Do Frequent-Flyer Program Partnerships Deter Entry at the Dominant Airports?

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Abstract

This paper empirically tests the competitive effect of FFP partnerships, in which members of one airline's FFP can earn that airline's points on flights operated by its partners, by identifying whether implement of such partnerships between legacy carriers deter entry of low-cost carriers (LCCs) into their hub routes. Using a sample period from 2002q1 to 2004q3, and focusing on two domestic FFP partnerships: Continental/ Delta/ Northwest and United/ US Airways, I find that FFP partnerships do not directly affect LCCs' entry decision to the routes departed from legacy carriers' dominant airports; however, when they do enter, the formation of FFP partnerships significantly drives down the ticket fares they can charge on these routes by 3.6% to 6.5%.

1. Introduction

There is a long tradition of research on the airline sectors. Before US airline deregulation in 1978, airline market was treated as competitive and the industry was characterized by constant returns to scale (Caves, 1962; White, 1979). After the deregulation, the liberalized industry did not approach the perfectly competitive model as scholars expected; airlines do respond in a number of different fashions to increase their competitiveness (such as hub-and-spoke network, frequency/ scheduling competition, frequent-flyer programs, price discrimination, yield management, etc.), but at the same time they also form strategic alliances acting like oligopolies in a way of imperfect competition (Zhang and Czerny, 2012).

An airline alliance is an agreement between two or more airlines to cooperate on a substantial level. The three largest passenger airline alliances are Star Alliance, SkyTeam and Oneworld. A typical agreement includes code sharing, sharing of sales offices,

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maintenance facilities, operational facilities such as computer systems, operational staff such as ground handling personnel, investments and purchases, frequent-flyer program reciprocity and so on.

Literatures on airline strategic alliance have explained the code sharing phenomenon, which allows each carrier to sell seats on specified flights that are operated by its partners, in terms of two categories of incentives: efficiency motives and competitive motives (Park et al., 2001; Brueckner, 2001; Bamberger et al., 2004; Bilotkach, 2005; Goetz and Shapiro, 2012; Bilotkach and Huschelrath, 2013). However, there is less evidence about why alliance agreements also include frequent-flyer program (FFP) partnership, in which members of one airline's FFP can earn that airline's points on flights operated by its partners. In this paper, I test whether FFP partnerships between legacy carriers deter entry of low-cost carriers (LCCs) into routes departed from their dominant airports.

FFPs are loyalty programs offered by many airlines. Lederman (2007, 2008) finds that FFPs allow airlines to exercise market power on routes that depart from their dominant airports, and FFPs may account for at least 25% of the "hub premium", which is the extra fares airlines receive on hub routes compare to what they do on comparable routes elsewhere in their network, and their competitors do on these routes (Berry et al., 1996; Lee and Prado, 2005; Ciliberto and Williams, 2010). As FFP has been shown to be one factor that provides airlines with market power on hub routes, if FFP partnership, an enhancement of FFP, has a competitive effect, we should be able to observe it on these routes.

Using data from the Bureau of Transportation Statistics' (BTS) Airline Origin and Destination Survey (DB1B) database, and Air Carrier Summary Data (Form 41 and 298C Summary Data) database, I estimate two fixed effect models to explore FFP partnerships' competitive effect. First, I estimate the marginal determinants of FFP partnerships on the probability of entry by LCCs, directly measures their entry deterrence effects. Second, I test whether LCCs, when they do enter, receive lower ticket fares on routes that are also served by the legacy carrier out of its dominated airports after the FFP partnership is formed. Specifically, I focus on two alliances formed in 2003: Continental/ Delta/ Northwest and United/ US Airways, and use a sample period from 2002q1 to 2004q3.

The LCCs in my analysis include AirTran Airways, Frontier Airlines, Spirit Airlines, JetBlue Airways and Southwest Airlines.

The results show that FFP partnerships do not directly affect LCCs' entry decision to the legacy carriers' dominant airports; however, when they do enter, the formation of legacy carriers' FFP partnerships significantly drives down the ticket fares they can charge on these routes. The UA/US FFP partnership significantly drives down the LCCs' mean fare by 6.5% on routes departed from United Airline's (UA) dominant airports. The CO/DL/NW FFP partnership significantly decreases the LCCs' mean fare by 3.6% and 4.3% on routed departed from Delta Air Lines' (DL) and Northwest Airlines' (NW) dominant airports respectively. This effect is stronger at the top of the price distribution, which represents mainly business and first class tickets.

The remainder of the paper is organized as follows. Section 2 is a literature review of the current research on airline alliances and its motives. Section 3 provides an overview of frequent-flyer programs and domestic FFP partnerships. Section 4 reviews the data and discusses the identification models. Section 5 presents the results. Section 6 concludes.

2. Literature review

Modern airline alliances appeared in the early 1990s, with airlines coordinating handling of interline passengers through various agreements. Airline alliances typically involve code sharing, an agreement between two carriers where one carrier (the operating carrier) allows another carrier (the marketing carrier) to market and sell seats on some of its flights. An alliance with code sharing agreements expand the involving carriers' network, allowing a carrier to offer service on at least some routes that it does not fly on by combining one leg of its flight with another leg of its partner's flight. Examples of domestic alliances are American Airlines/ Hawaiian Airlines formed in Mar., 1998, American Airlines/ Alaska Airlines formed in Apr., 1999, United Airlines/ US Airways formed in Jan., 2003[1] , Continental/ Delta/ Northwest formed in Jun., 2003[2] etc. Global airline alliances emerged from multi-airline code sharing agreements. Oneworld is the

[1] United and US Airways ended their partnership when the latter merged into American Airlines in Mar., 2013.

[2] Continental quitted the alliance when it merged into United in Oct., 2010; Northwest merged into Delta in Apr., 2008.

expanded American Airlines and British Airways partnership, SkyTeam comes from the Delta Air Lines and Air France partnership, and Star Alliance from the United Airlines-Lufthansa alliance. Some carriers form only marketing alliances, which typically link frequent-flyer programs, provide passengers access to each other's airport lounges but do not include code sharing. The proposed American/ US Airways partnership in 1998 was intended to begin as a marketing alliance, with code sharing added later, which was abandoned by the Department of Transportation because of anticompetitive concerns.

