfares increase with distance traveled; and U.S. outbound travel is more expensive than inbound travel.

1.4.2 Quantity Effect

The data used to examine quantity effects came from the T-100 International Market sample, which contains air traffic information on passenger service reported by the U.S. carriers on a monthly basis. The passenger flows in each month were reported by carriers for each market. I restrict the sample to markets between gateway airports in China (Beijing and Shanghai) and any U.S. airports observed in the data set. In particular, given the limitation of data, I focus on two opened routes: Beijing-Washington, D.C. and Shanghai-Detroit. For the other two opened routes, there was no record of traffic in the Beijing-Seattle and Shanghai-Newark

markets before the U.S. carriers started direct flights in 2009, because services in these markets were offered only by carriers from China, which were not required to report to the DOT. However, traffic information became available after direct flights were granted to U.S. carriers as these carriers are required to report to the DOT.

I estimate the difference in traffic volume change by comparing the opened markets to those markets with the same origin airport that did not experience a change in route. Instead of including a direction indicator, I consider each direction for a market separately, so that I can control for the same origin airport and match the demand among compared markets. The outcome variable Y_{imt} in Equation (1.1) is the number of passengers and itinerary characteristics X_{imt} includes distance and nonstop indicator. The parameter of interest, δ , now captures how the passenger flow changes in the opened markets relative to the other markets. In this specification, year fixed effect, market fixed effect, and carrier fixed effects are included.

The impact of nonstop flights on traffic is reported in Table 1.5. I find a significant increase in traffic in three of the directional markets, although some of the result came from moving passengers from China's airlines to the U.S. airlines. The traffic in the Beijing-Washington, D.C. market almost tripled as a result of the introduction of nonstop flights, while the traffic in the Shanghai-Detroit market also experienced an increase, but the effect was not statistically significant. On average, the nonstop flights have led to a 100 percent increase in air traffic volume.

Although the other two markets (Beijing-Seattle and Shanghai-Newark) are not directly observed, they are also expected to have an increase in traffic due to the introduction of nonstop flights. This increase in traffic comes from the introduction of new nonstop routes, and also from the traffic growth on the pre-existing routes.

1.4.3 Spillover Effect

This section aims to estimate how the Amendment affects the markets originating from any beyond-gateway cities between the U.S. and China. I compare the beyond markets that are more-or-less connected to the new gateways depending on how many flights between a beyond

airport and the new gateway airport. Based on the limitation on data availability, only the price effect is presented.¹⁶

This model is estimated using DB1B ticket level data set and T-100 Domestic Segment data. The sample contains U.S. outbound round-trip itineraries from selected beyond-gateway cities to any city in China.

To estimate how the Amendment affects the markets originating from any beyond-gateway city in the U.S. and traveling to China, I select 17 major beyond-gateway airports (in 16 cities) in the U.S. that have a significant number of flights that travel to China. I then examine the price and quantity effects associated with the three opened markets in 2009. Given the network of domestic airline routes, the impact of nonstop flights in certain markets on the beyond markets is expected to lead to lower fares and increased traffic as a result of more options being available for connections. Such effects may also depend on the connection between a beyond market and the opened markets.

Now I must define the measure of level of connection. Specifically, as I restrict the sample to U.S. outbound markets, the measure of connection is constructed as the average frequency of domestic nonstop flights between a beyond city to the three opened cities (Seattle, Newark, and Detroit) within the U.S. A city is considered to be more closely connected to the opened cities if it has a higher nonstop flight frequency with the three opened cities on average. The level of connection is measured using the number of departures recorded in the T-100 Domestic Segment Data in 2007, which provides the number of nonstop flights between domestic U.S. airports. In particular, the level of connection for a beyond city m is

$$Connect_m = \log(Avg.Frequency_m)$$

where *Avg.Frequency* represents the average number of nonstop flights between each beyond city m and the three cities with opened routes. The level of connection is measured using the

¹⁶In the T-100 International Market data set, traffic information on routes without direct flights is not complete for my analysis. Similar empirical analysis would be conducted with respect to traffic volume upon the availability of data source.

logarithm of these averaged numbers. Table 1.6 presents a list of these beyond-gateway cities with the nonstop flight frequencies between them and the opened cities. Two cities were excluded in the calculation of level of connection: Washington, D.C. (IAD) was dropped with respect to Baltimore (BWI), because BWI airport serves as a substitute airport for Washington, D.C., and there are very few direct flights between these two places; Seattle (SEA) was dropped with respect to Hartford (BDL), because the number of direct flights was not available in the data set.

I estimate the following model

$$Y_{imt} = \alpha_0 + \delta postAG \times Connect_m + X_{imt}\beta + \alpha_t^1 + \alpha_m^2 + \alpha_r^3 + \epsilon_{imt}$$

For each outcome variable (Y_{imt}) representing airfare (log) for a ticket i in market m in year t , $postAG$ is an indicator variable that equals to 1 for the tickets observed after certain markets opened ($postAG = 1\{Year \geq 2009\}$), and $Connect_m$ is the measure of connection. I control for the number of stops in X_{imt} , and also include α_t^1 , α_m^2 , α_r^3 as year, market, and carrier fixed effects. The parameter of interest is δ , which captures the impact of direct flights on the beyond-gateway markets.

Table 1.7 presents the estimation results, indicating a significant negative price effect of opened markets on beyond-gateway markets when the nonstop flights started in 2009. Moreover, this impact also depends on the level of connection among the cities: the more closely a city is connected to opened cities, the bigger the impact induced. On average, the price has dropped 43 percent in the beyond markets as a result of adding nonstop routes.¹⁷ The price might be pushed up by the increasing demand for the direct flights, as well as by firms' increasing pricing power with new products.

¹⁷This result comes from the calculation of the product of $\hat{\delta}$ and the mean of $Connect_m$: $\exp(-0.07*8.05)-1=-0.43$.

1.5 Structural Model

Although the reduced-form estimation shows the price effect and quantity effect associated with the expansion of gateway airports, this approach is not sufficient for policymakers to assess the Amendment regarding the nonstop flights on certain routes. A structural econometric model allows us to identify the demand and supply source of price and quantity changes associated with the introduction of direct flights, and to perform counterfactual and a welfare analysis.

Introducing direct flights into certain markets results in the following changes:

- carriers can offer additional itineraries in existing markets
- passengers are provided with more options when booking a flight

In each market, a travel product is defined as a combination of carrier alliance, number of stops, and gateway type (either the gateway airports in the U.S. or China, or a gateway airport located in a third country that could be used as a connection). For a connecting itinerary, it must make use of one of the gateway airports. Depending on the carriers' network structure, it is very likely that the connecting gateway airport is in a third country near the U.S. or China. In fact, most of such third-country gateway airports are located in Japan and Canada.¹⁸

I assume all of the observed products are provided by three firms, or the three airline alliances. The airlines flying between the U.S. and China cooperate in airline alliance and Code-sharing. As shown in Table 1.2, by 2010, Star Alliance includes Continental Airlines, United Airlines, and Air China, while Sky Team Alliance includes Northwest, Delta, and China Southern Airlines. American Airlines is a member of the OneWorld alliance, and China Eastern code-shares with several OneWorld members although it is not a member. Airline alliances and code-sharing are intended to increase passenger traffic on each participating airline by allowing broad frequent flyer program benefits and increasing the number of flights that an airline can offer in the international air travel market.

¹⁸The third-country gateway airports include Tokyo (NRT) in Japan and Toronto (YYZ) in Canada, as well as Hong Kong (HKG) in China, Seoul (ICN) in South Korea, etc.

For all the markets covered in the sample, I focus on the round-trip tickets and collapse the data by averaging the price and aggregating the number of passengers so that each product has a unique observation in each market for each year. The final sample contains 2,202 markets with 7,040 products that are offered by three firms (airline alliances) over the 6-year period. For all the directional origin-destination markets, the number of products ranges from 1 to 23.

A new product refers to a travel product which makes use of any new gateway airport as a connection. In other words, if a product is connected by one of the new nonstop flights (Beijing-Washington, D.C. or Seattle; Shanghai-Newark or Detroit), then it is considered to be a new product. As the four new nonstop routes came into service, all new products appeared after 2007 and covered about 20 percent of the passengers from 2007 to 2010. All of these products are grouped by carrier alliances because passengers who usually invest in a frequent flyer program among one of the airline alliances consider the products from the same alliance as a closer substitute when making an airline choice. The outside option in each market refers to air travel products that are not included in this data set, as well as the option of not flying. For example, the outside option could be a product offered by single or multiple airlines from other countries other than the U.S. and China, and they are not required to report to the DOT.

1.5.1 Model

Demand Following recent empirical work by Peters (2006), Berry and Jia (2008), Gayle and Brown (2010), all examining the recent airline mergers, I use a discrete choice framework to model the demand for air travel, in particular, a nested logit model. Each passenger i in market l during period t chooses among $J_{lt} + 1$ products, with the outside option being $j = 0$. The nested logit model allows for a more reasonable substitution pattern than the simple logit model. The nested logit model allows correlation in consumer tastes within nests, by including a measure of degree of independence in unobserved utility within nests.

Products in a market are assumed to be grouped by firm (i.e., airline alliance), which are mutually exclusive. I assume that we have $G + 1$ mutually exclusive groups, $g = 0, 1, 2, \dots, G$,

and the outside option is the only product in group 0. According to how a product is defined, a group refers to a set of products offered by the same firm in a market.

Consumer i 's utility from product j is given by

$$U_{ijtl} = \delta_{jtl} + \zeta_{itlg} + (1 - \sigma)\epsilon_{ijtl}$$

where δ_{jtl} is the mean level utility across consumers choosing j , ζ_{itlg} is a within group random component (common across products in the same group, and depends on σ), and ϵ_{ijtl} is an identical and independently distributed extreme value. The parameter $\sigma \in (0,1)$ measures the correlation of a consumer's utility across products within the same group. As σ approaches 1, the correlation of utility level within the same group increases, and as σ approaches 0, such correlation goes to zero.