There has been controversy about these alliances. Supporters argue that alliances increase social welfare and efficiency, not only by providing an expanded availability and streamlining of services (Park et al., 2001), but also by removing the elevated markup, or "double marginalization", which is present when each airline sells its own flight segments separately (Brueckner, 2001).

Another group focuses on their competitive motives which can be viewed as an attempt to gain or preserve market power, which have an ambiguous effect on total welfare. Bamberger et al. (2004) investigate the effect of two domestic airline alliances (the Continental/America West alliance and Northwest/Alaska alliance), and find that average fares paid by passengers fell by about 5-7% and total traffic increased by 6% after the creation of the alliances on those city pairs affected by the alliances. They also find that these effects arise in part as a response of other airlines to the increased competition from an alliance. Bilotkach and Huschelrath (2013) examine whether international airline partnerships operating under antitrust immunity, which allows the partner carriers to cooperatively make scheduling and pricing decisions on the corresponding joint networks and share revenue, could result in market foreclosure. They find evidence consistent with the airlines operating under antitrust immunity refusing to accept connecting passengers from the outside carriers at respective hub airports; specifically, airlines outside the partnership reduce their traffic to the partner airlines' hub airports by 4.1% to 11.5%. Ito and Lee (2007) find that, contrast to international code sharing, which creates a convenient connecting itinerary that combines the networks of two different operating carriers, the majority of domestic code-share itineraries involve a single operating carrier, and these virtual code sharing itineraries are priced lower than the respective ones operated and marketed by a single carrier, which indicates that carriers may be using virtual code sharing to compete for the most price-sensitive passengers. Fares for local passengers may rise following an alliance. Bilotkach (2005) observes that code sharing may allow the partners to price discriminate the spoke-to-hub passengers from the connecting spoke-to-spoke passengers by bundling the two spoke-to-hub services and offering a lower whole trip price than the sum of two separate spoke-to-hub services. Armantier and Richard (2006, 2008) find that code share agreements between Continental Airlines and Northwest Airlines reduced average prices for interline passengers but increased the average price paid for non-stop flights used as a portion of a code-share product. Goetz and Shapiro (2012) directly test for the presence of competitive motives by identifying an incumbent airline's use of code-sharing in response to the threat of future entry by a low cost competitor. Estimates show that an incumbent carrier is 25% more likely than average to be codesharing with its partner when its segment is threatened by a low-cost carrier.

As the existing literatures devote more attention to the code sharing aspect of the airline alliances, there is less evidence about why those alliance agreements also include frequent-flyer program (FFP) partnership, in which members of one airline's FFP can earn that airline's points on flights operated by its partners. FFPs, as loyalty programs, are used by many airlines. Banerjee and Summers (1987) model FFP as collusion-facilitating devices. Price cutting becomes less attractive when customers' cost of switching between products is increased. As a result, inducing loyalty enables firms to split the market and to charge higher prices. Lederman (2007) tests whether FFPs allow airlines to exercise market power on routes that depart from their dominant airports. She finds that controlling for the other advantages of airport dominance, enhancements to an airline's FFP through FFP partnership increases its demand on those routes that depart from its dominant airports and in the new equilibrium, there are fewer passengers carried and higher fares paid. In another paper, Lederman (2008) estimates the exact magnitude of the FFP share on hub premium: FFPs may account for at least 25% of the "hub premium". Her logic is if FFPs allow an airline to charge higher fares on routes that depart from its hubs, FFP partnerships should allow an airline's partner to charge higher fares on routes that depart from these same airports, in which case separate the FFP effect from any other effects from dominant airline's other sources of advantage such as reputation.

This paper examines whether FFP partnerships between legacy carriers deter entry of low-cost carriers into routes departed from their dominant airports. It fits into the category of airline alliances' competitive effect, while differs from the previous researches by looking at FFP partnership rather than code sharing. Following Lederman (2007, 2008), I only examines FFP partnership's effect on routes departed from legacy carriers' dominant airports. It has been established that airlines have market power on hub routes, in a sense that they receive higher fares on these routes than they do on comparable routes elsewhere in their network, and their competitors do on these routes (Berry et al., 1996; Lee and Prado, 2005; Ciliberto and Williams, 2010). As FFP has been shown to be one reason causing the hub premium, meaning it provides airlines with market power on this group of routes, if FFP partnership, an enhancement of FFP, has a competitive effect, we should be able to observe it on these routes.

3. Overview of frequent-flyer programs

3.1 Frequent-flyer programs

A frequent-flyer program (FFP) is an airline offered loyalty program where enrolled airline customers accumulate frequent-flyer miles corresponding to the distance flown on that airline. FFPs act as a commitment of the airlines to charge lower effective prices to old than to new customers without any advance commitment as to the overall level of prices. Acquired miles can be redeemed for air travel, other goods or services. Depending on an airlines' program, members can also redeem their earnings toward cabin upgrades, hotel stays, car rentals and various retail consumption opportunities. American Airlines is generally credited with developing the first frequent flier program, its AAdvanage program, launched in May 1981, 3 years after the deregulation of the airline industry, and quickly followed by United Airlines with its Mileage Plus program. [3] In the United States, FFPs of legacy carriers include Delta Air Lines' SkyMiles, US Airways' Dividend Miles[4], Alaska Airlines' Mileage Plan, Hawaiian Airlines' HawaiianMiles etc. Low cost carriers

[3] For more history, see Rowell (2010).
[4] Dividend Miles will be merged into American Airlines AAdvantage program.

also have their FFPs: AirTran Airways' A+ Rewards, Frontier Airlines EarlyReturns, JetBlue Airways' TrueBlue, Southwest Airlines' Rapid Rewards, etc.

FFP rewards are structured such that a minimum number of points must be earned before any reward can be redeemed, after which the value of rewards generally increases nonlinearly with the number of points required. In most programs, members can earn different levels of elite status after accumulating the required number of flown miles, which are called elite-qualifying miles, within a calendar year. For example, American Airlines has Gold/ Platinum/ Executive Platinum status. Each level entitles a traveler to an increasing amount of benefits, such as automatic bonus miles for every flight, complimentary upgrades, preferred seat assignments, and priority boarding, which creates discrete increases in the value of frequent flyer points near the thresholds. Since the bonus value is an increasing marginal function of the mileage or points accumulated, passengers have an incentive to concentrate all of their points in a single or a few airlines' FFPs. As Borenstein (1989) points out, the FFP of the dominant airline at a traveler's home airport is more attractive because of two reasons. First, the customer is likely to choose the airline that he expects to be travelling with most often in the future: the one with the most service on the routes he flies and the one that flies the most routes from his home, which gives him more opportunities to collect frequent-flyer points. Second, the dominant airline provides the largest selection of reward destinations.

Once customers start to invest in that airline's FFP, any flight not taken with that airline forgo beneficial points. Other airlines, who are not dominant at that airport and thus cannot offer FFPs as attractive as the dominant airline's, must offer a lower price as compensation for the customers' lose in FFP points in order to attract them to buy their tickets. As a result, FFPs provide airlines with extra market power at their dominant airports. A dominant airline's FFP not only deters entry by airlines that plan to serve only a small set of routes out an airport, but also lowers the price they can charge if they do enter. In addition, it leads to higher prices and fewer tickets sold by the dominant incumbent.

One of the reasons why FFPs may be so effective is because they exploit a principal-agent problem between business travelers and their employers (Lederman, 2008). Business travelers book their own tickets and keep the associated FFP points for own future use, and it is their employers who pay for the travel. In this case, business travelers value the FFP points more, even more than their true reservation value of the reward flights.

3.2 FFP partnerships

For most airline alliances, the frequent-flyer program reciprocity are includes, where members for one the alliance carriers' FFP can earn elite-qualifying frequent-flyer miles on flights marketed or operated by the other alliance partner(s) and vice versa. The formation of a FFP partnership enhances participating airlines' frequent-flyer programs. It increases the value of the airline's FFP by expanding the set of flights on which consumers can earn and redeem the airline's FFP points. It may also affect an airline's demand by increasing the attractiveness of an airline's flights to members of its partner's FFP by allowing them to earn their preferred points (Lederman, 2008).

The domestic alliances with FFP partnership agreements operating in recent years are listed in Table 1. During the period of my analysis, from 2002q1 to 2004q3, the alliances newly formed are Continental/ Delta/ Northwest and United/ US Airways. I choose this sample period because each airline is forming alliances with another one or two with no overlapping, which makes it easier to detect the FFP's effect on those airlines' routes from their dominant airports. A longer sample period can be used, but need to take into account different effects from FFP partnerships with different airlines for a single carrier. For example, Delta formed an alliance with Alaska in 2004, and formed another alliance with Hawaiian in 2008. More recently, legacy carriers start to form alliances with low-cost carriers. This should be due to reasons other than the entry deterrence motive I would like to exploit here.

[Table 1 Domestic alliances with FFP partnership agreements in recent years]

4. Data and methods

4.1 Data sources and sample construction

The two primary sources of data are the Airline Origin and Destination Survey (DB1B) database[5], and Air Carrier Summary Data (Form 41 and 298C Summary Data) database[6] from the Bureau of Transportation Statistics (BTS). Observations from DB1B are the main airline operating data I use in the analysis, supplemented with airline dominance level calculated from Air Carrier Summary Database.

The Airline Origin and Destination Survey (DB1B) is a 10% sample of domestic airline tickets from reporting carriers collected by the Office of Airline Information of the Bureau of Transportation Statistics. Data includes origin, destination and other itinerary details of passengers transported. The DB1B dataset is published quarterly as three separate files, representing coupon data, market data and ticket data, which can be merged by a unique itinerary id. The raw data are constructed on the coupon-level, meaning there is a separate observation for each flight segment that a passenger flies between two airports. I supplement the coupon-level data with ticket-level information, especially the dollar fare of each itinerary. The merged dataset contains information on the route traveled (origin, destination, and any connecting airports), the operating carrier, the type of trip (one-way, round-trip), number of passengers traveled on that itinerary, the distance of the trip, the dollar fare, number of coupons in the itinerary, year and quarter.

I limit the sample to domestic direct flights from one-way and round-trip itineraries. I use only direct flights because these flights are more likely to have similar unobservable dimensions from a same carrier on a given route across different times (before and after the FFP partnership is established). I convert the dollar fares from different years into 2002 dollars by using Consumer Price Index (CPI) from Bureau of Labor Statistics[7]. I break round-trip itineraries into two one-way trips, each with half of the total fare and half of the total distance of the complete trip. I eliminate the observations whose price is of questionable magnitude: 1) those marked as unreliable fares by variable "dollar_cred" according to BTS criteria; 2) fare, measured in 2002 dollars, less than $10 per directional

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[5] http://www.transtats.bts.gov/Tables.asp?DB_ID=125&DB_Name=Airline%20Origin%20and%20Destination%20Survey%20%28DB1B%29&DB_Short_Name=Origin%20and%20Destination%20Survey

[6] http://www.transtats.bts.gov/Tables.asp?DB_ID=130&DB_Name=Air%20Carrier%20Summary%20Data%20%28Form%2041%20and%20298C%20Summary%20Data%29&DB_Short_Name=Air%20Carrier%20Summary

[7] http://www.bls.gov/cpi/

trip, as they are likely to be frequent flyer reward tickets or tickets for other types of unique passengers such as the airline employees. I also eliminate the observations with directional trip distance less than 50 miles, as they are likely to represent trips between airports located in the same city (such as JFK and LaGuardia).