The mean level utility δ_{jtl} is given by

$$\delta_{jtl} = X_{jtl}\beta - \alpha p_{jtl} + \xi_{jtl}$$

where X_{jtl} is a vector of observed product characteristics (distance, number of stops, whether the origin is hub for the carrier or its airline alliance), p_{jtl} is the price of product j , and ξ_{jtl} represents unobserved product characteristics, such as product quality and airline reputation, which are likely to be correlated with price. α and β are the marginal utilities associated with observed product characteristics and price respectively.

For each year, in market l , the predicted group share of product j is given by

$$s_{j|g}(\delta, \sigma) = \frac{e^{\delta_j/(1-\sigma)}}{D_g}$$

where $D_g = \sum_{j \in F_g} e^{\delta_j/(1-\sigma)}$. The predicted share for group g is

$$s_g(\delta, \sigma) = \frac{D_g^{(1-\sigma)}}{\sum_{g=0} D_g^{(1-\sigma)}} = \frac{D_g^{(1-\sigma)}}{1 + \sum_{g=1} D_g^{(1-\sigma)}}$$

The last equality holds because the outside option is the only member in group 0, and we normalize $\delta_0 = 1$; therefore $D_0^{1-\sigma} = e^{\delta_0} = 1$. Hence, the market share of product j is given by

$$s_j(\delta, \sigma) = s_{j|g} \times s_g = \frac{e^{\delta_j/(1-\sigma)}}{D_g^\sigma [1 + \sum_{g=1} D_g^{(1-\sigma)}]} \quad (1.2)$$

The demand parameters to be estimated are $\theta_d = (\beta, \alpha, \sigma)$.

Supply Following the prevailing literature in the airline industry, I assume that the marginal cost is constant and log linear,

$$\ln(mc_{jt}) = W_{jt}\gamma + \omega_{jt}$$

where W_{jt} is a vector of observed marginal cost shifters, and ω_{jt} captures unobserved cost shocks.

Suppose there are G firms in a market, each firm g produces a subset of products in each market F_g . In each market, the market demand for a product j is given by

$$d_j = M \times s_j(x, p, \xi; \theta_d)$$

where M represents the market size, which is given by the population in the origin city. Based on the market demand, firm g 's profit in a market is given by

$$\pi = \sum_{j \in F_g} (p_j - mc_j) M \times s_j(x, p, \xi, \theta_d) - C_j$$

where C_j is the fixed cost of production. Under the Bertrand-Nash assumption, the price

for each product, p_j , must satisfy the first order condition

$$s_j(p, x, \xi; \theta_d) + \sum_{k \in F_g} (p_k - mc_k) \frac{\partial s_k}{\partial p_j} = 0$$

By defining the matrix Δ , which is

$$\Delta_{jk} = \begin{cases} -\frac{\partial s_k}{\partial p_j}, & \text{if } (k, j) \text{ are offered by the same firm} \\ 0, & \text{otherwise} \end{cases}$$

the first order conditions can be represented in matrix notation

$$s(p, x, \xi, \theta_d) - \Delta \cdot (p - mc) = 0$$

Assume the existence of pure-strategy Bertrand-Nash equilibrium in prices for the airline industry, the marginal cost is solved as

$$mc = p - \Delta^{-1} s(p, x, \xi, \theta_d)$$

The price equation implies

$$\ln[p - \Delta^{-1} s(p, x, \xi, \theta_d)] = W\gamma + \omega \quad (1.3)$$

Under the nested logit setting and the market share given in Equation (1.2), each element in matrix $\Delta(\alpha, \sigma)$ can be expressed in terms of market shares, which can be analytically solved as

$$\frac{\partial s_j}{\partial p_j} = -\alpha \frac{\partial s_j}{\partial \delta_j} = \frac{\alpha}{\sigma - 1} s_j [1 - \sigma s_{j|g} - (1 - \sigma) s_j]$$

$$\frac{\partial s_j}{\partial p_k} = -\alpha \frac{\partial s_j}{\partial \delta_k} = \alpha s_j \left[\frac{\sigma}{1-\sigma} s_{k|g} + s_k \right], \text{ for } k \neq j$$

Given $\hat{\alpha}$ and $\hat{\sigma}$ are estimated from the demand side, the marginal cost parameters γ in price equation (1.3) can be estimated by linear estimation.

1.5.2 Estimation

The estimation strategy that I use here follows Berry (1994). I first estimate the demand equation by itself, and then interpret and discuss the results. I then turn to the supply side estimation using the demand parameter estimates, where the marginal cost is recovered. These will be used to simulate prices for the counterfactual and welfare analysis in the following.

Instrument In the demand equation, price and within group share (p_j and $S_{j|g}$) are endogenous as they are likely to be correlated with unobserved product characteristics captured in ξ_j . It requires that valid instruments should be uncorrelated with residual and correlated with endogenous variables. These potential instruments are motivated by supply theory, including the level of competition and rival products. Both level of competition and potential substitutes are correlated with price and within group share as they are related to a product's markup. I include the following instruments in the estimation:

- number of firms in the market
- number of competitor products in the market
- number of other products offered by an airline in the market
- mean number of itinerary stops across products offered by an airline in a market

Demand Estimation In the nested logit model, following Berry(1994), the mean level utility can be analytically solved, and the parameters are chosen such that the observed product shares are equal to the predicted shares. The estimation equation is

$$\ln(S_j) - \ln(S_0) = X_j\beta - \alpha p_j + \sigma \ln(S_{jg}) + \xi_j$$

where X_j is a vector of observed product characteristics, including number of stops, nonstop indicator, and itinerary distance. The demand equation estimates are reported in Table 1.8. The first column reveals the OLS estimates, which ignores the endogeneity of price and within group share (p_j and S_{jg}), therefore the estimated coefficient on price and σ will be inconsistent. I will focus on the results reported in the second column, where appropriate instruments are included in estimation.

All the coefficient estimates have the expected signs, and are statistically different from zero. Product's price has negative effect on the utility. As measure of convenience for an air travel product, number of stops and distance both have negative coefficients. A negative coefficient on the number of stops for a product indicates that passengers are more likely to choose a product with fewer intermediate stops. Similarly, the utility decreases with the distance of the air travel. The coefficient on the nonstop indicator is positive, revealing the fact that nonstop flights are more popular than other choices in a market. The estimate of σ (sigma) is significantly greater than zero, and the magnitude is very close to zero. Since σ measures the correlation of utility obtained from products offered by the same firm, the estimate provides evidence that passengers demonstrate loyalty to an airline alliance, even though it is not very strong.

Marginal cost parameter estimation The observed marginal cost shifters include itinerary distance, a nonstop indicator, and a hub indicator of origin airport for operating carrier. The year, carrier, and market fixed effects are included in the estimation. Data from 2005 to 2006, collected prior to the introduction of new products, is used to estimate the marginal cost parameters in Equation (1.3). The parameters are estimated by ordinary least square based on the demand estimation $\hat{\theta}_d$. Table 1.9 presents the estimates of marginal cost parameters. All of the coefficients on Distance, Hub and Nonstop have the expected signs, and are statistically

different from zero. This finding suggests that marginal cost increases with distance, and that the marginal cost is higher if the origin airport is a hub for the operating carrier, but is lower for a nonstop flight.

1.5.3 Elasticity

On the demand side, I use the demand parameter estimates to calculate the own- and cross-price elasticities among firms for each opened market in each year, and then compare the change before and after when the nonstop flights entered each market.¹⁹ These elasticities play an important role in policy analysis. The elasticity matrix is constructed for each market in each year. An element in a elasticity matrix provides the percentage change in demand for the row firm due to the price change of the column firm. The elements on the diagonal of each matrix are the average own-price elasticity of demand for a firm, while the off-diagonal elements represent the average cross-price elasticities of demand among firms. The price elasticities of the market shares in the nested logit model are

$$\eta_{jk} = \frac{\partial s_j}{\partial p_k} \frac{p_k}{s_j} = \begin{cases} \frac{\alpha}{\sigma-1} p_j [1 - \sigma s_{j|g} - (1 - \sigma) s_j] & \text{if } j = k \\ \alpha p_k (\frac{\sigma}{1-\sigma} s_{k|g} + s_k) & \text{if } j, k \subset \text{same group} \\ 0 & \text{otherwise} \end{cases}$$

Table 1.10-1.13 shows the estimated elasticity matrices for the four opened U.S.-China markets. For example, the elasticities for the Washington, D.C.-Beijing market from 2005 to 2010 are presented in the first panel. The estimates for 2005 suggest that a 1 percent increase in American Airlines' (AA) price would lead to a 1.56 percent drop in demand for AA. Similarly, a 1 percent increase in Delta Airlines' (DL) price will reduce the demand for DL by 1.1 percent. In contrast, the cross-price elasticities suggest that a 1 percent increase in United Airlines' (UA) price will increase AA's demand by 0.00007 percent, while a 1 percent increase in AA's price will increase UA's demand by 0.00001 percent.

In general, the magnitudes of cross-price elasticities were very small and did not change

¹⁹Firms are referred to as alliances represented by three major U.S. airlines. F1=AA (OneWorld alliance), F2=DL (Sky Team alliance), F3=UA (Star Alliance)

much from year to year, which indicates that products from each of the three firms are not close substitutes for each other. On the other hand, the own-price elasticities experienced changes after the firm offered new products. In the Washington, D.C.-Beijing market, for example, with the introduction of direct flights by UA in 2007, the demand became slightly less price-sensitive for UA, decreasing in absolute value from 1.60 to 1.57. For the other three markets (Seattle-Beijing, Newark-Shanghai, and Detroit-Shanghai) where new direct flights were introduced in 2009, the demand for the firms that offered new products became substantially less price-sensitive. For example, in the Newark-Shanghai market presented in the third panel, the addition of direct flights resulted in a reduction of UA's own-price elasticity by 28 percent. These findings are intuitively consistent, since providing new products allows a firm to gain more market power, although it also depends on changes in the firm's marginal cost and the actions of the airline's rivals.

1.6 Counterfactual Analysis

In this section, I use the estimates from the structural model to perform counterfactual analysis, which reveals how the introduction of new products affects equilibrium price and consumer welfare. The counterfactual analysis tries to answer the question: How would the equilibrium price and consumer welfare change if the new products were removed?