After filtering the itineraries, I collapse all flight coupons to airline-route-quarter level. Depending on factors such as the exact data or time of the travel, and how many days in advance the ticket is purchased, a given carrier route in a given quarter charges different prices though the other observable characteristics are identical. I aggregate the different fares paid for the same airline route in a given quarter by calculating the passenger-weighted mean. I also calculate the sum of passengers traveled on a certain airline route in each quarter. Based on this number, I eliminate routes with very low passenger counts because these routes are very small market routes that are often served by only a single regional carrier and have virtually no chance of being threatened by LCCs. Specifically, I eliminate routes where an airline has fewer than 10 passengers in a month (or equivalently 30 passengers in a quarter).

The Air Carrier Summary Database contains the non-stop segment and on-flight market data reported by air carriers on Form 41 and Form 298C. The data are transmitted in Schedules T1, T2, and T3 to the Office of Airline Information of the Bureau of Transportation Statistics. I use the data in the T3 table to calculate an airline's dominance level at the origin airport of a route. T3 (U.S. Air Carrier Airport Activity Statistics) table summarizes the T-100 traffic data reported by U.S. air carriers. The quarterly summary is compiled by origin airports, carrier entities (geographical regions in which a carrier operates), and service classes, and includes scheduled departures, departures performed, passengers, freight, and mail.

I first collapse observations to airline-origin-quarter level. For an airline in a given quarter, T3 table contains several observations for different carrier entities. I sum up all flight departures an airline performed from the same airport in a quarter to different geographical regions to be the airline departures. After that, I calculate total number of flight departures all airlines performed from a certain airport in a given quarter to be all airline departures. Dominance level of an airline at an airport in a quarter is calculated by dividing the former airline departures by the latter all airline departures. I repeat the same steps to get the total number of passengers all airlines transported from an airport in a quarter. This passenger number is a proxy for the aggregate airport-level demand in a quarter.

After that, I merge the two datasets from the two sources. When exploiting the entry deterrence effect of FFP partnerships, I limit the sample to include only those routes on which at least one of the five legacy carriers has a direct service. This sample contains 17,948 observations on route-quarter level. When testing the effect on LCCs' fare, I use a sample where only routes on which at least one of the five LCCs provides a direct flight service are included. This sample contains 15,011 observations on airline-route-quarter level.

4.2 Models and predictions

I estimate two models to test whether FFP partnerships deter entry at the dominant hub airports. The first model, estimating the marginal determinants of FFP partnerships on the probability of entry by LCCs, directly measures their entry deterrence effects. The second model provides a further step to exploit the competitive motives of the partnerships by testing whether LCCs, when they do enter, receive lower ticket fares on routes that are also served by the legacy carrier out of its dominated airports after the FFP partnership is formed.

4.2.1 The entry deterrence effect

The main specification is a linear probability model (LPM). While index models such as probit or logit restrict the predicted value to the unit interval, they might give biased estimation of the marginal effects.

Since a LCC has different entry decision on every single route at different times, the estimation is conducted on a route-quarter level. Specifically, I estimate the following equation:

$$P(LCCi_{rt}=1)=\beta_1\cdot k_{rt}\cdot Dom_{krt}+\beta_2\cdot k_{rt}\cdot Dom_{krt}\cdot Partnership_{kt}+\alpha_1\cdot\ln(OrigPass_{rt})+\alpha_2\cdot\ln(DestPass_{rt})$$
$$+\gamma_r+\delta_t+\varepsilon_{rt} \qquad (1)$$

where

1) r indicates the route, t indicates the quarter;

2) $LCCi_{rt}$ is a {0,1} variable indicating whether or not low-cost carrier i operates on route r in quarter t, $P(LCCi_{rt}=1)$ is the probability of LCC i operating flight service on route r in quarter t, aka enters this route market;

3) k_{rt} is a {0,1} variable indicating whether or not legacy carrier k operates on route r in quarter t;

4) Dom_{krt} is the dominance level of legacy carrier k at the origin airport on route r in quarter t;

5) $Partnership_{kt}$ is a {0,1} variable indicating whether legacy carrier k's FFP partnership is in place in quarter t;

6) $OrigPass_{rt}$ represents the total number of passengers departed from the origin airport on route r in quarter t, $DestPass_{rt}$ represents the total number of passengers departed from the destination airport on route r in quarter t;

7) γ_r is a route fixed effect, δ_t is a quarter fixed effect, ε_{rt} is the error term.

I include all the five legacy carriers (United Airlines, US Airways, Continental Airlines, Delta Air Lines and Northwest Airlines) on the right hand side. In other words, for each legacy carrier, there is a $k_{rt}\cdot Dom_{krt}$ and a $k_{rt}\cdot Dom_{krt}\cdot Partnership_{kt}$ term. I interact the operating dummy k_{rt} with the dominance and FFP partnership variables because a legacy carrier's dominance at the origin of a route and its FFP partnership matters for a LCC when making an entry decision only if the legacy carrier operates on that particulate route. I limit the regression sample to include only those routes on which at least one of the five legacy carriers has a direct service, since I am interested in a LCC's entry decision into those markets where there are already some legacy carrier incumbents. I estimate each low-cost carrier's decision equation one by one. The LCCs in my analysis are AirTran Airways, Frontier Airlines, Spirit Airlines, JetBlue Airways and Southwest Airlines. I cannot pool the five LCCs into one regression and do the airline-route-quarter level analysis because for each LCC carrier the route and quarter combinations are the same and the model is not able to distinguish the different between the carriers.

As the demand on either end of the route may affect both a LCC's entry decision and a legacy carrier's operating decision, I include the numbers of total passengers as controls. I also include two sets of fixed effects to control for the differences in route and time.

Note that β_2 is the change in marginal effect of dominance on the probability of entry from LCC when that legacy carrier's FFP partnership comes into effect (given the legacy carrier operates on that route), so a finding of $\beta_2 < 0$ would indicate that forming a FFP partnership deters entry on the routes departing from the dominant airports.

I also estimate a second specification where I replace the dependent variable $P(LCCi_{rt} = 1)$ with the number of total LCC entries $numLCC_{rt}$, which records how many LCCs out of the five operate flights on route r in quarter t. Everything else is the same as the main specification.

$$numLCC_{rt} = \beta_1 \cdot k_{rt} \cdot Dom_{krt} + \beta_2 \cdot k_{rt} \cdot Dom_{krt} \cdot Partnership_{kt} + \alpha_1 \cdot \ln(OrigPass_{rt}) + \alpha_2 \cdot \ln(DestPass_{rt}) + \gamma_r + \delta_t + \varepsilon_{rt} \quad (2)$$

For equation (2), same as before, a finding of $\beta_2 < 0$ would indicate that forming a FFP partnership deters entry.