With the estimated marginal cost parameters, I first recover the marginal cost by Equation (1.3), then solve for the predicted equilibrium prices for the period excluding the new products. Following Nevo (2000), the price can be predicted using Equation (1.3) by changing the matrix to Δ_{old} accordingly. Then the predicted prices can be compared to the actual prices, and we can analyze the impact on the markets when new products were introduced.

Similar to the simulation technique in Nevo (2000), the supply parameters are set to the estimates as shown in Table 1.9. I remove the new products introduced after 2007 while holding the market conditions constant, and then simulate the market equilibrium for the four opened markets.

The marginal costs for each product are recovered using the marginal cost parameter

estimates

$$\hat{M}C_j = \exp(W_j \hat{\gamma}) + \hat{\omega}_j$$

Then the simulated price p^* can be solved using the price equation (1.3)

$$p_{j^*} = M\hat{C}_j + \Delta_{old}^{-1} s_j(p, x, \xi, \theta_d)$$

The actual prices serve as a benchmark to compare with simulated prices p^* . The difference between p and p^* reveals how the equilibrium price changes as a result of the introduction of new products. The summary of comparison is presented in Table 1.14. Without the introduction of new products, the average prices for the opened markets are predicted to be higher than they are with the new products. For example, in the Washington, D.C.-Beijing market, the simulated prices after the year 2007 are on average 10 percent higher than the actual prices. The only exception occurs in 2008 where the predicted price turns out to be lower than the observed price at that time.²⁰ These findings are consistent with the results from the reduced form estimation, where a reduction of airfare was found to be associated with the introduction of direct flights.

One of the measures for consumer welfare is the consumer surplus. In the nested logit demand model, the expression for consumer surplus is

$$CS = \frac{1}{\alpha} \ln\left(1 + \sum_g D_g^{(1-\sigma)}\right)$$

In order to examine the change in consumer welfare due to the introduction of new products, the consumer surplus is calculated in two cases. On one hand, I calculate the consumer surplus, $CS(p)$, for the year 2007-2010 based on the observed equilibrium prices. On the other hand, assuming all the new products were removed, I calculate the consumer surplus, $CS(p^*)$, for

²⁰One potential explanation would be the Olympic Game held in Beijing in 2008, which increased the demand for air travel to Beijing and resulted in higher airfares in the routes related to Beijing.

the same period based on the simulated prices. Therefore, the difference between $CS(p)$ and $CS(p^*)$ would reflect the change in consumer welfare that is associated with the liberalization. I find that $CS(p) = 3.35$ and $CS(p^*) = 2.89$. In fact, the consumer surplus decreased by 14 percent if the new products were removed, which is evidence that the introduction of direct flights did benefit consumers.

The estimation of a structural model also allows me to decompose the effect of new direct flights into their effects on demand and supply, which provides a better understanding on the market effect associated with the Amendment. The reduced-form regressions estimate the changes in price and quantity pre- and post- the opening up of markets, which are combination of effects from the demand side and the supply side. A structural model aims to understand the demand changes and the airline pricing behavior changes separately.

The actual prices and recovered marginal costs are summarized in Table 1.15, where both are averaged at firm level in each year. In the year 2009, the nonstop flights in the Seattle (SEA)-Beijing (PEK) and Detroit (DTW)-Shanghai (PVG) route started and were operated by Delta Airlines (DL), while the nonstop flights in Newark (EWR)-Shanghai (PVG) route started and were operated by United Airlines (UA). To investigate the introduction of new products, I present the observed prices and recovered marginal costs for two years before and after 2009. Table 1.15 shows that Delta Airlines experienced a slight increase (approximately 1 percent) in marginal cost between 2008 and 2009, while United Airlines saw a subtle decrease (approximately 0.2 percent) in marginal cost.

Since the reduced-form model suggests the evidence that the price effects associated with the introduction of direct flights is a 9 percent decrease on average, which is a combination of impacts on demand and supply, the heterogenous effects on marginal cost pick up the change in cost for a firm. Given the expected demand-increasing effect associated with the introduction of nonstop flights on those routes, which would push up prices, the increase in average marginal cost suggests a drop in mark-up on average, which could be due to the increased competition in these markets.

1.7 Conclusion

This paper studies the airline market and the bilateral aviation agreement between the U.S. and China. The expansion from the 2007 Amendment liberalized the market with respect to routes, carriers, and traffic volume. I find that the introduction of direct flights leads to a 9 percent reduction in airfare and a 100 percent increase in air traffic volume in those opened markets. This expansion also has a spillover effect on other beyond-gateway markets, which is a 43 percent reduction in price. I also estimate a structural econometric model of demand and supply for air travel, which allows for a decomposition of effect of new direct flights into their effect on demand and supply. I use the demand parameter estimates to calculate the own- and cross- price elasticities among firms, which play an important role in policy analysis with respect to demand. By simulating the price and recovering the marginal costs in the case where new products are removed, I find that the predicted prices are higher than the observed prices, the consume welfare is improved, and the average marginal cost decreased. These results suggest the impacts of the 2007 Amendment to the Aviation Agreement on the U.S.-China airline market, which will be helpful for policymakers when considering liberalization in the future.

City (Airport)	City (Airport)	Year	Carrier
Beijing (PEK)	New York (JFK)		CA*
	Newark (EWR)		CO
	Chicago (ORD)		UA
	San Francisco (SFO)		CA/UA
	Los Angeles (LAX)		CA*
	Seattle (SEA)		HU*
	Washington D.C. (IAD)	2007-present	UA
	Seattle (SEA)	2009-present	DL
Shanghai (PVG)	New York (JFK)		MU*
	Chicago (ORD)		AA/UA
	San Francisco (SFO)		UA
	Los Angeles (LAX)		MU*
	Atlanta (ATL)		DL
	Newark (EWR)	2009-present	CO
	Detroit (DTW)	2009-present	NW
Guangzhou (CAN)	Los Angeles (LAX)		CZ*

* Carriers from China

List of Airlines			
China		U.S.	
Code	Airline Name	Code	Airline Name
CA	Air China	AA	American Airlines
CZ	China Southern Airlines	UA	United Airlines
FM	Shanghai Airlines	CO	Continental Airlines
HU	Hainan Airlines	NW	Northwest Airlines
MU	China Eastern Airlines	DL	Delta Airlines

Table 1.1: Direct Flights Between the U.S. and China

U.S. Carrier	China Carrier	Code-sharing	Alliance
Continental (CO)*	Air China (CA)	2009-present	Star Alliance
	China Southern (CZ)	2004-2009	Sky Team
	Shanghai Airline (FM)	2009-2010	Star Alliance
Delta Airlines(DL)**	China Southern (CZ)	2007-present	Sky Team
Northwest (NW)**	China Southern (CZ)	2007-2009	Sky Team
United (UA)	Air China (CA)	2007-present	Star Alliance
	Shanghai Airlines (FM)	2007-2010	Star Alliance

*Continental exited Sky Team, and joined Star Alliance in 2009

**Northwest merged with Delta in 2009

Table 1.2: Airline Alliances between the U.S. and China

Variable	2005	2006	2007	2008	2009	2010
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Fare(\$100)	14.01 (5.59)	14.65 (5.37)	15.3 (5.90)	16.17 (6.46)	14.51 (8.47)	17.47 (8.10)
Fare of Nonstop (\$100)	12.2 (4.25)	13.52 (4.58)	14.47 (5.54)	15.42 (5.31)	13.27 (7.62)	16.65 (7.90)
Nonstop Passenger Share	0.2	0.19	0.22	0.24	0.28	0.25
No. Connections	2.11 (1.27)	2.14 (1.27)	2.02 (1.27)	1.92 (1.29)	1.84 (1.34)	1.89 (1.28)
Distance (1000 miles)	14.73 (1.73)	14.77 (1.74)	14.68 (1.70)	14.68 (1.80)	14.75 (1.57)	14.7 (1.58)
Distance of nonstop (1000 miles)	12.74 (0.81)	12.93 (0.83)	13.16 (0.81)	13.34 (0.97)	13.59 (1.00)	13.34 (1.15)
Third Country Gateway	0.32 (0.47)	0.31 (0.46)	0.29 (0.45)	0.24 (0.43)	0.23 (0.42)	0.16 (0.37)
U.S. Outbound Share	0.75 (0.43)	0.69 (0.46)	0.69 (0.46)	0.66 (0.47)	0.64 (0.48)	0.61 (0.49)
No. Markets	885	941	939	995	1034	1113
No. Passengers	9972	11037	12044	11824	12759	15253
Observations	8312	9532	10210	9910	10429	13058

Table 1.3: Summary Statistics of U.S.-China Passenger Air Transport

	Dependent variable: Economy Class Airfare (log)				
	(1)	(2)	(3)	(4)	(5)
Beijing-D.C.	-0.016 (0.031)				
Beijing-Seattle		-0.171*** (0.028)			
Shanghai-Newark			-0.055 (0.032)		
Shanghai-Detroit				-0.038 (0.031)	
Average Effect					-0.088** (0.037)
Nonstop	0.085** (0.029)	0.075* (0.034)	0.076* (0.032)	0.078* (0.032)	0.080*** (0.020)
Distance(1000mile)	0.065*** (0.005)	0.067*** (0.006)	0.060*** (0.004)	0.060*** (0.004)	0.069*** (0.006)
US outbound	-0.166*** (0.012)	-0.159*** (0.009)	-0.165*** (0.012)	-0.158*** (0.009)	-0.171*** (0.011)
Constant	6.223*** (0.076)	6.213*** (0.092)	6.286*** (0.082)	6.288*** (0.074)	6.174*** (0.078)
Observations	11,822	10,890	11,335	11,034	14,886
R-squared	0.134	0.129	0.133	0.128	0.135

Note: Robust standard errors are in parentheses and are clustered by market and year. Column (1)-(4) are based on each market. Column (5) groups all these four markets. Carrier, market and year dummies are included for estimation.

*** Significant at 1% level. ** Significant at 5% level. * Significant at 10% level.

Table 1.4: Price Regression-Compare with Pre-existing Gateway Markets

Dependent Variable: Passenger Flow (log)					
	(1)	(2)	(3)	(4)	(5)
<i>U.S. outbound</i>					
D.C.-Beijing	2.498*** (0.117)				
Detroit-Shanghai		0.995*** (0.235)			
<i>U.S. inbound</i>					
Beijing-D.C.			2.834*** (0.147)		
Shanghai-Detroit				0.515 (0.612)	
Average Effect					2.028*** (0.513)
Constant	7.875*** (0.0637)	7.682*** (0.138)	7.572*** (0.098)	7.377*** (0.244)	7.907*** (0.228)
Observations	65	52	65	56	238
R-squared	0.713	0.398	0.687	0.202	0.044

Note: Robust standard errors are in parentheses and are clustered by market and year. Column (1)-(4) are based on each market. Column (5) groups all these four markets. Carrier, market and year dummies are included for estimation.

*** Significant at 1% level. ** Significant at 5% level. * Significant at 10% level.

Table 1.5: Quantity Regression

State	City (m)	Airport	Frequency (#Departures)			Log (Avg.Frequency)				
			Washington D.C.(IAD)	Seattle (SEA)	Newark (EWR)	Detroit (DTW)	d(m,IAD)	d(m,SEA)	d(m,EWR)	d(m,DTW)
Connecticut	Hartford	BDL	3668	N/A	2694	3347	8.21	N/A	7.90	8.12
Massachusetts	Boston	BOS	10082	1919	8066	5379	9.22	7.56	9.00	8.59
Pennsylvania	Pittsburgh	PIT	5175	50	6231	3800	8.55	3.91	8.74	8.24
Pennsylvania	Philadelphia	PHL	3023	1210	84	8762	8.01	7.10	4.43	9.08
Florida	Orlando	MCO	8549	1460	10530	9636	9.05	7.29	9.26	9.17
Florida	Miami	MIA	2758	730	5769	2393	7.92	6.59	8.66	7.78
Maryland	Baltimore	BWI	58	203	2768	6844	4.06	5.31	7.93	8.83
North Carolina	Charlotte	CLT	7232	855	10484	7102	8.89	6.75	9.26	8.87
Indiana	Indianapolis	IND	2877	149	3325	5548	7.96	5.00	8.11	8.62
Ohio	Cleveland	CLE	4544	501	4284	6207	8.42	6.22	8.36	8.73
Minnesota	Minneapolis	MSP	4027	5558	7025	11082	8.30	8.62	8.86	9.31
Missouri	Kansas City	MCI	2501	1280	2872	3299	7.82	7.15	7.96	8.10
Texas	Houston	IAH	4122	4888	8036	6353	8.32	8.49	8.99	8.76
Texas	Dallas	DFW	5244	7917	7698	7132	8.56	8.98	8.95	8.87
Arizona	Phoenix	PHX	1503	10380	5199	7039	7.32	9.25	8.56	8.86
Colorado	Denver	DEN	6204	11285	4541	6275	8.73	9.33	8.42	8.74
Utah	Salt Lake City	SLC	1287	7422	2005	739	7.16	8.91	7.60	6.61

Table 1.6: Beyond-gateway Cities

Variable	lnprice
postAG*Connect	-0.066*** (0.025)
Number of Stops	0.0265*** (0.009)
Constant	6.926*** (0.031)
Observations	13,797
Number of bgw_id	372
R-squared	0.051

Note: Robust standard errors are in parentheses and are clustered by market. Carrier, market and year dummies are included for estimation.

*** Significant at 1% level. ** Significant at 5% level. * Significant at 10% level.

Table 1.7: Effect of the Amendment on Beyond-gateway Markets

Variables	OLS Coefficient	2SLS Coefficient
Price	-0.938*** (0.053)	-1.233*** (0.464)
<i>sigma</i>	0.281*** (0.0157)	0.045** (0.022)
Stops	-0.0619*** (0.0223)	-0.0629*** (0.023)
Nonstop	2.156*** (0.224)	2.314*** (0.227)
Distance	-0.086*** (0.0115)	-0.093*** (0.015)
Constant	-4.717*** (0.410)	-2.722 (3.275)
Observations	14,529	14,529
R-squared	0.063	0.047

Note: Standard errors are in parentheses. The dependent variable for the ordinary least squares (OLS) and two-stage least squares (2SLS) is $\ln(s_{jt}) - \ln(s_{0t})$. Carrier, market and year dummies are included for estimation.

*** Significant at 1% level. ** Significant at 5% level.

* Significant at 10% level.

Table 1.8: Demand Parameter Estimates

Variable	Coefficient	SE	t-stat
Distance	0.045	0.003	17.493
Nonstop	-0.116	0.029	3.989
Hub	0.110	0.008	14.390
Constant	6.030	0.100	60.380
R-squared	0.437		

Note: Carrier dummies, market dummies and year dummies are included for estimation.

Table 1.9: Cost Parameter Estimates

Market: Washington, D.C.-Beijing				
Year	AA	UA	DL	
2005	AA	-1.56	1.41E-05	7.31E-05
	UA	9.99E-06	-1.10	0.02
	DL	9.99E-06	2.94E-03	-1.64
Year	AA	UA	DL	
2006	AA	-1.38	1.18E-05	9.61E-04
	UA	1.54E-05	-1.51	9.78E-04
	DL	7.25E-04	6.60E-03	-1.60
Year	AA	UA	DL	
2007	AA	-1.34	1.03E-05	1.11E-02
	DL	2.14E-06	-1.28	5.49E-04
	UA*	3.17E-05	2.94E-04	-1.57
Year	AA	UA	DL	
2008	AA	N/A	N/A	N/A
	DL	N/A	-1.32	2.18E-04
	UA	N/A	6.31E-06	-2.51
Year	AA	UA	DL	
2009	AA	-1.12	3.02E-06	2.53E-04
	DL	1.78E-06	-1.23	1.22E-02
	UA	3.03E-05	-9.04E-02	-1.79
Year	AA	UA	DL	
2010	AA	-1.48	8.69E-06	1.97E-04
	DL	2.36E-06	-1.84	1.18E-02
	UA	3.31E-05	2.08E-02	-1.96

* indicates the firms that provided new products (direct flight)

AA (American Airlines) represents the OneWorld Alliance

DL (Delta Airlines) represents the Sky Team Alliance

UA (United Airlines) represents the Star Alliance

Table 1.10: Elasticity Estimation in Washington, D.C.-Beijing Market

Market: Seattle-Beijing			
Year	AA	DL	UA
2005	AA	N/A	N/A
	DL	N/A	-1.18
	UA	N/A	3.32E-03
2006	AA	N/A	N/A
	DL	N/A	-1.18
	UA	N/A	4.05E-03
2007	AA	N/A	N/A
	DL	N/A	-1.31
	UA	N/A	4.59E-03
2008	AA	N/A	N/A
	DL	N/A	-2.26
	UA	N/A	6.34E-03
2009	AA	N/A	N/A
	DL*	N/A	-1.53
	UA	N/A	1.18E-05
2010	AA	N/A	N/A
	DL	N/A	-1.60
	UA	N/A	4.38E-03

* indicates the firms that provided new products (direct flight)

AA (American Airlines) represents the OneWorld Alliance

DL (Delta Airlines) represents the Sky Team Alliance

UA (United Airlines) represents the Star Alliance

Table 1.11: Elasticity Estimation in Seattle-Beijing Market

Market: Detroit-Shanghai				
Year	AA	DL	UA	
2005	AA	-1.28	2.34E-05	2.37E-05
	DL	5.17E-06	-1.88	2.37E-05
	UA	5.17E-06	2.34E-05	-1.28
Year	AA	DL	UA	
2006	AA	-1.33	3.03E-05	2.05E-03
	DL	2.16E-05	-2.64	1.10E-05
	UA	3.48E-03	3.03E-05	-1.40
Year	AA	DL	UA	
2007	AA	-1.29	4.16E-05	6.85E-03
	DL	3.16E-05	-2.05	1.01E-03
	UA	3.12E-03	6.76E-03	-1.75
Year	AA	DL	UA	
2008	AA	-1.16	3.91E-05	2.07E-02
	DL	2.03E-05	-1.89	3.87E-03
	UA	3.27E-03	4.06E-04	-1.90
Year	AA	DL	UA	
2009	AA	-1.19	7.25E-05	3.19E-03
	DL*	9.65E-06	-1.56	4.32E-03
	UA	6.31E-04	5.14E-03	-1.09
Year	AA	DL	UA	
2010	AA	-1.73	3.22E-03	6.00E-03
	DL	4.38E-03	-3.77	7.45E-03
	UA	3.95E-03	5.75E-03	-2.27

* indicates the firms that provided new products (direct flight)

AA (American Airlines) represents the OneWorld Alliance

DL (Delta Airlines) represents the Sky Team Alliance

UA (United Airlines) represents the Star Alliance

Table 1.12: Elasticity Estimation in Detroit-Shanghai Market

Market: Newark-Shanghai				
Year	AA	DL	UA	
2005	AA	-1.35	3.48E-03	3.68E-03
	DL	1.00E-02	-1.01	4.39E-03
	UA	1.07E-02	5.15E-03	-1.60
Year	AA	DL	UA	
2006	AA	-1.28	4.79E-05	3.53E-03
	DL	4.79E-05	-1.06	3.29E-04
	UA	2.97E-03	4.66E-03	-1.88
Year	AA	DL	UA	
2007	AA	-1.18	3.85E-05	1.24E-03
	DL	1.66E-04	-1.53	5.08E-03
	UA	2.91E-03	2.12E-02	-1.50
Year	AA	DL	UA	
2008	AA	-1.23	3.93E-05	1.94E-03
	DL	9.48E-05	-1.37	1.65E-03
	UA	2.61E-03	7.29E-03	-1.65
Year	AA	DL	UA	
2009	AA	-0.94	4.31E-03	5.69E-04
	DL	5.06E-04	-0.98	4.60E-03
	UA*	4.64E-03	5.55E-03	-1.19
Year	AA	DL	UA	
2010	AA	-1.48	9.03E-03	7.04E-04
	DL	3.88E-03	-1.70	7.42E-03
	UA	7.50E-03	9.14E-03	-1.98

* indicates the firms that provided new products (direct flight)