4.2.2 The effect on LCCs' ticket fare

FFP partnership may also provide a legacy carrier with competitive advantage when LCCs do enter into routes that depart from dominated airports, in a sense that it may drive down the price LCCs can charge. This effect happens to all LCCs' flights on those routes also served by a legacy carrier out of that carrier's hubs. As a result, I limit the sample to the routes where any of the five LCCs is operating on. The analysis is conducted on the airline-route-quarter level. I estimate the following equation:

$$\ln(MeanFare_{irt}) = \theta_1 \cdot k_{rt} \cdot Dom_{krt} + \theta_2 \cdot k_{rt} \cdot Dom_{krt} \cdot Partnership_{kt} + \alpha_1 \cdot \ln(OrigPass_{rt}) + \alpha_2 \cdot \ln(DestPass_{rt}) + \lambda_{ir} + \mu_{it} + \varepsilon_{irt} \quad (3)$$

where

1) i indicates the low-cost carrier, r indicates the route, t indicates the quarter;

2) $MeanFare_{irt}$ is the passenger-weighted mean one-way fare paid on LCC i's flight on route r in quarter t, in 2002 dollars;

3) k_{rt} , Dom_{krt} , $Partnership_{kt}$, $OrigPass_{rt}$, $DestPass_{rt}$ are defined same as those in equation (1);

4) λ_{ir} is an airline-route fixed effect, μ_{it} is an airline-quarter fixed effect, ε_{irt} is the error term.

I include all the five legacy carriers on the right hand side as I do for the previous model. Unlike before, I pool the five LCCs into one regression to see the overall effect on price. I can do this because different carriers operate on different routes in a given quarter.

For any other unobservable factors that cause the level of an airline's fares due to differences in carrier, route or time, I control them by including airline-route and airline-quarter fixed effects.

The effect of FFP partnerships is estimated as the change in marginal effect of dominance on LCCs' ticket fares on those routes after the partnership is in place. When there is no FFP partnership, a one unit increase in the legacy carrier's dominance at the origin airport on a given route would change the fare a LCC can charge on the same route by θ_1 percent. After the FFP partnership comes into effect, that same increase in the dominance now changes the LCC's fare by $\theta_1 + \theta_2$ percent. Thus a finding of θ_2 <0 would indicate FFP partnership drives down the price LCCs can charge on routes also served by that legacy carrier out of its dominant airports.

I also investigate whether the FFP partnership has a larger impact on fares at the top of the price distribution than at the bottom. Since higher class travelers such as business travelers place more value on FFP points, LCCs need to decrease price more to attract this group of passengers. I test this by replacing the dependent variable with $\ln(80\,percentFare)$ and $\ln(20\,percentFare)$ in equation (3), which is the passenger-weighted 80th and 20th percentile one-way fare paid respectively, both in 2002 dollars. If we see an even negative θ_2 when the dependent variable is $\ln(80\,percentFare)$ and a less negative θ_2 when the dependent variable is $\ln(20\,percentFare)$, that would indicate the effect captured comes from FFP partnerships.

4.3 Variables and summary statistics

Table 2 and Table 3 shows the variable definitions and their summary statistics for each of the two sample used for the two models.

[Table 2 Variables for the sample estimating the entry deterrence effect]

The first sample (Table 2) includes only the route markets of the five legacy carriers, where at least one of the five legacy carriers provides a direct flight service. Note that LCCs do not enter the routes where some legacy carrier is already operating on a lot: each of the five LCCs operates on around 5% of the routes in the sample period. An average of 0.2 LCCs and a maximum of 2 LCCs provide service on a certain route in a certain quarter. This indicates a small overlap between LCCs' route market and legacy carriers' route market.

Among this type of routes, though the average share of departing flights from the origin airport of each legacy carriers is not high, within a range of 5% to 10%, each legacy carrier does have some very big hub airports where they provide most of the departing services. The five legacy carriers have a maximum dominance of 53% to 84% at some of the airports in the sample.

[Table 3 Variables for the sample estimating the effect on LCCs' ticket fare]

The second sample (Table 3) is limited to the route markets of the five LCCs, only including the routes on which at least one of the five LCCs provides a direct flight service. Passengers are paying an average of $124 (in 2002 dollars) when traveling on an LCC's one-way direct flight. The average 80th and 20th percentile fares are $162 and $89 respectively. I do not include the following numbers in the table because they are not a part of the regression variables, but to get a sense about the price distribution, I report them here. For all carriers, including the five legacy carriers, the five LCCs and the other airlines, the comparable numbers are $173 (mean), $233 (80th percentile) and $106 (20th percentile). For the five legacy carriers only, the comparable numbers are $202 (mean), $273 (80th percentile), $116 (20th percentile). Although the LCCs and the legacy carriers serve different route markets, these numbers show that the former charges a much lower price than the latter generally, which is indeed a characteristic of the LCCs.

As a same pattern that we see in the legacy carrier route markets, in the LCC route markets, the legacy carriers do not operate direct flights a lot. Delta is the legacy carrier that enters the most, and it only operates on 11% of the LCC routes. The other four enters less than 10% of the routes each. This again indicates that the two groups of carriers serve different route markets. In the LCC route markets, the average share of departing flights from the origin airport of each legacy carriers is even lower, within a range of 3% to 8% (compare to 5% to 10% in the legacy carrier route markets). But the LCCs do not totally avoid routes that depart from some dominant airports of legacy carriers. At the origin of some LCC operated routes, the legacy carrier has a share of 53% to 68% departing flights. This is lower than the dominance in the legacy carriers' market, but still a considerable magnitude. These observations provide the main variance to identify the FFP partnership effect.

5. Empirical results

5.1 The entry deterrence effect

The fixed effect regression results are presented in Table 4.

[Table 4 The entry deterrence effect]

As I have described in the previous section, our main interest is on the sign of the coefficient of the interaction term $k_{rt} \cdot Dom_{krt} \cdot Partnership_{kt}$. A negative coefficient would suggest FFP partnerships deter entry from LCCs at the legacy carriers' dominant airports. However, the regressions show mixed patterns. At the United Airline's (UA) dominant airports, the UA/US FFP partnership has a positive effect on the probability of Spirit Airlines (NK) entering, a negative effect on the probability of Southwest Airlines (WN) entering, while it has no effect on entry from other LCCs or the total number of LCC entries. At the US Airways' (US) dominant airports, the UA/US FFP partnership has a positive effect on the probability of AirTran Airways (FL) and Southwest Airlines (WN) entering, and a positive effect on the total number of LCC entries, while no effect on entry from other LCCs. For the CO/DL/NW FFP partnership, it has a negative effect on the probability of Southwest Airlines (WN) entering the routes from Continental Airlines' (CO) and Delta Air Lines' (DL) dominant airports, a negative effect on the probability of JetBlue Airways (B6) entering the routes from Northwest Airlines' (NW) dominant airports, a positive effect on the probability of Southwest Airlines' (WN) entering the routes from Northwest Airlines' (NW) dominant airports, while has no effect on other entries or the total number of LCC entries. Overall, there does not exist a clear pattern of how FFP partnerships affect LCCs' entry decision to the legacy carriers' dominant airports in my sample.

The extent of the entry deterrence effect of dominant airports before FFP partnerships come into effect might help to explain why FFP partnerships do not enhance this deterrence effect. When FFP partnerships are not in place, the entry deterrence effect of the dominant airports is captured by the coefficients of $k_{rt} \cdot Dom_{krt}$ terms. As one might notice, these coefficients are mostly statistically insignificant or even positive. However, recall that LCCs generally operate in different route markets as legacy carriers (Table 2 and Table 3), it is very likely that they do enter some of the legacy carriers' route markets because there is huge demand on either (or both) end(s) of the route or some other unobservable reasons. I have controlled for the demand by including origin and destination airport passengers transported, but there can still be some other reasons that both cause LCCs to enter the route, and that a legacy carrier has a dominant share at the origin airport. In other words, since a legacy carrier's dominance at the origin airport does not directly affect LCCs' entry decision, the implement of FFP partnership which enhances a carrier's dominance status can have no effect on LCCs' entry decision either.

Both the demands at the origin airport and the destination airport of a route has significant positive effect on LCCs' entry decision, except for Frontier Airlines (F9), which is more like a regional hub-and-spoke carrier as Goetz and Shapiro (2012) have pointed out.

5.2 The effect on LCCs' ticket fare

Now I turn to analyze FFP partnership's effect on LCCs' ticket fare when those LCCs do operate on the legacy carriers' routes departed from their dominant airports. Table 5 shows the fixed effects regression results.

[Table 5 The effect on LCCs' ticket fare]

Same as before, a negative coefficient on $k_{rt} \cdot Dom_{krt} \cdot Partnership_{kt}$ would suggest FFP partnership has an entry deterrence effect in a sense that it decreases the fare a LCC can charge on legacy carrier routes departed from that legacy carrier's dominant airports and drives the LCC out of that route market if the fare is too low to cover its cost. For the route markets LCCs do enter, the UA/US FFP partnership significantly drives down the

LCCs' mean fare by 6.5%, which is around $8 (in 2002 dollars) given a mean fare of $124.41 (from Table 3), on routes departed from United Airline's (UA) dominant airports. The CO/DL/NW FFP partnership significantly drives down the LCCs' mean fare by 3.6% ($4.5 in 2002 dollars) on routed departed from Delta Air Lines' (DL) dominant airports; and also a significant decrease of 4.3% ($5.3 in 2002 dollars) on LCCs' mean fare on routes departed from Northwest Airlines' (NW) dominant airports. There is no significant change on LCCs' mean ticket price on routes departed from US Airways' (US) and Continental Airlines' (CO) dominant airports. This less effect on the latter two airlines is not surprising because UA, DL and NW each operates on 7%, 11% and 4% of the LCCs' routes, while US and CO only operates on 3% and 1%.

If the price change is truly due to the implement of FFP partnerships, we should see a stronger price effect at the top of the price distribution, which represents business or first class tickets, since those passengers value FFP points the most. Indeed, this is true for the two carriers who enter LCCs' routes the most, UA and DL. The price decrease on 80 percentile tickets almost doubles the magnitude of the decrease on mean tickets. The UA/US FFP partnership significantly decreases LCCs' mean 80 percentile fare by 12.7% (which is $20.6, in 2002 dollars given a mean 80 percentile fare of $162.14 from Table 3) on routes departed from UA's dominant airports. The CO/DL/NW partnership significantly decreases this fare by 6% ($9.7, in 2002 dollars) on routes departed from DL's dominant airports. The price decrease effect is no longer significant at the bottom of the price distribution (20 percentile fares) for routes departed from these two carriers' dominant airports. Interestingly, this pattern is reversed for Northwest Airlines (NW). The FFP partnership has a stronger price effect on the bottom price distribution than the top.

Table 5 also shows that an increase in demand at either the origin airport or the destination airport of a route significantly increases the LCCs' ticket fares, as one would expect.

Above all, results in Table 5 strongly suggest that in LCCs' route markets, FFP partnerships add competitive advantage to the legacy carriers by decreasing the ticket fare LCCs can charge on routes served by a legacy carrier out of its dominant airports.

6. Concluding remarks

This paper provides evidence that although FFP partnerships between legacy carriers do not directly affect LCCs' entry decision to routes departed from legacy carriers' dominant airports, for the routes they do enter, the formation of FFP partnerships significantly drives down the ticket fares they can charge on these routes. These estimates indicate that FFP partnerships are used by legacy carriers as a competitive tool to enhance their market power.