AA (American Airlines) represents the OneWorld Alliance

DL (Delta Airlines) represents the Sky Team Alliance

UA (United Airlines) represents the Star Alliance

Table 1.13: Elasticity Estimation in Newark-Shanghai Market

Washington, D.C.-Beijing		
	Actual Price	Simulated Price
2007	1338.25	1575.38
2008	2135.92	1724.09
2009	1398.47	1486.59
2010	1745.36	1839.63

Seattle-Beijing		
	Actual Price	Simulated Price
2007	1636.00	1493.88
2008	1676.50	1701.54
2009	1490.76	1462.60
2010	1866.74	1821.00

Newark-Shanghai		
	Actual Price	Simulated Price
2007	1334.18	1592.80
2008	1337.00	1676.51
2009	957.25	1471.38
2010	1542.96	1782.05

Detroit-Shanghai		
	Actual Price	Simulated Price
2007	1606.35	1473.52
2008	1593.50	1606.74
2009	1164.35	1415.54
2010	2589.46	1666.50

Table 1.14: Summary of Simulated Prices

Year	Airline	Actual Price	Marginal Cost
		Mean (Std. Error)	Mean (Std. Error)
2007	AA	1494.57 (34.11)	1361.30 (3.25)
	DL	1492.27 (22.29)	1376.31 (3.10)
	UA	1622.81 (13.72)	1382.56 (2.36)
2008	AA	1791.69 (42.71)	1362.93 (3.44)
	DL	1611.02 (23.83)	1370.09 (2.34)
	UA	1737.94 (16.28)	1382.30 (2.43)
2009	AA	1573.55 (44.98)	1364.03 (2.96)
	DL*	1429.90 (29.86)	1381.78 (3.10)
	UA*	1642.00 (24.50)	1379.67 (2.17)
2010	AA	1643.89 (28.53)	1351.25 (2.23)
	DL	1782.13 (40.02)	1382.77 (4.07)
	UA	1930.72 (20.84)	1381.06 (2.01)

Note: * indicates the firms that provided new products (direct flight) in 2009.

Table 1.15: Price and Recovered Marginal Cost

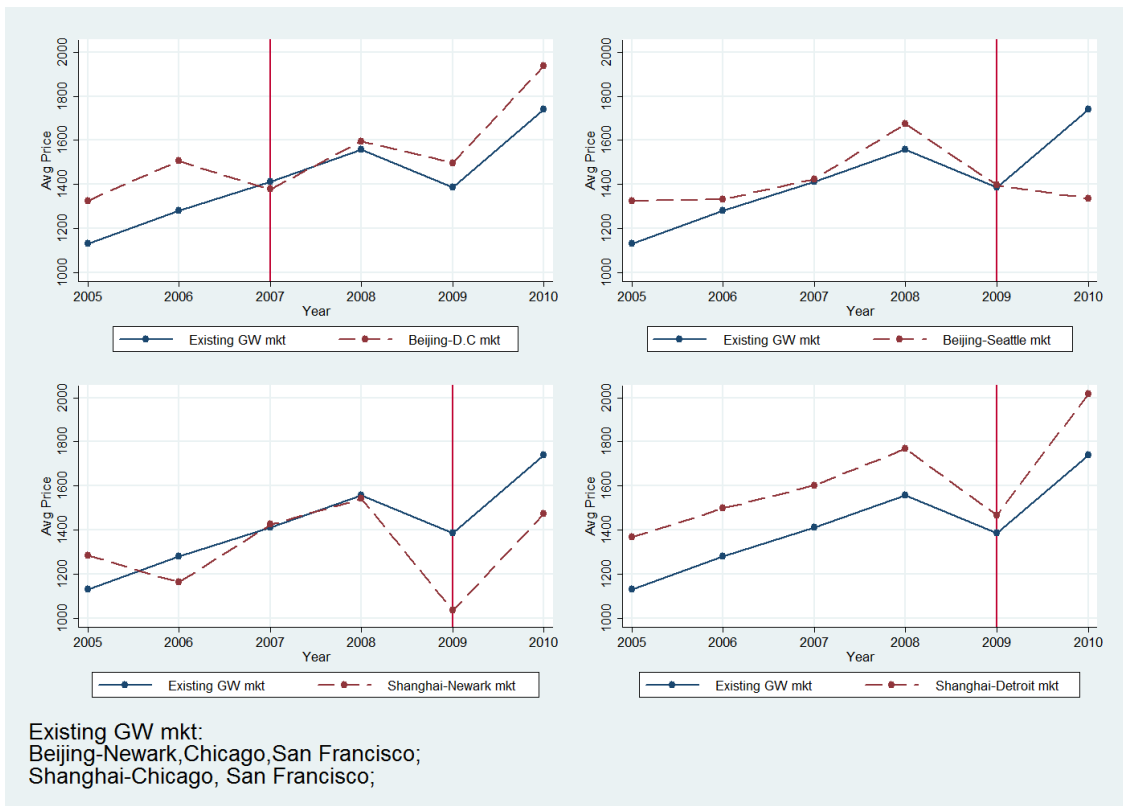


Figure 1.1: Price Trend in the Existing Gateway Markets and New Gateway Markets

Chapter 2

Price and Output Effects of Code-share in the U.S.-China Airline Market

2.1 Introduction

As international airlines have expanded in recent decades, increasing demand for air travel between the U.S. and China has prompted U.S. airlines to forge alliances with their overseas counterparts in China in order to extend the reach of their network. In general, carriers offer service on routes between their hubs and the largest international cities and transfer passengers to foreign carriers if their destinations are beyond these large cities. This cooperation represents the airline industry's strategic response to regulatory barriers that prevent any one carrier from expanding its international network.

An airline alliance is an agreement between two or more airlines to cooperate on a substantial level. The three largest passenger alliances are the Star Alliance, SkyTeam and OneWorld. In 2004, carriers from the U.S. and China became involved in Star Alliance and Sky Team Alliance,¹ where they have code-share agreements with their alliance partners. While non-alliance interline service suffers from a double marginalization problem, this problem could be partly internalized by an alliance. Within an alliance, the multi-carrier (interline) itineraries mimic single carrier (online) service, and the alliance partners can reap some of the benefits associated with the online service, for example, reducing layovers and increasing frequencies.

Code-share flights between these airlines are, for the most part, seamless. With code-sharing, a trip is ticketed as if it occurred on a single carrier, even though some of the route

¹The 2004 Amendment allowed carriers from each country to serve any city in the other country, and permitted unlimited code-sharing between U.S. and Chinese airlines, which was previously restricted to certain cities.

segments are operated by the code-share partner. In addition, trips under code-share have more flexibility in the price than under the traditional interline arrangement.

Given the increasing globalization of the world economy, especially the rapidly growing economy of China and the consequent increasing demand for international air travel, it is important to study the impact of cooperation among international carriers. Compared to the impact on passenger convenience, it is much easier to measure the impact of airline cooperation on fare and output (number of passengers). This paper examines the effect of code-sharing on fares and output for interline trips in a large sample of international city-pair markets. However, we do not investigate the effect of code-sharing on fares for nonstop travel on a single carrier between international gateway airports. According to the empirical results, I find that code-sharing among international carriers generates substantial fare benefit for passengers. I also find that code-sharing is associated with greater number of international passengers.

The next section details the DB1B data set. Section 3 presents the summary statistics and empirical results. Section 4 discusses the major findings and conclusions.

2.2 Data Source

The data used for the empirical analysis comes from the quarterly Origin and Destination Survey by the Department of Transportation (DOT). The Airline Origin and Destination Survey (DB1B) is a 10% sample of airline tickets from reporting carriers. The sample includes all traffic either ticketed by U.S. carriers or where a U.S. carrier operated at least one segment. Each observation is an itinerary with origin, destination, fare, connecting airports, number of sampled passengers and other itinerary details.

This analysis uses the data for the third quarter of each year from 2005 through 2009. In order to study the effect of airline alliances between U.S. and China, the data is restricted to U.S.-China traffic. Several adjustments were made to the data to correct for data problems and allow for regression analysis. Itineraries were deleted if the fare was likely in error according to the DOT's Dollar Credibility Indicator. Itineraries with a one-way component exceeding 4 coupon segments were deleted. Itineraries with unknown carrier codes or origins, destinations,

or stops outside of the continental U.S. and China were deleted. Commuter carriers were re-coded to their major carrier partners.

Each itinerary was broken into its one-way components, and half of the fare was applied to each direction. Itineraries with more than two carriers were deleted in order to compare the fares for alliances to fares for traditional interline and online services. In this paper, I constructed a broader measure of airline cooperation by assuming that airline partners would behave cooperatively in all the markets they serve. Carriers with a code-sharing agreement were identified as alliance partners, even though their code-share activity may have been limited to a certain set of markets.

The data were aggregated to the route-carrier level. Each observation is an itinerary that is unique to the origin-destination pair and the operating carrier or carrier pair. Therefore, each origin-destination pair will have multiple observations if there is more than one carrier or carrier pair offering service on that market.

There are four basic categories for the international routes, two of which are included in the empirical analysis for this paper: behind-to-gateway routes and behind-to-beyond routes. Behind-to-gateway includes routes between a non-gateway U.S. airport and a foreign gateway airport, where U.S. carriers can provide online service, but foreign carriers can only serve the route in conjunction with a U.S. carrier. Behind-to-beyond routes are between two non-gateway airports, thus only interline service is possible, either alliance or non-alliance. Since foreign carriers cannot have online service on either of these route types, all service on these is sampled by the DOT, providing a complete picture of service on these routes. Excluding some routes is necessary because, in this empirical analysis, an itinerary has to have a segment on a U.S. carrier to be reportable to the DOT. The excluded categories are gateway-to-gateway and gateway-to-beyond routes, where a substantial amount of traffic is taken by online service of foreign carriers which can go unobserved and potentially bias the empirical result.

Data on alliance, code-share agreement and their effective dates are listed in Table 2.1. There are seven code-sharing agreements that appear in two of the airline alliances, Star Alliance and Sky Team, over the five-year period. The first alliance was formed between

Continental Airlines (CO) and China Southern Airlines (CZ) in 2004. The two airlines began code-sharing since they were both in the Sky Team Alliance. Most of the other alliances and code-sharing agreements began in 2007, and continued throughout the entire sample period.

For this data, there are 1237 different routes between cities in the U.S. and China, and there are 34 carriers involved. The summary statistics for this data set are presented in Table 2.2. For this route-carrier data set, the average fare (Avg. Fare) is \$1051, itineraries have an average of 2.1 coupon segments (Avg. Coup), and 37% of them are from one-way travel itineraries (Pct OW). In a quarter, the average number of sampled passengers on each route (Mkt_Pax) is 30.8, corresponding to 308 actual passengers. Dummy variables are used to indicate whether the service was single carrier (Online) or code-share alliance (code-share). In summary, in this data set, 65% of service is online, 6% is code-sharing, and the rest is non-alliance service.

Competition in the markets is measured using Herfindahl-Hirschman index (HHI). Similar to Brueckner (2003) and Whalen (2007), separate HHIs were calculated for carriers offering online service or alliance (HHI_Oa), and for carriers offering only non-alliance interline service (HHI_Int). This is because competition mainly comes from carriers offering online service or alliance interline service; however, competition could also come from carriers providing non-alliance interline service, but one could argue that the pricing of the latter type could heavily depend on International Air Transport Association (IATA) and its pricing may reflect some cartel behavior. When calculating shares to get HHI, passengers traveling on code-sharing alliances were divided equally between the two carriers.

2.2.1 Estimation Strategy

I estimate the reduced form regression of price and output. In particular, fixed effect regressions were estimated to measure the price effect and output effect of different types of service. The basic form of regression equation for price and output is listed below.

$$DepVar_{imt} = f(Online_{imt}, code - share_{it}, AvgCoup_{imt}, AvgDist_{imt},$$

$$PctOW_{imt}, HHI_Oa_{mt}, HHI_Int_{mt}, YearEffects_t, \\ CarrierEffects_i, RouteEffects_m)$$

In this regression, the subscript i refers to the carrier, m refers to the route or market, t refers to the year. On the left-hand-side, $DepVar$ is the log transformation of price in the price regression and log transformation of number of passengers in the output regression. The route effects in the regression equation would be differenced out using fixed effects. Carrier dummy variables are constructed to control for the carrier-specific effect, in particular, the carrier effect variable is set to 1 for online service and 1/2 for each carrier providing interline service. Year dummies were included to capture time-specific effects.

Previous theory suggests that alliance service, such as code-sharing and immunized alliance, could internalize the double marginalization problem and result in lower fares than non-alliance interline service. Moreover, under the code-sharing agreement, the bilateral prorate negotiations are more efficient than fares set through the IATA process. So in the price regression we would expect the signs of coefficients on the variables measuring online and alliance service (Online, code-share) to be negative.

The HHIs will be treated as endogenous in some specifications of the regression analysis. In this case, the lagged HHIs will be included as instruments for all service, online, alliance, and interline service. A detailed discussion will be presented below.

2.3 Regression Results

2.3.1 Price Regressions

Table 2.3 presents the results of the fixed effects estimation on price. The OLS regressions are included in the first two columns. The first specification in OLS(1) includes the time effects and route effects, while OLS(2) includes carrier specific effects in addition. The third and fourth, IV(3) and IV(4), repeat these specifications using the lagged HHI as instruments to control for the potential endogeneity of the HHIs.

All of the regressions produce results that are consistent with what we expected on the

coefficients of interests. According to Table 2.3, I find that the effect of online service on fares is highly statistically significant across all of the specifications, and is quantitatively higher when carrier-specific effects are included in both OLS and IV regression. In the first specification OLS(1), online service is associated with 6% lower fares compared to non-alliance interline service. In the second specification OLS(2) where carrier-specific effects are included, the effect of online rises to 23%. The effects are similar in the IV estimates, where without carrier-specific effects online service has fares that are 6% lower, and moving to 23% lower with carrier-specific effects being included. These results suggest that carriers are not able to price non-alliance interline service efficiently.

The results for code-sharing suggest that the effect of code-sharing on fares is statistically significant only when the carrier-specific effects were included, and they are qualitatively similar in both OLS and IV specification. In both of the OLS and IV regression, code-sharing is not statistically significant without the carrier effects, while it is associated with 11% lower fares as compared to the non-alliance interline service. Unlike the online result, adding the carrier-specific effect does have significant impact on the coefficients. This is not surprising given the expectation that low-price carriers would be more likely to enter into code-sharing agreements to escape the IATA process. Moreover, it is important to notice that code-sharing has roughly half of the effect of online service.

For all the other coefficients, I find that increases in number of coupons result in slightly higher fares, which is unusual since itineraries with more connections are less preferred. Both coefficients on HHI_Oa and HHI_Int are significant, suggesting that an increase in concentration of online and alliance service is associated with higher fares, and an increase in concentration of non-alliance interline service is also associated with higher fares. The former results for HHI_Oa is unusual, which is likely due to correlation between HHI_Oa and some other unobservables.

2.3.2 Output Regressions

Table 2.4 contains the results of the fixed effects estimation on output. In the basic regression equation, the dependent variable is the log transformation of number of passengers on a route. According to the results, it is consistent with the price effects that online service and code-sharing alliance are associated with large and significant increases in output when the carrier-specific effects are included.

In Table 2.4, the effects of online service on fares is quantitatively similar across all of the specifications. Without carrier-specific effects, online service is associated with 1% increase in output; while with carrier-specific effects, online service has 2% lower output than non-alliance interline service. The inclusion of carrier-specific effects raises the effect of the online service on the number of passengers, which suggests that carriers with higher output are more likely to offer online service. Columns (2) and (4) suggest that having a code-sharing agreement could have 1% increase in output.

All the other coefficients are generally consistent with our expectations. An increase in average number of coupons (Avg.Coup) is associated with less output, because additional connections are not preferred by passengers. The HHI_Oa, which measures the competition for carriers offering online or alliance service, has a negative and significant sign, suggesting that increased concentration is associated with lower output. However, for the HHI_Int, which measures the competition in non-alliance service, the coefficients are not even statistically significant, suggesting that HHI_Int does not have an impact on output.

2.4 Conclusion

This paper uses a 5-year panel of data to examine the effects of airline alliances on price and output in the U.S. - China markets. The results suggest that code-sharing is associated with significantly lower fares compared to non-alliance interline service. These results suggest that code-sharing fares are 11% lower as compared to non-alliance interline service. This paper also finds that online service is associated with 23% lower fares than non-alliance interline service. Because online service does not suffer from the double marginalization problem as found in

code-sharing agreements, it is reasonable that code-sharing fares have roughly half of the effect as online service. However, it seems likely that code-sharing, while not sufficient to eliminate the externality, still brings some benefit to the passengers. Consistent with the results for price, online and code-sharing alliances are associated with an increase in output.

U.S. Carrier	Chinese Carrier	Code-sharing	Alliance
Continental (CO)	Air China (CA)	Oct 2009	Star Alliance
	China Southern (CZ)	2004-2009	Sky Team
	Shanghai Airline (FM)	Oct.2009-Nov 2010	Star Alliance
Delta Airlines(DL)	China Southern (CZ)	2007	Sky Team
Northwest (NW)	China Southern (CZ)	2007-2009	Sky Team
United (UA)	Air China (CA)	Dec 2007	Star Alliance
	Shanghai Airline (FM)	Dec 2007-Nov 2010	Star Alliance

Northwest merged with Delta in 2009

Continental exited Sky Team, and joined Star Alliance in 2009

Table 2.1: Code-sharing and Alliances

Route-Carrier data (59,482 obs)		
Variables	Mean	Sta. Dev.
Avg. Fare	1051.302	926.3659
Online	0.646	0.478
Codeshare	0.058	0.235
Avg. Coup	2.088	0.301
Pct OW	0.366	0.482
Avg. Dist.	7534.324	708.805
HHI_Oa	0.402	0.265
HHI_Int	0.126	0.176
Mkt_Pax	30.828	98.135

Table 2.2: Summary Statistics

VARIABLES	(1) OLS	(2) OLS	(3) IV	(4) IV
Online	-0.0596*** (0.00705)	-0.259*** (0.0184)	-0.0593*** (0.00714)	-0.266*** (0.0188)
Codeshare	-0.0214 (0.0148)	-0.111*** (0.0204)	-0.0233 (0.0152)	-0.118*** (0.0212)
AvgCoup	0.0954*** (0.0303)	0.0131 (0.0302)	0.0931*** (0.0341)	0.00786 (0.0340)
AvgDist	5.22e-06 (1.64e-05)	2.61e-05 (1.63e-05)	-2.18e-06 (1.80e-05)	2.56e-05 (1.79e-05)
PctOW	0.344*** (0.0251)	0.325*** (0.0248)	0.350*** (0.0279)	0.327*** (0.0275)
HHI_Oa	0.0716*** (0.0129)	0.0215* (0.0128)	0.0735*** (0.0135)	0.0207 (0.0134)
HHI_Int	0.112*** (0.0398)	0.206*** (0.0407)	0.114** (0.0482)	0.241*** (0.0497)
Constant	6.357*** (0.120)	6.508 (12,448)		
Time effects	Yes	Yes	Yes	Yes
Carrier effects	No	Yes	No	Yes
Route effects	Yes	Yes	Yes	Yes
Observations	59,482	59,482	57,151	57,151
R-squared	0.013	0.042	0.013	0.042
Number of mkt_id	2,073	2,073	922	922

Standard Errors in Parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.3: Price Regression Results: Route-Carrier Data

VARIABLES	(1) OLS	(2) OLS	(3) IV	(4) IV
Online	0.0107*** (0.00233)	0.0173*** (0.00617)	0.0109*** (0.00237)	0.0190*** (0.00634)
Codeshare	-0.00684 (0.00488)	0.0127* (0.00685)	-0.00772 (0.00502)	0.0124* (0.00714)
AvgCoup	-0.0142 (0.0100)	-0.00718 (0.0101)	-0.0179 (0.0113)	-0.0113 (0.0114)
AvgDist	-9.27e-07 (5.43e-06)	-3.46e-06 (5.48e-06)	2.69e-07 (5.98e-06)	-2.29e-06 (6.02e-06)
PctOW	0.00948 (0.00829)	0.0115 (0.00831)	0.0113 (0.00924)	0.0133 (0.00925)
HHI_Oa	-0.0119*** (0.00426)	-0.00780* (0.00431)	-0.0116*** (0.00447)	-0.00757* (0.00451)
HHI_Int	0.0149 (0.0132)	0.0119 (0.0137)	0.0157 (0.0160)	0.0126 (0.0167)
Constant	0.0761* (0.0398)	0.0905 (4,175)		
Time effects	Yes	Yes	Yes	Yes
Carrier effects	No	Yes	No	Yes
Route effects	Yes	Yes	Yes	Yes
Observations	59,482	59,482	57,151	57,151
R-squared	0.001	0.003	0.001	0.003
Number of mkt_id	2,073	2,073	922	922

Standard Errors in Parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2.4: Output Regression Results: Route-Carrier Data

Chapter 3

Effects of the Merger between Code-sharing Airlines on the U.S.-China Route

3.1 Introduction

One merger of particular interest in the airline industry is the merger between Delta Airlines and Northwest Airlines which was approved by the Department of Justice in October 2008. After these two airlines combined, the "new Delta" network was based in the Atlanta and Detroit hubs. The merger of these two carriers formed the largest commercial airline in the world.