I focus on two FFP partnerships that were formed in 2003, Continental/ Delta/ Northwest and United/ US Airways and use a sample period of 2002q1 to 2004q3. Further research can be done to explore the long term effect of FFP partnerships, as well as a single carrier forming separate partnerships with several different airlines in different times. Moreover, legacy carriers start to form alliances with low-cost carriers more recently, which is a phenomenon also requires an explanation.

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Tables

Table 1 Domestic alliances with FFP partnership agreements in recent years

Alliance	Begin Time	End Time
Northwest/Hawaiian	1995	January, 2010
American/Hawaiian	March, 1998	-
Continental/Alaska	March, 1999	March, 2012
American/Alaska	April, 1999	-
Northwest/Alaska	August, 1999	January, 2010
Continental/Hawaiian	August, 1999	March, 2012
United/US Airways	January, 2003	March, 2014
Continental/ Delta/ Northwest	June, 2003	March, 2012
Delta/ Alaska	December, 2004	-
Delta/ Hawaiian	April, 2008	-
United/ Hawaiian	May, 2008	-
American/ JetBlue	November, 2010	March, 2014
Hawaiian/ JetBlue	June, 2012	-
Hawaiian/ Virgin America	November, 2012	-

Notes: 1. Resources: Ito and Lee (2007), and carrier websites; 2. The end date is either the official end date posted on the carrier's website, or the time when a carrier ceased operation after a merge; 3. Continental merged into United and ceased operation in March, 2012; Northwest merged into Delta and ceased operation in January, 2010; US Airways merged into American in March, 2014.

Table 2 Variables for the sample estimating the entry deterrence effect

Variable	Definition	Mean	SD	Min	Max
LCCi	Set of low-cost carrier entry dummies, including the following five				
FL	=1 if AirTran Airways operates on the route	0.05	0.22	0	1
F9	=1 if Frontier Airlines operates on the route	0.04	0.19	0	1
NK	=1 if Spirit Airlines operates on the route	0.03	0.16	0	1
B6	=1 if JetBlue Airways operates on the route	0.01	0.11	0	1
WN	=1 if Southwest Airlines operates on the route	0.06	0.23	0	1
numLCC	Total number of LCCs out of the five operating on the route	0.19	0.41	0	2
k	Set of legacy carrier operating dummies, including the following five				
UA	=1 if United Airlines operates on the route	0.22	0.41	0	1
US	=1 if US Airways operates on	0.19	0.40	0	1

	the route				
CO	=1 if Continental Airlines operates on the route	0.15	0.35	0	1
DL	=1 if Delta Air Lines operates on the route	0.30	0.46	0	1
NW	=1 if Northwest Airlines operates on the route	0.23	0.42	0	1
Dom_k	Set of legacy carrier dominance level at the origin airport on the route, including the following five				
Dom_{UA}	United Airlines' share of direct departing flights at the origin airport on the route	0.07	0.11	0	0.53
Dom_{US}	US Airways' share of direct departing flights at the origin airport on the route	0.07	0.14	0	0.84
Dom_{CO}	Continental Airlines' share of direct departing flights at the origin airport on the route	0.05	0.11	0	0.61
Dom_{DL}	Delta Air Lines' share of direct departing flights at the origin airport on the route	0.10	0.13	0	0.58
Dom_{NW}	Northwest Airlines' share of direct departing flights at the origin airport on the route	0.08	0.15	0	0.76
$Partnership_k$	Set of frequent-flyer program partnership dummies, including the following five				
$Partnership_{UA}$ $Partnership_{US}$	=1 if UA/US FFP partnership is in place	0.63	0.48	0	1
$Partnership_{CO}$ $Partnership_{DL}$ $Partnership_{NW}$	=1 if CO/DL/NW FFP partnership is in place	0.45	0.50	0	1
OrigPass	Total number of passengers departed from the origin airport on a route	3,007,041	2,435,638	5,875	10,582,507
ln(*OrigPass*)	Natural log of *OrigPass*	14.48	1.13	8.68	16.17
DestPass	Total number of passengers departed from the destination airport on a route	3,015,758	2,429,063	5,875	10,582,507
ln(*DestPass*)	Natural log of *DestPass*	14.49	1.12	8.68	16.17

Notes: 1. Sample is limited to the routes on which at least one of the five legacy carriers provides a direct flight service; 2. Observations are on route-quarter level, from 2002q1 to 2004q3; 3. Number of observations=17,948.

Table 3 Variables for the sample estimating the effect on LCCs' ticket fare

Variable	Definition	Mean	SD	Min	Max
MeanFare	Passenger-weighted mean one-way fare paid for LCC tickets, in 2002 dollars	124.41	36.26	36.27	287.16
ln(*MeanFare*)	Natural log of *MeanFare*	4.78	0.31	3.59	5.66
80 *percentFare*	Passenger-weighted 80th percentile one-way fare paid for LCC tickets, in 2002 dollars	162.14	54.77	34.22	462
ln(80 *percentFare*)	Natural log of 80 *percentFare*	5.03	0.34	3.53	6.14
20 *percentFare*	Passenger-weighted 20th percentile one-way fare paid for LCC tickets, in 2002 dollars	89.01	25.52	25.42	256
ln(20 *percentFare*)	Natural log of 20 *percentFare*	4.44	0.31	3.24	5.55
k	Set of legacy carrier operating dummies, including the following five				
UA	=1 if United Airlines operates on the route	0.07	0.26	0	1
US	=1 if US Airways operates on the route	0.03	0.16	0	1
CO	=1 if Continental Airlines operates on the route	0.01	0.10	0	1
DL	=1 if Delta Air Lines operates on the route	0.11	0.31	0	1
NW	=1 if Northwest Airlines operates on the route	0.04	0.19	0	1
Dom_k	Set of legacy carrier dominance level at the origin airport on the route, including the following five				
Dom_{UA}	United Airlines' share of direct departing flights at the origin airport on the route	0.05	0.07	0	0.53
Dom_{US}	US Airways' share of direct departing flights at the origin airport on the route	0.03	0.06	0	0.68
Dom_{CO}	Continental Airlines' share of direct departing flights at the origin airport on the route	0.03	0.03	0	0.56
Dom_{DL}	Delta Air Lines' share of direct departing flights at the origin airport on the route	0.08	0.10	0	0.58
Dom_{NW}	Northwest Airlines' share of direct departing flights at the	0.04	0.07	0	0.60

	origin airport on the route				
$Partnership_k$	Set of frequent-flyer program partnership dummies, including the following five				
$Partnership_{UA}$ $Partnership_{US}$	=1 if UA/US FFP partnership is in place	0.65	0.48	0	1
$Partnership_{CO}$ $Partnership_{DL}$ $Partnership_{NW}$	=1 if CO/DL/NW FFP partnership is in place	0.47	0.50	0	1
OrigPass	Total number of passengers departed from the origin airport on a route	2,138,911	2,008,531	28,913	10,582,507
ln(*OrigPass*)	Natural log of *OrigPass*	14.12	1.04	10.27	16.17
DestPass	Total number of passengers departed from the destination airport on a route	2,136,125	2,008,221	28,913	10,582,507
ln(*DestPass*)	Natural log of *DestPass*	14.12	1.04	10.27	16.17

Notes: 1. Sample is limited to the routes on which at least one of the five LCCs provides a direct flight service; 2. Observations are on airline-route-quarter level, from 2002q1 to 2004q3; 3. Number of observations=15,011.

Table 4 The entry deterrence effect

	Entry measurement					
	P(FL=1)	P(F9=1)	P(NK=1)	P(B6=1)	P(WN=1)	*numLCC*
UA· Dom_{UA}	.034	-.111***	.033	-.004	.013	-.035
	(.045)	(.039)	(.026)	(.020)	(.033)	(.073)
UA· Dom_{UA} · $Partnership_{UA}$	.008	.018	.030***	-.006	-.025*	.025
	(.019)	(.017)	(.011)	(.009)	(.014)	(.031)
US· Dom_{US}	.087***	.019	.016	.006	.031*	.159***
	(.022)	(.019)	(.013)	(.010)	(.016)	(.036)
US· Dom_{US} · $Partnership_{US}$	.086***	.010	.010	-.004	.052***	.153***
	(.019)	(.016)	(.011)	(.008)	(.014)	(.030)
CO· Dom_{CO}	.027	.010	.017	.010	.019	.082
	(.062)	(.054)	(.036)	(.028)	(.045)	(.101)
CO· Dom_{CO} · $Partnership_{CO}$	-.009	-.001	.001	-.011	-.020*	-.041
	(.016)	(.014)	(.010)	(.007)	(.012)	(.027)
DL· Dom_{DL}	.074**	.032	.038**	-.022*	.013	.135***
	(.030)	(.026)	(.017)	(.014)	(.022)	(.049)
DL· Dom_{DL} · $Partnership_{DL}$	.020	-.005	-.001	.007	-.023**	-.002
	(.012)	(.011)	(.007)	(.005)	(.009)	(.020)
NW· Dom_{NW}	.092	.066	.021	.014	.107**	.299***
	(.058)	(.051)	(.034)	(.026)	(.043)	(.095)
NW· Dom_{NW} · $Partnership_{NW}$	.002	.002	.007	-.010**	.019**	.020
	(.011)	(.010)	(.007)	(.005)	(.008)	(.018)
ln(*OrigPass*)	.020**	.000	.011**	.006*	.010*	.048***
	(.008)	(.007)	(.005)	(.004)	(.006)	(.013)
ln(*DestPass*)	.021***	.003	.010**	.008**	.004	.044***
	(.008)	(.003)	(.004)	(.003)	(.006)	(.013)
Observations	17,948	17,948	17,948	17,948	17,948	17,948
R^2	0.86	0.86	0.91	0.88	0.93	0.89

Notes: 1. Sample is limited to the routes on which at least one of the five legacy carriers provides a direct flight service; 2. Observations are on route-quarter level, from 2002q1 to 2004q3; 3. All regressions include route and quarter fixed effects; 4. Standard errors are in parentheses; 5. * significant at 10% level, **significant at 5% level, *** significant at 1% level.

Table 5 The effect on LCCs' ticket fare

	Ticket fare measurement		
	$\ln(MeanFare)$	$\ln(80\,percentFare)$	$\ln(20\,percentFare)$
UA· Dom_{UA}	-.122**	-.122	-.157**
	(.051)	(.077)	(.077)
UA· $Dom_{UA}\cdot Partnership_{UA}$	-.065**	-.127***	.067
	(.028)	(.042)	(.042)
US· Dom_{US}	-.052	-.032	-.003
	(.045)	(.068)	(.069)
US· $Dom_{US}\cdot Partnership_{US}$	-.065	-.058	-.010
	(.048)	(.072)	(.072)
CO· Dom_{CO}	-.828*	-.993	-.682
	(.441)	(.666)	(.667)
CO· $Dom_{CO}\cdot Partnership_{CO}$	.050	.077	.048
	(.095)	(.144)	(.144)
DL· Dom_{DL}	-.058**	-.057	-.071*
	(.024)	(.037)	(.037)
DL· $Dom_{DL}\cdot Partnership_{DL}$	-.036**	-.060**	.032
	(.017)	(.026)	(.026)
NW· Dom_{NW}	-.171**	-.278**	-.206*
	(.072)	(.108)	(.108)
NW· $Dom_{NW}\cdot Partnership_{NW}$	-.043**	-.017	-.050*
	(.019)	(.030)	(.030)
$\ln(OrigPass)$	.057***	.055***	.066***
	(.007)	(.011)	(.011)
$\ln(DestPass)$	.039***	.032***	.057***
	(.007)	(.011)	(.011)
Observations	15,011	15,011	15,011
R^2	0.95	0.91	0.90

Notes: 1. Sample is limited to the routes on which at least one of the five LCCs provides a direct flight service; 2. Observations are on airline-route-quarter level, from 2002q1 to 2004q3; 3. All regressions include airline-route and airline-quarter fixed effects; 4. Standard errors are in parentheses; 5. * significant at 10% level, **significant at 5% level, *** significant at 1% level.