Mergers between airlines can be driven by both domestic and international competition incentives, but may have different impacts on domestic and international markets. There are two forces that result from a merger. On one hand, a merger could decrease competition, especially when it occurs between airlines that were code-share partners. In some cases, dramatic price increases could happen on routes where the airlines competed prior to their merger, and even code-sharing between airlines with significant overlapping routes would bring concerns about competition. On the other hand, a merger could bring prices down due to the cost efficiencies created in the merger. This paper aims to estimate the impact of a merger between two domestic airlines on the prices for their code-share products in one of their international markets.

Airline companies offer different types of products for an itinerary, including online (single carrier) and code-share (multiple carrier) products. For international air travel, code-share could happen between airline partners with a code-share agreement. Code-sharing and mergers share similarities. People commonly think that code-sharing would reduce competition as the

collusion issue in a merger. However, when we carefully examine a code-share agreement, it is not simply like a merger where the merged airlines set prices together. We were not able to observe the compensation mechanism in the contract process for code-share partners, but the basic structure is clear. In a code-share agreement, the operating carrier (“Carrier A”) sells seats on its flights to the ticketing carrier (“Carrier B”) at an agreed lower price. Carrier B then re-sell these seats to its customers. In fact, since Carrier A and B are selling extremely similar products, which are the seats on the same plane, they are competing with each other. This competitive situation may still lead to lower prices, rather than a higher price as a result of a double marginalization problem or a potential collusion on price.

Unlike the domestic airline market where code-share happens between domestic carriers, code-share in the international markets usually takes place between domestic carriers and their foreign partners. A merger could have a more significant effect in the markets where the code-share existed prior to the merger.

Airline merger cases have been studied for various reasons. Previous literature investigating airline mergers includes Borenstain (1990, 1992), Brueckner and Spiller (1991), Morrison (1996), Peters (2006), Martin (2011), Gayle and Brown (2012), and Luo (2014). Most of the previous studies have examined the effects of mergers on fares and network competition. For example, Morrison(1996) studied three mergers in the 1980’s using a long-run approach. For the case of Delta and Northwest merger, Brown and Gayle(2009) analyzed the potential effects of this merger using pre-merger data and a structural model.

This paper studies the impact of Delta and Northwest merger on their international routes, focusing on the U.S.-China routes. The U.S.-China market provides a good sample for this study. The structure and network in this market are clear, with five major U.S. carriers involved, covering three gateway cities in China and eight in the U.S. The benefit of studying this market comes from eliminating heterogeneity and allowing to focus on the market’s characteristics. Based on the observed code-share and online products before and after the merger. Specifically, I estimate the price effects associated with the merger on code-share products. This paper empirically tests whether code-sharing is similar to merger by estimating the im-

fact of merger on the former code-share markets. This analysis provides empirical evidence and guidance for policymakers.

This paper is organized as follows: Section 2 introduces the data source for the empirical analysis, and presents some related summary statistics. Section 3 includes the estimation strategy and the regression result. Section 4 is the conclusion.

3.2 Data Description

The data used for empirical analysis is the Airline Origin and Destination Survey (known as DB1B) provided by the U.S. Department of Transportation (DOT), which represents a 10 percent random sample of airline tickets from the U.S. reporting carriers. The data set used for this paper covers international air travel to and from the U.S. over the period 2005-2010, and it contains detailed itinerary information for each ticket, including airfare paid by each passenger, origin and destination airports, connecting airports, travel distance, ticketing and operating carrier for each segment, and the number of passengers on each itinerary with the same fare. This data allows an examination of fares and competition on routes one year before and after the merger.

Since this paper focuses on the carriers and their products, tickets with missing operating carrier or ticketing carrier are eliminated from the sample. I restrict the sample to the air travel tickets reported by five major carriers, including United Airlines (UA), Northwest Airlines (NW), Continental Airlines (CO) ¹, American Airlines (AA), and Delta Airlines (DL). In order to identify the tickets which were code-share products provided by each carrier, the feeder/regional carriers are re-coded to their major company and, therefore, are not counted as code-share product. For example, SkyWest Airlines (OO) was operating carrier for United (UA), American (AA), and Delta (DL), and accordingly re-coded to match the name of one of these major companies. A list of code-share ticketing carriers involved in the final sample is presented in Table 3.1.

¹Continental and United merged later in 2010, but they are treated separately here.

3.2.1 Summary Statistics

A market is defined as a directional pair of origin and destination. Each itinerary has more than one segment with both operating carriers and ticketing carriers. An itinerary is an online product if it has a single ticketing carrier and operating carrier over the whole trip. However, an itinerary could have different ticketing carriers on different segments, or have a different operating carrier and ticketing carrier within one or more segments. In this case, it is defined as a code-share product. A U.S. carrier could code-share with either domestic airlines or foreign airlines based on the alliance agreements among them. In international travel, most code-share involves a foreign carrier as part of the itinerary.

Table 3.2 and Table 3.3 present a summary statistic on the market share for each carrier. Among the five U.S. carriers, United Airlines (UA) is the one that takes most of the market share, ranging from 57 percent in 2005 when United Airlines enjoyed a advantage from authorized routes, to 44 percent in 2010 when other carriers competed for passengers with more access to routes as a result of liberalization.

Each carrier code-shares with their domestic and foreign partners, from either alliance members or code-share agreements. United Airlines did not have many code-share products, declining from 20 percent in 2005 to around 12 percent in 2010. This happened because United entered the U.S.-China airline market at a very early stage with an advantage in a few authorized routes, and therefore did not require much code-sharing with other carriers except for the foreign spokes. American Airlines had almost all products code-shared in 2005, and experienced a substantial drop to as low as 39 percent of code-share products in 2006 when granted nonstop Chicago (ORD)-Shanghai (PVG) route. Thereafter, the code-share products fluctuated around 30 percent. Continental Airlines (CO) is also one of the carriers that have operated several nonstop routes since the mid 2000's. Before merging with United Airlines in 2010, Continental had a low percentage of code-share products, ranking next to United.

Northwest Airlines (NW) had a market share second to United Airlines, which is 30-50 percent of United's market share. Northwest mostly offered online products, since it had access to the U.S.-Japan routes serving as a bridge to China. However, the absence of nonstop

routes to China still created a limitation on Northwest's market share competing with United. The name of Northwest disappeared in 2010, one year after the merger with Delta. Therefore, we do not observe any tickets reported by Northwest in 2010.

In 2008, Delta merged with Northwest; in the same year, Delta started the nonstop route in Shanghai-Atlanta. Until 2007, all of Delta's products were code-share products with one or more carriers. In 2008, Delta experienced a dramatic drop in code-sharing to 15 percent. We observe a rebound in code-sharing for Delta in 2009, 62 percent of which involved Northwest. The percentage of code-share for Delta dropped again in 2010 back to 11 percent, even lower than 2008.

Before Delta and Northwest merged, they not only code-shared with each other, but also with other domestic and foreign airlines. Delta and Northwest still reported separately in 2009 one year after they merged, so we still observe code-share products between them. From 2010, Northwest disappeared from the data, and we do not see any code-share between them. For Northwest, the code-share products with Delta account for up 5 percent of its total code-share products in 2005 and 2006; however, this number jumped to around 20 percent in 2008 and 2009, moving to 92 percent in 2009 when the merger completed. For Delta, on the other hand, the code-share products with Northwest account for at most 5 percent of total code-share products over 2005 to 2008, with a sharp increase to 62 percent in 2009.

On the market level, Delta and Northwest code-shared in 15 markets in 2008, which are presented in Table 3.4. Delta and Northwest were observed to have code-sharing over 142 markets in 2009 after they merged, but this is considered as aggregate behavior after merger since for some reason they still report separately to the DOT. In 2010, Northwest's name disappeared, and we do not observe any code-share between Delta and Northwest in 2010. Given the nature of airline industry, it usually takes a long time for the merged carriers to adjust to the new environment including setting new pricing strategies and network strategies. In this case, we observe the "new Delta" one year after the merger occurred.

In the markets where Delta and Northwest code-shared prior to the merger, there were other competing carriers (United, Continental, and American Airlines) offering service in 80

percent (12 out of 15) of these markets before the merger, and in 87 percent (13 out of 15) after the merger. Therefore, any fare change should not simply attributed to the elimination of competition between Delta and Northwest. Table 3.5 presents a statistical summary of price trend for these carriers in the year 2008 and 2009.

3.3 Empirical Analysis

3.3.1 Estimation Strategy

The main question that this paper aims to answer is: How does the merger affect the price in the markets where Delta and Northwest previously code-shared before the merger. This short-run analysis examines the fare changes one year after the merger relative to the fares in the year before merger. I use fixed effect regression to estimate the price effects of the merger by comparing the fares in markets where Delta and Northwest had code-shared with those in three types of control groups. The control groups include the following types of markets: (1) the markets where Delta and Northwest code-share with other carriers; (2) the markets where Delta and Northwest provide online products (non-code-share) respectively; (3) the markets where United, Continental and American provide code-share products; and (4) the markets which is a mix of types (1) and (2)². The identifying assumption is that in the absence of the merger, the markets where Delta and Northwest had code-sharing would have a similar price change as the other three types of markets; therefore, any difference should come from the merger.

The analysis is formulated by the following estimation

$$Price_{imt} = \beta_0 + \gamma YR2009 + \delta Market_m \times YR2009 + \beta X_{imt} + \alpha_m^1 + \alpha_r^2 + \epsilon_{imt} \quad (3.1)$$

The outcome variable is the price for each ticket paid by the passenger. $YR2009$ is a year dummy which equals to 1 if the ticket is observed in the post-merger period, and $Market_m$ equals to 1 for tickets in the markets where Delta and Northwest code-shared before

²The Type (4) is created in order to increase the number of observations in Type (1)

merger. I include a set of variables that influence cost and demand in X_{imt} , including itinerary distance, number of stops, nonstop dummy, hub dummy, and origin population. I also include market dummies and carrier dummies to capture the market fixed effects and carrier fixed effects as in α_m^1 and α_r^2 .

The parameter of interest is δ , which captures the change in fares in markets where Delta and Northwest had code-share before merger relative to the other three markets. Thus, δ picks up the impact from merger by separating out the common trend in price change before and after the merger.

3.3.2 Regression Results

Table 3.6 presents the estimates of Equation 1.1. Column (1)-(3) report the estimates from the comparison with each control group respectively. Column (4) shows the estimation from the comparison with a mix of control groups (1) and (2). I find a significant decrease in price for the year after merger in all of the specifications. However, for all of the control groups, I find that coefficients on the interaction term are statistically insignificant, suggesting that merger did not have much effect on the routes where Delta and Northwest previously code-shared relative to either of the above three types of markets. One potential explanation is the substantial competition from other carriers in the U.S.-China route. In order to have higher profits, merged firms have the ability to set higher prices due to the gained market power. However, since all of the major U.S. carriers were competing at the time when the merger happened, merger did not increase the market power for the new Delta in the U.S.-China international market. This result also suggests that on the U.S.-China route, the code-sharing is very similar to a merger.

3.4 Conclusion

This paper studies the impact of Delta and Northwest merger on their U.S.-China routes. I estimate the price effects associated with the merger on code-share products. The estimation results suggest that the merger between Delta and Northwest did not have a significant effect

on their code-share products on the U.S.-China route. While Chapter 2 finds that code-sharing brings a negative impact on price due to the elimination of double-marginalization problem, the merger between domestic carriers does not have a significant impact on prices for the code-share products on the U.S.-China route. This paper also empirically tests that code-sharing is similar to merger by estimating the impact of merger on the former code-share markets. This analysis provides empirical evidence and guidance for policymakers. More work needs to be done to understand the effects of the Delta/Northwest merger using a long-run analysis.

Code	Airlines	Code	Airlines
9W	Jet Airways (India) Limited	MH	Malaysian Airline System
AA	American Airlines	MU	China Eastern Airlines
AC	Air Canada	NH	All Nippon Airways Co.
AE	Air Europe Limited	NW	Northwest Airlines Inc.
AF	Air France	OZ	Asiana Airlines Inc.
AM	Aeromexico	QF	Qantas Airways Ltd.; Austrilia
AS	Alaska Airlines	RU	AirBridgeCargo Airlines; Russia
AZ	Compagnia Aerea Italiana	SK	Scandinavian Airlines Sys.
BA	British Airways Plc	SQ	Singapore Airlines
BR	Eva Airways Corporation	TG	Thai Airways International
CA	Air China	UA	United Air Lines Inc.
CI	China Airlines Ltd.	US	US Airways Inc.
CO	Continental Airlines	VS	Virgin Atlantic Airways; British
CX	Cathay Pacific Airways		
CZ	China Southern Airlines		
DL	Delta Airlines		
EI	Aer Lingus Plc; Airland		
FM	Federal Express Corporation		
HU	Hainan Airlines		
IR	Iran National Airlines Corp		
JL	Japan Air Lines Co. Ltd.		
JO	Jalways Co. Ltd.; Japan		
KA	Hong Kong Dragonair		
KE	Korean Airline		
KL	Klm Royal Dutch Airlines		
LH	Lufthansa German Airlines		
LX	Swiss International Airlines		

Table 3.1: List of All Code-share Carriers

year = 2005

Carrier	Freq.	Percent
UA	4,213	57.01
NW	1,803	24.4
CO	937	12.68
AA	300	4.06
DL	137	1.85

year = 2008

Carrier	Freq.	Percent
UA	4,278	48.53
NW	1,436	16.29
CO	1,212	13.75
DL	1,035	11.74
AA	855	9.7

year = 2006

Carrier	Freq.	Percent
UA	3,841	48.42
NW	1,833	23.11
AA	1,089	13.73
CO	1,029	12.97
DL	140	1.77

year = 2009

Carrier	Freq.	Percent
UA	3,993	43.73
CO	2,180	23.87
NW	1,496	16.38
AA	998	10.93
DL	465	5.09

year = 2007

Carrier	Freq.	Percent
UA	4,553	51.35
NW	1,900	21.43
CO	1,229	13.86
AA	1,065	12.01
DL	119	1.34

year = 2010

Carrier	Freq.	Percent
UA	4,440	44.32
CO	2,135	21.31
DL	1,955	19.52
AA	1,487	14.84
Total	10,017	100

Table 3.2: Market Share for Each Carriers

year	UA		AA		CO	
	mean	sd	mean	sd	mean	sd
2005	0.20	0.40	0.99	0.08	0.27	0.44
2006	0.17	0.38	0.39	0.49	0.16	0.36
2007	0.13	0.34	0.35	0.48	0.12	0.32
2008	0.12	0.32	0.23	0.42	0.09	0.29
2009	0.10	0.30	0.43	0.50	0.07	0.25
2010	0.12	0.32	0.27	0.45	0.06	0.24

year	DL		%CS_DLNW in all the DL's CS	
	mean	sd	mean	sd
2005	1	0	0.03	0.17
2006	1	0	0.01	0.08
2007	1	0	0.03	0.16
2008	0.15	0.35	0.05	0.21
2009	0.72	0.45	0.62	0.49
2010	0.11	0.31	N/A	N/A

year	NW		%CS_DLNW in all the NW's CS	
	mean	sd	mean	sd
2005	0.04	0.19	0.03	0.18
2006	0.02	0.15	0.05	0.21
2007	0.03	0.16	0.17	0.38
2008	0.04	0.19	0.21	0.41
2009	0.22	0.42	0.92	0.28
2010	N/A	N/A	N/A	N/A

Table 3.3: Percentage of Code-share Products for Each Carrier

Origin	Code	Destnation	Code
<u>U.S.-China</u>			
Atlanta	ATL	Guangzhou	CAN
Atlanta	ATL	Beijing	PEK
Birmingham (AL)	BHM	Guangzhou	CAN
Baton Rouge (LA)	BTR	Shanghai	PVG
Detroit	DTW	Shanghai	PVG
Los Angelos	LAX	Beijing	PEK
Richmond (VA)	RIC	Guangzhou	CAN
Salt Lake City	SLC	Beijing	PEK
Salt Lake City	SLC	Shanghai	PVG
St. Louise	STL	Shanghai	PVG
<u>China-U.S.</u>			
Shanghai	PVG	Los Angelos	LAX
Shanghai	PVG	Kansas City	MCI
Shanghai	PVG	Seattle	SEA
Shanghai	PVG	San Francisco	SFO
Shanghai	PVG	Salt Lake City	SLC

Table 3.4: List of Markets where DL/NW Code-shared in 2008

Year	Mean	SD	Min	Max
<i>The Delta/Northwest Code-Share products</i>				
20083	1652.471	648.9455	157	9596
20093	1446.97	812.9225	118	8999
<i>Delta's Other Code-Share products</i>				
20083	1762.887	480.2657	914	4004
20093	1427	441.7372	264	2710
<i>Northwest's Other Code-Share products</i>				
20083	1778.65	765.0879	116	3940
20093	2215.357	1016.262	838	5199
<i>Delta's Online products (Non-Code-Share)</i>				
20083	1385.638	513.9152	113	6481
20093	1414.805	1134.062	466	7596
<i>Northwest's Online products (Non-Code-Share)</i>				
20083	1539.938	737.9997	111	7295
20093	1403.503	858.039	405	9729
<i>United's Code-Share products</i>				
20083	1774.142	620.4909	149	5951
20093	1649.244	813.7961	204	7594
<i>Continental's Code-Share products</i>				
20083	1879.202	1011.398	258	5929
20093	1610.328	895.1227	271	7947
<i>American Airl's Code-Share products</i>				
20083	2000.137	1126.194	200	7508
20093	1508.137	1048.742	113	9549

Table 3.5: Price Statistics for Each Control Group

Dependent Variable: Price (log)				
VARIABLES	(1)	(2)	(3)	(4)
YR2009	-0.288*** (0.0733)	-0.153*** (0.0282)	-0.136*** (0.0297)	-0.153*** (0.0265)
Market*YR2009	0.0870 (0.0837)	-0.0459 (0.0418)	-0.0259 (0.0626)	-0.0335 (0.0378)
Nonstop	0.0373 (0.0547)	0.0920 (0.0573)	0.00859 (0.0585)	0.0613 (0.0572)
Number of Stops	0.0226 (0.0251)	0.0401* (0.0207)	-0.0491** (0.0190)	0.0286 (0.0195)
Distance	-0.0146 (0.0261)	0.0112 (0.0246)	0.0420*** (0.0127)	0.00408 (0.0282)
Constant	7.459*** (0.409)	6.844*** (0.358)	6.885*** (0.222)	6.993*** (0.418)
Observations	728	3,283	2,726	3,554
R-squared	0.085	0.040	0.048	0.043

Note: Robust standard errors in parentheses and are clustered by market

***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

Table 3.6: Price Regression for the DL/NW Merger

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Curriculum Vitae

